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Welcome!

Microwave 101

Microwave 101 Webinar Series

PRESENTER

Greg Macey
Manager, Microwave

REGISTER:
www.comsearch.com/microwave-101/

DAY 1: **Microwave Fundamentals Part I** (May 23)

- Microwave Components
- RF Propagation
- Field Survey
- 6 GHz Microwave Assurance

DAY 2: **Microwave Fundamentals Part II** (June 27)

- Path Reliability
- Path Design Considerations
- iQ·link — Microwave Design Software (Live Demo)

DAY 3: **Understanding the Frequency Coordination Process** (July 25)

- Interference Analysis
  - Microwave
  - Earth Station
- Frequency Planning & Protection
- FCC Licensing & Management
- Comsearch Connect - Customer Portal
- FCC Regulatory Updates (6 GHz, 80 GHz, 13 GHz)

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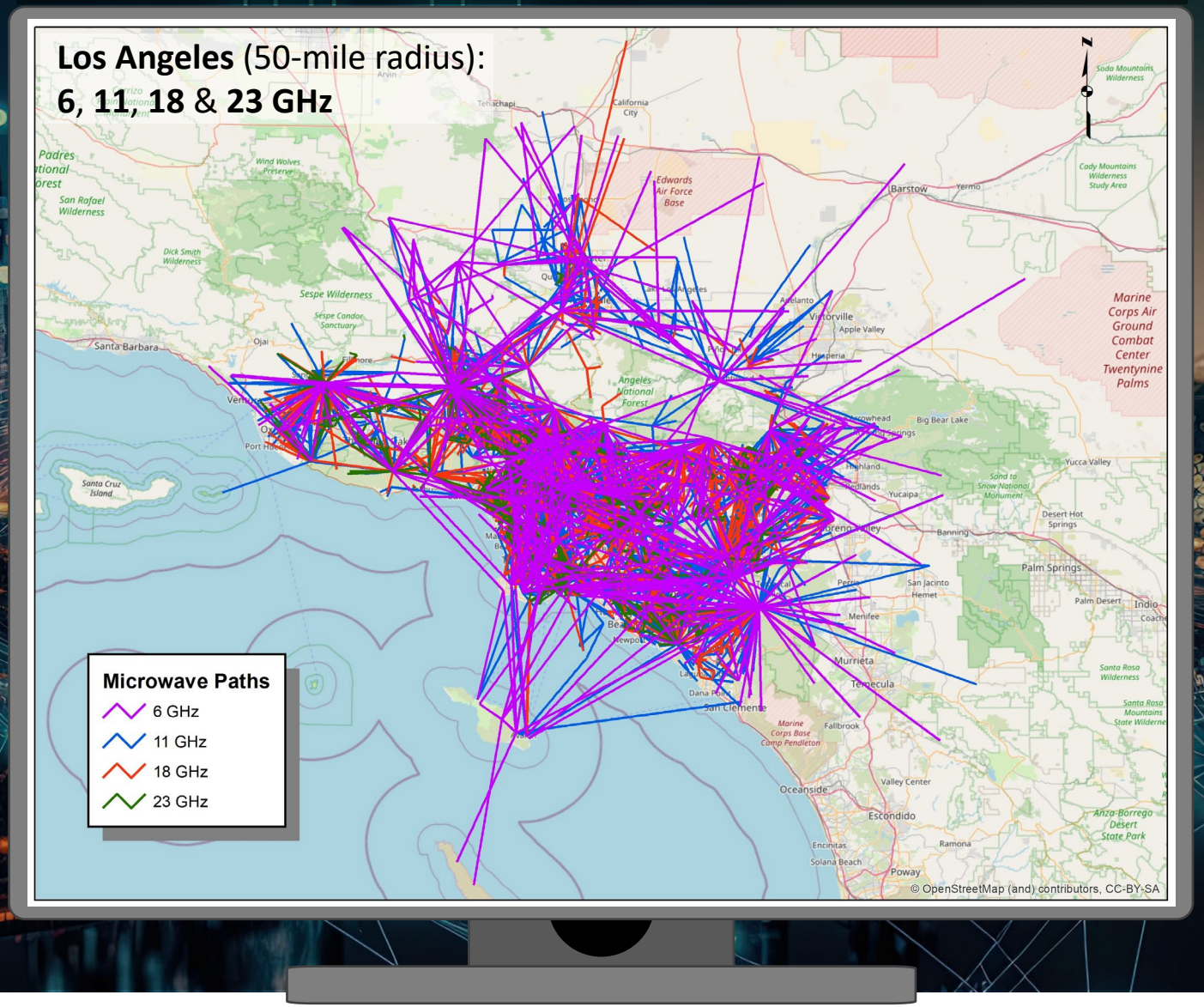
Understanding the Frequency Coordination Process

