

TV White Spaces NLOS

Fixed Wireless Internet Solutions

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Final Mile Communications

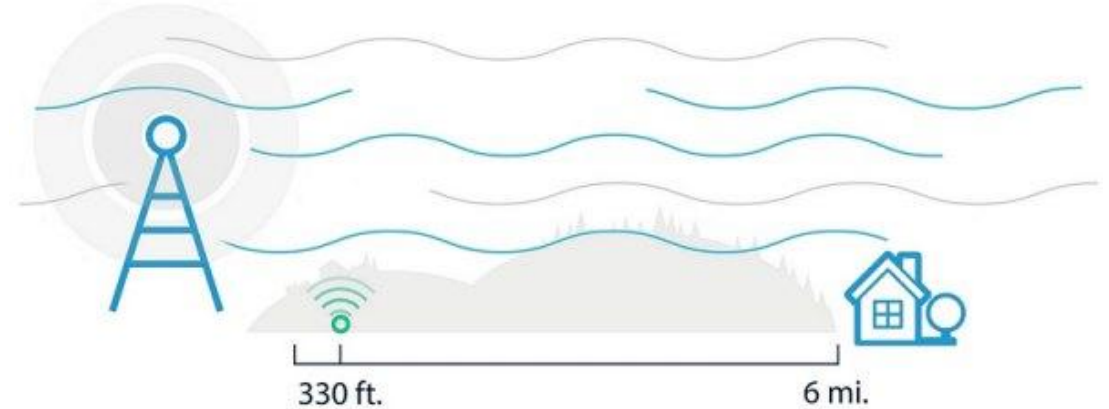
The logo for Final Mile Communications features the company name in a bold, sans-serif font. Below the name are three horizontal lines of varying lengths, with the longest line centered under the word 'Communications'.

TVWS: Low Frequency Wireless Signals

Travel Long distances

+

Non-Line-of-Sight Connectivity



PENETRATES
TREES



CONNECTS
OVER HILLS



MOUNT CPEs ON ROOFTOPS
OR OTHER STRUCTURES

TVWS provides wireless broadband service for hard-to-serve areas.

