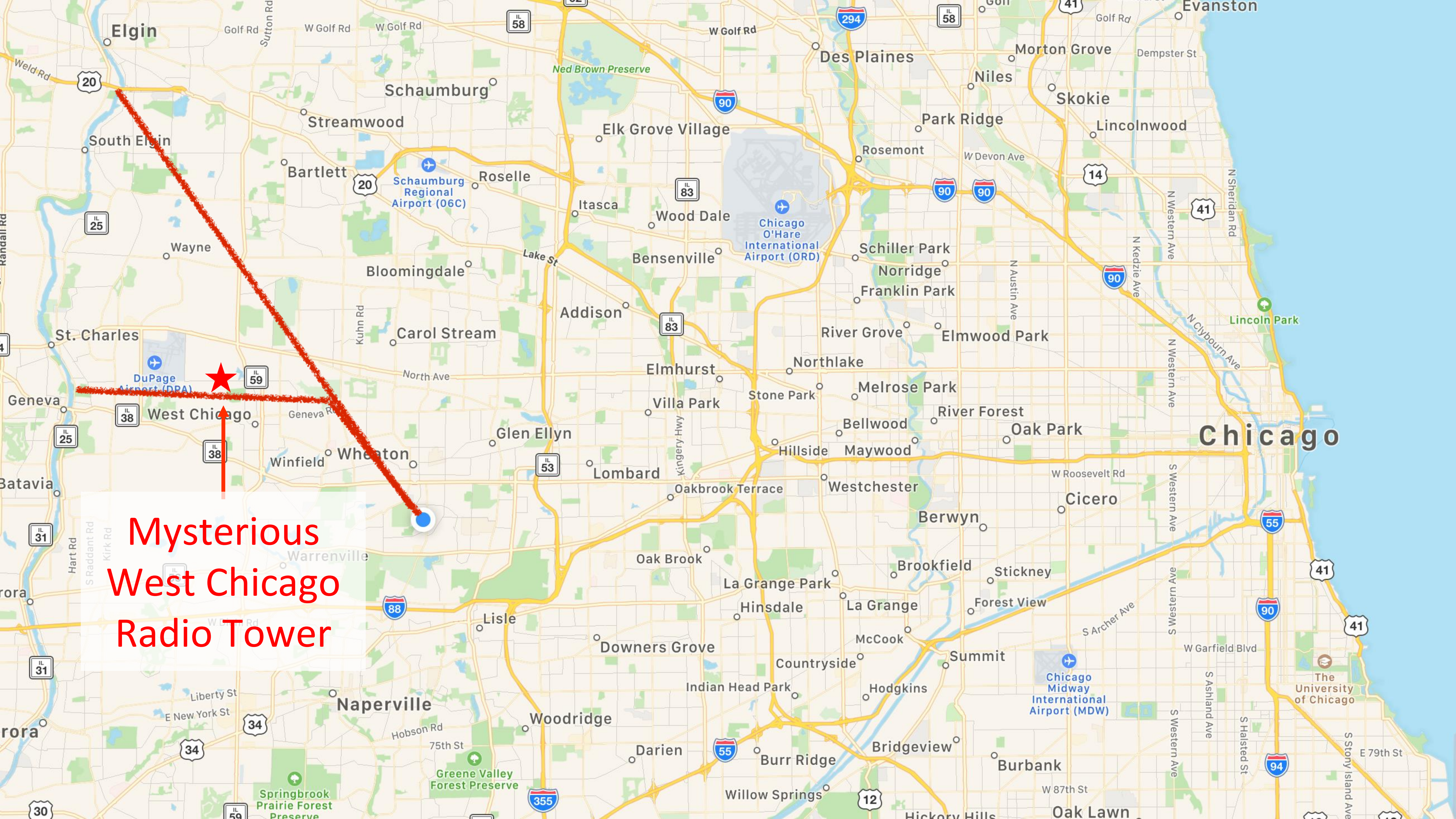


Shortwave Trading

Bob Van Valzah
June 13, 2018

Act One

The West Chicago Radio Tower Mystery



Mysterious
West Chicago
Radio Tower

Simple Cell Tower

- * Just one carrier
- * Note triangular head
- * Directional antennas on each side of triangle
- * Makes a pattern of hexagons to cover an area



A photograph of a tall, complex cell tower against a clear blue sky. The tower is covered in various antennas, including large white microwave dishes and numerous vertical and horizontal antenna arrays. A worker in a safety harness and helmet is visible on a platform, working on one of the antenna arrays. Two red circles highlight specific features: one around a microwave dish and another around the worker. The text 'Microwave Dish' is written in yellow with a red outline, and 'Note worker size compared to antenna' is written in yellow. At the bottom, the title 'More Complicated Cell Tower' is displayed in large yellow letters with a red outline.

Microwave
Dish

Note worker size
compared to antenna

More Complicated Cell Tower

A tall, slender, grey cell tower stands vertically in the center of the frame. The top of the tower is covered in a dense, dark green foliage that mimics the appearance of a tree's canopy. The tower is surrounded by several large, leafy green trees, some of which are in the foreground, partially obscuring the tower. The sky is filled with soft, white clouds. The overall scene is a low-angle shot looking up at the tower.

Fake Tree Cell Tower Wesley Hills, NY



Microwave
Dish

No
Triangles!

Four Huge
Ocean-Crossing
Antennas

The Mysterious
West Chicago Tower



What's At the Base of the Tower?

A Barbed Wire Fence!

A photograph of a radio tower and equipment inside a chain-link fence. The tower is a tall, grey, cylindrical structure. In the foreground, there is a grey metal cabinet with four circular ports labeled A, B, C, and D. To the right of the cabinet is a wooden box. The entire setup is enclosed within a chain-link fence. In the background, there are bare trees and a cloudy sky. A sign on the fence reads "verticalbridge" and "NO TRESPASSING".

Inside, a Power Meter



U.S. CELLULAR

A

Why is U.S. Cellular is Paying for Power to Cross Oceans?



U.S. CELLULAR

A

A Cell Site With a Garbage Pile?!?!?



More Garbage, But Wait



783196-01



USRP X3XX 1U RACK MOUNT (2
USRP X300 DEVICES) - ETTUS
RESEARCH

PRODUCT OF USA

SN:

EU Representative:
4031 Debrecen, Határ út 1/A, Hungary

That Box Looks Interesting

783196-01



USRP X3XX 1U RACK MOUNT (2
USRP X300 DEVICES) - ETTUS
RESEARCH

PRODUCT OF USA

SN:

EU Representative:
4031 Debrecen, Halász út 1/A, Hungary

Why Does a Cell Site Need Research?