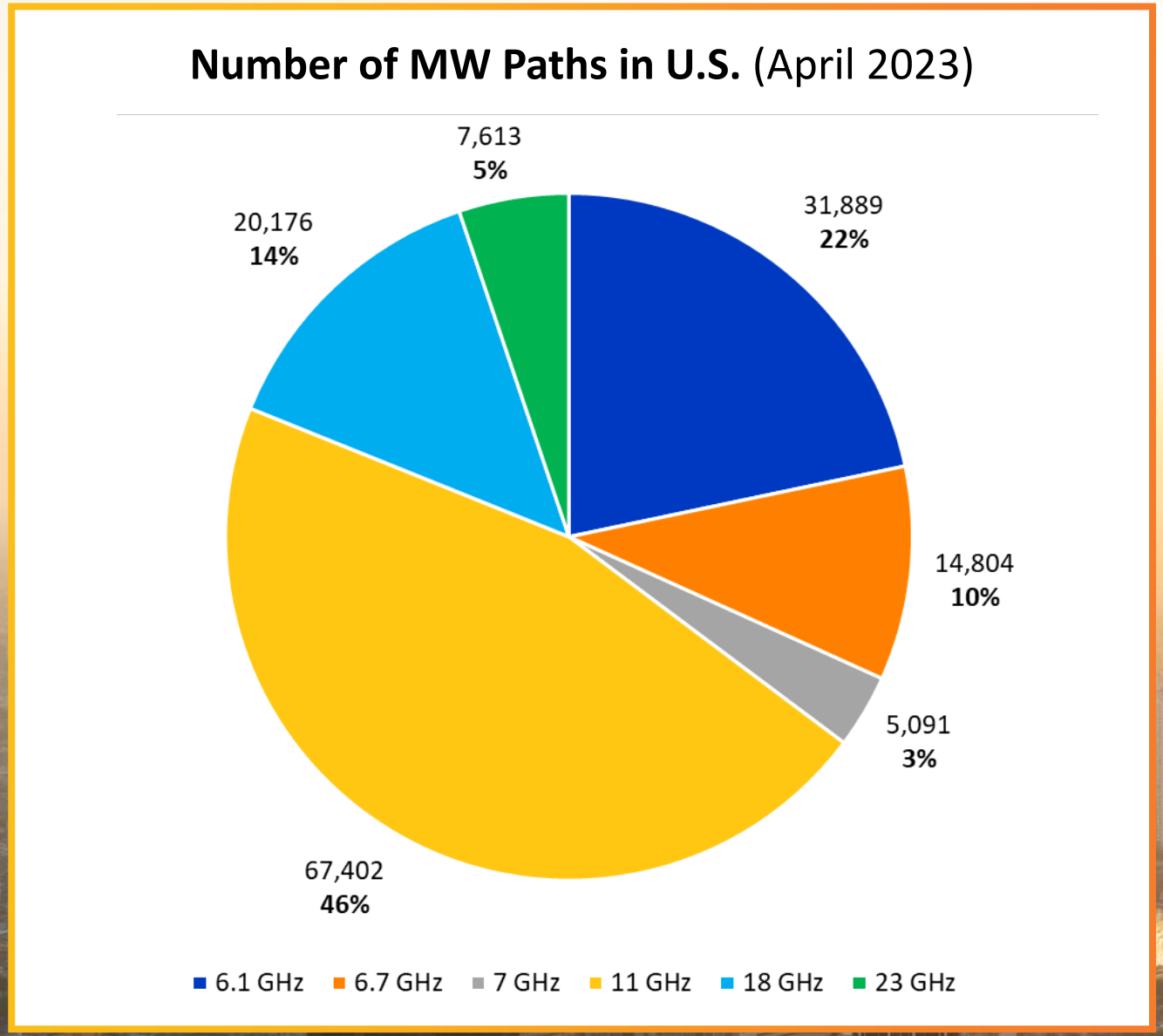
1. Interference Analysis

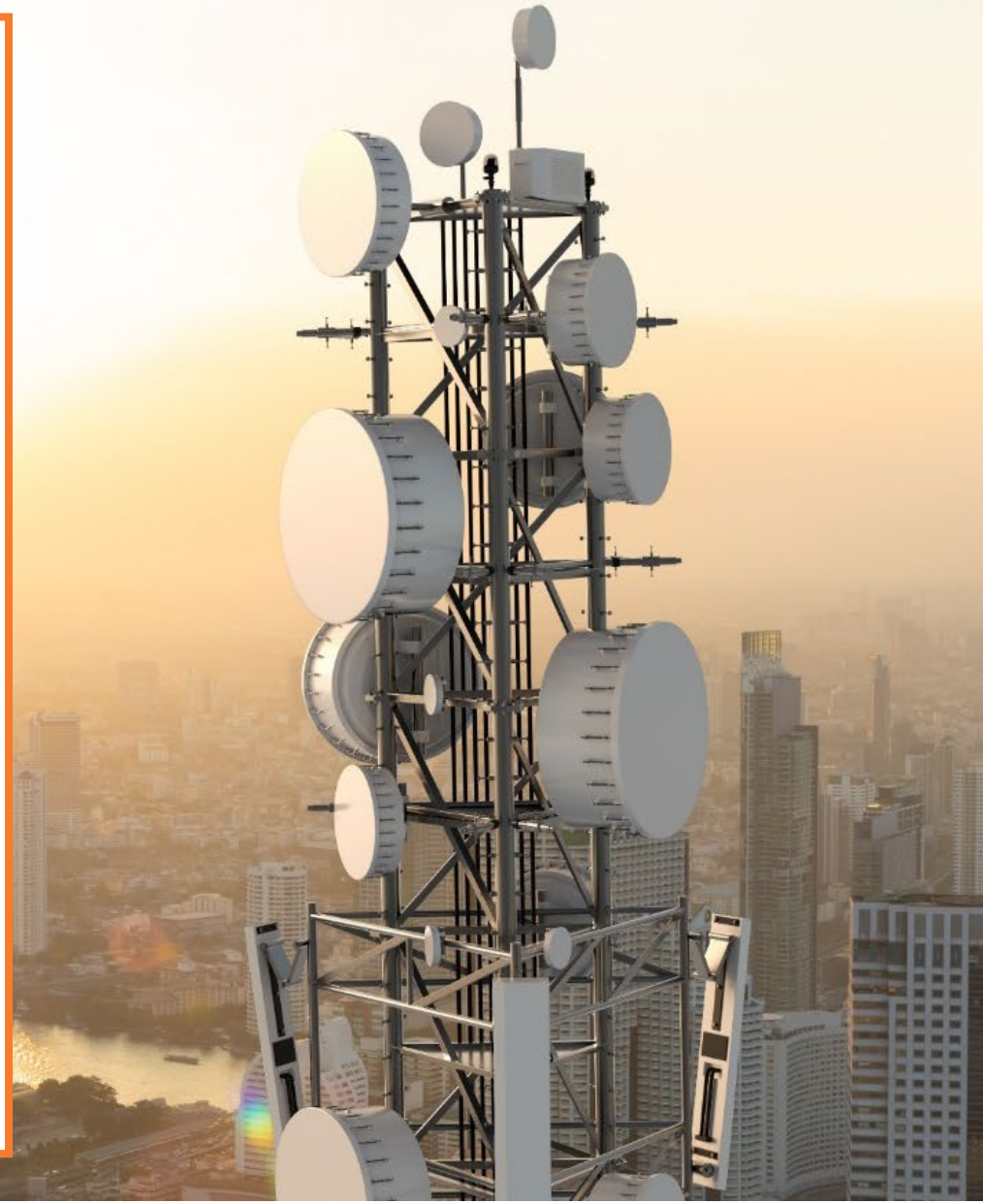
Greg Macey
Manager, Microwave

Why do you need an interference analysis?