UNLICENSED TVWS: SPECTRUM AVAILABILITY IS A LOCATION-SPECIFIC RESOURCE

Chippewa County, MN – Available TVWS Spectrum



138 MHz
23 TV Channels

84 & 24 MHz
14 & 4 TV Channels

0 MHz
No TV Channels

12 MHz
2 TV Channels

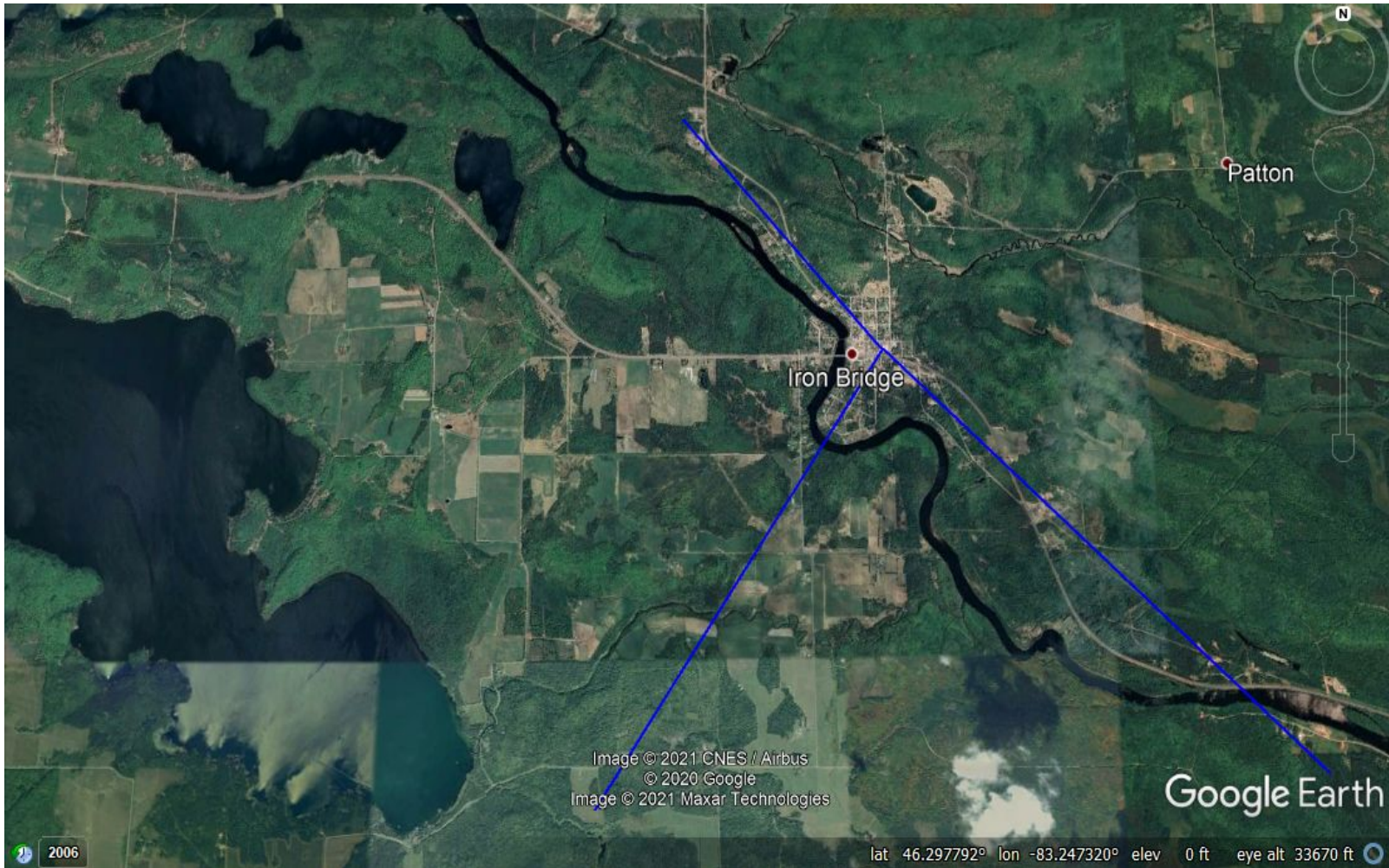
TV White Spaces Broadband in Ironbridge, Ontario



TVWS GWS5000 Series



Ironbridge, Ontario - Terrain Characteristics



Overview

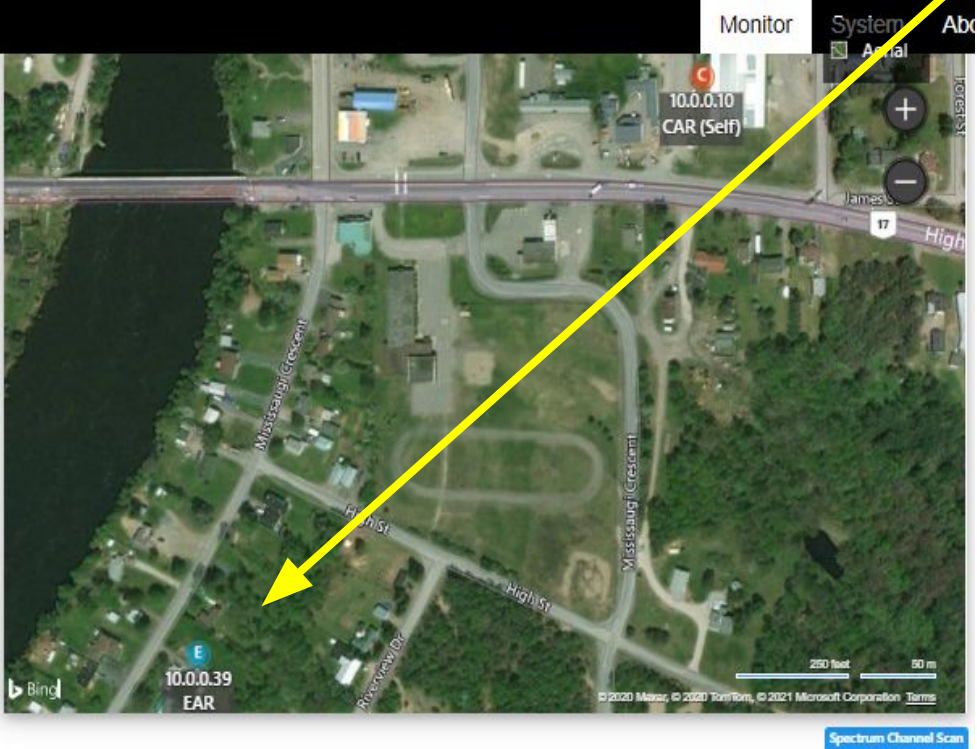
- Very heavily treed area - thick pine trees
- Rolling hills
- Dense 3x3 blocks in village center
- Houses along lakefront
- Displacing DSL
- Increase range expectations & densify clients in forested area
- Adding additional towers and base stations to increase & densify coverage

