

# **Amateur Radio Data Networking in Event/Incident Communications**

SPECS Annual Meeting

Jan 31, 2015

Revised: 31-Jan-2015

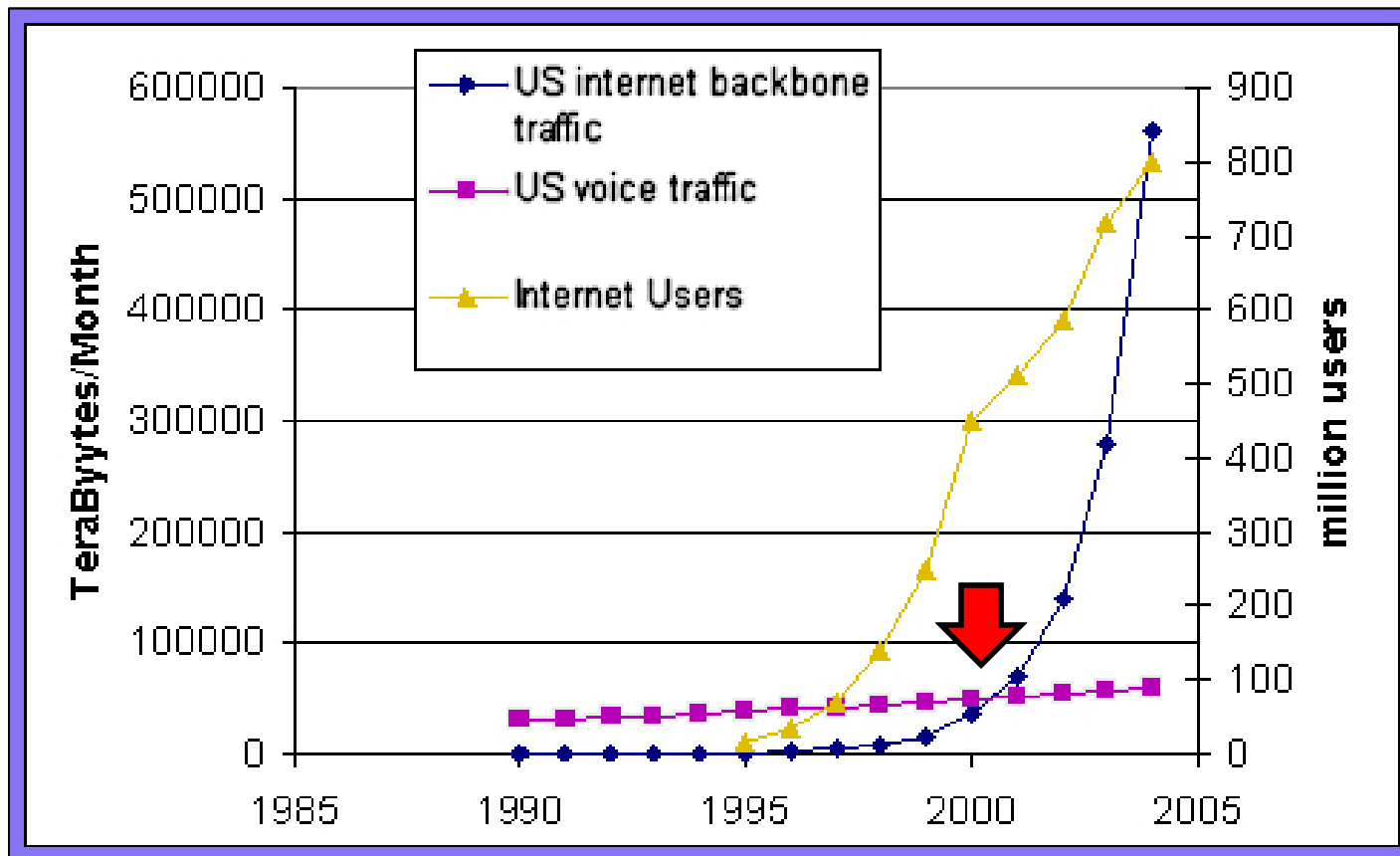
# Why Do We Care About Data Networking?

- 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

Year	Fixed Tel Line	Mobile Line	Internet User	Source
2005	59%	68%	68%	ITU
2006	56%	76%	69%	ITU
2007	52%	83%	75%	ITU
2008	53%	85%	74%	ITU
2009	49%	89%	71%	ITU
2010	48%	91%	72%	ITU
2011	46%	94%	70%	ITU
2012	43%	96%	79%	ITU
2013	42%	96%	84%	ITU
2014			87%	PEW

# Mobile Lines Are Not Just For Voice ...

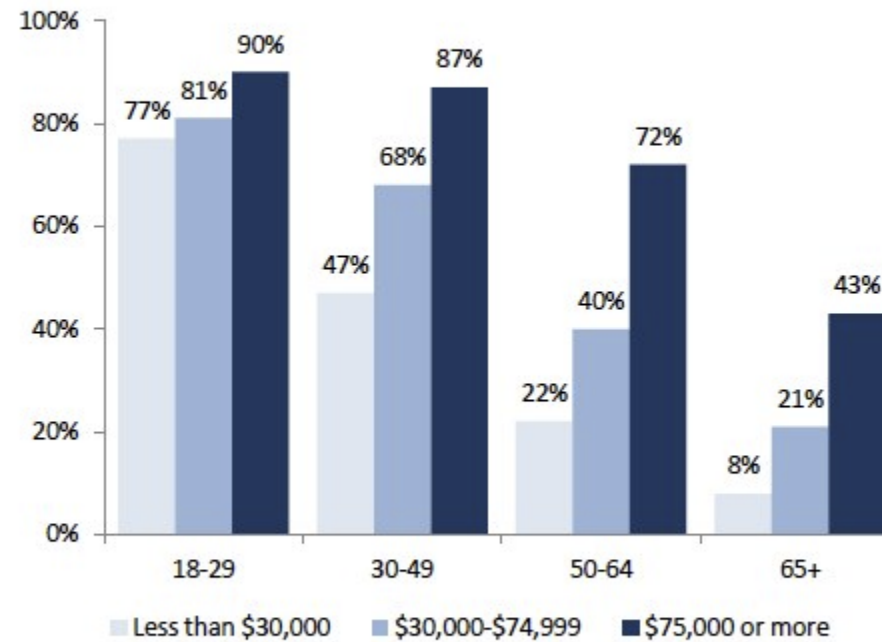


- 4G LTE mobile data communications
- Multi-Mbps up/download
- Personal WiFi hotspot