This Might Come In Handy at Home

F.C.C. ANTENNA
STRUCTURE REGISTRATION

1265025



Antenna Structure Registration

[FCC](#) > [WTB](#) > [ASR](#) > [Online Systems](#) > ASR Search

[FCC Site Map](#)

ASR Registration Search

Registration 1265025

Tower Was Built in 2009

[? HELP](#)

[New Search](#) [Return to Results](#) [Printable Page](#) [Reference Copy](#) [Map Registration](#)

Registration Detail			
Reg Number	1265025	Status	Constructed
File Number	A1073336	Constructed	02/05/2009
EMI	No	Dismantled	
NEPA	No		
Antenna Structure			
Structure Type	TOWER - Free standing or Guyed Structure used for Commu		
Location (in NAD83 Coordinates - Convert to NAD27)			
Lat/Long	41-53-54.2 N 088-13-14.4 W	Address	1 N. 741 PILSEN RD
City, State	CHICAGO , IL		
Zip	60185	County	DUPAGE
Center of AM Array		Position of Tower in Array	
Heights (meters)			
Elevation of Site Above Mean Sea Level		Overall Height Above Ground (AGL)	
231.9		50.3	



Federal Communications Commission

Wireless Telecommunications Bureau

1270 Fairfield Road

Gettysburg, PA 17325-7245

NOTICE OF ANTENNA STRUCTURE REGISTRATION CHANGE OF OWNERSHIP

ATTN: RENEE MAZUR -- 8831366

UNITED STATES CELLULAR CORPORATION

8410 W. BRYN MAWR AVE #700

CHICAGO, IL 60631

Date: 12-13-2014

Reference No.: 0838267

Re: UNITED STATES CELLULAR CORPORATION

The Commission recently processed an application to change the ownership for the antenna structure listed below. This antenna structure was previously registered under your name, and has been MODIFIED to reflect a change of ownership. Therefore, you are no longer listed as the owner on this antenna structure registration.

Google Street View 2012

- * Street View shows triangular head, but no antennas
- * Built by U.S. Cellular in 2009
- * Already decommissioned by 2012
- * U.S. Cellular sold it at the end of 2014





Universal Licensing System

FCC > WTB > ULS > Online Systems > License Search

[FCC Site Map](#)

Microwave Industrial/Business Pool License - WQZC458 - CA Teleco LLC

Locations Summary

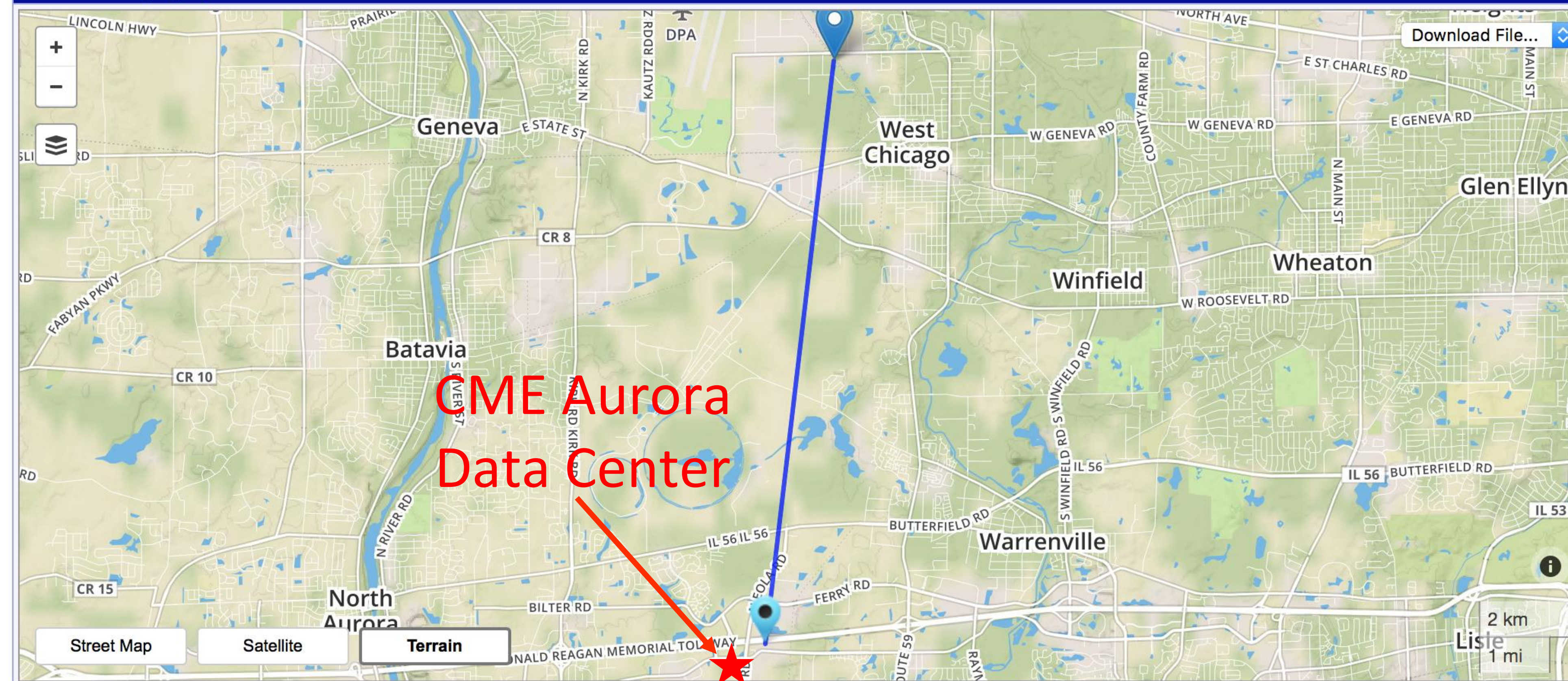
[? HELP](#)

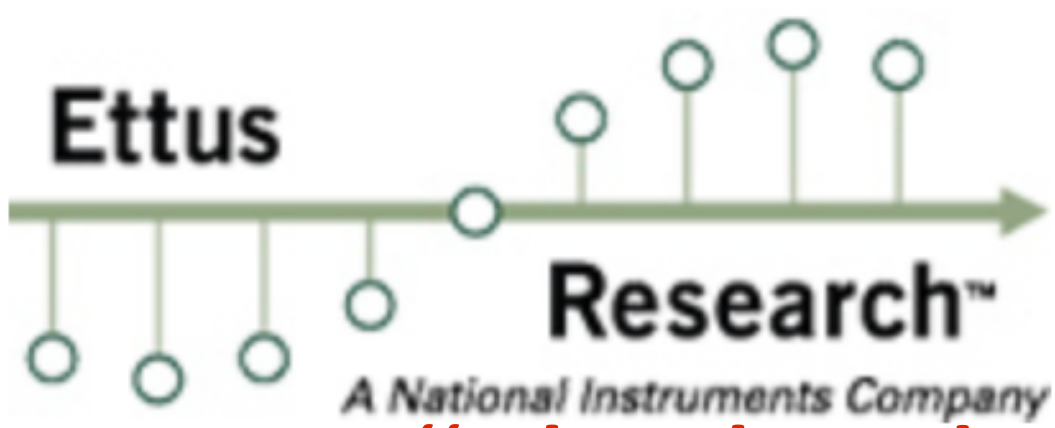
[New Search](#) [Refine Search](#) [Return to Results](#) [Printable Page](#) [Reference Copy](#)

MAIN ADMIN LOCATIONS PATHS MAP

Call Sign	WQZC458	Radio Service	MG - Microwave Industrial/Business Pool
-----------	---------	---------------	---

License Geography





“The leader in
Software Defined Radio”

[Home](#) » [Product Categories](#) » [USRP X Series](#) » USRP X300

[Ordering Help](#) | [Blog](#) | [Events](#) | [Careers](#)

[Products](#)

[SDR Software](#)

[Support](#)

[Applications & Partners](#)

[About Us](#)

[Contact](#)

What Was in That Cardboard Box?