NLOS Broadband

- Dense tree cover cannot use LOS FWA, even at less than ½ mile
- MIMO Downlink through thick trees & foliage
- 25/15 service

- TVWS Radios**
Co-Located with:
- 2.4GHz (Altai)
 - 5GHz (Altai)
 - 24GHz backhaul
 - LTE failover backhaul

6HARMONICS <small>CONNECTING PEOPLE & THINGS</small>	
Radio Type / MAC	GWS5002 / AC:EE:3B:03:01:59
Connected Stations	1 station connected
IP / SSID	10.0.0.10 / IronbridgeT2
LAN Speed Duplex	100 Mbps full duplex Diagnosis
Location	(46.279278 , -83.219254) PE<7.8m, 95%CL Map
Channel(Freq)/Noise/Region	CH 21 22 (518 MHz) / -102 dBm / CA / Config
Tx State / Tx Power	TX ON / 31 dBm Config
RX Gain	8 dB Config
Temperature	18.00 °C
Channel Bandwidth	12 MHz Config
System Up Time	1Days-20h14m57s
Free Memory	MemFree: 92696 kB



Connection Status

Up Link Status at CAR

+	IP/MAC	RSSI (dBm)/ Noise Floor (dBm)/ SNR	Modulation / Tx Packets	Modulation / Rx Packets	Radio Link Up Time
+	10.0.0.39	-72 dBm / -102 dBm / SNR 30 20 ms ago	MCS 13, short GI 5548081 Pkts.	MCS 7, short GI 2716644 Pkts.	1Days-20h:14m:21s