# Now, > 60% of U.S. Adults Have Smart Phones

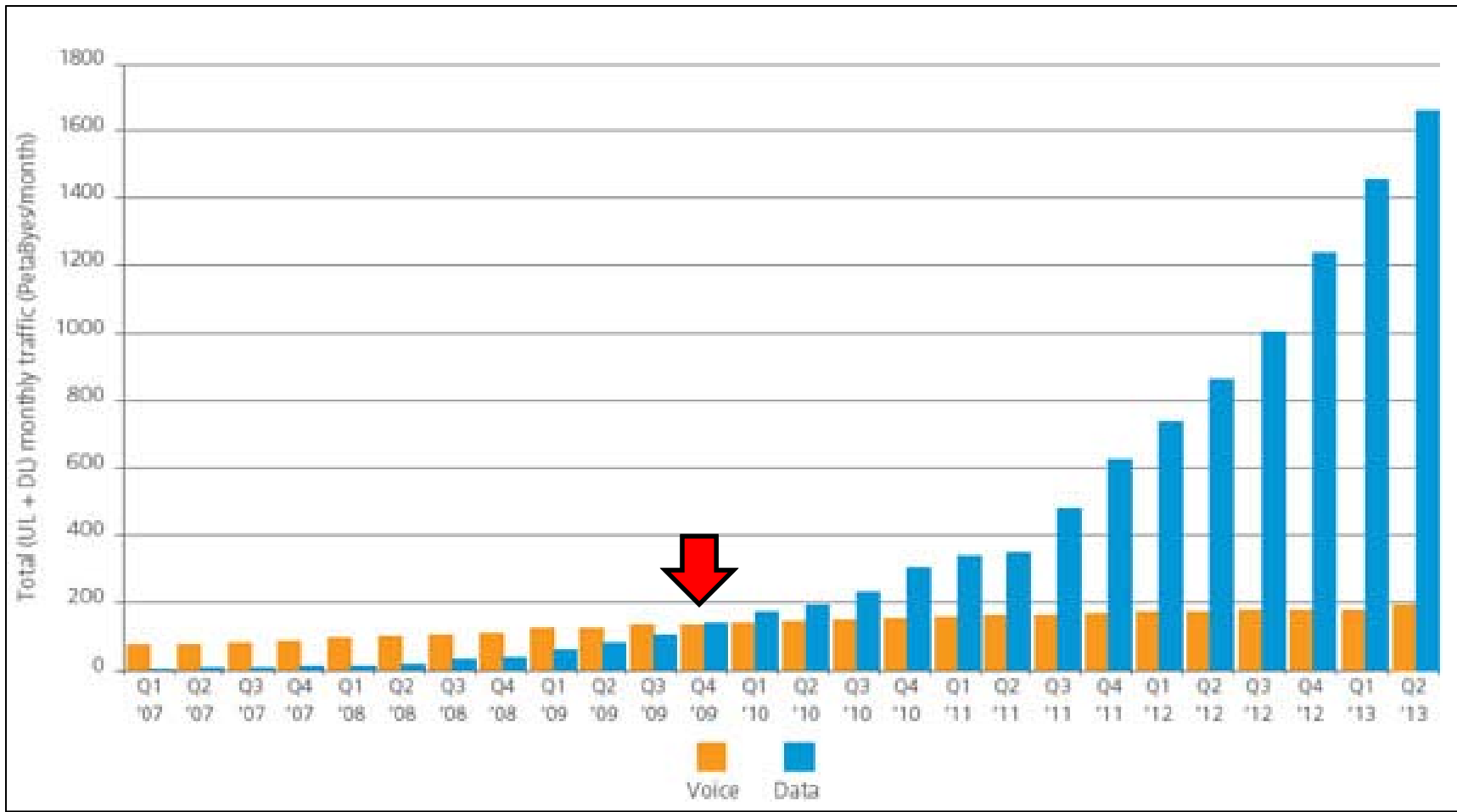
## Smartphone ownership by income/age grouping

% within each age/income grouping who own a smartphone (example: 77% of 18-29 year olds with an annual household income of less than \$30,000 are smartphone owners)



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.

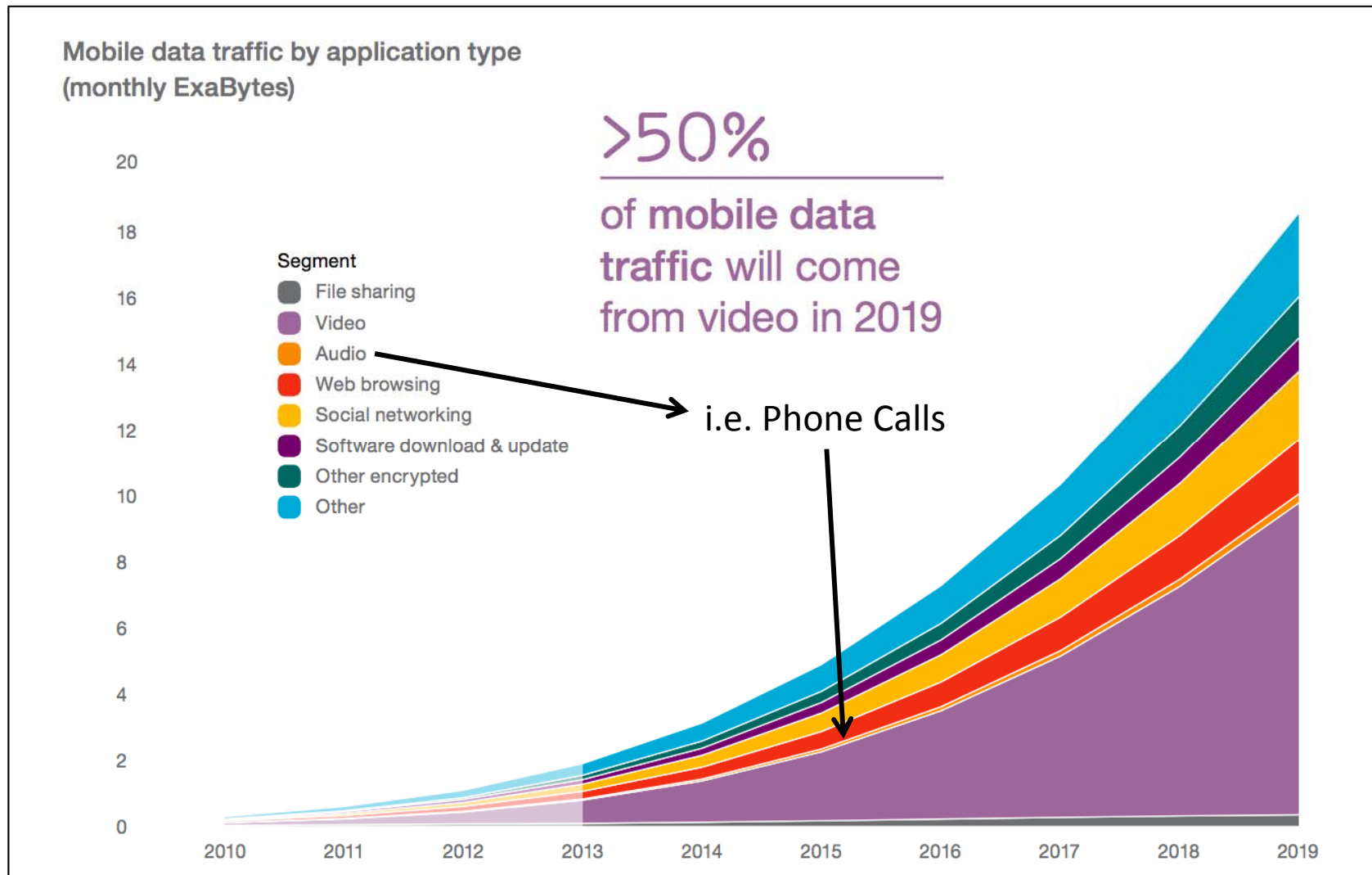
# Mobile Data Surpassed Voice in 2009



Source: Akamai & Ericsson



# And Data Applications Continue to Grow



# 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 to 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



CERT - DAMAGE ASSESSMENT FORM																						
DATE: 5/15/11		EVENT: Citywide Exercise					PERSON RECORDING / ID#:					PAGE #: 1 of 1										
Incident #	Reported	Priority	BURNING	OUT	GAS LEAK	H2O LEAK	ELECTRIC	CHEMICAL	LIGHT	MODERATE	HEAVY	IMMEDIATE **	DELATED	TRAPPED	DEAD	ACCESS	NO ACCESS	OTHER	ASSIGNED	COMPLETED	COMMENTS	
#	TIME	By	LOCATION	FIRE	HAZARD	BUILDING Damage	PEOPLE	ROAD	X													
1	1301	2	1	325 Paw	1	0	0	0	0	0	1	6	18	0	2							
2	1303	6	1	25W Dana		0	1	0	0	0	1	8	20	60	3	0	1					Apartment wing collapsed
3	1304	9	2	125 Church		0	1	0	0	0	1					0	1					Tree across Church
4	1305	4	1	135 Mercy	1	0	1	0	1	0	0	1	4	9	0	2	1	0				Powerline down
5	1307	8	1	152 Bush	1	0				0	0	1	2	3	10	0	1					Thick smoke
6	1309	6	1	272 Bush	1	0	1	0	0	0	0	1	1	4	9	1	0	1				
7	1310	4	1	372 Bryant		0	1	0	0	0	1	0	2	6	11	2	1	0				Chimney fell
8	1311	3	1	631 Oak	1	0	1	0	0	0	0	1	0	1	2	5	1	1	0			
9	1313	9	1	238 Villa						0	0	3	0	2	2	0						3 Townhouses down
10	1315	1		118 Eblora	1	0	1	0	0	0	1	0	2	3	6	0	1	0				
1320				Totals	6	0	5	3	1	0	0	4	8	26	67	103	11	5	3			20%

Radio Priority 1 - Life Threatening or growing, and Priority 2 - Property/Fire incidents immediately as you find them. \*\* Immediate Medical = life threatening; others are delayed/minor. Use "?" for Unknown. Put an "X" in the OTHER column for descriptions that don't fit elsewhere.