USRP X300

\$4,296.00

Their top-of-the-line product



USRP X300

783144-01

Qty:

1

[Add to Parts List](#)

USRP X300 (KINTEX7-325T **FPGA**) 2 CHANNELS, **10GIGE AND PCIE BUS**

Qty:

1

[US Power Cord for USRP X300/X310/N310](#)



\$11.00

Features

- Two wide-bandwidth RF daughterboard slots

• Up to 160MHz bandwidth each (wideband versions of GPX, WBPX, SPX)

What Could Be Interesting Across an Ocean?



For Radio, Europe is Northeast



I Know What It Is!

- * Four huge shortwave antennas
- * Microwave link to CME
- * Software Defined Radios
- * A low-latency transatlantic market connection!

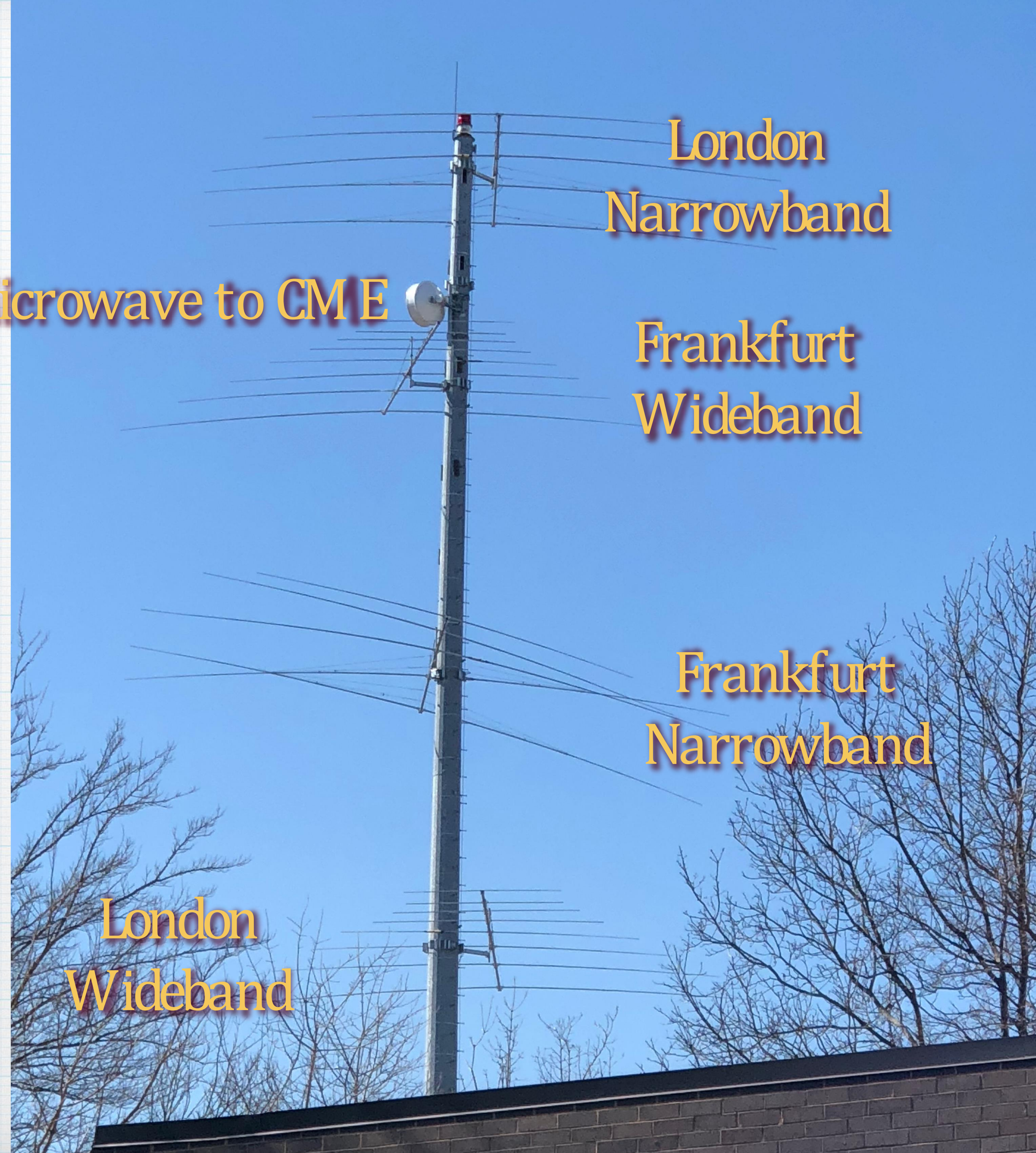
Microwave to CME

London
Narrowband

Frankfurt
Wideband

Frankfurt
Narrowband

London
Wideband



Act Two

Everything You Need to Know About Radio ...

... In Just Three Minutes

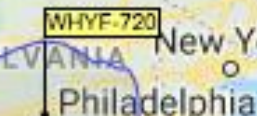
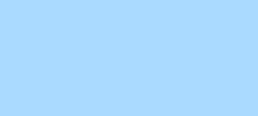
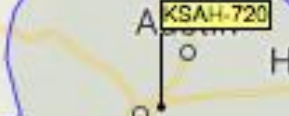
Why is Radio Latency Lower?

- * Straighter line
- * Full speed of light, not just 66% of it
- * See M att Hurd on M eanderful blog:
 - * <https://meanderful.blogspot.com/2017/05/lines-radios-and-cables-oh-my.html>