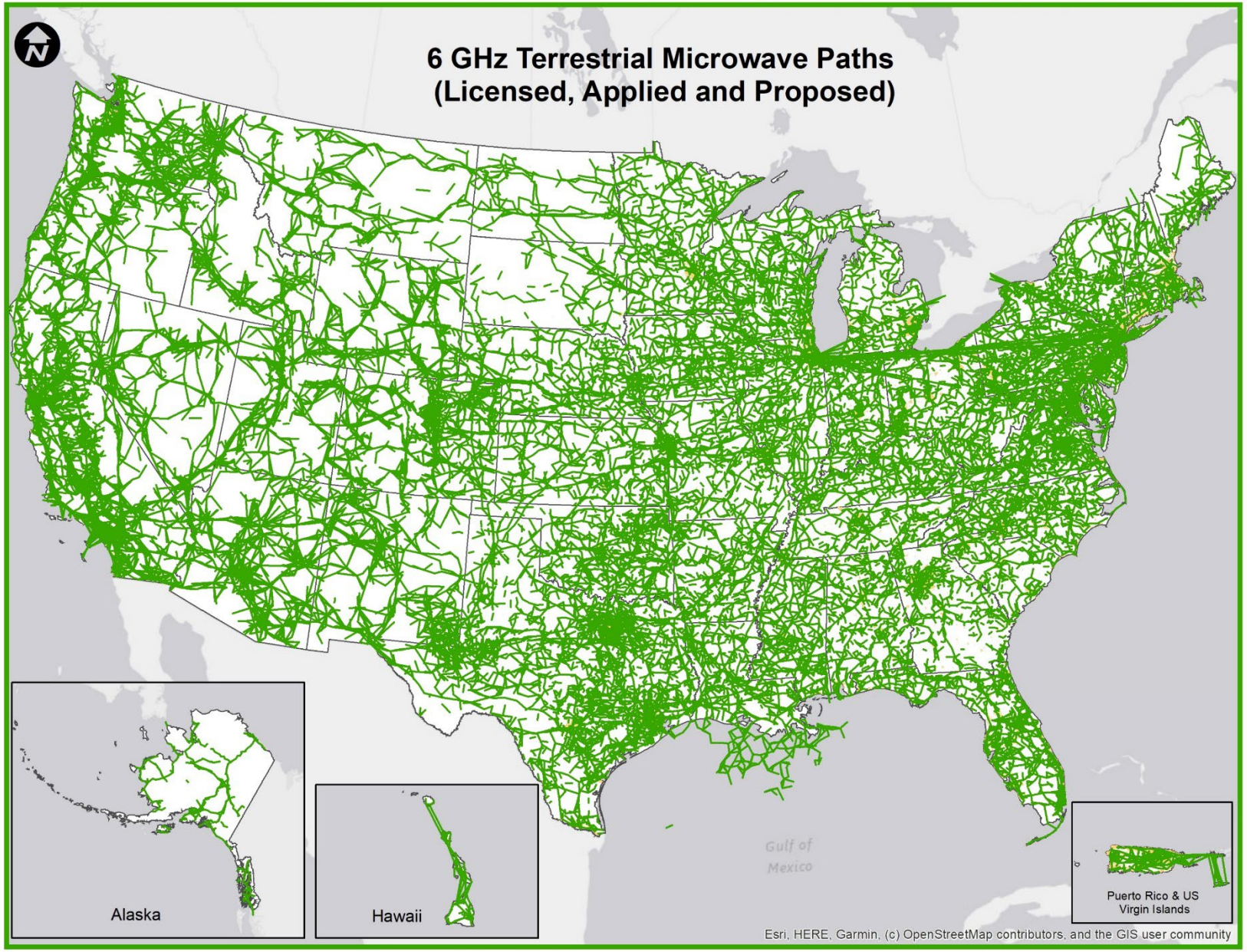


MICROWAVE PATH COUNTS BY BAND

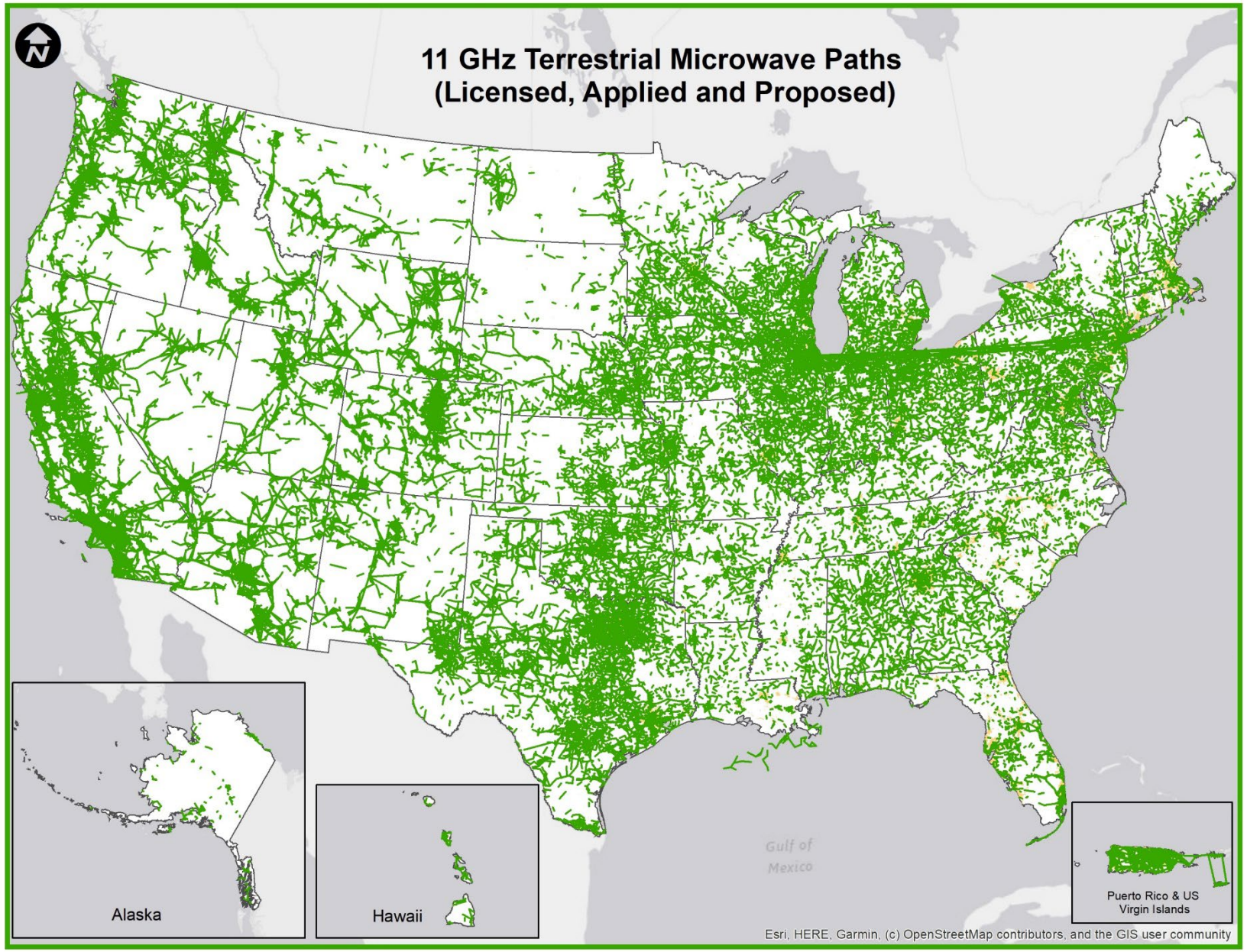




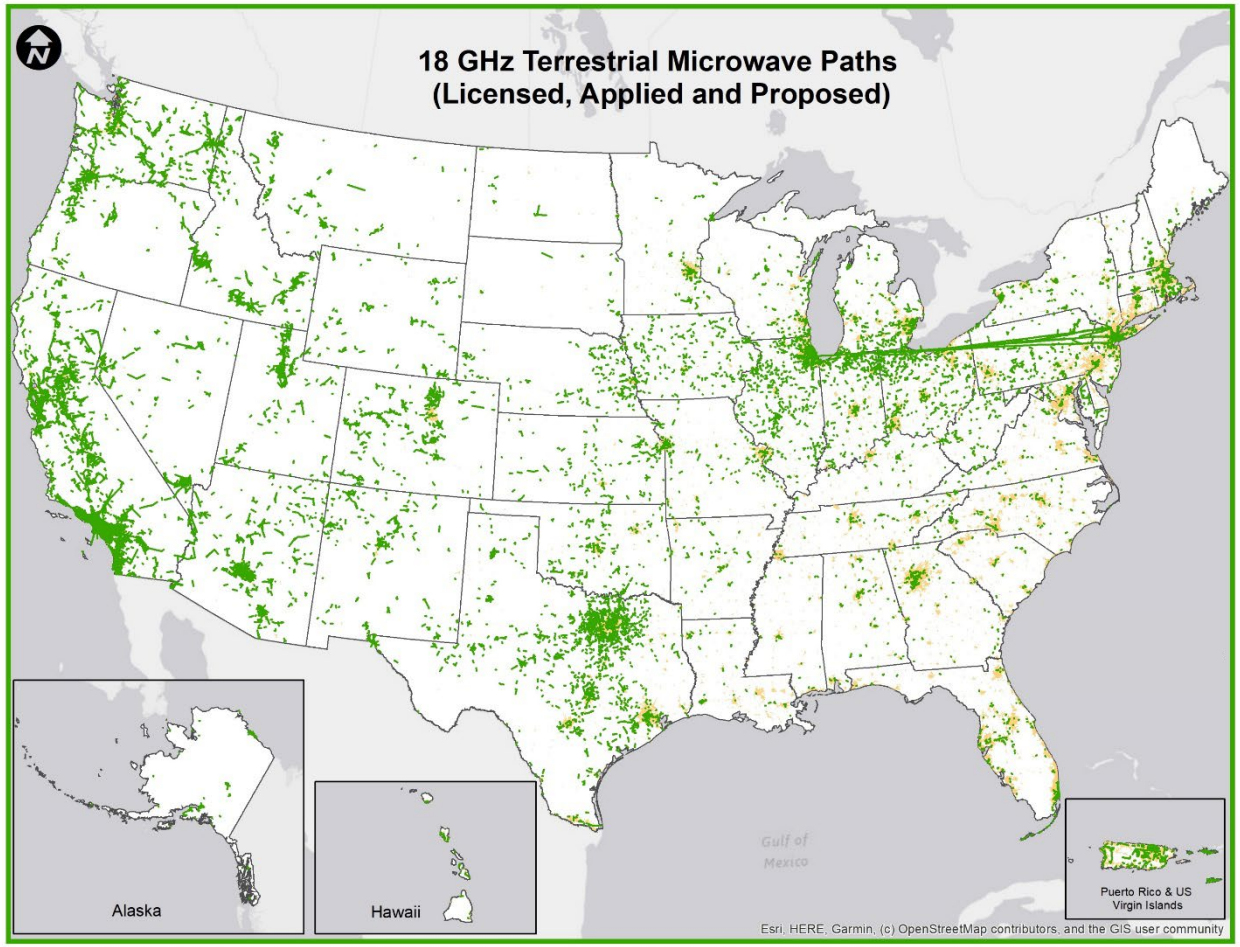
MICROWAVE PATHS IN THE U.S. — **6 GHZ BAND**