# Field Data Station



Wes Freeman, KG6POV

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# Amateur Radio Application: PacFORMS

ARES/RACES MESSAGE FORM - Mozilla Firefox

file:///C:/RVM/CERT - MTW/Drill 10-22-11/CERT-DA-Install/CERT-DA-MTWUniversal-message.html

(This form works with Outpost/OpDirect for Automatic ASCII text save)  
 For Instructions using this form [Click Here.](#)

<b>1a.) Date: (MM/DD/YY)</b> <input type="text" value="05/15/11"/>	<b>4.) Situation Severity (Select One)</b> <input type="radio"/> EMERGENCY <small>(e.g., Life Threat)</small> <input type="radio"/> URGENT <small>(e.g., Property Threat)</small> <input checked="" type="radio"/> OTHER <small>(All Others)</small>	<b>5.) Msg. Handling Order (Select One)</b> <input type="radio"/> IMMEDIATE <small>(As Soon as Possible)</small> <input checked="" type="radio"/> PRIORITY <small>(Less Than One Hour)</small> <input type="radio"/> ROUTINE <small>(More Than One Hour)</small>	<b>6.) Message Requests You to:</b> <b>TAKE ACTION (Check one)</b> <input type="radio"/> Yes <input checked="" type="radio"/> No <b>REPLY (Check one)</b> <input type="radio"/> Yes, by <input type="text"/> <input checked="" type="radio"/> No <input checked="" type="checkbox"/> FOR YOUR INFO. <small>(No action required)</small>
<b>1b.) Time: (24 hr time)</b> <input type="text" value="1320"/> <small>0001 to 2400          2:00 PM = (2+12)=1400 Hrs.</small>			

<b>7.) ICS Position: (required)</b> <input type="button" value="Display Dropdown List"/> <input type="text" value="Planning"/>	<b>8.) ICS Position: (required)</b> <input type="button" value="Display Dropdown List"/> <input type="text" value="Planning"/>
<b>9a.) Location: (required)</b> <input type="text" value="Mountain View EOC"/>	<b>9b.) Location: (required)</b> <input type="button" value="Display CERT List"/> <input type="text" value="Old Mtn. View CERT"/>
<b>Name: (optional)</b> <input type="text"/>	<b>Name: (optional)</b> <input type="text"/>
<b>Telephone #: (optional)</b> <input type="text"/>	<b>Telephone #: (optional)</b> <input type="text"/>

**10.) SUBJECT:**

**11.) REFERENCE (e.g., Number of earlier msg.):**

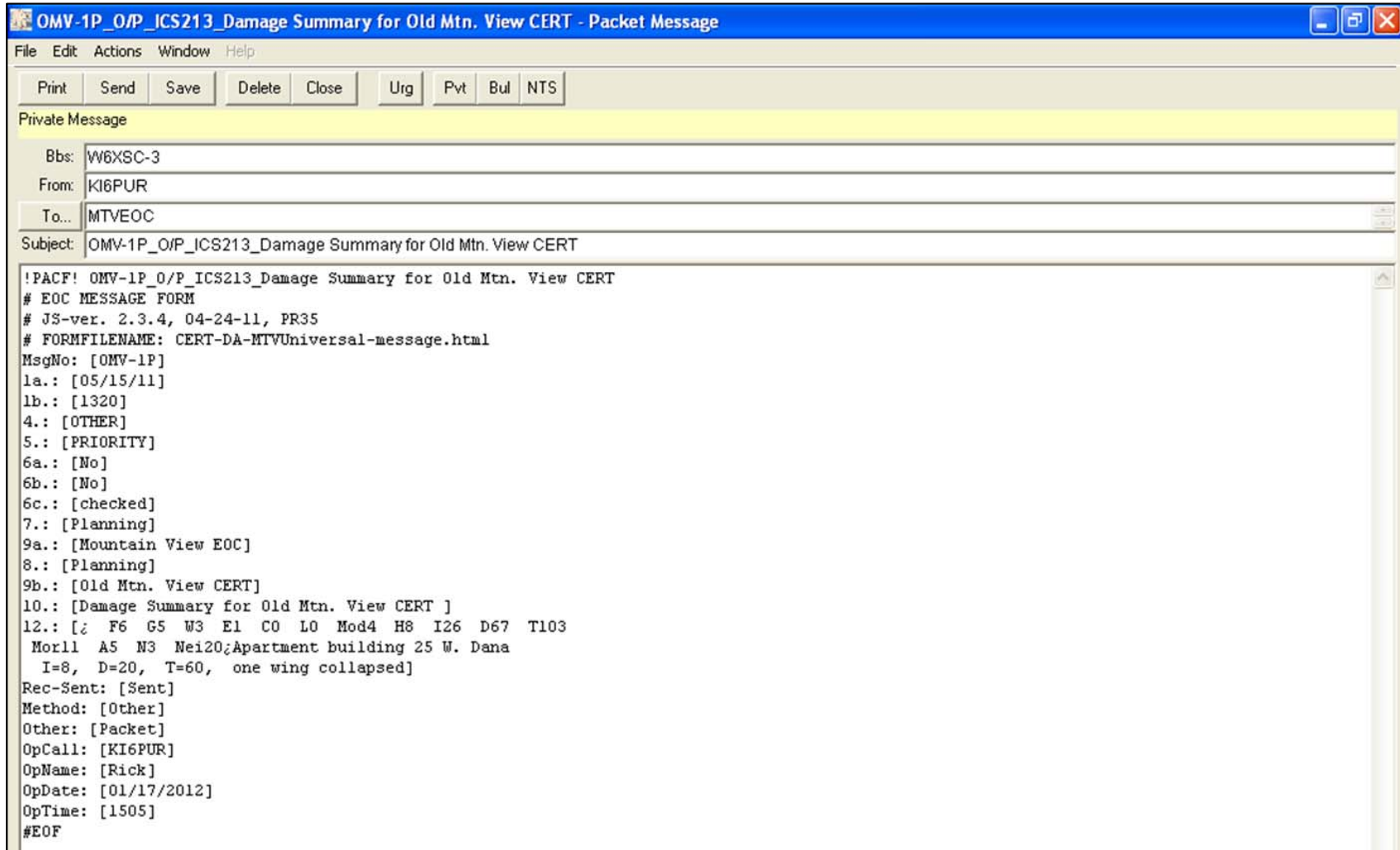
Fill in the blanks with your current Damage Assessment column TOTALS.

Fire & Hazzard					Building			People				Roads		Neighborhood
Fires	Gas Leak	Water Leak	Electrical	Chemical	Light	Mod	Heavy	Immediate	Delayed	Trapped	Morgue	Access	No access	% surveyed
6	5	3	1	0	0	4	8	26	67	103	11	5	3	20

**12.) Message (what, when, where needed; how long; contact name and phone number) KEEP MSG BRIEF**  
 Optional: Enter top 1-3 incidents with locations and situation details.

