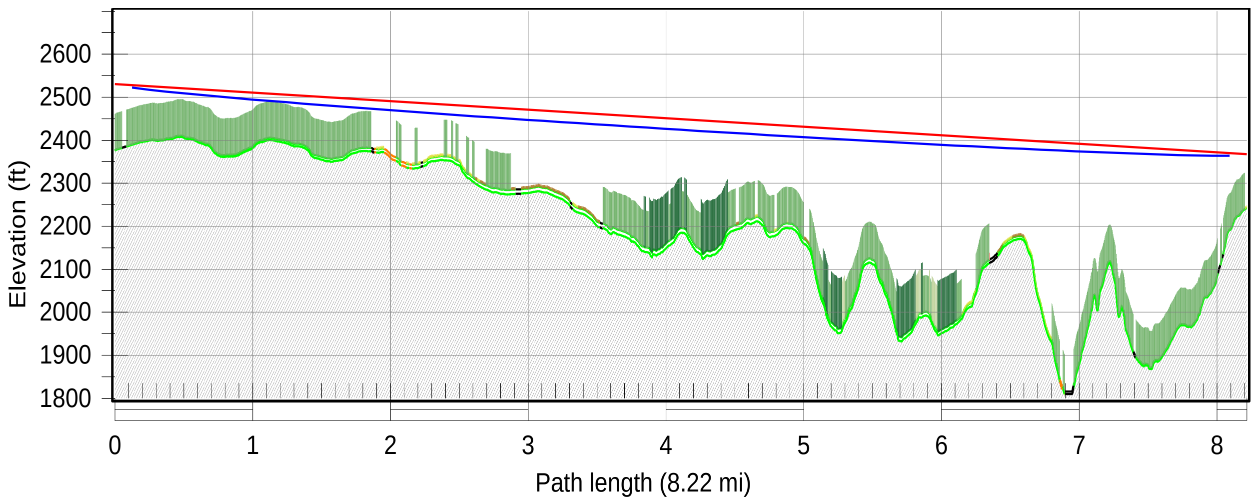
Microwave Networks Configuration/Design

To design a Microwave Network, first, locations are selected by the customer for sites which will be on the microwave network. These sites must be able to handle the antenna mounting requirements, waveguide or coax cable runs, and power requirements. Microwave Networks Systems Engineers will initially run Path Profiles and Path Analysis via software called PathLoss5 to determine if the path will work, based on available antenna mounting heights, based on Line of Sight with a proper Fresnel Zone to provide a microwave path that will perform at 99.999% availability.

In addition, the Microwave Radio Link Design (Frequency, Transmit power, Capacity, Antenna System, etc.) will be defined by Link Engineering. Link Engineering is performed via the PathLoss software to show the clearances and link budget of the microwave radios/antenna systems. The Link Budget adds all the gains and losses of the system to determine the expected Receive Signal Level (RSL) and Flat Fade Margin. Below is a sample Path Profile and Path Engineering Analysis, which is a deliverable in a Microwave Link Design.



Pendleton		Frequency (MHz) = 6175.0	Carrolltown	
Latitude	40 30 18.36 N	K = 1.00	Latitude	40 36 26.51 N
Longitude	078 47 47.42 W	%F1 = 60.00	Longitude	078 42 59.51 W
Azimuth	30.79°		Azimuth	210.84°
Elevation	2375 ft ASL		Elevation	2242 ft ASL
Antenna CL	155.0 ft AGL		Antenna CL	125.0 ft AGL

Transmission details (Pendleton-Carrolltown.pl5)

	Pendleton	Carrolltown
Latitude	40 30 18.36 N	40 36 26.51 N
Longitude	078 47 47.42 W	078 42 59.51 W

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	Pendleton	Carrolltown
True azimuth (°)	30.79	210.84
Vertical angle (°)	-0.26	0.17
Elevation (ft)	2375.41	2242.14
Tower height (ft)	180.00	150.00
Tower type	self supporting	self supporting
Antenna model	PAD 6 - W57B (R) (TR)	PAD 6 - W57B (R) (TR)
Antenna gain (dBi)	38.90	38.90
Radome loss (dB)	0.50	0.50
Antenna diameter (ft)	6.00	6.00
Antenna height (ft)	155.00	125.00
TX line model	E60	E60
TX line unit loss (dB/100 ft)	1.18	1.18
TX line length (ft)	205.00	175.00
TX line loss (dB)	2.43	2.07
Connector loss (dB)	0.20	0.20
Frequency (MHz)	6175.00	
Polarization	Vertical	
Path length (mi)	8.22	
Free space loss (dB)	130.71	
Atmospheric absorption loss (dB)	0.11	
Net path loss (dB)	58.92	58.92
Configuration	Non Protected	Non Protected
Radio model	MX/I/6G/30M/HP	MX/I/6G/30M/HP
TX power (dBm)	32.00	32.00
Emission designator	30M0D7W	30M0D7W
EIRP (dBm)	67.77	68.13
RX threshold criteria	128 QAM	128 QAM
RX threshold level (dBm)	-71.00	-71.00
Receive signal (dBm)	-26.92	-26.92
Thermal fade margin (dB)	44.08	44.08
Dispersive fade margin (dB)	46.00	46.00
Dispersive fade occurrence factor	1.00	
Effective fade margin (dB)	41.92	41.92
Climatic factor	1.00	