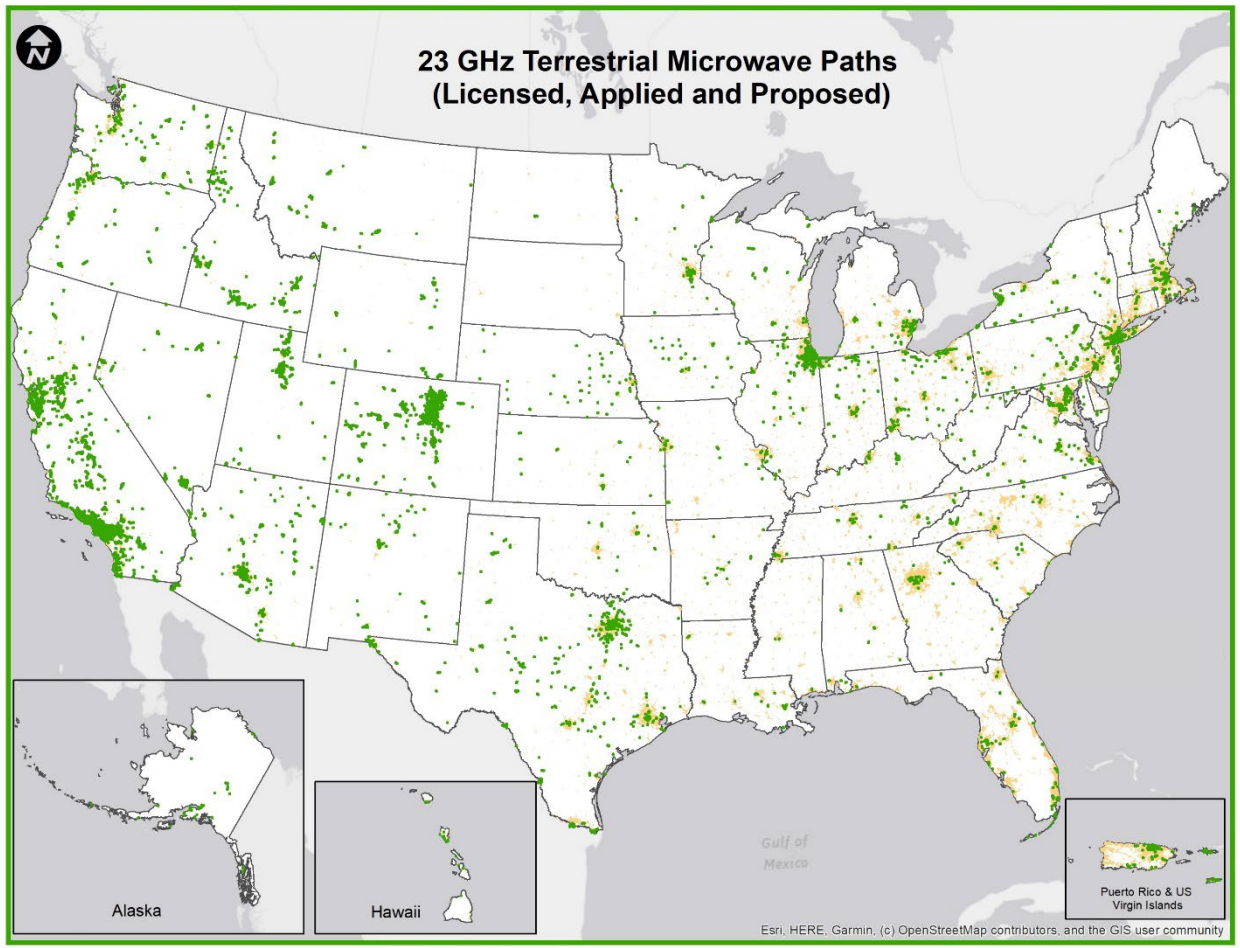


MICROWAVE PATHS IN THE U.S. — **11 GHZ BAND**

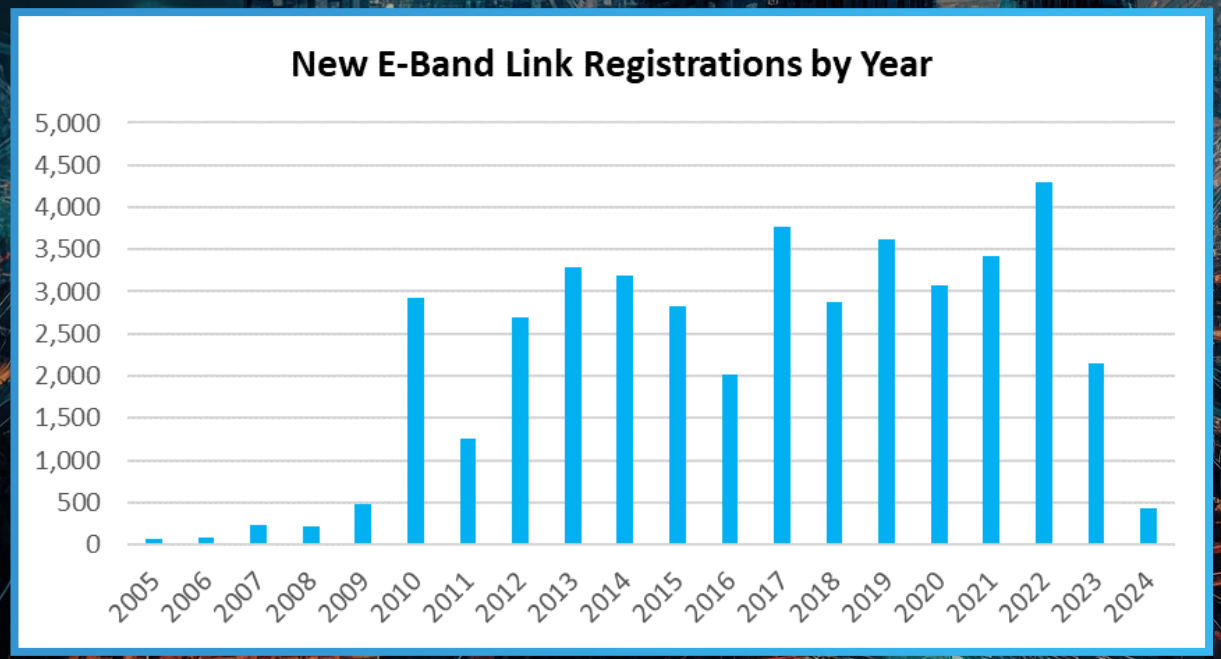


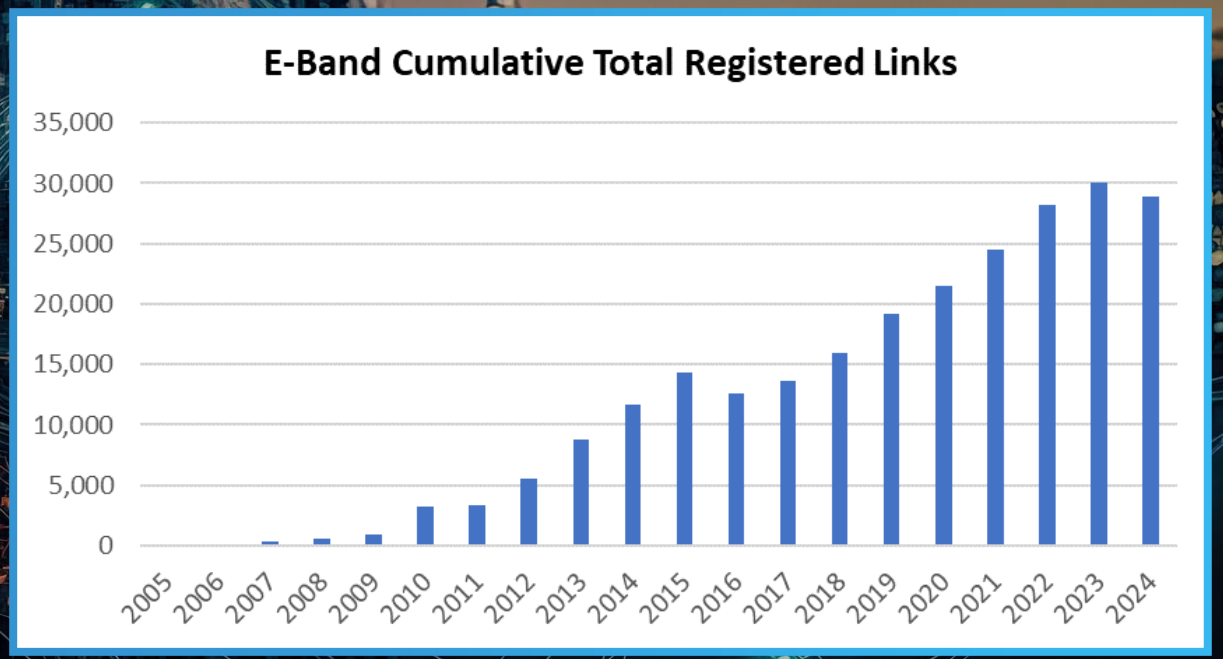
MICROWAVE PATHS IN THE U.S. — **18 & 23 GHZ BAND**