**13.) Action Taken: (For use by Originator / Recipient) -> USE SEPARATE MESSAGE FORM IF SENDING REPLY!**

# Amateur Radio Application: Outpost




# Amateur Radio Application: MTV DA Summary

DA Summary
\_ □ ×

File Settings Help

	Fires Burning	Gas Leaks	Water Leaks	Electrical	Chemical	Light	Building Moderate	Heavy	Immediate	People Delayed	Trapped	Morgue	Roads Access	No Access	Neighborhood % Surveyed	Report Time
<b>TOTALS:</b>	8	7	6	2	0	11	7	10	27	68	105	11	5	3	2 %	1320
Ada Park	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Appletree Area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
The Crossings	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cuesta Park	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dutch Haven	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Monta Loma	-	2	3	1	-	7	1	-	-	1	-	-	-	-	10 %	1319
Mountain View Gardens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
North Whisman	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Old Mtn. View	6	5	3	1	0	0	4	8	26	67	103	11	5	3	20 %	1320
Rex Manor	2	-	-	-	-	4	2	2	1	-	2	-	-	-	-	1312
Saint Francis Acres	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shady Ridge	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sylvan Park	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wagon Wheel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-


Projected onto a screen in the Mountain View EOC



C:\...packetCommLog\_101111\_Recvd.csv 01-Jun-2011 01::