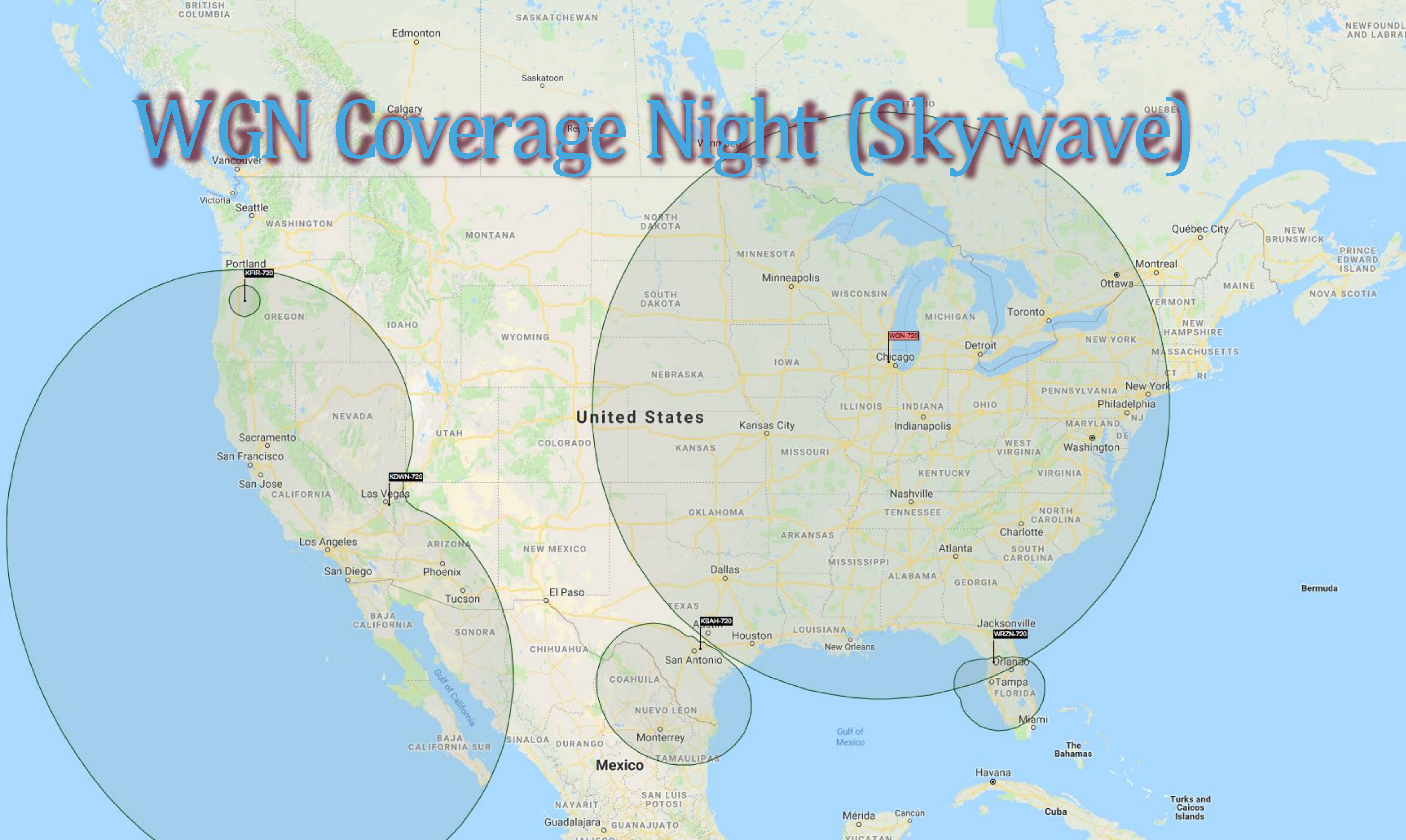
How Radio Waves Travel

- * Line of Sight -- Just like light travels
- * Ground wave -- Follows curvature of Earth over horizon
- * Skywave -- Bounces off ionosphere and Earth ("Skip")

WGN Coverage Day (Groudwave)



WGN Coverage Night (Skywave)



	Reach	Reliability	Bandwidth	Latency	Maturity
Fiber	Around the world	Essentially perfect	10 gbps	1.5 x Radio	Off the shelf
Microwave and Millimeter Wave	Line of Sight 50ish miles per hop	High	100ish mbps	Radio	Off the shelf
Shortwave (High Frequency)	Around the world	Low	A few kbps Think dialup	Radio	Do It Yourself \$ \$ \$ \$

Shortwave has the reach of fiber and the latency of microwave, but it's unreliable, expensive, and has the bandwidth of dialup.

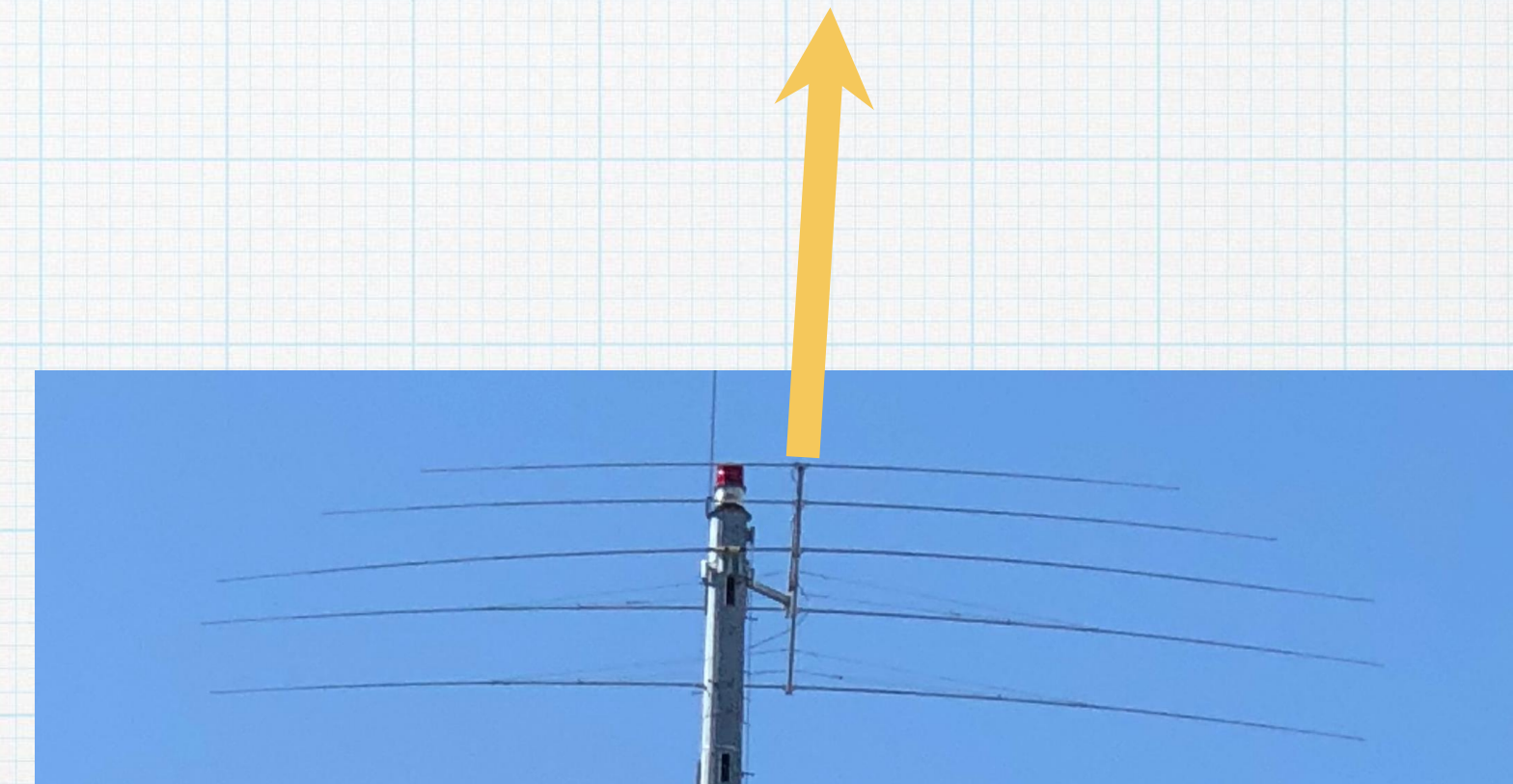
Two Guns Analogy

- * Bullets from your "radio gun" fly fastest
 - * But some bullets explode in flight
 - * Must wait ~millisecond to reload
 - * Possibility of "shooter's remorse"
- * Bullets from your "fiber gun" fly more slowly
 - * But every bullet arrives
 - * Fire as often as you like



Directional Antennas

- * If neither end moves, why point in all directions?
- * Carefully arranged aluminum "points" an antenna
- * The smaller end points at target
- * Opening of dish points at target
- * More aluminum = stronger signal
- * Lower frequencies require more metal



What About Satellite?