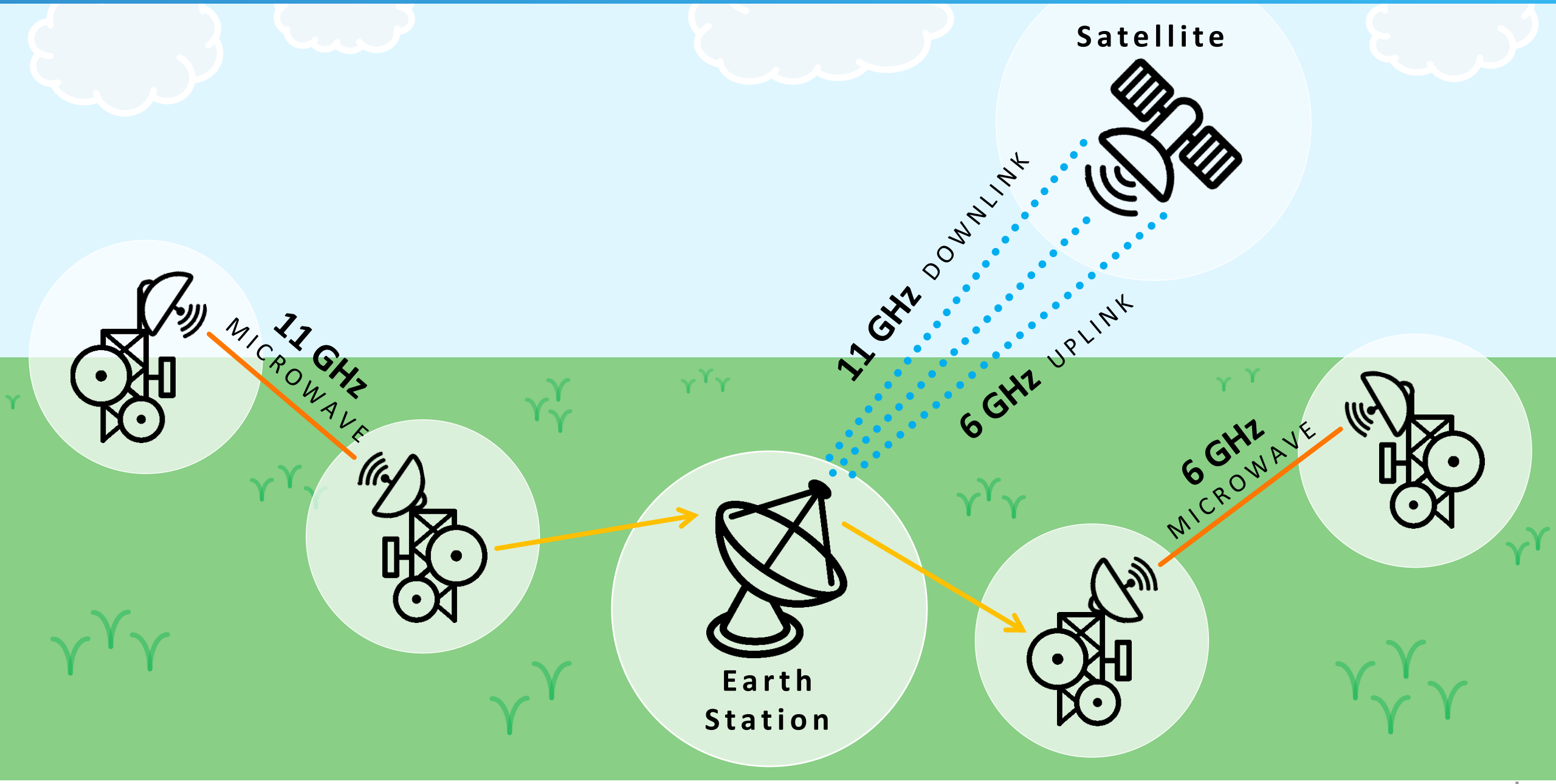


E-BAND (71-76 / 81-86 GHZ) LINK REGISTRATION GROWTH



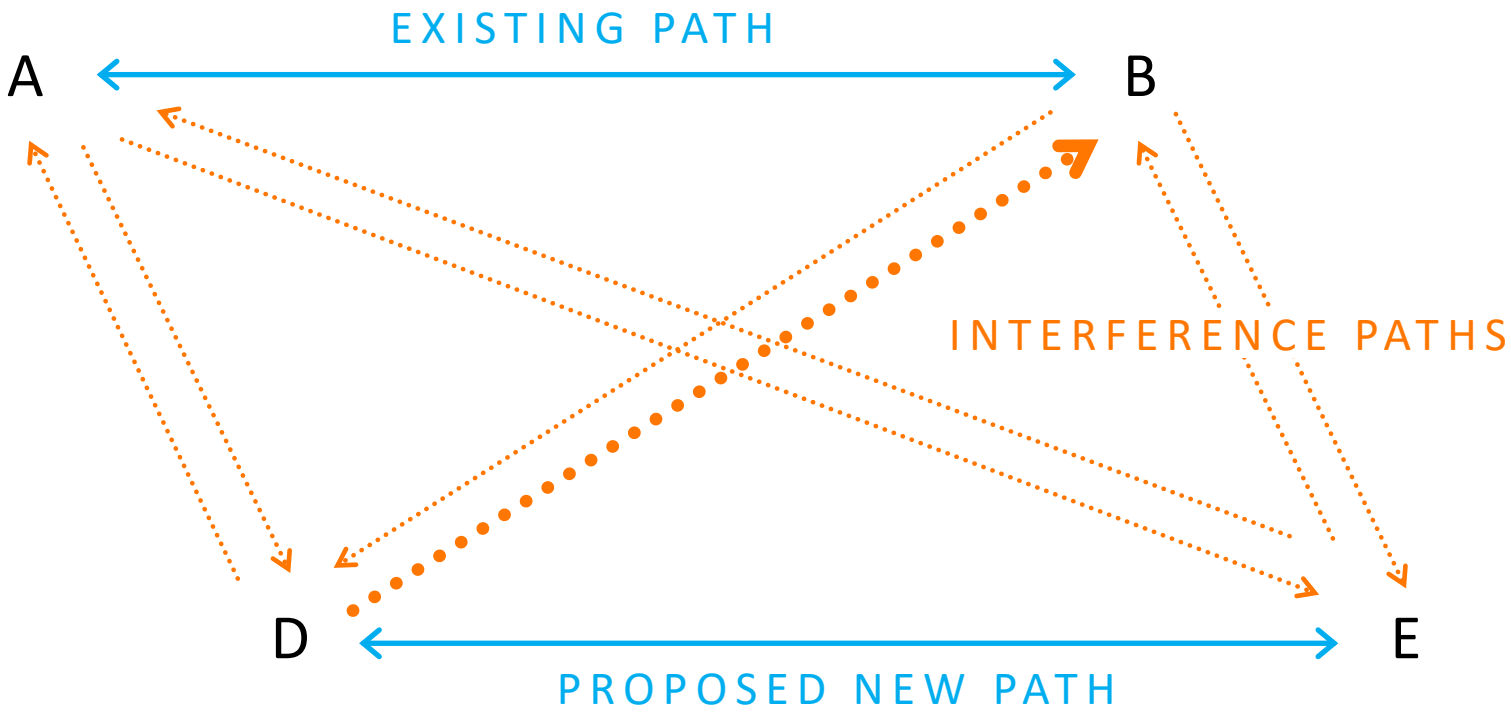


INTERFERENCE ANALYSIS | SOURCES



C/I → The ratio of desired signal power to interference power at the receiver

$$C/I = C(dBm) - I(dBm)$$

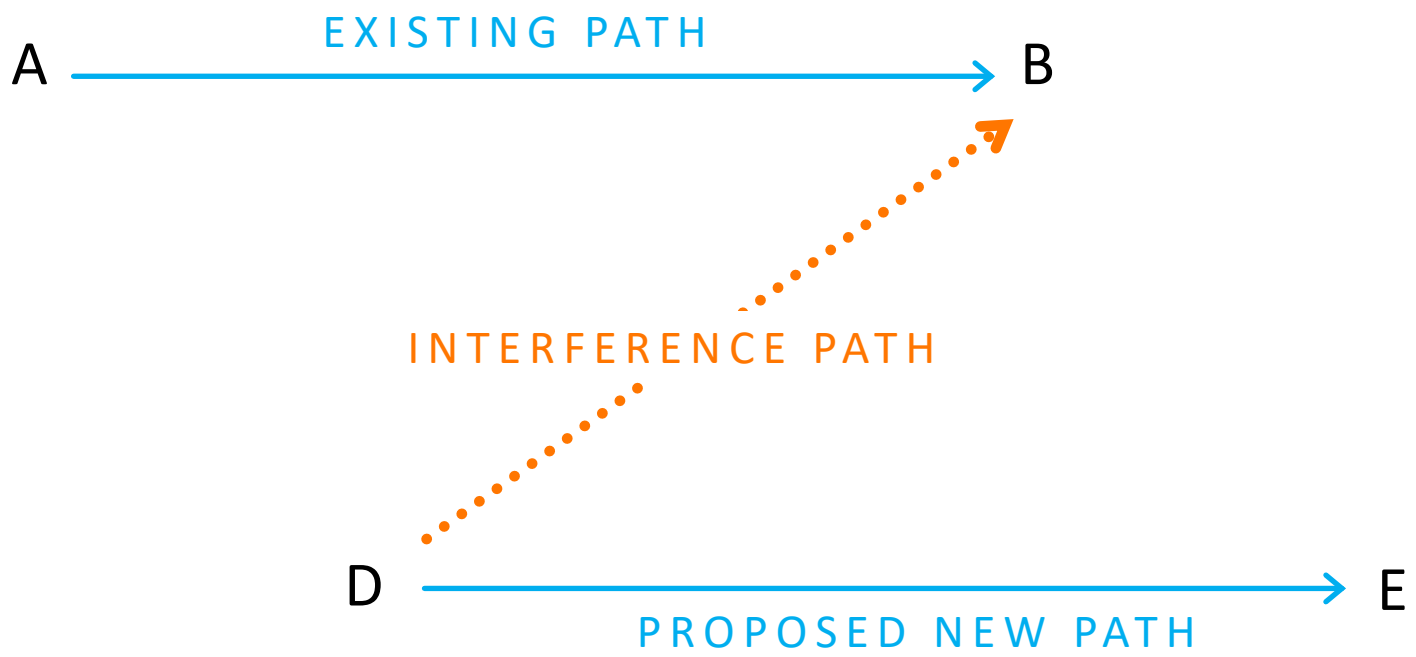


The interference path from **Site D to Site B** will be used as an ongoing example

$$C/I_{ACTUAL} = C_B - I_B$$

C = Receive signal level

I = Interference level



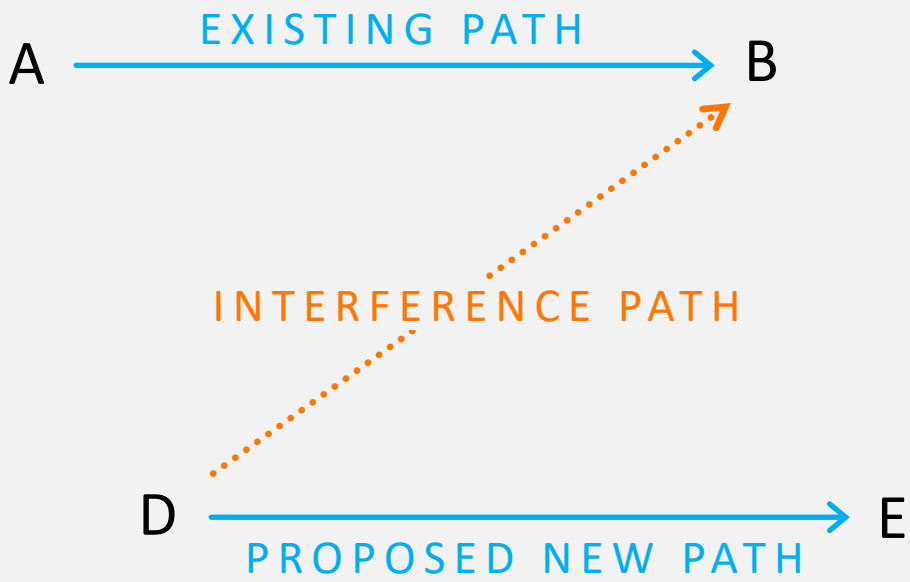
C/I Objective is the target criteria to satisfy a condition of non-interference

$C/I_{Objective} = C - T + T/I$

C = Receive level

T = Threshold

T/I = Threshold to interference value



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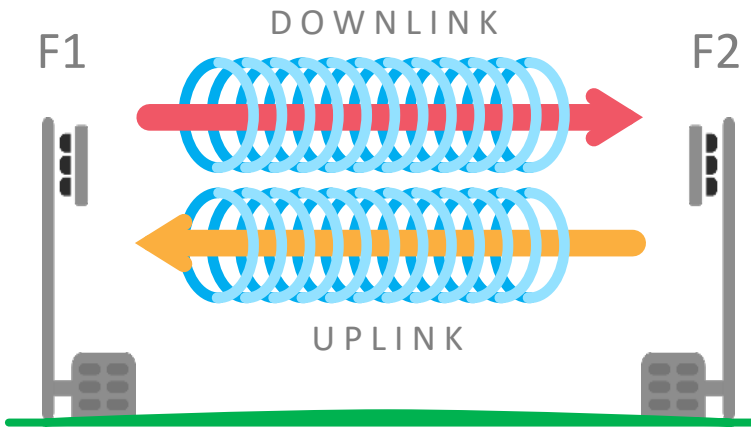
Understanding the Frequency Coordination Process

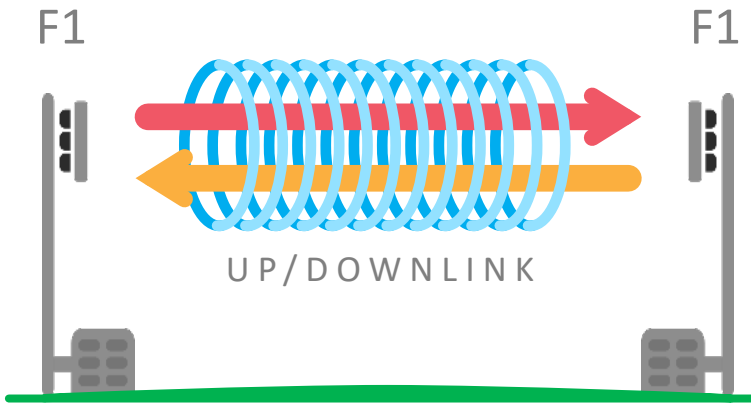
2. Frequency Planning & Protection

Greg Macey
Manager, Microwave



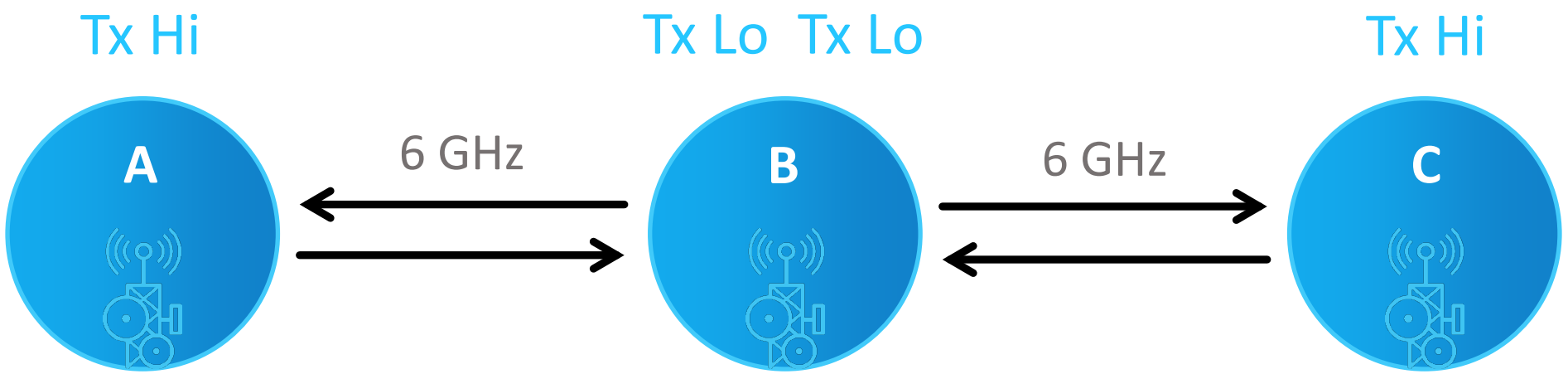
FDD

Microwave systems are typically ***Frequency Division Duplex*** where you have **different frequencies** at each end of the path