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	Pendleton	Carrolltown
Terrain roughness (ft)	64.54	
C factor	0.72	
Average annual temperature (°F)	47.97	
Fade occurrence factor (Po)	6.146E-003	
Worst month multipath availability (%)	99.99996	99.99996
Worst month multipath unavailability (sec)	1.04	1.04
Annual multipath availability (%)	99.99999	99.99999
Annual multipath unavailability (sec)	2.99	2.99
Annual 2 way multipath availability (%)	99.99998	
Annual 2 way multipath unavailability (sec)	5.97	
Polarization	Vertical	

All paths are engineered to meet or exceed an annual two-way availability of >99.999% (defined by Customer) at a BER of 10E-6 using the Vigants-Barnett model. The preliminary calculations for path performance are based on Microwave Networks published 10E-6 receiver threshold levels. Bellcore Standard transmission engineering practices, formulas and topographic data are the foundation of these calculations. Typical Clearance criteria used to determine preliminary antenna centerlines are:

K = 4/3 @ 100% F1

1/3" Arc USGS terrain data

30 meter NLCD 2001/2011 clutter data

Before system implementation a microwave path engineering survey will be conducted on all paths (see ***ExhibitB3-Services-Other Surveys)***. The objective of this survey is "information verification" to confirm the information to be used for clearance and engineering performance objectives. This confirmation includes site location (latitude/longitude coordinates), elevation above mean sea level (AMSL), accurate measurement of path obstructions along the path (i.e. trees and buildings, electrical transmission lines, cellular towers, the presence of reflective surfaces) and general compilation of local climate information.

At locations with existing towers, pre-determined azimuths and centerlines will be checked for availability/adaptability in terms of proposed antenna mounting.

Overall, Microwave Networks Systems Engineers will determine the best design for the microwave network, looking at redundancy via rings or hot standby spurs, to best support the traffic flow of the network. Below is a sample design of a typical countywide network.

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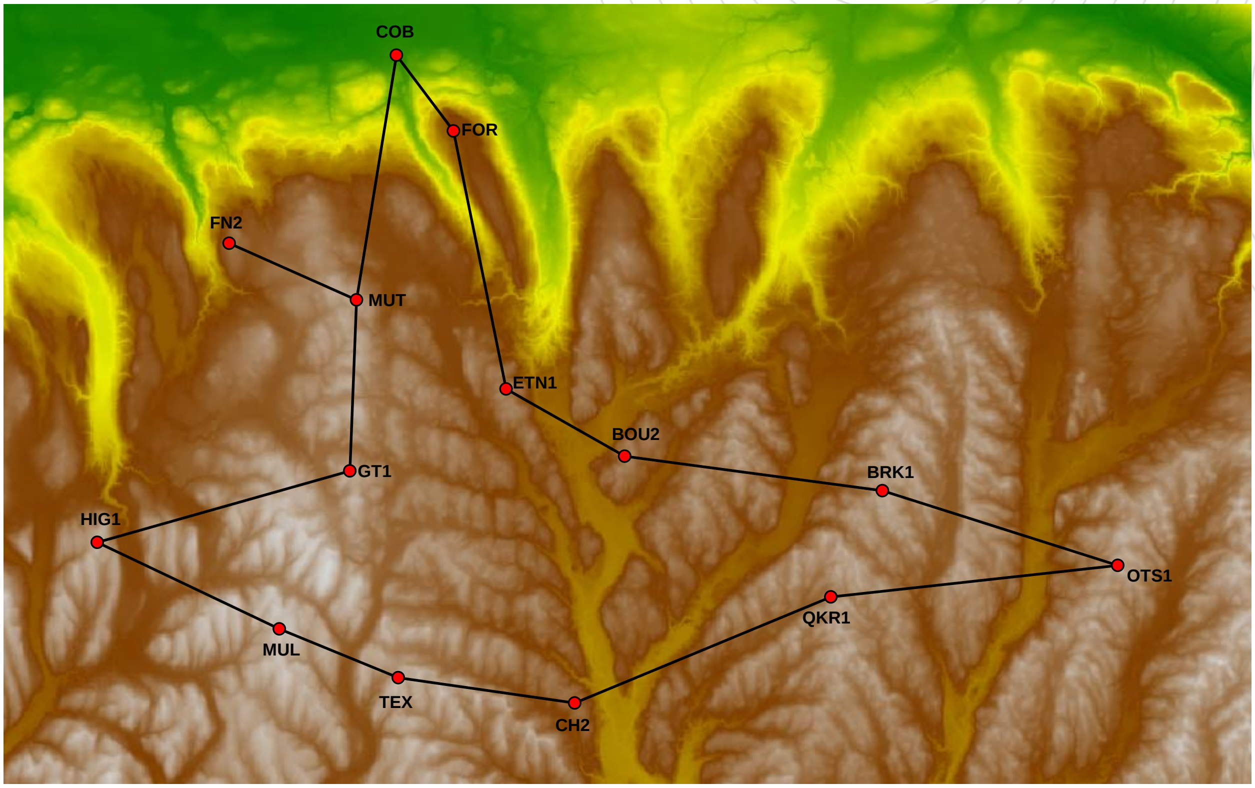
Microwave NETWORKS



In summary, Microwave Networks Systems Engineers will work with the customer to define a mission critical network that meet the customer's needs with regards to capacity, availability, and cost effectiveness.

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