- * Lowest-latency orbit (LEO) is high compared to ionosphere
- * Interesting paths require several satellite hops
- * Always more latency than microwave or shortwave, but likely higher bandwidth
- * But lower-latency than fiber--on some paths, sometimes
- * See Stephane Tyc's [talk from NYC STAC Summit last fall](#)

Act Three

CM E Area Shenanigans

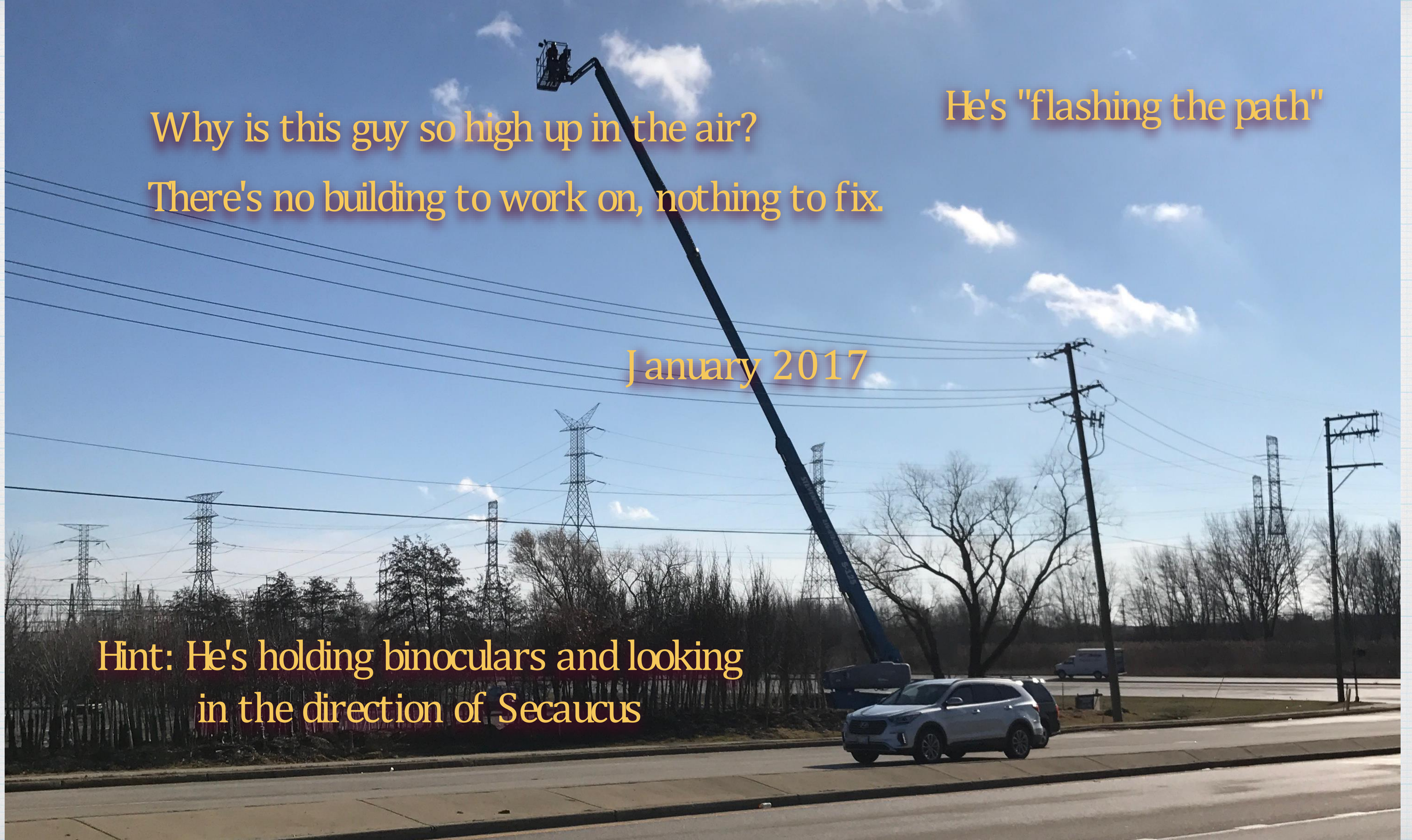
Why is this guy so high up in the air?

There's no building to work on, nothing to fix.

He's "flashing the path"

January 2017

Hint: He's holding binoculars and looking
in the direction of Secaucus



Cell tower near Eola Road to be rebuilt to 350 feet tall

April 2017



McKay Brothers is a company involved in microwave data transmission. It plans to increase the size of its cell tower near Eola Road to 350 feet. (McKay Brothers / Handout)

Took Their Antenna and Went Home

Fancy steerable
microwave antenna

June 3, 2017

No antenna

September 24, 2017

A Shipping Container Sprouts a Millimeter Wave Antenna



July 2, 2017

CM E Zero-Mile Manhole

- * Looking south at CM E across Diehl Rd.
- * Can't get any closer to the matching engine unless you're on CM E property
- * I'm standing on the utility easement
- * But guess what's on the property behind me