TDD

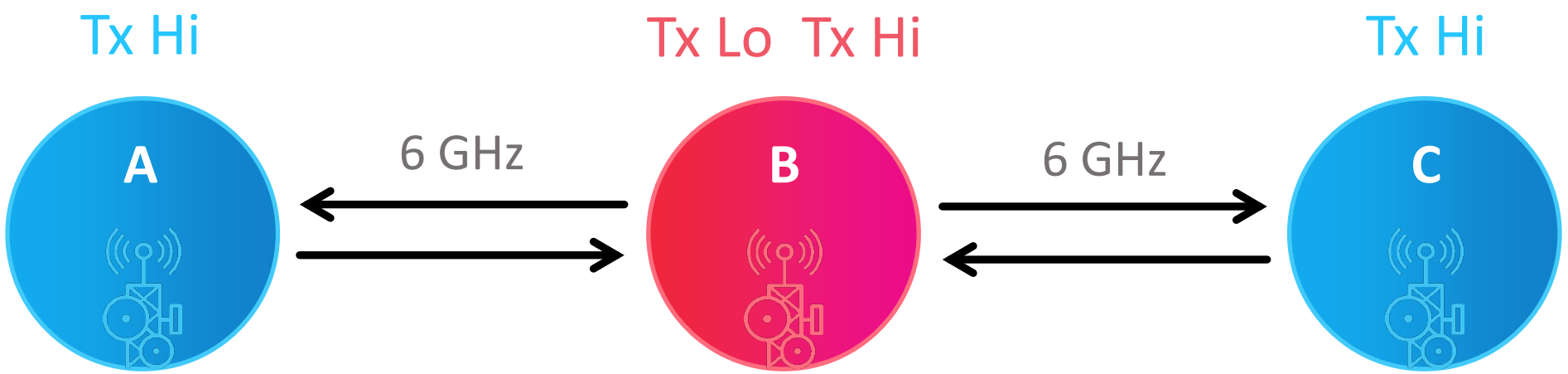
Conversely, ***Time Division Duplex*** systems transmit the **same frequency** at each end but in different time slots



HI / LO FREQUENCY PLAN

- Frequency separation between transmitters and receivers (T/R split)
- Established by industry or regulatory body
- Each site transmits in one half of the band (hi or lo) and receives in the opposite half of the band (lo or hi)
- Alternate Hi / Lo plan in tandem paths

FREQUENCY PLANNING | BUCKING



BUCKING = Transmit and receive on the **same side** of the frequency plan at a site

- Receiver possibly exposed to high interference level from collocated transmitter
- Interference calculations uncertain
- System expansion limited at bucking site
- Sufficient T/R separation required

Analyze against all licensed and planned systems

Identify interference-free frequencies

Green = **Clear by line of sight (LOS)**

Yellow = **Clear by terrain LOS**

Red = **Doesn't meet interference objective**

Blue = **Co-channel bucking**

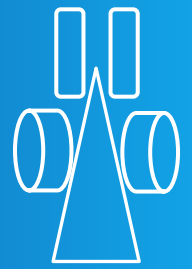
	Freq Plan - **J1**	11225.0000		11265.0000		11305.0000		11345.0000		11385.0000		11425.0000		11465.0000		11505.0000		11545.0000		11585.0000		11625.0000		11665.0000	
Path #	Polarization	V	H	V	H	V	H	V	H	V	H	V	H	V	H	V	H	V	H	V	H	V	H	V	H
1	JSY - **EQS**	•	X			X	•																		
2	JSY - **WAG**	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
3	**WAG** - 83D	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
4	**RIV** - FTL									X	•	•	X												
5	JSY - **55B**	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	Polarization	V	H	V	H	V	H	V	H	V	H	V	H	V	H	V	H	V	H	V	H	V	H	V	H
	Freq Plan - Q1	10735.0000		10775.0000		10815.0000		10855.0000		10895.0000		10935.0000		10975.0000		11015.0000		11055.0000		11095.0000		11135.0000		11175.0000	

FREQUENCY PLANNING | INTERFERENCE MITIGATION METHODS

FLIP
HI-LO PLAN

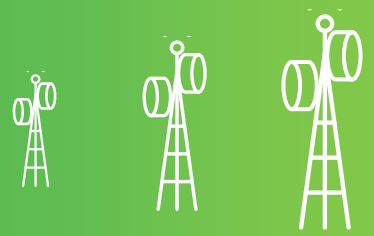
FREQUENCY /
POLARIZATION
OFFSET

TERRAIN
BLOCKAGE

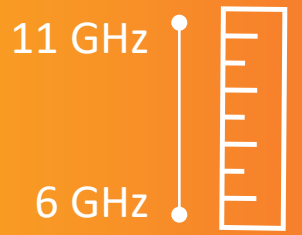


TRANSMIT
PADS OR ATPC

GROWTH CHANNEL
RELINQUISHMENT



ANTENNA
UPGRADES



DIFFERENT
FREQUENCY BAND

Avoid Licensing Problems

WARNINGS DOCUMENT

FCC rule
& technical
compliance

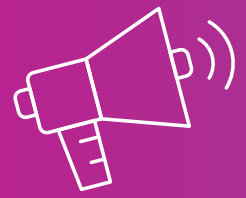
ASR REPORT

Identify nearby
registered
towers (ASRs)

CALL SIGN REPORT

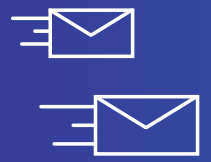
Match existing
FCC
call signs

FREQUENCY PLANNING | PRIOR COORDINATION NOTICE (PCN)



1
NOTIFICATION

Notify all potentially affected parties



2
RESPONSE

Parties have 30 days to respond

3
RESOLUTION

Resolve interference concerns

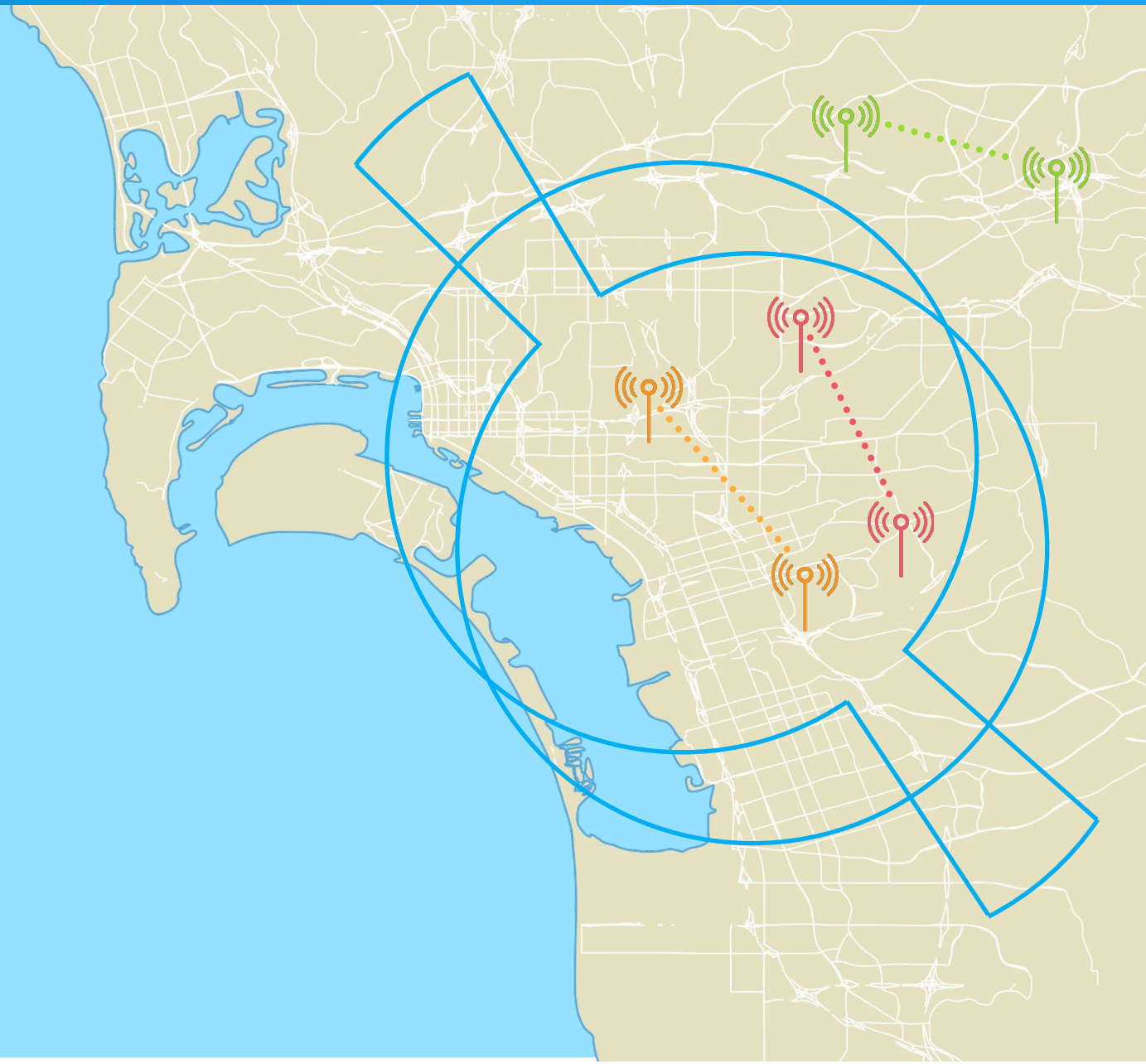
Coordination Area

keyhole within 5 degrees
of antenna main beam azimuth

Coordination Recipients

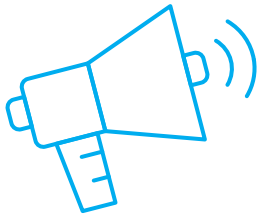
licensed, applied and proposed
microwave and earth station systems