Monitor is On

New Information: Click to reset

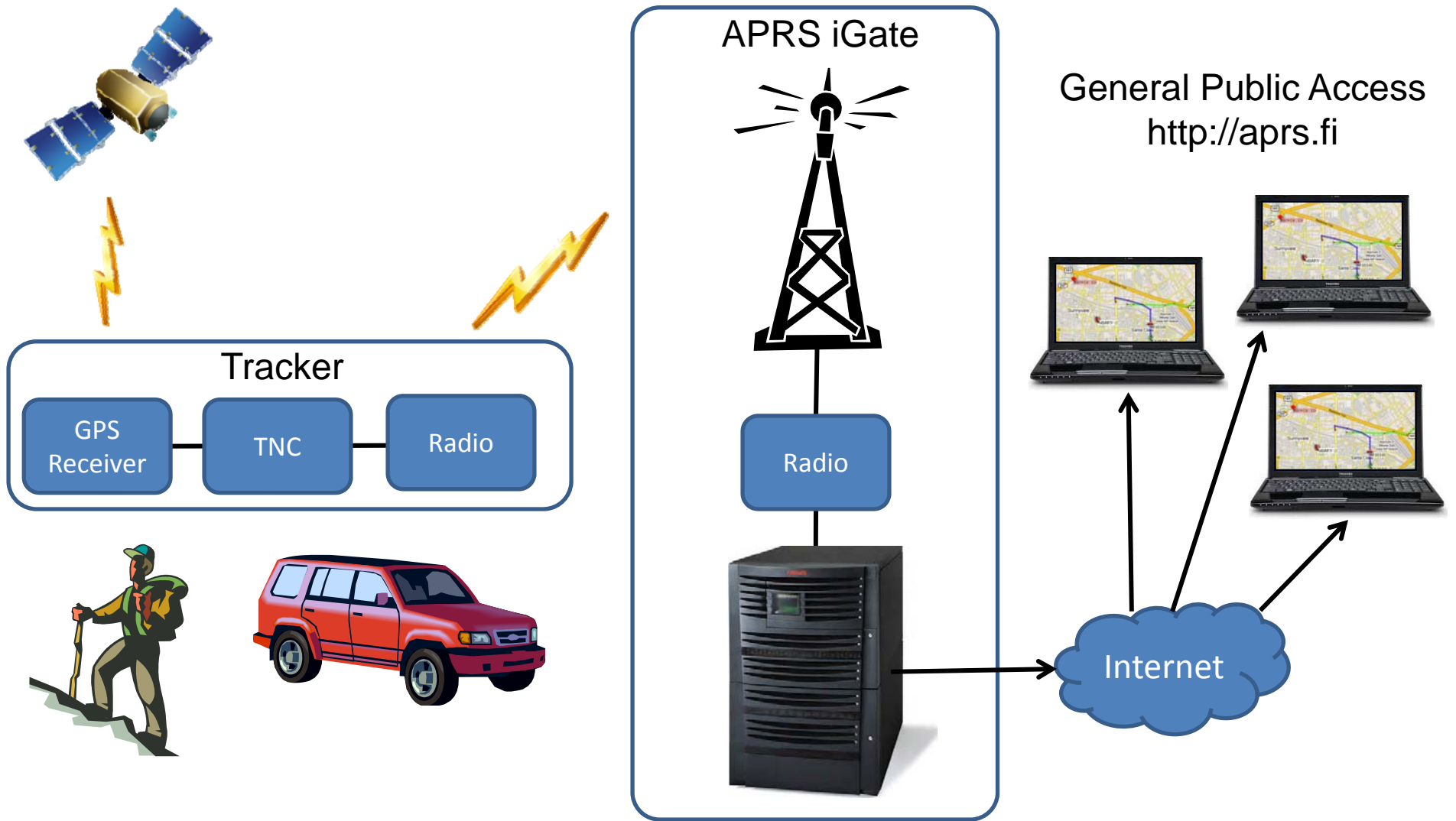


Examples: Bike Race; Los Altos Festival of Lights Parade

# **NARROWBAND DATA**

# **MOBILE ASSET TRACKING**

# Typical APRS Connectivity to the Internet



# 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 ...



Kenwood  
TH-D72



Yaesu  
VX-8DR



Byonics  
Micro-Track AIO



Kenwood  
TM-D710G



Byonics  
Micro-Track RTG



# Portable APRS Tracking Solution for Events

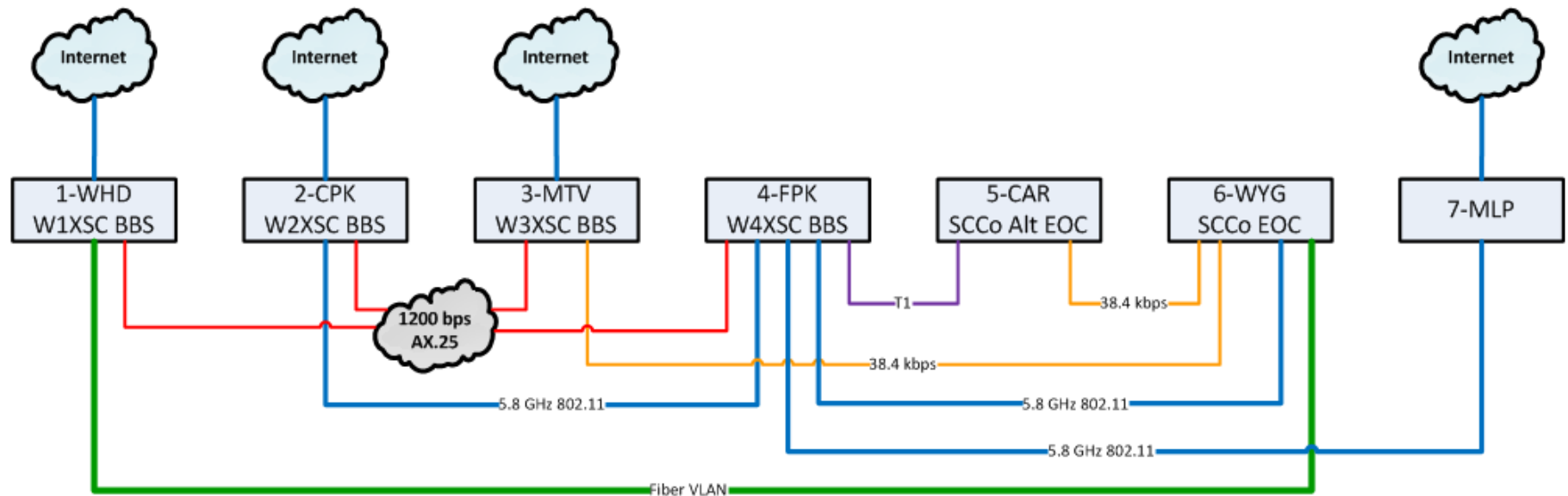


# **FASTER NARROWBAND DATA 56KBPS – 100KBPS RADIO**

# 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



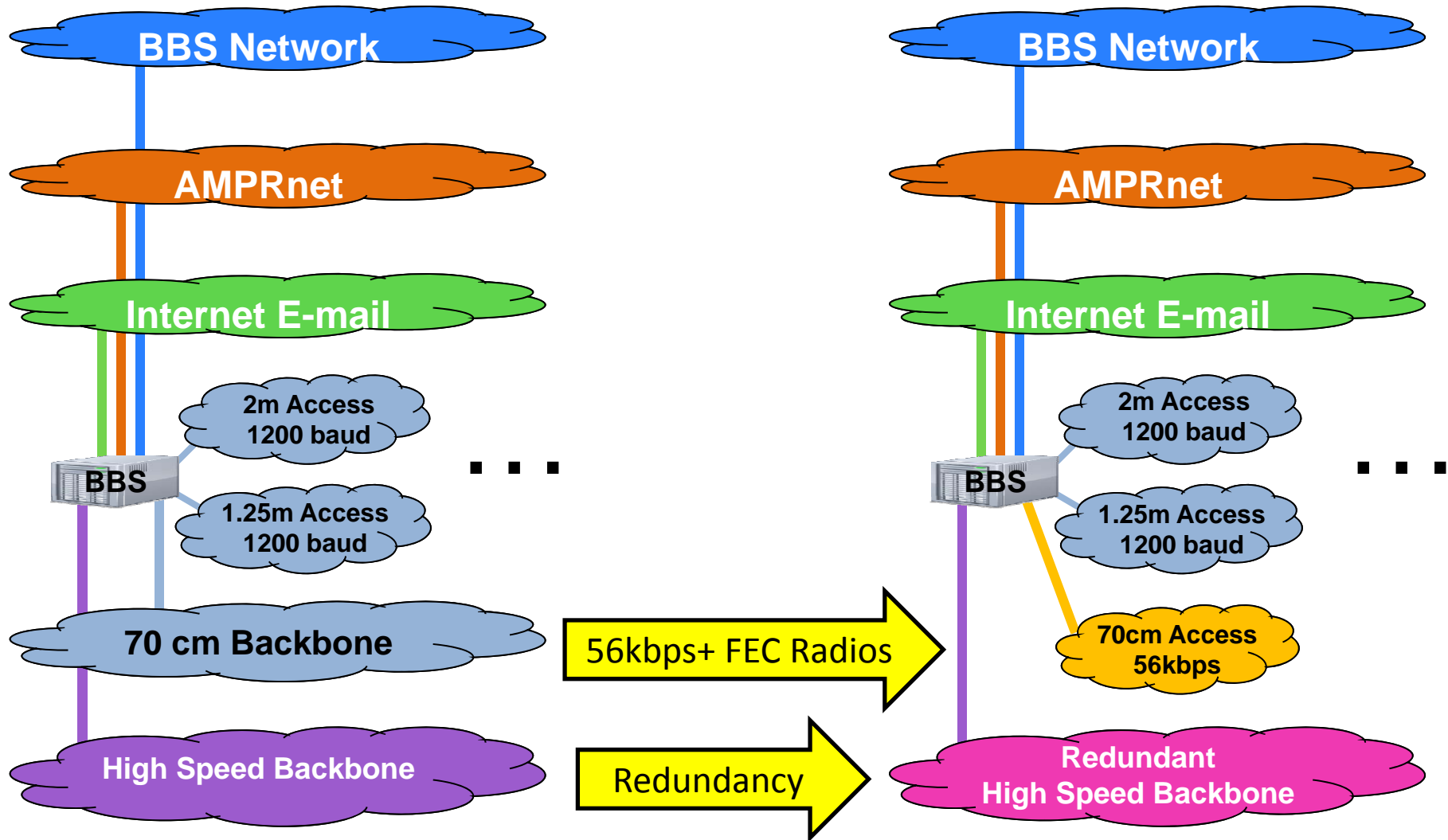
Legend:

- 100+ Mbps
- 10+ Mbps
- 1+ Mbps
- 10+ kbps
- 1+ kbps

Next steps:

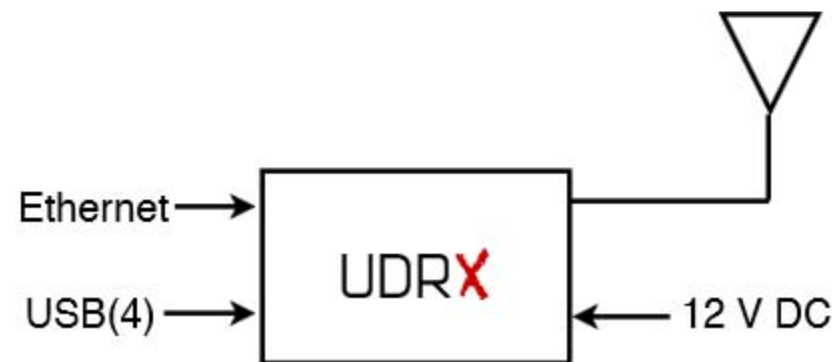
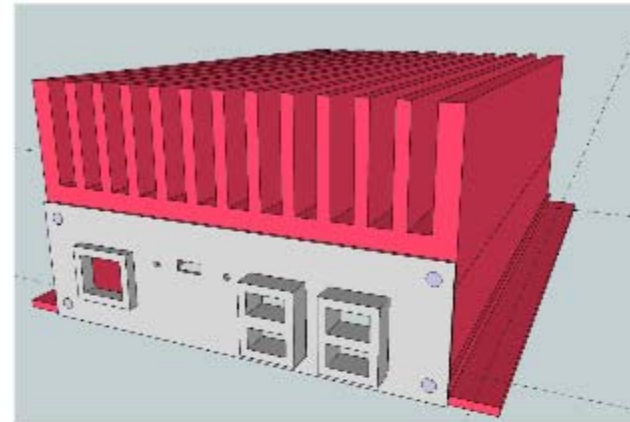
1. Move to high speed backbone as main BBS-to-BBS transport; 70cm network as backup
2. Add links to high-speed backbone to become fully redundant; 70cm can be repurposed

# High Speed 440 Access in the Future?



# Example: NW Digital Radio UDRX-440

- 25W, 70 cm Transceiver
- Linux platform
- Browser interface
- 1 Ethernet
- 4 USB