December 28, 2016



The Famous Diesel Generator

Microwave Uplink
to Nearby Towers

December 28, 2016



Bloomberg Notices May 12, 2017



Bloomberg
Markets



Trading Fortunes Depend on a Mysterious Antenna in an Empty Field

By **Brian Louis**

May 12, 2017, 5:00 AM CDT

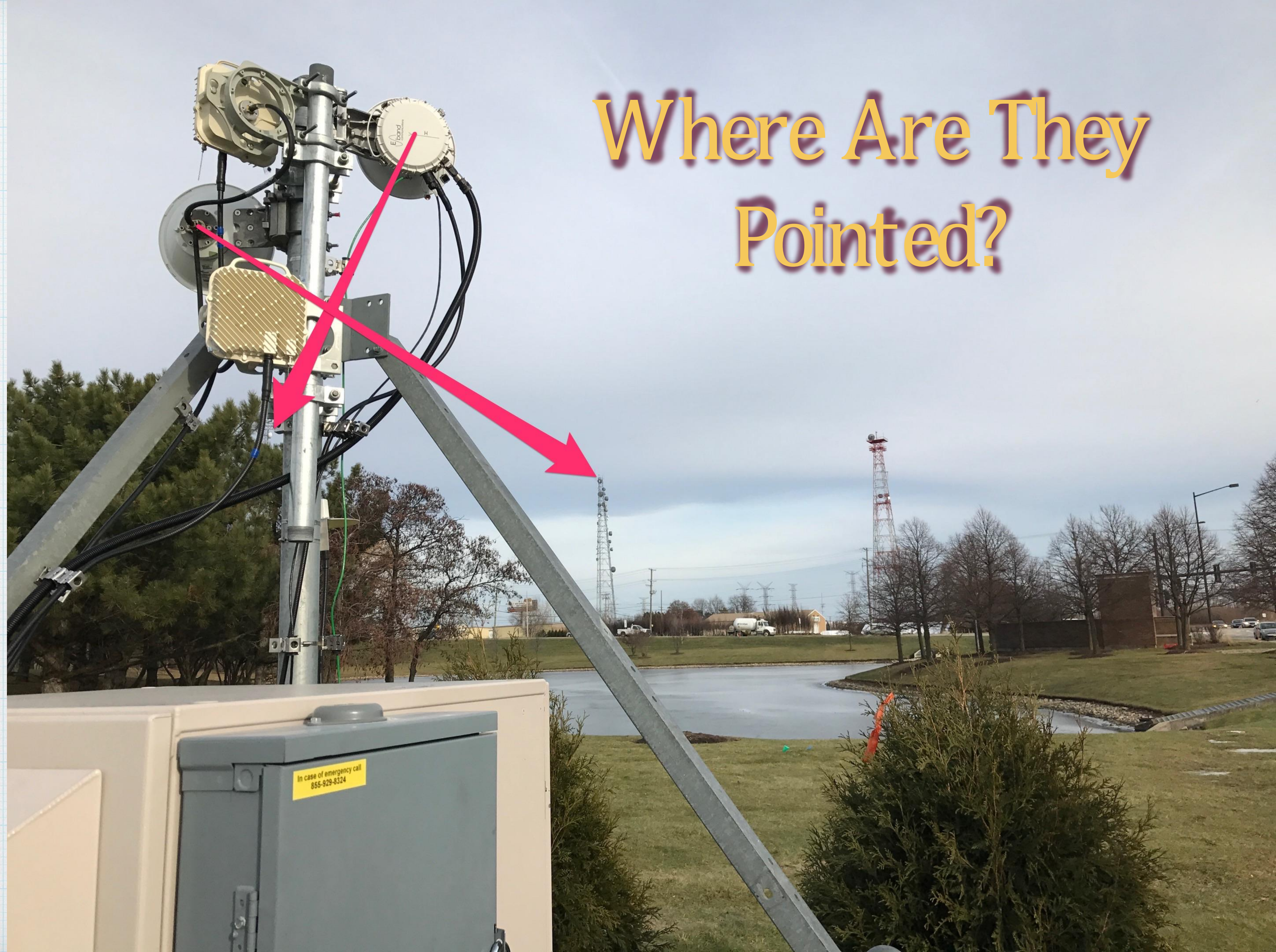
Updated on May 12, 2017, 8:36 AM CDT

Making It More Permanent



April 22, 2018

Where Are They
Pointed?



Latency Savings: $1\mu\text{s}$

Fiber Path

1394'@0.66c

$\sim 2.07\mu\text{s}$

Microwave
Tower

Radio Path

1035'@1.0c

$\sim 1.03\mu\text{s}$

CME

Image NOAA

CME

Image NOAA



Fresh Antennas June 2018

Fola Rd

CME

Act Four

Is Anybody Else Using Shortwave
for Trading?

FCC Database Query

- * Experimental shortwave sites within 100 miles of CM E?
- * 9 hits, 2 of those bogus, 4 have no shortwave antennas
- * I stumbled onto one
- * But there are two sites left

Wanatah, Indiana



An aerial photograph of a rural landscape featuring a patchwork of agricultural fields. The fields are divided by straight lines, likely roads or irrigation canals. The colors of the fields vary, with some appearing dark green, others light green, and many others in shades of brown and tan, suggesting different crops or stages of land use. A few small structures, possibly farmhouses or barns, are visible in some of the fields. The text "Zoom 1" is overlaid in the upper center of the image in a blue, serif font with a red drop shadow.

Zoom 1

Zoom 2



Zoom 3

Farmhouse

18-Wheeler



Zoom 4



A photograph of two tall, dark radio towers with multiple cross-arms, each supporting numerous horizontal wires. The towers are set against a pale, overcast sky. In the foreground, a metal guardrail is visible, with a red sign partially showing the letters 'CIS'.

From the Closest Country Road

More Barbed Wire, No Garbage Pile





Beautiful, Aren't They?

Big Guns in Indiana

- * 768 kilowatts of power
- * Over 20x the 36 kilowatts of power used in West Chicago
- * Much more metal in the air than a comparable cell tower
- * You can literally see it a mile away



Wanatah Indiana

- * Same formula as West Chicago
 - * Big shortwave antennas and a microwave link
- * Recognize that 45 degree angle? London & Frankfurt
- * Where does that microwave dish point?
 - * Tower owner's microwave links back into Illinois where ...
 - * The urbancom.net WISP backbone carries it back to Aurora