Frequency (GHz)	Radius (mi)	Keyhole (mi)
< 15	125	250
> 15	80	150



1 MONITOR

Analyze PCNs against existing paths



2 REPORT CASES

Notify all impacted parties

3 RESOLUTION

Resolve interference concerns

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Understanding the Frequency Coordination Process

3. FCC Licensing & Management

Greg Macey
Manager, Microwave

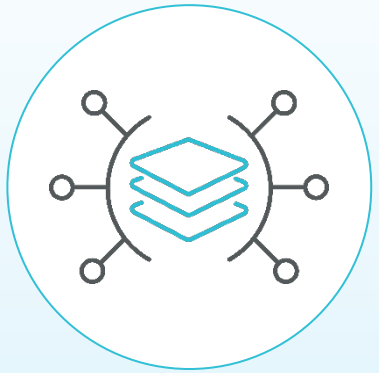
FCC FILING | APPLICATION FILING

Microwave paths **require** FCC Licensing

FCC microwave database is **site-based**

FCC FORM 601

ULS (Universal Licensing System)



Application includes **main** and up to **4 supplemental schedules**

Time to complete one FCC application is **1.25 hours**

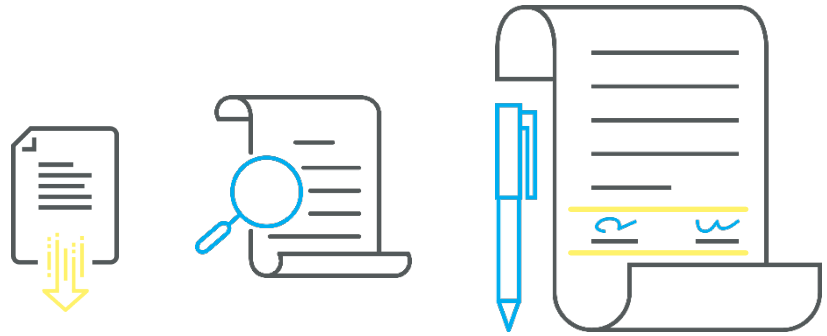
Proof of frequency coordination (supplemental showing)

*Over **52,000 applications** filed in last **3 years***

Preparation for Filing FCC Form 601

PATH DATASHEET

APPLICATION



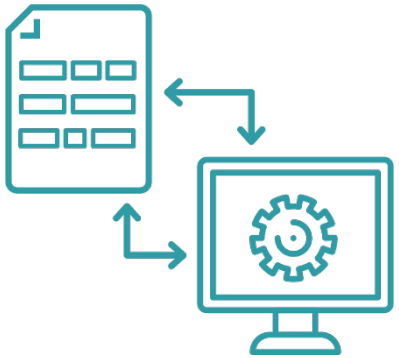
SUPPLEMENTAL SHOWING

LICENSE

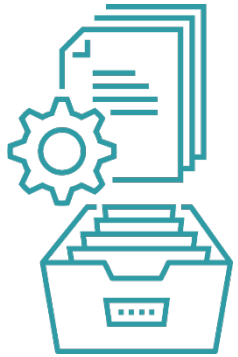
FCC Form 601 Batch Filing Advantages

Faster!

***No** typographical errors*



*Direct **data transfer** from microwave database **into form***



*Multiple FCC applications **filed simultaneously***

FORM 601, SCHEDULE K

Completion of Construction (COC)

FINAL STEP
OF
FCC Licensing

PROVIDE
construction date
FOR EACH
path + frequency

AUTOMATIC
TERMINATION
IF NOT FILED

PATH MUST BE **OPERATIONAL**
within **18** months
FROM **LICENSE GRANT DATE**

- 101.31 Conditional Authorization
- 101.63 Construction Period
- 101.103 Frequency Coordination Procedures
- 101.109 Maximum Allowed Bandwidth
- 101.113 Maximum EIRP
- 101.115 Antenna Standards
- 101.141 Modulation / Bit Efficiency
- 101.143 EIRP Limitations on Short Paths
- 101.145 Interference into Geostationary Satellites
- 101.147 Frequency Tables
- 1.924 Quiet Zones
- 1.929 Major versus Minor Filings

REFERENCE | USEFUL LINKS

- Universal Licensing System (ULS): https://www.fcc.gov/wireless/universal-licensing-system
- FCC License Search: https://wireless2.fcc.gov/UlsApp/UlsSearch/searchLicense.jsp
- ASR Home: https://www.fcc.gov/wireless/systems-utilities/antenna-structure-registration
- ASR Determination: https://wireless2.fcc.gov/UlsApp/AsrSearch/towairSearch.jsp
- FCC Rules part 101 online: https://www.ecfr.gov/current/title-47/chapter-I/subchapter-D/part-101?toc=1 (click parts 80-199 and then part 101)
- National Spectrum Management Association: https://www.nsma.org/
- Fixed Wireless Communications Coalition: https://www.fwcc.us/index.html
- Path Design, Frequency Coordination and Licensing: https://www.comsearch.com/services/frequency-coordination-licensing/microwave/

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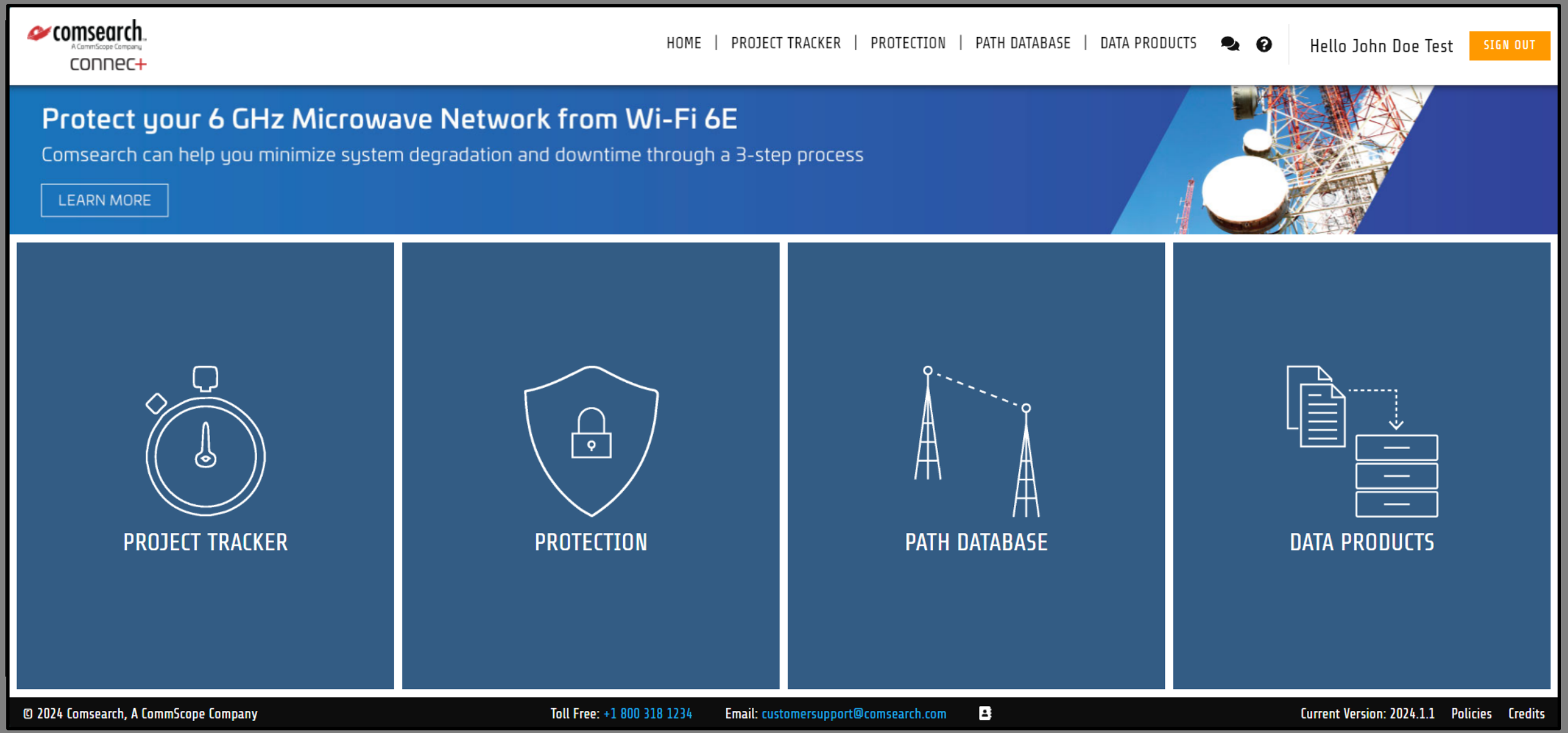
Understanding the Frequency Coordination Process