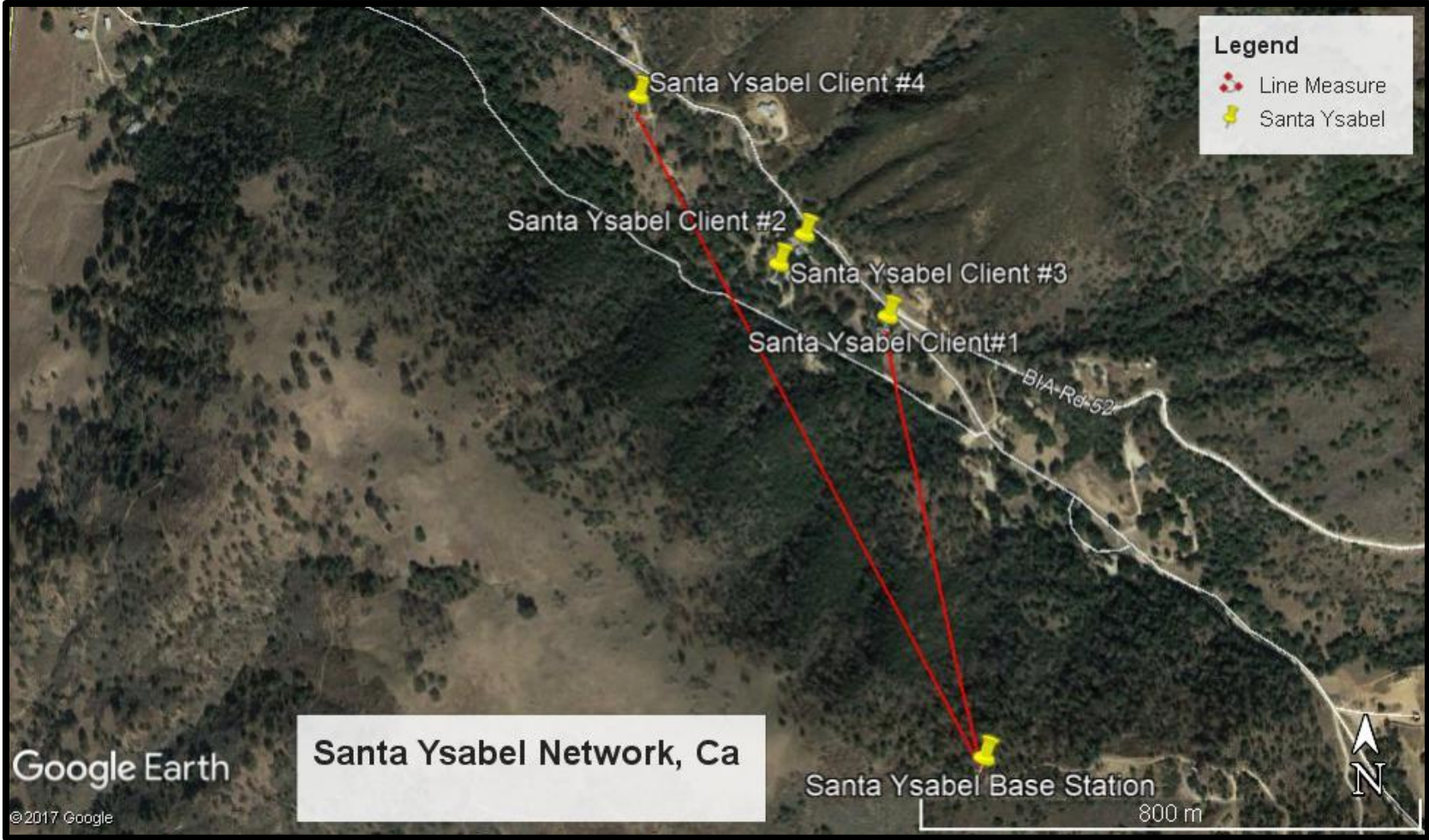
Hillman, Michigan

- 5 TVWS BTSs on a water tower
- Operating since Sept 2017
- Hybrid Unlicensed Network:
 - 5 GHz (LOS)
 - TVWS (NLOS)
 - TVWS service range: 500 yards to 6 miles
- Terrain:
 - Low hills
 - Dense trees including pine
 - 100' forest canopy
- Successfully co-located with:
 - FM radio
 - 156MHz public safety
 - 5GHz fixed access
 - 700MHz and 800MHz cellular



