

Keystone
Alpha Test Plan
November 30, 2014

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Test Configurations: Error! Bookmark not defined.

Summary

This document is to cover the network architecture, wireless topology and system configuration for the Keystone Alpha test using commercial towers. Keystone is a broadband radio platform which supports frequency ranging from 100MHz to 6GHz with channel bandwidth ranging from 12.5kHz to 20MHz. The Alpha test will be conducted in both the 900 MHz MAS band and the upper 4 MHz of the 915 ISM band.

The 900MHz MAS radio is defined as:

- Radio Interface Single, Narrowband Radio
 - o RF Spectrum Licensed 928-960MHz
 - o Transmitter Output up to 5 Watt
 - o Antennas Omni and Directional
- Network Interface 2 Ethernet and 2 Serial Ports
 - o Ethernet Ports 10/100 Mbps, Auto-Sensing
 - o Serial Ports RS-232
 - o USB Micro B for device configuration
 - o Power 7 to 30VDC
- Enclosure Rugged
- Airlink:
 - o Modulation QPSK, 16QAM, 64QAM
 - o FEC $\frac{1}{2}$ rate
 - o Duty Cycle Half Duplex
 - o Channel Size 12.5kHz, 25kHz and 50 kHz channel sizes
 - o Layer 2 ARQ
- Test Applications:
 - o Ping Variable size pings
 - o Iperf TCP Iperf TCP throughput testing
 - o RTU Polling data over the airlink
 - o HTTP Polling WP GUI pages

The 915 MHz ISM radio is defined as:

- Radio Interface Single, Narrowband Radio
 - o RF Spectrum 926 MHz +/- 1.5 MHz
 - o Transmitter Output up to 1 Watt
 - o Antennas Omni directional
- Network Interface 2 Ethernet and 2 Serial Ports
 - o Ethernet Ports 10/100 Mbps, Auto-Sensing
 - o Serial Ports RS-232
 - o USB Micro B for device configuration

- o Power 7 to 30VDC
- Enclosure Rugged
- Airlink:
 - o Modulation QPSK, 16QAM, 64QAM
 - o Modulation Symbol Rate 2.4 Msps with 30 % excess Raised Cosine pulse shape
 - o FEC $\frac{1}{2}$ rate
 - o Duty Cycle Half Duplex
 - o Channel Size 3 MHz
 - o Layer 2 ARQ
- Test Applications:
 - o Ping Variable size pings
 - o Iperf TCP Iperf TCP throughput testing
 - o RTU Polling data over the airlink
 - o HTTP Polling WP GUI pages

Wireless Topology

Below is the wireless topology for the 900 MHz MAS test setup. The 900MHz Omni antennas will be installed at the FreeWave Office and Arapahoe towers for point to point as well as Point to Multipoint testing with shorter range. The 900MHz Yagi antennas will be installed at the Arapahoe and Erie Tower for point to Point testing with longer distance.

Overall Wireless Topology

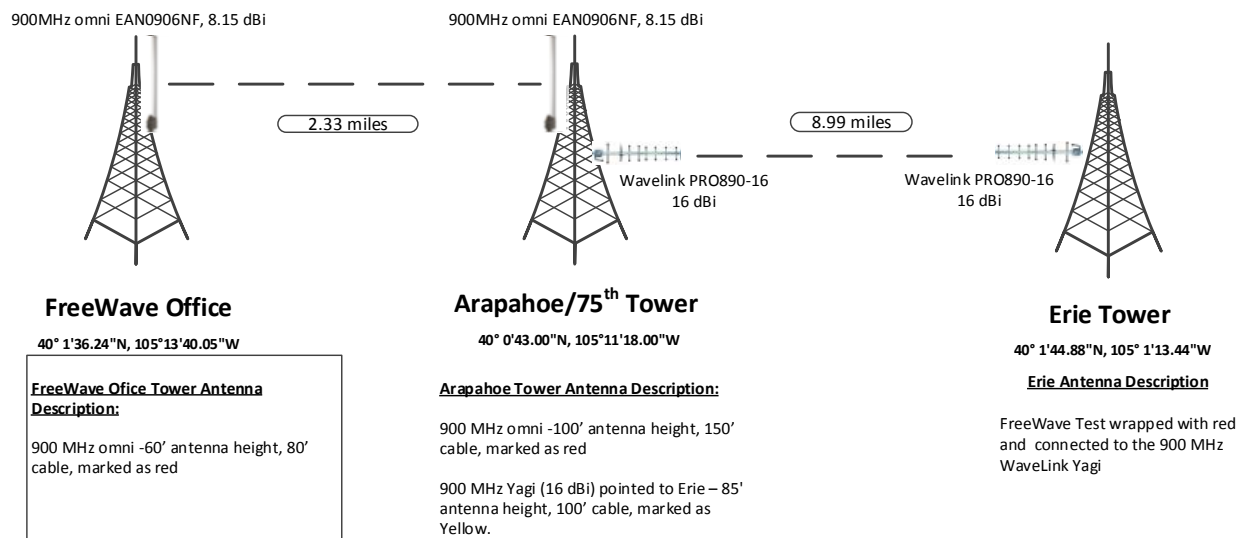


Figure 1: Experimental Radio Network Configuration Parameters

The 915 MHz ISM testing will only be done as a point-to-point between the Boulder office and the Arapahoe tower with the omni antennas, and in a point-to-multipoint configuration between the Boulder office omni antenna and multiple locations near the Boulder office.

Link Analysis

The following table is a link analysis assuming only 1 Watt transmit power levels. We may go up to 5 Watts for some testing, but it does not appear that is required.

At 1 Watt transmit power the links should have 30 dB margin at 50 kHz channel bandwidth and 40 dB margin for the 12.5 kHz channel bandwidth. This is seen in the table by comparing the Link Loss Budget values against the Estimated Link Losses values.

For the 915 MHz ISM testing the link loss budget is 121.7 dB. The estimated link loss between the Boulder office and the Arapahoe tower is 103 dB. So, there is adequate margin for the testing.

Free Space Path Loss @ 2 Miles & 940 MHz (dB)	103.3		
Free Space Path Loss @ 9 Miles & 940 MHz (dB)	115.1		
			Link Loss Budget (dB)
1 Watt Tx Power (30 dBm)	30		
Receiver Sensitivity @ 9600 Bps (dBm)	-115.7		145.7
Receiver Sensitivity @ 19.2 kbps (dBm)	-112.7		142.7
Receiver Sensitivity @ 38.4 kbps (dBm)	-109.7		139.7
Receiver Sensitivity @ 2.4 Msps (dBm)	-91.7		121.7
Omni Antenna Gain (dBi)	8		
Yagi Antenna Gain (dBi)	16		
	LMR 300	LMR 900	
Cable Loss at Araphoe Tower 150 ft. Max (dB)	10	3	
Cable Loss at Erire Tower 150 ft. max (dB)	10	3	
Cable Loss at Boulder Office 100 ft. max (dB)	6	3	
Estimated Link Losses (dB)		Araphoe Omni	Erie Yagi
	Boulder Omni	103.3	
	Arapahoe Yagi		103.1

Table 1: Link Analysis Summary