

Central Pennsylvania Amateur Radio Data Network

This wide area network was built by hams for hams and does not receive government support nor does it fall under the control of any government agency. Groups of amateur radio operators have voluntarily cooperated to form a wide area network. The network integrity and operational status is verified by daily utilization of its functions. This system is mostly regulated by Part 15 and as a result, we have expanded the available frequencies by using some of the Part 97 allocations in addition to Part 15 allocations. The Part 15 rules offer less oversight and allow more flexible operations. Most of the network is constructed in the 5.25 to 5.850 GHz range. The amateur band is 5.650 to 5.925 GHz. Inexpensive, mass produced equipment has made this possible as of January 2009. We are fortunate to be located away from the more populated urban centers where the spectrum is more congested. We also have multiple mountain top sites available that are 500 to 1700 feet above the service area.

The goal is to connect all the RACES rooms in the eight county Emergency Operation Centers and PEMA, to this network. By doing so, the following features can be utilized:

- Disaster and humanitarian communication without relying on public Internet, public phone system, cell phones, public safety radio, satellites, or traditional amateur radio voice/ data circuits.
- Throughput from end to end in excess of 30 Mbps.
- Centrally located email server capable of sending traditional email with large attachments. A traditional web browser, such as Internet Explorer is utilized to access the web-based email.
- A VoIP SIP server supports an Internet phone system. The phone is simply plugged into an Ethernet connection and is readily available from multiple vendors.
- An IP based camera with a multicast capability has been requested for the PEMA RACES room. This would allow any computer on the

network with Internet Explorer to view and listen to the signal from PEMA.

- Each county has at least one high-speed Internet connection. These can be utilized if needed and are functioning during a disaster. But if the disaster is serious or wide spread the likelihood that they will be available is reduced. Each user can access the Internet in any county.

VOAD (Volunteer Organizations Active in Disasters) in Central Pa have expressed interest in amateur radio data support. The throughput would permit additional users and the equipment cost is reasonable. The interested agencies include:

- Red Cross,
- Salvation Army,
- Episcopal Church shelters.

Prior to adding agencies, the network must prove that it will function properly with the grade of service required.

Multiple amateur radio operators are needed in each county to use the system on a daily basis to verify its operational status. This encourages innovation, development and testing of new ideas.

Multiple UHF amateur repeaters are being linked by the data network. Initially Harrisburg, York, Cornwall, and Newport will be tied together by a time division multiplex (TDM) system that utilizes up to 24 channels of audio. Access to this DS1 system is available throughout the entire data network. Additional linked UHF repeaters are planned at Lam's Gap and Reeser's Summit, south of Harrisburg. This system will provide portable grade coverage in each area.

Portable data connections are possible where an access point is available. The typical RF connection would be a transmitter attached to a two-foot grid dish on a ten foot pole. This portable connection can provide all the services that are available to fixed locations and more.

- A laptop computer would have access to email and video from any location in the system.
- A VoIP phone can give access to any VoIP phone in the system. An IP (Internet Protocol) camera can send video from the field to multiple fixed locations in the system.
- A wireless router can provide connectivity to multiple computers in the field. These computers would also be able to access a public Internet gateway in any county.

Access points in Lebanon, Lancaster, Dauphin, York, and Cumberland County should be functioning in several months. Adams, Franklin, and Perry Counties will take longer to complete.

This data network could be duplicated in most counties except near Philadelphia and Pittsburgh. Frequency congestion near the urban centers will probably limit the usefulness of this low power microwave. Existing amateur sites and ham friendly tower sites are available.

Equipment Vendors:

1. <http://www.microcom.us/browse-by-brand--ubiquiti-networks.html>
2. http://www.ubnt.com/downloads/b5_datasheet.pdf
3. <http://www.ipphone-warehouse.com/Vivotek-IP7131-Network-IP-Camera-p/vivotek-ip7131-ip-camera.htm>
4. http://www.voiplink.com/Cisco_Voice_Over_IP_Phones_s/2.htm
5. <http://www.l-com.com/item.aspx?id=10041>
6. <http://www.l-com.com/item.aspx?id=22016>
7. <http://www.l-com.com/item.aspx?id=22613>
8. <http://www.l-com.com/item.aspx?id=10033>

9. http://www.amazon.com/Linksys-EZX588W-EtherFast-8-Port-Workgroup/dp/tech-data/B00003006K/ref=de_a_smtd

List of Equipment for a Complete 5 GHz Data Link

This link is suitable up to 10 miles and uses the unlicensed band from 5.25 to 5.35 GHz. The transmitters are limited to $\frac{1}{4}$ watt and they should be currently available from the distributors. The power must be reduced for each dB of antenna gain in excess of 6 dB. When using directional 27 dBi gain antennas, the power must be reduced a total of 21 dB. That means the power output is now two milliwatts. The transmitters are not capable of a full 250 milliwatt output at +24 dBm. Instead the output is only +22 dBm. The pigtail has a 2 dB loss. So the output only needs to be reduced by 17 dB to be legal. The legal output power is +7 dBm.

Gains:	Transmit antenna gain:	+27 dBi
	Receive antenna gain:	+27 dBi
	Transmitter output	+7 dBm
	Total Gains:	+61 dB

Losses:	Three mile path at 5.3 GHz:	-120 dB
	Transmit 2 ft pigtail	- 2 dB
	Receive 2 ft pigtail	- 2 dB
	Total Losses:	-124 dB

Gains minus losses = signal at receiver	-63 dBm
Signal needed for maximum throughput	-77 dBm
Signal margin for path fade, equip aging	14 dB

A typical recommended signal margin would be 6 to 10 db at this distance. No license is needed in this band.