Tower Owner's Microwave Path Stops Here

Millimeter Wave Antennas

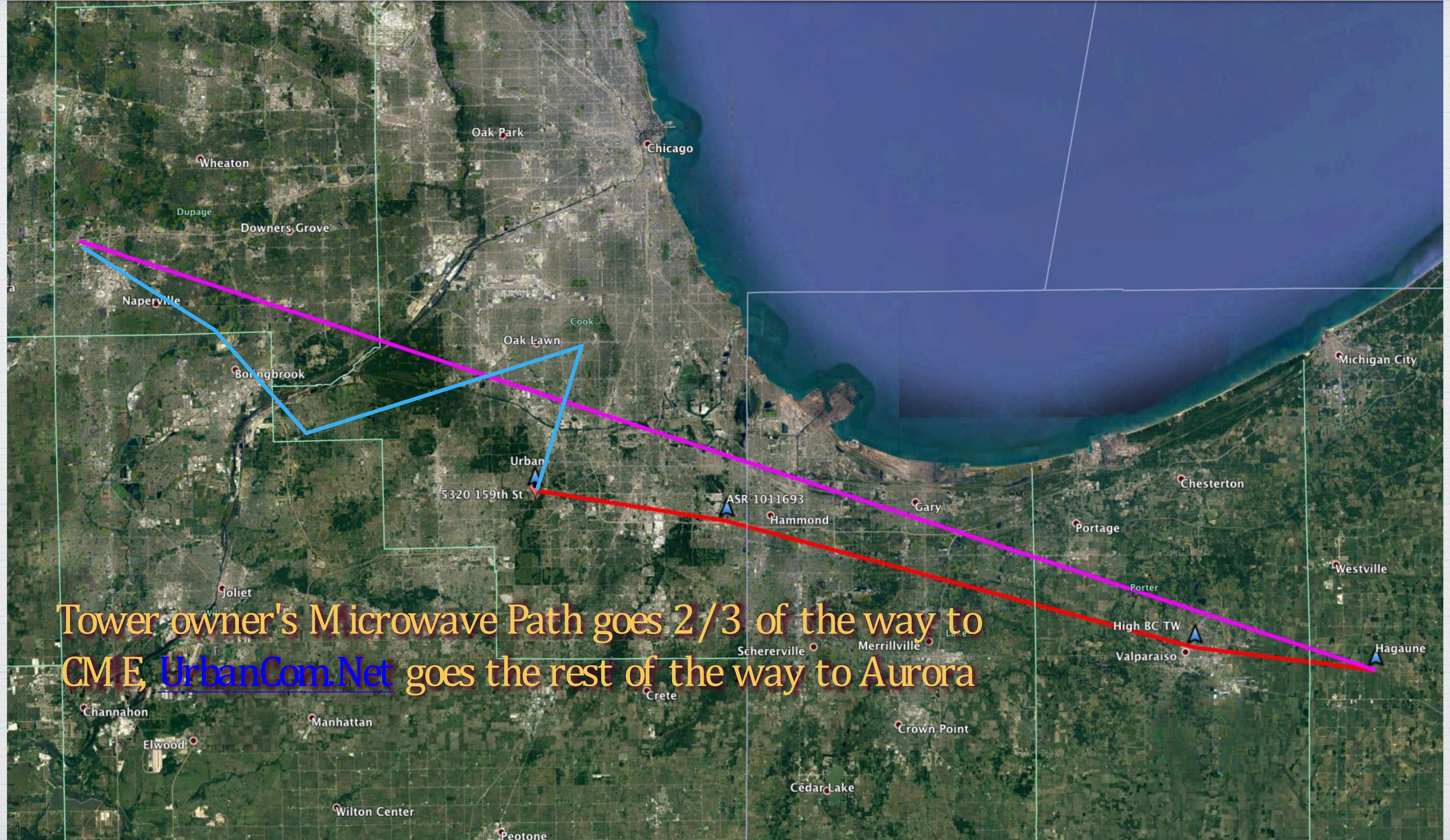
Incoming Microwave from Wanatah

Code Name for Site is "Urban"

5320 159th St.
Oak Forest, IL



Fiber Right of Way



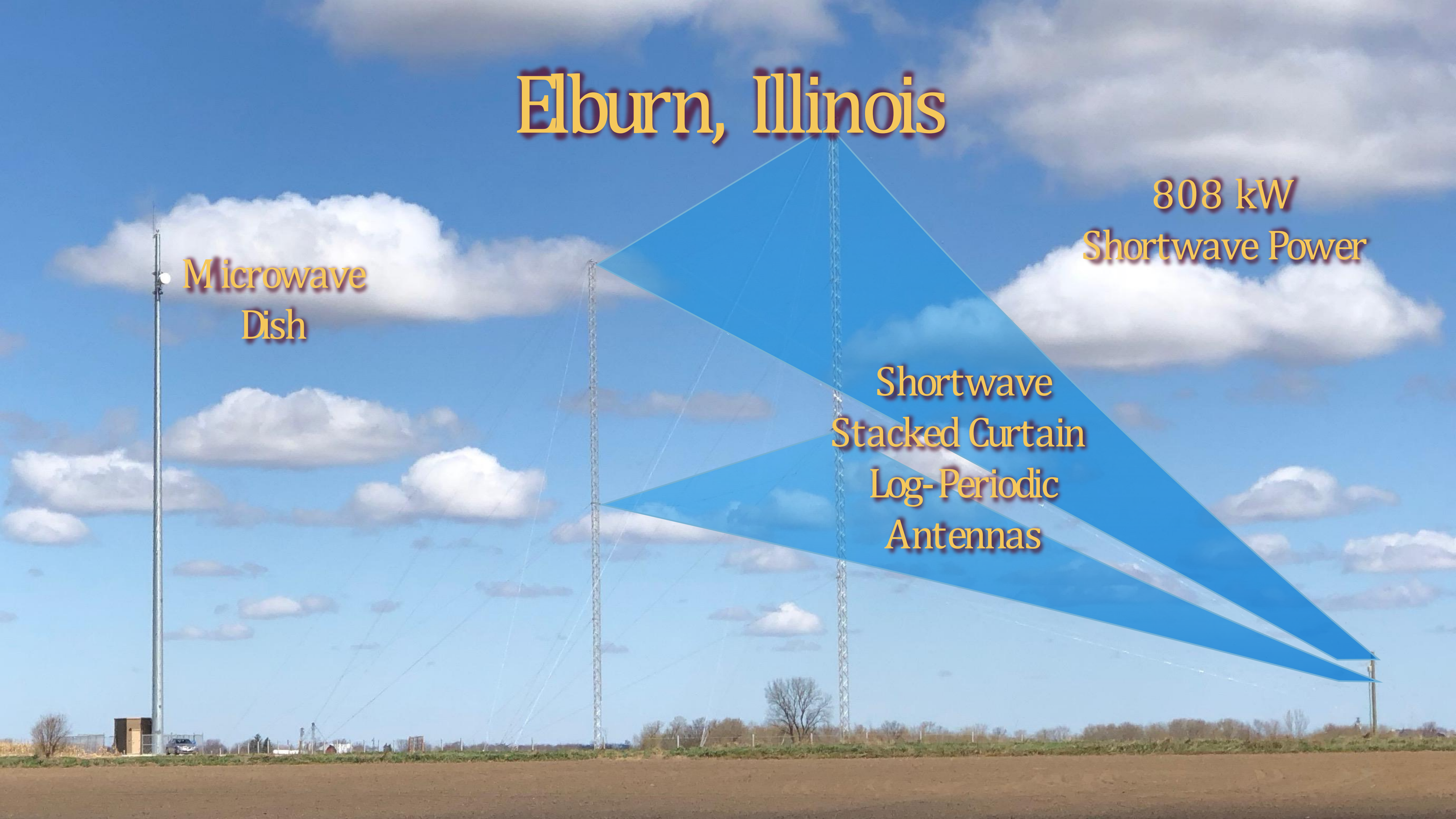
Tower owner's Microwave Path goes 2/3 of the way to
CME, [UrbanComNet](#) goes the rest of the way to Aurora

Elburn, Illinois

808 kW
Shortwave Power

• Microwave
Dish

Shortwave
Stacked Curtain
Log-Periodic
Antennas



Where Do Those Antennas Point?