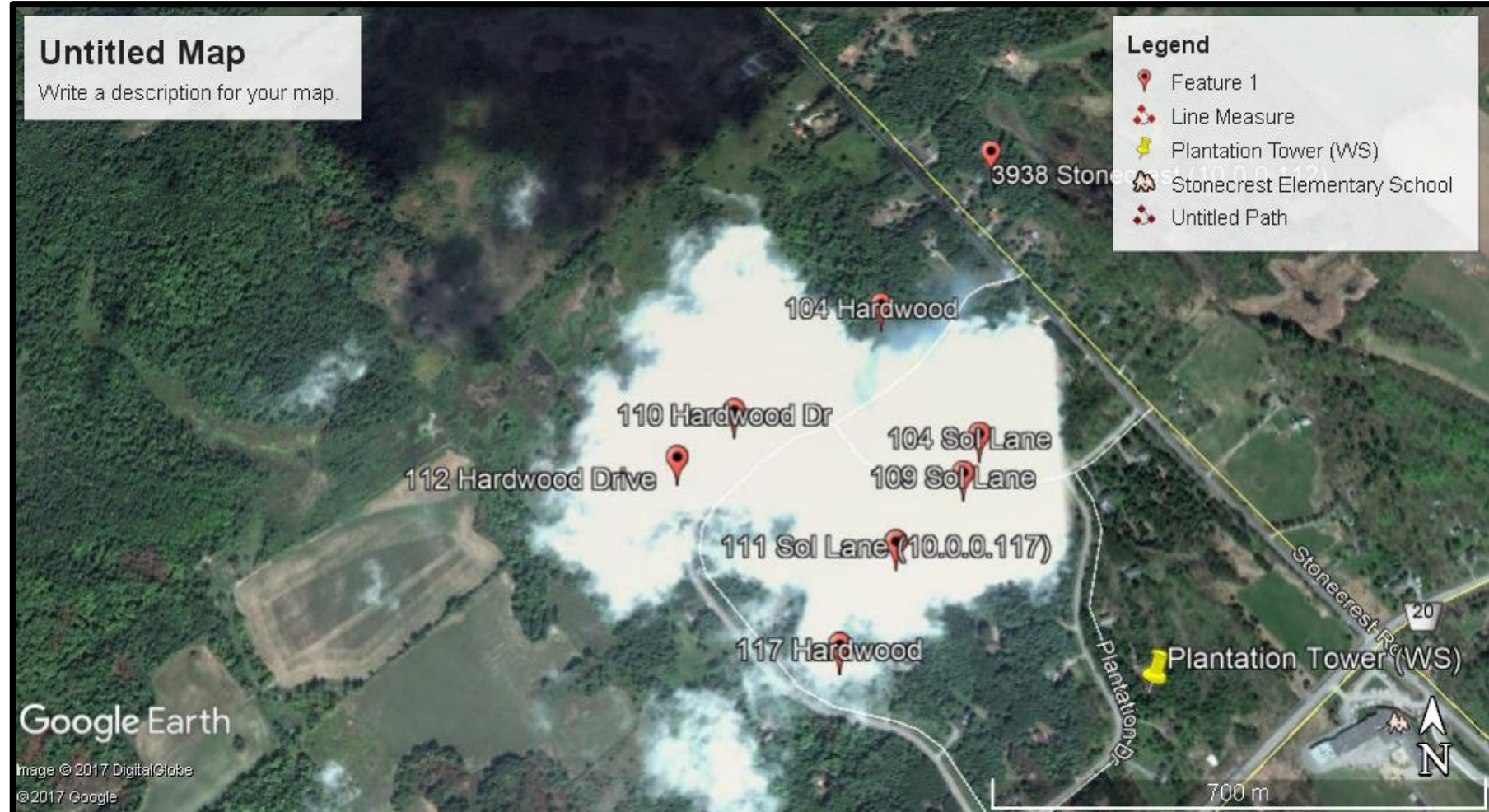
Santa Ysabel, CA

TOTAL NLOS: TVWS CPEs in a canyon, need to overcome large hill with small trees that separate BTS from CPEs. Range from 0.4 to 0.8 miles.



Carp, Ontario

Four (2 channel bonded) BTSs with 24 CPEs about .5 miles to 1.2 miles from BTS in heavily forested area. BTS and treeline 100 ft. high. Clients streaming Netflix and use online gaming since 2017. Expanding network to upgrade TVWS and include 5 GHz & 3.65 GHz radios.



TVWS GWS5000 Series

FCC Certified 5th Generation Version for 2021

- 6Harmonics since 2010 - Ottawa, Ontario based
- Highest FCC certified power for 4 Channel bonding
- Power increases built in when/if rules permit
- Wi-Fi protocol – ideal for unlicensed use
- Throughput 4 Channel (UDP)
 - Max 100 / 100 Mbps MIMO-MIMO
 - Typical 95DL / 70UL MIMO-SISO
- Goodput 4 Channel (TCP/IP)
 - Max 75/75 Mbps MIMO-MIMO
 - Typical 65DL / 45UL MIMO-SISO
- 3 channels + MIMO >25 / 3 real world
- MIMO downlink / SISO uplink
- Conducted max 27.8dBm / SS with 4 contiguous channels