A. Two: 5.4 GHz 26 dBi 802.11a Die Cast Grid Antenna
<http://www.l-com.com/item.aspx?id=20219/>

\$53.99 each \$107.98

The grid antennas are only available with this frequency spread. We are using them in Dauphin County with good results.

B. Two: N-Male to N-Female, Pigtail 2 ft 195-Series

<http://www.l-com.com/item.aspx?id=22613>

\$9.99 each \$19.98

C. Two: Ubiquiti Networks The Bullet 5 HD26864

<http://www.wirelessnetworkproducts.com/index.asp?PageAction=VIEWPROD&ProdID=1973>

\$56.00 each \$112.00

D. Two: 15 Volt PoE with US power cord. HD27012

<http://www.wirelessnetworkproducts.com/index.asp?PageAction=VIEWPROD&ProdID=2020>

\$14.95 each \$29.90

E. Two: Indoor Med Power 10/100 Base-T Shielded CAT5 Lightning Surge

Protector

<http://www.l-com.com/item.aspx?id=23168>

\$37.99 each \$74.98

Total \$344.84

Plus tax and shipping

Notes:

1. The antenna s are mounted to 1-1/4" O.D. pipe
2. The antennas must be aimed using enclosed software.
3. N connectors must be waterproofed with three layers of tape.
Bottom and top layer: Scotch Super 88
Middle layer: Scotch 2242
Do not pull tape to cut it. End of tape must not be stretched.
4. Cable ties must eliminate tension on cables
5. Outdoor CAT5 cable must be used from transmitter to bldg
Typical cost is 25 cents per foot plus connectors

Section 15.247 5.725 GHz to 5.850 GHz

Section 15.407 5.15 GHz to 5.25 GHz Indoor only
GHz to 5.35 GHz

5.47 GHz to 5.725 GHz

5.725 GHz to 5.825 GHz

For more information:

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International Table		United States Table		FCC Rule Part(s)
Region 1 Table	Region 2 Table	Region 3 Table	Non-Federal Table	
4990-5000 FIXED MOBILE except aeronautical mobile RADIO ASTRONOMY Space research (passive) 5.149			4990-5000 RADIO ASTRONOMY US74 Space research (passive) US246	
5000-5010 AERONAUTICAL RADIONAVIGATION RADIONAVIGATION-SATELLITE (Earth-to-space) 5.367			5000-5010 AERONAUTICAL RADIONAVIGATION US260 RADIONAVIGATION-SATELLITE (Earth-to-space) 5.367 US211 US344	Satellite Communications (25) Aviation (87)
5010-5030 AERONAUTICAL RADIONAVIGATION RADIONAVIGATION-SATELLITE (space-to-Earth) (space-to-space) 5.328B 5.443B 5.367			5010-5030 AERONAUTICAL RADIONAVIGATION US260 RADIONAVIGATION-SATELLITE (space-to-Earth) (space-to-space) 5.443B 5.367 US211 US344	
5030-5150 AERONAUTICAL RADIONAVIGATION 5.367 5.444 5.444A			5030-5150 AERONAUTICAL RADIONAVIGATION US260 5.367 5.444 5.444A US211 US344	
5150-5250 AERONAUTICAL RADIONAVIGATION FIXED-SATELLITE (Earth-to-space) 5.447A MOBILE except aeronautical mobile 5.446A 5.446B			5150-5250 AERONAUTICAL RADIONAVIGATION US260 FIXED-SATELLITE (Earth-to-space) 5.447A US344	RF Devices (15) Satellite Communications (25) Aviation (87)
5.446 5.447 5.447B 5.447C 5250-5255 EARTH EXPLORATION-SATELLITE (active) RADIOLOCATION SPACE RESEARCH 5.447D MOBILE except aeronautical mobile 5.446A 5.447F 5.447E 5.448 5.448A			5.447C 5.444 US211 US307 US344 5250-5255 EARTH EXPLORATION-SATELLITE (active) RADIOLOCATION G59 SPACE RESEARCH (active) 5.447D 5.448A 5255-5350 EARTH EXPLORATION-SATELLITE (active) RADIOLOCATION SPACE RESEARCH (active) 5.448A 5350-5460 EARTH EXPLORATION-SATELLITE (active) 5.448B SPACE RESEARCH (active) 5.448C AERONAUTICAL RADIONAVIGATION 5.449 RADIOLOCATION 5.448D	RF Devices (15) Private Land Mobile (90)
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5460-5470 RADIONAVIGATION 5.449 EARTH EXPLORATION-SATELLITE (active) SPACE RESEARCH (active) RADIOLOCATION 5.448D 5.448B	5460-5470 RADIONAVIGATION 5.449 US65 EARTH EXPLORATION-SATELLITE (active) SPACE RESEARCH (active) RADIOLOCATION G56 5.448B US49 G130	5460-5470 RADIONAVIGATION 5.449 US65 EARTH EXPLORATION-SATELLITE (active) SPACE RESEARCH (active) RADIOLOCATION G56 5.448B US49 G130	Private Land Mobile (90)
5470-5570 MARITIME RADIONAVIGATION MOBILE except aeronautical mobile 5.446A 5.450A EARTH EXPLORATION-SATELLITE (active) SPACE RESEARCH (active) RADIOLOCATION 5.450B 5.448B 5.450 5.451 5570-5650	5470-5570 MARITIME RADIONAVIGATION US65 EARTH EXPLORATION-SATELLITE (active) SPACE RESEARCH (active) RADIOLOCATION G56 5.448B US50 G131	5470-5570 MARITIME RADIONAVIGATION US65 EARTH EXPLORATION-SATELLITE (active) SPACE RESEARCH (active) RADIOLOCATION G56 5.448B US50 G131	RF Devices (15) Maritime (80) Private Land Mobile (90)
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