- * FCC database says shortwave heading 48 degrees
 - * Beam width covers both London and Frankfurt
- * Microwave not yet found in FCC database
- * I took GPS coordinates of microwave tower and a reference point under the path
 - * I was standing on the path to CM E
 - * It's only 16 miles, likely one hop

Station Location

City	State	Latitude	Longitude	Mobile Street (or other indication of location)	County
0 Elburn	Illinois	North 41 55 36	West 88 29 48	County Highway 23, Kane County, Illinois	KANE

Datum: NAD 83

Is a directional antenna (other than radar) used? Yes

Exhibit submitted: No

(a) Width of beam in degrees at the half-power point: 38.00

(b) Orientation in horizontal plane (degrees from True North): 48.00

(c) Orientation in vertical plane (degrees from horizontal): 16.00



Act Four Point Five

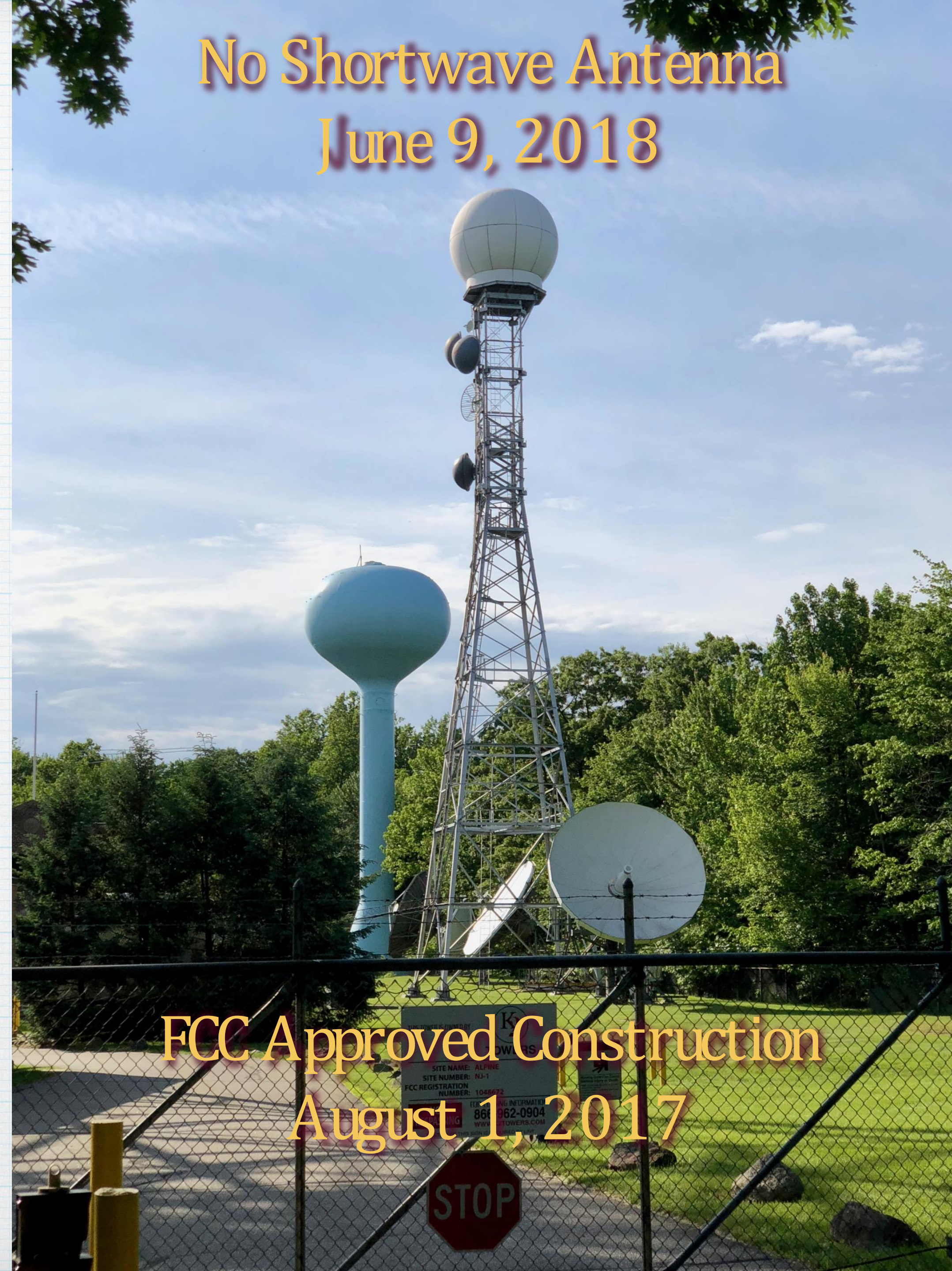
East Coast Sites

Application: Alpine, NJ



EXHIBIT E-4
ALPINE - RADAR TOWER
INSTALLATION STRUCTURE
PRESENT STATUS

No Shortwave Antenna
June 9, 2018



FCC Approved Construction
August 1, 2017

Riverhead, Long Island, NY

Car





New Antennas
Late 2017

Microwave Heading:
Secaucus

Act Five

Parting Shots

FAQ

Bob, Are You Sure?

- * Three sites with shortwave to Europe and microwave to CM E
- * I'm certain they're not cell towers
- * I'm certain they're not beacons for space aliens to land
- * So yeah, I'm sure they're trying to trade over shortwave radio

CME Paths to Europe



Is Shortwave Used Elsewhere?

- * Some Chicago-area licensees also have sites near Mahwah
- * One has a site in Anchorage Alaska, on the path to Tokyo
- * Rumors in Frankfurt, Canada, Brazil
- * So I'd say it's highly likely

How Much Lower is Shortwave Latency?

- * CM E to Europe in 20ish ms vs. 30ish ms for fiber ($RTT/2$)
- * But sending a 64-byte packet could take the whole 10 ms gain due to dialup-like throughput of shortwave
- * So don't send FIX or TCP

Can Anybody Receive Their Signal?

- * Yes, but it'd be foolish of them not to encrypt it
- * No, encryption isn't too slow (just one XOR at each end)
- * No, you can't crack it
 - * It's just pseudorandom noise unless you have the key

When Did This Start?

- * Some expired licenses date back to late-2011
- * Applications sent in mid- to late-2015
- * Indiana towers built mid-2016
- * West Chicago had fresh garbage late-2017
- * West Chicago site changed in April 2018
- * Elburn site is apparently still under construction





March 10, 2018



Two Antennas
Removed in April

April 22, 2018

Are You Spilling Secrets?

- * In a word: No!
- * Bloggers had speculated (Meanderful, The Sniper in Mahwah) it was possible
- * FCC license information is public; antennas are too big to hide
- * I've added maps, photos, background info, and analysis
- * In fact, I'm not disclosing the ownership info I have
 - * I don't want to anger potential employers
- * It's no surprise that: Business + Physics = Shortwave ... The Final Frontier

Why Me?

- * The muddy bike path changed my usual route
- * Being a ham, I recognized the antennas
- * I could see the potential, having worked in trading
- * I'm on gardening leave so current trading ideas are my own
- * I was inspired by the work of The Sniper in Mahwah blog

Bob, Why do you do this?

It answers an uncomfortable
job application question!

Work Information

Are you party to any agreement, such a non-compete agreement, that would restrict your ability to perform this job at [redacted]? ☐ Yes ☐ No

If yes, explain:

Please use this section to explain any gaps on your resume.

I was mining the FCC database and traipsing around muddy corn fields to document the use of shortwave radio by high-frequency traders!



Thank You!