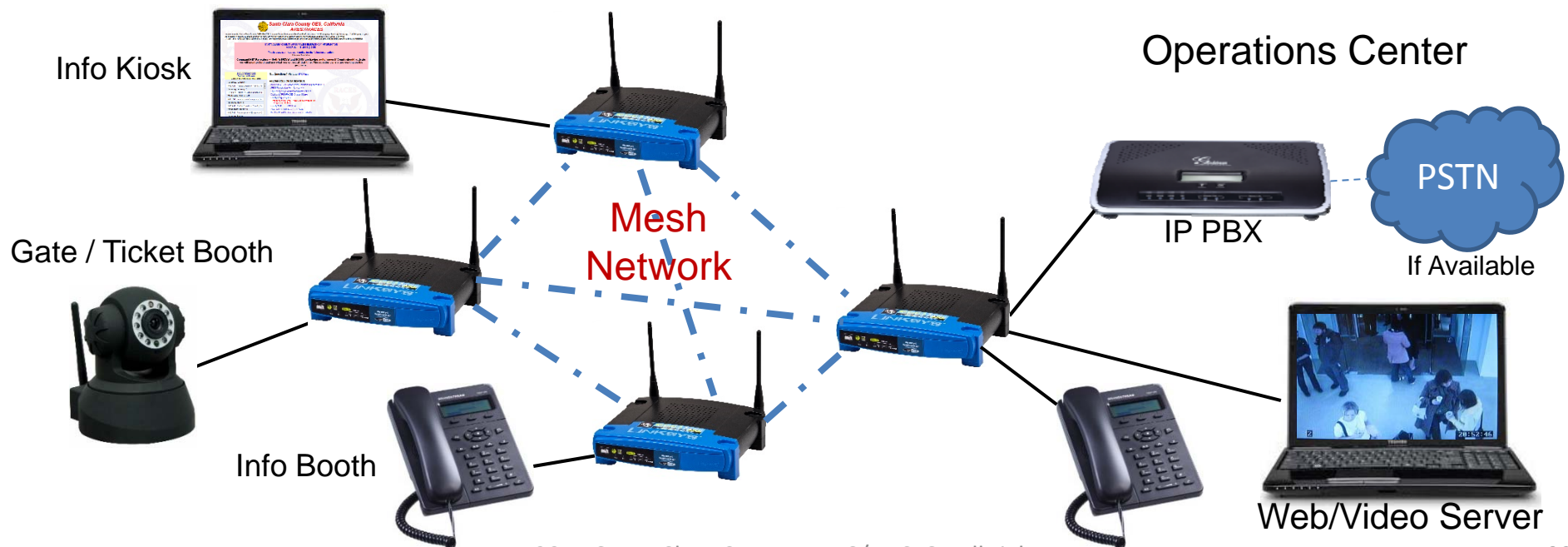


Example: Art & Wine Festival; SCCo County-wide Drill

# **BROADBAND MESH EVENT CONNECTIVITY**

# Voice/Video Solution for Public Service Event

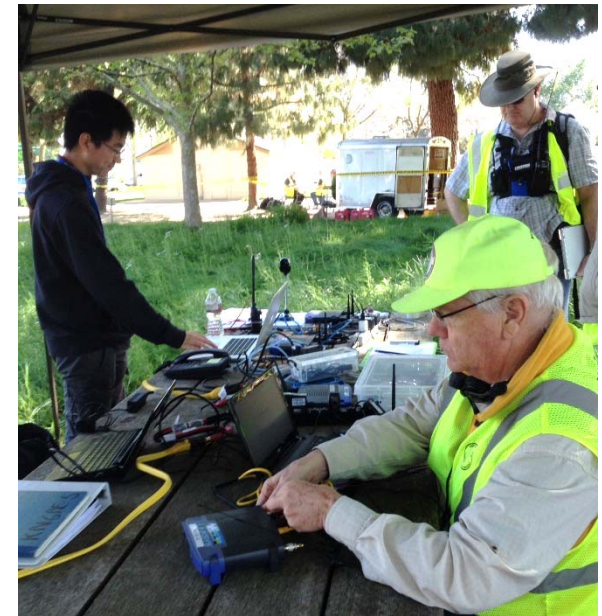
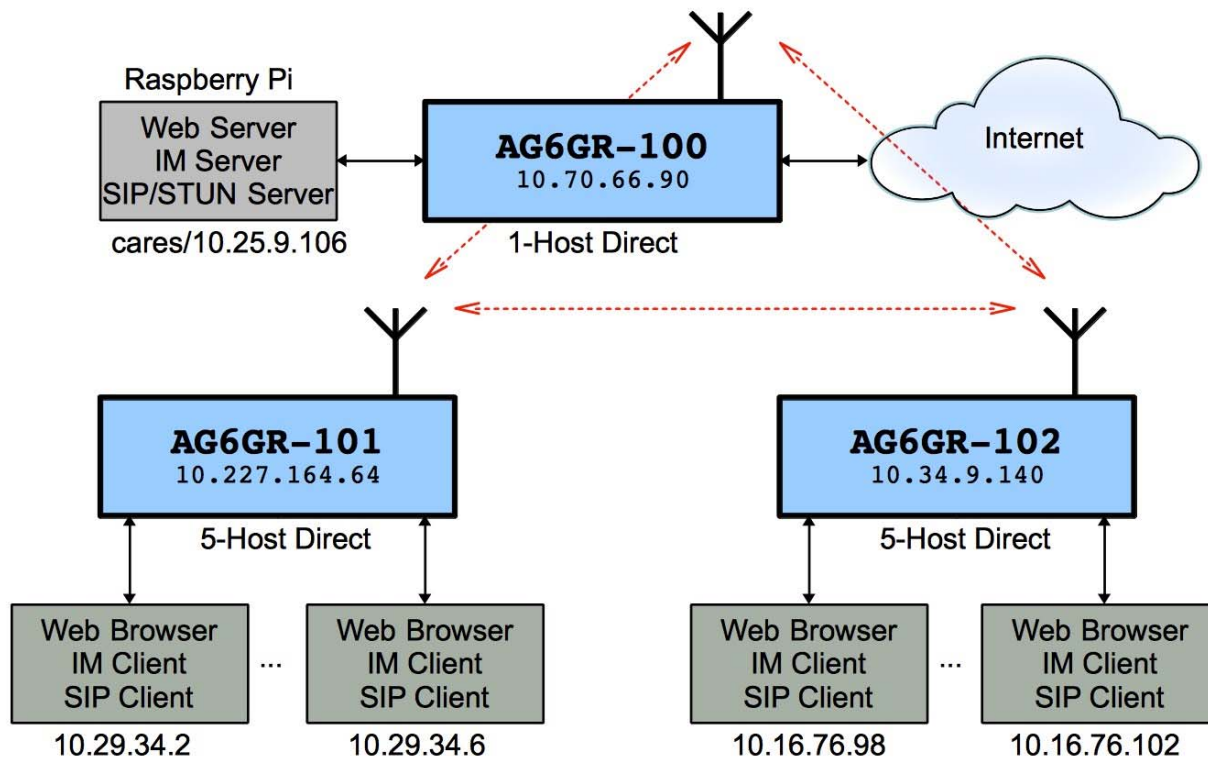
- Provide easy-to-use services to public and event workers
  - Info booths, start/finish line, press office, first aid station, ...
- Monitor conditions at entrance, start/finish line, ...
- Independent of commercial power or network





# Mesh Networking Experimentation

- 2014 SCCo ARES/RACES County-wide Exercise



Example: WB6ECE voted/simulcast system

# **BROADBAND VOIP REPEATER LINKING**

# Analog Voice Repeater Linking Options

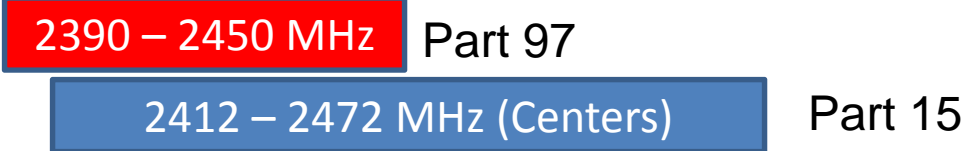
- Typical Analog Link




- 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 3<sup>rd</sup> party)
- Or, the same gear can be used under Part 15 rules (encryption, 3<sup>rd</sup> party, but lower power)

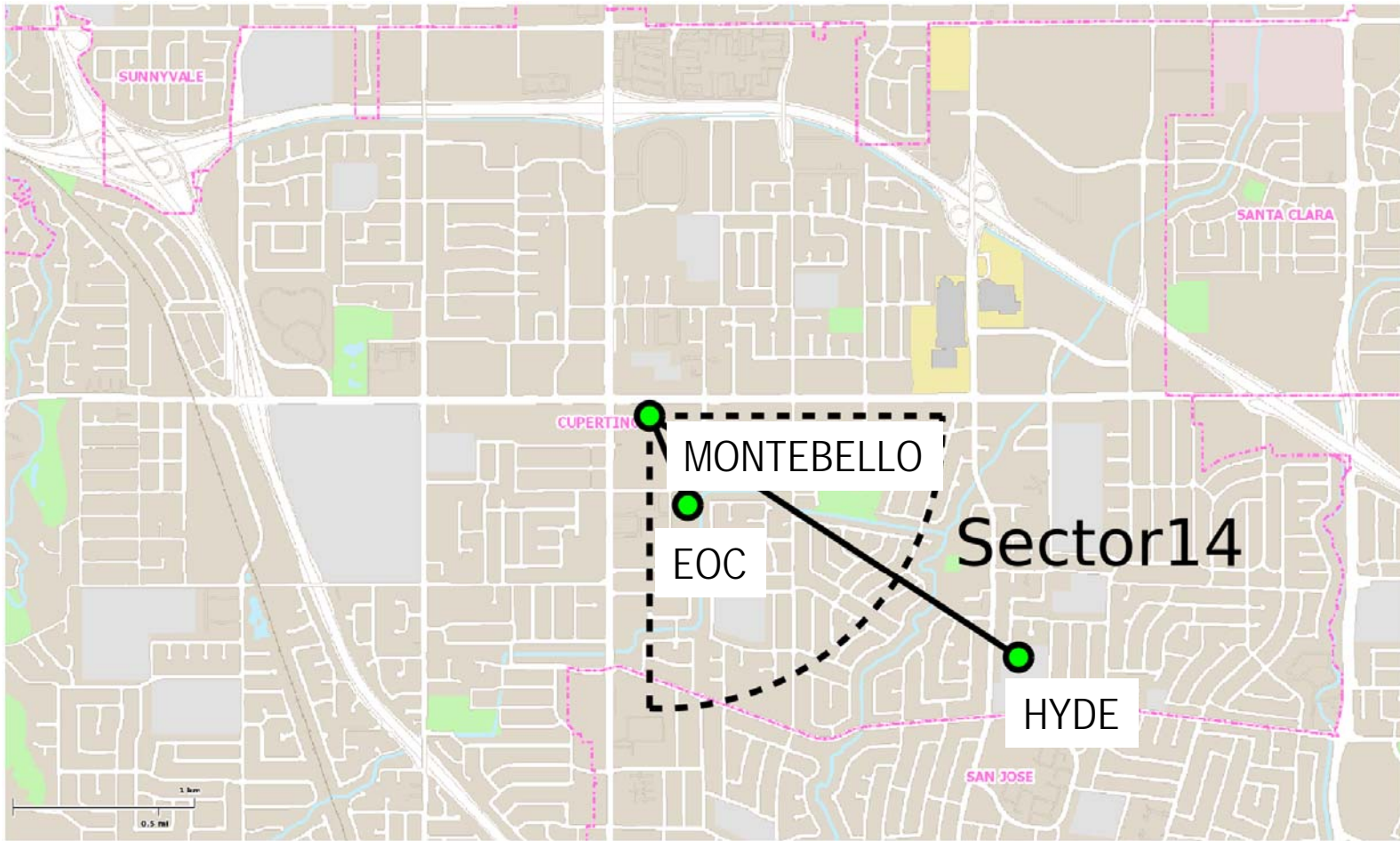
Example: Cupertino ARKnet

# **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



# Montebello Site

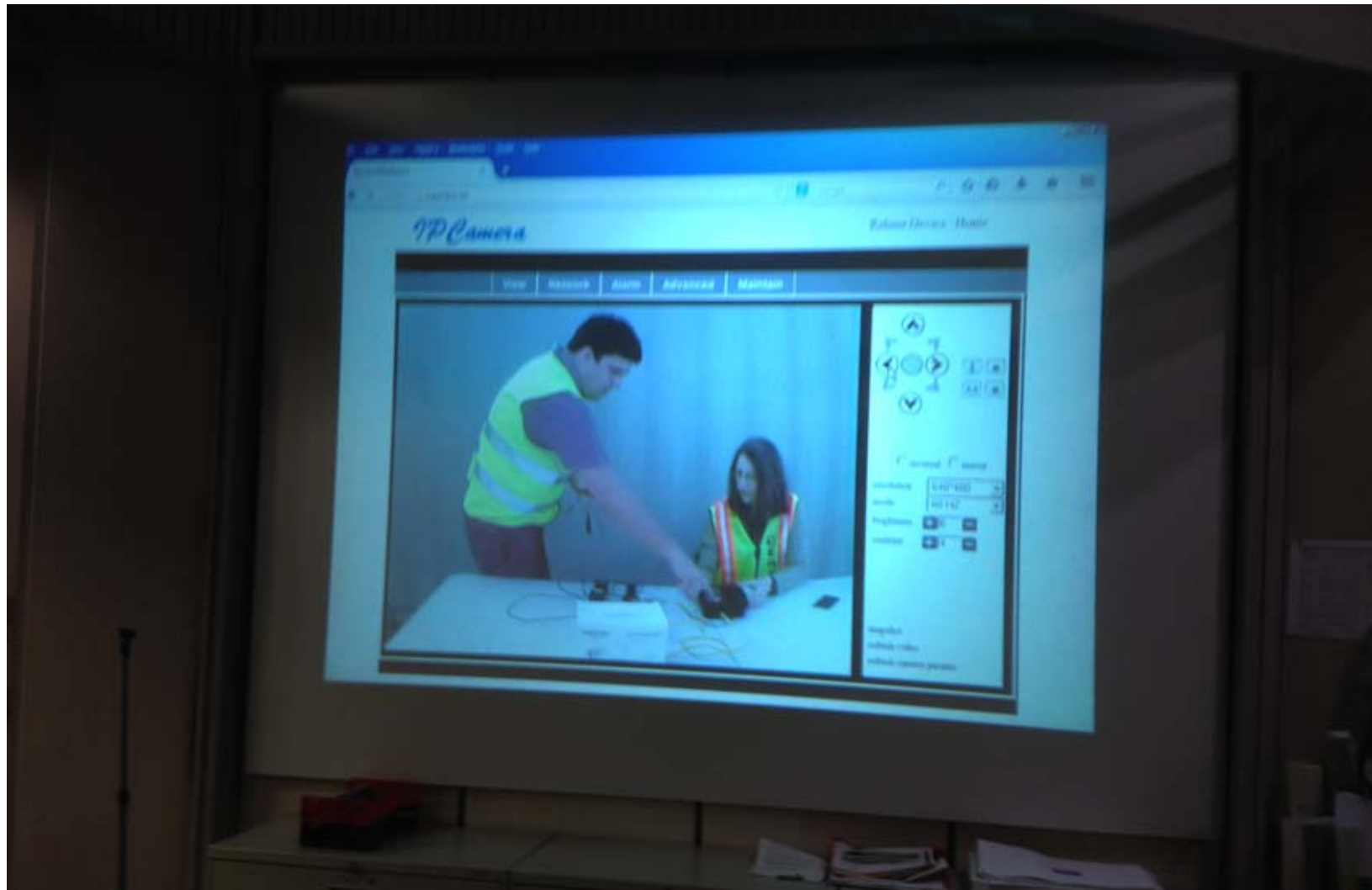


# Hyde ARK site

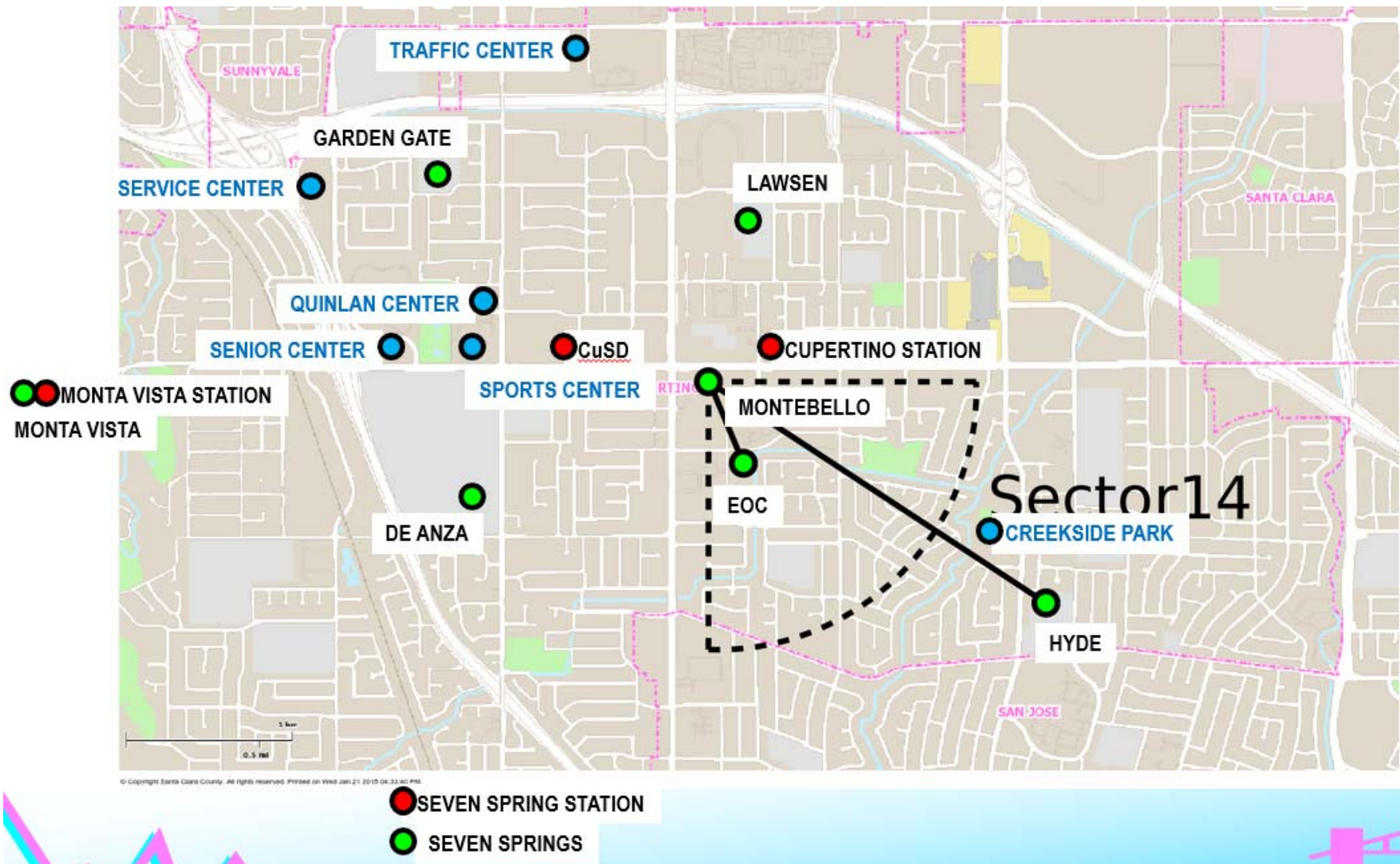




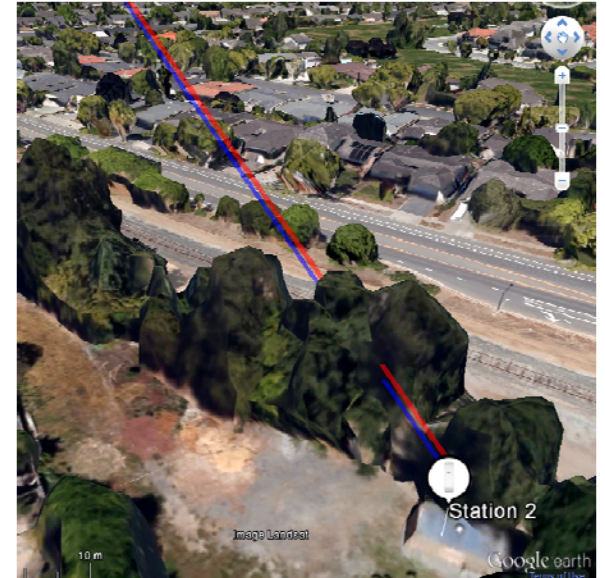
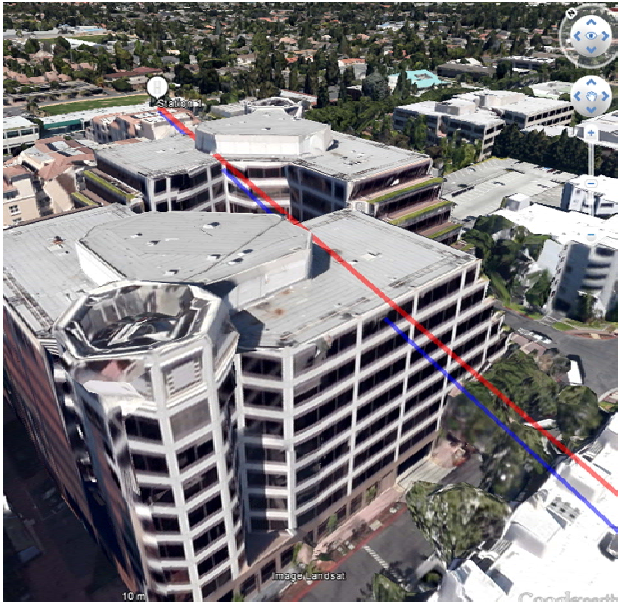
# Demo... live, from Hyde Ark!



# 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

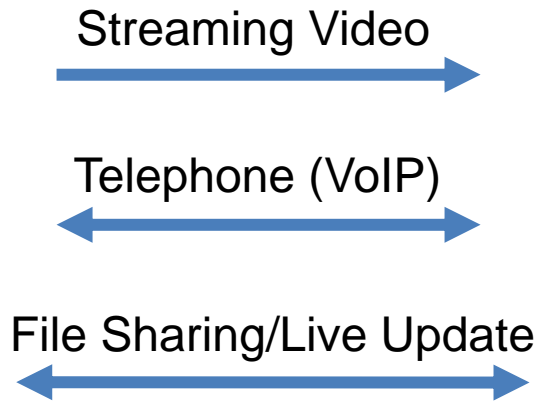
# Demo Diagram and Explanation

# ARKnet Demo

## ARK Location



## Demo Applications:



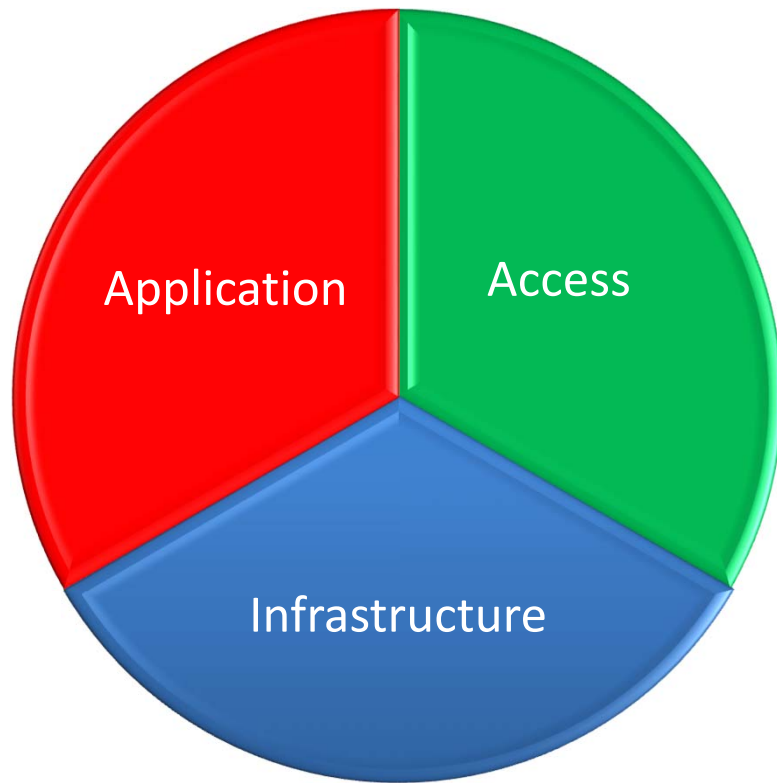
## Central Location



# 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