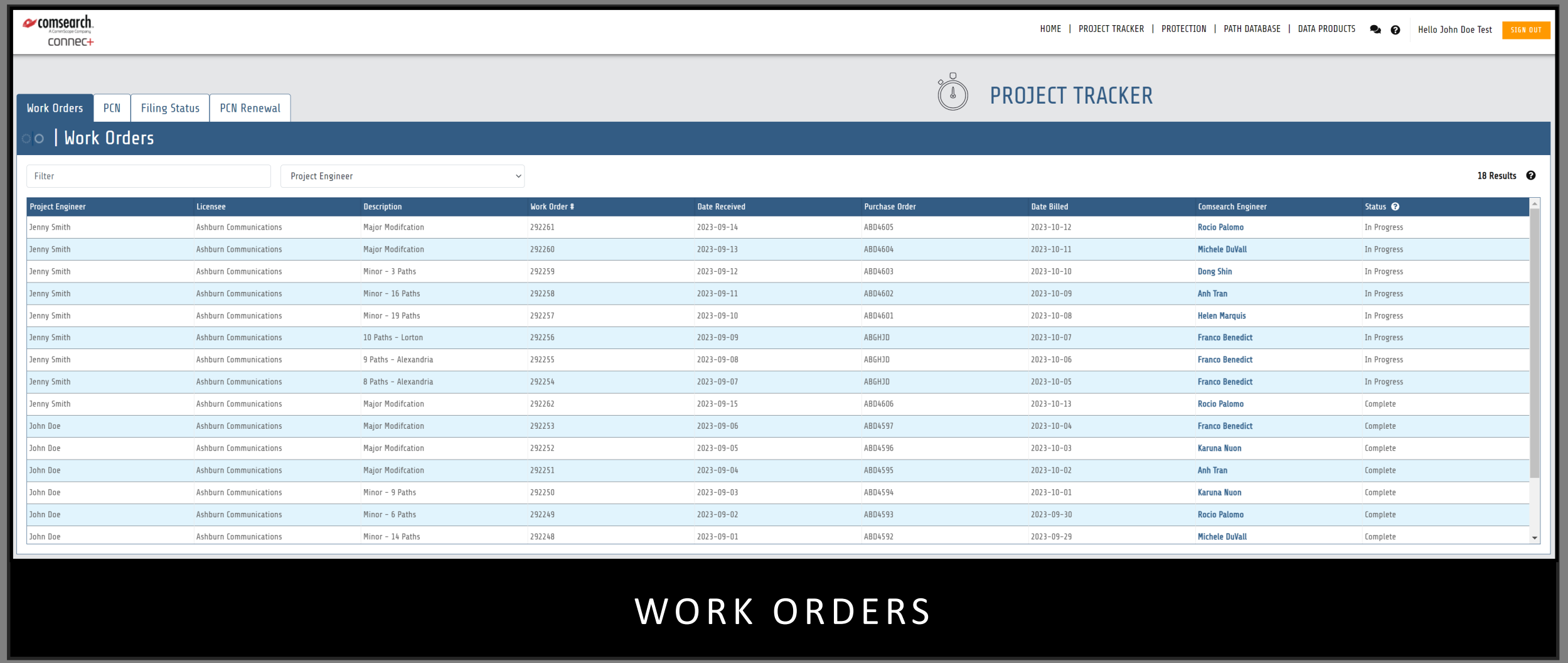
4. Comsearch Connect — Customer Portal

Greg Macey
Manager, Microwave

COMSEARCH CONNECT | CUSTOMER PORTAL



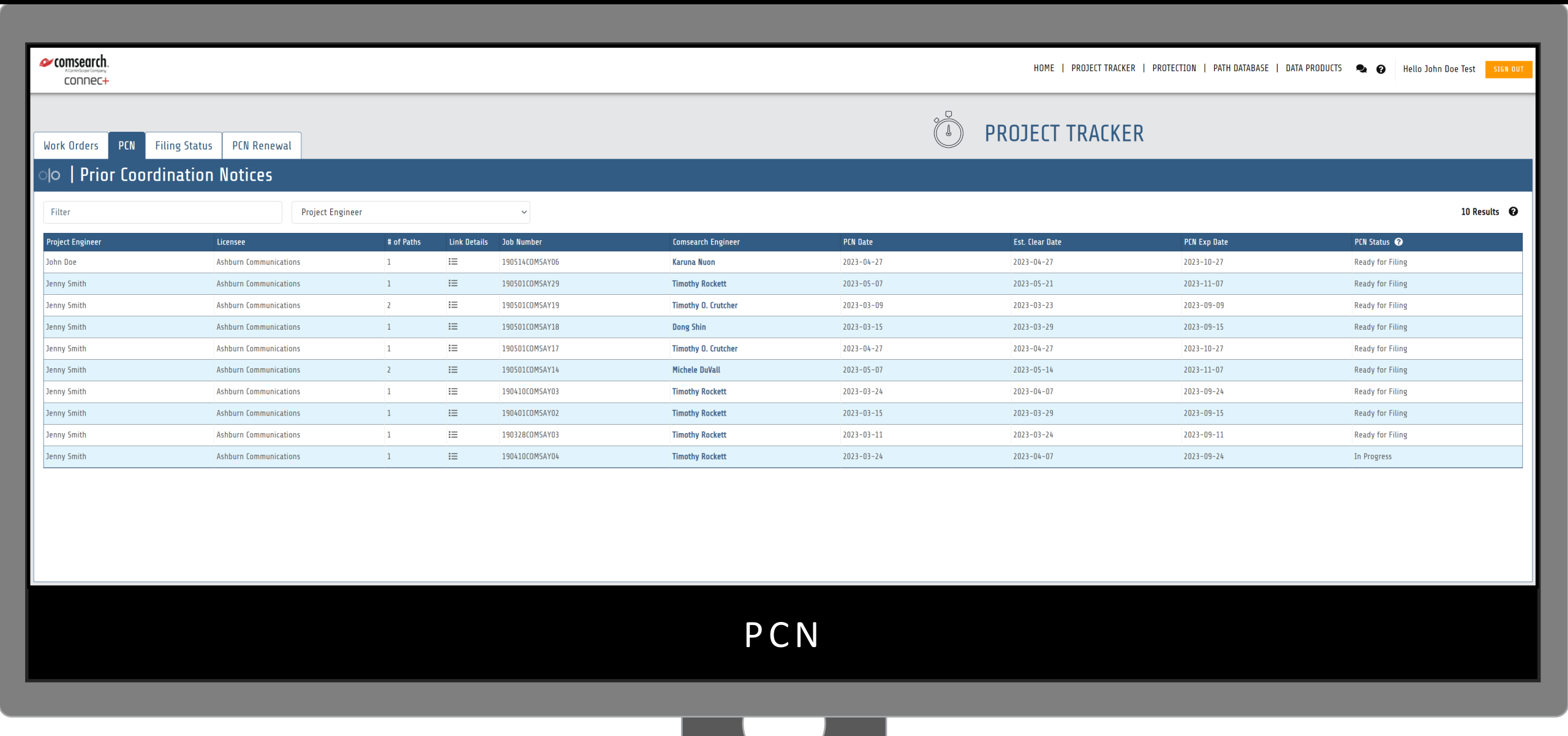
COMSEARCH CONNECT | CUSTOMER PORTAL



Project Engineer	Licensee	Description	Work Order #	Date Received	Purchase Order	Date Billed	Comsearch Engineer	Status
Jenny Smith	Ashburn Communications	Major Modifcation	292261	2023-09-14	ABD4605	2023-10-12	Rocio Palomo	In Progress
Jenny Smith	Ashburn Communications	Major Modifcation	292260	2023-09-13	ABD4604	2023-10-11	Michele DuVall	In Progress
Jenny Smith	Ashburn Communications	Minor - 3 Paths	292259	2023-09-12	ABD4603	2023-10-10	Dong Shin	In Progress
Jenny Smith	Ashburn Communications	Minor - 16 Paths	292258	2023-09-11	ABD4602	2023-10-09	Anh Tran	In Progress
Jenny Smith	Ashburn Communications	Minor - 19 Paths	292257	2023-09-10	ABD4601	2023-10-08	Helen Marquis	In Progress
Jenny Smith	Ashburn Communications	10 Paths - Lorton	292256	2023-09-09	ABGHJD	2023-10-07	Franco Benedict	In Progress
Jenny Smith	Ashburn Communications	9 Paths - Alexandria	292255	2023-09-08	ABGHJD	2023-10-06	Franco Benedict	In Progress
Jenny Smith	Ashburn Communications	8 Paths - Alexandria	292254	2023-09-07	ABGHJD	2023-10-05	Franco Benedict	In Progress
Jenny Smith	Ashburn Communications	Major Modifcation	292262	2023-09-15	ABD4606	2023-10-13	Rocio Palomo	Complete
John Doe	Ashburn Communications	Major Modifcation	292253	2023-09-06	ABD4597	2023-10-04	Franco Benedict	Complete
John Doe	Ashburn Communications	Major Modifcation	292252	2023-09-05	ABD4596	2023-10-03	Karuna Nuon	Complete
John Doe	Ashburn Communications	Major Modifcation	292251	2023-09-04	ABD4595	2023-10-02	Anh Tran	Complete
John Doe	Ashburn Communications	Minor - 9 Paths	292250	2023-09-03	ABD4594	2023-10-01	Karuna Nuon	Complete
John Doe	Ashburn Communications	Minor - 6 Paths	292249	2023-09-02	ABD4593	2023-09-30	Rocio Palomo	Complete
John Doe	Ashburn Communications	Minor - 14 Paths	292248	2023-09-01	ABD4592	2023-09-29	Michele DuVall	Complete

WORK ORDERS

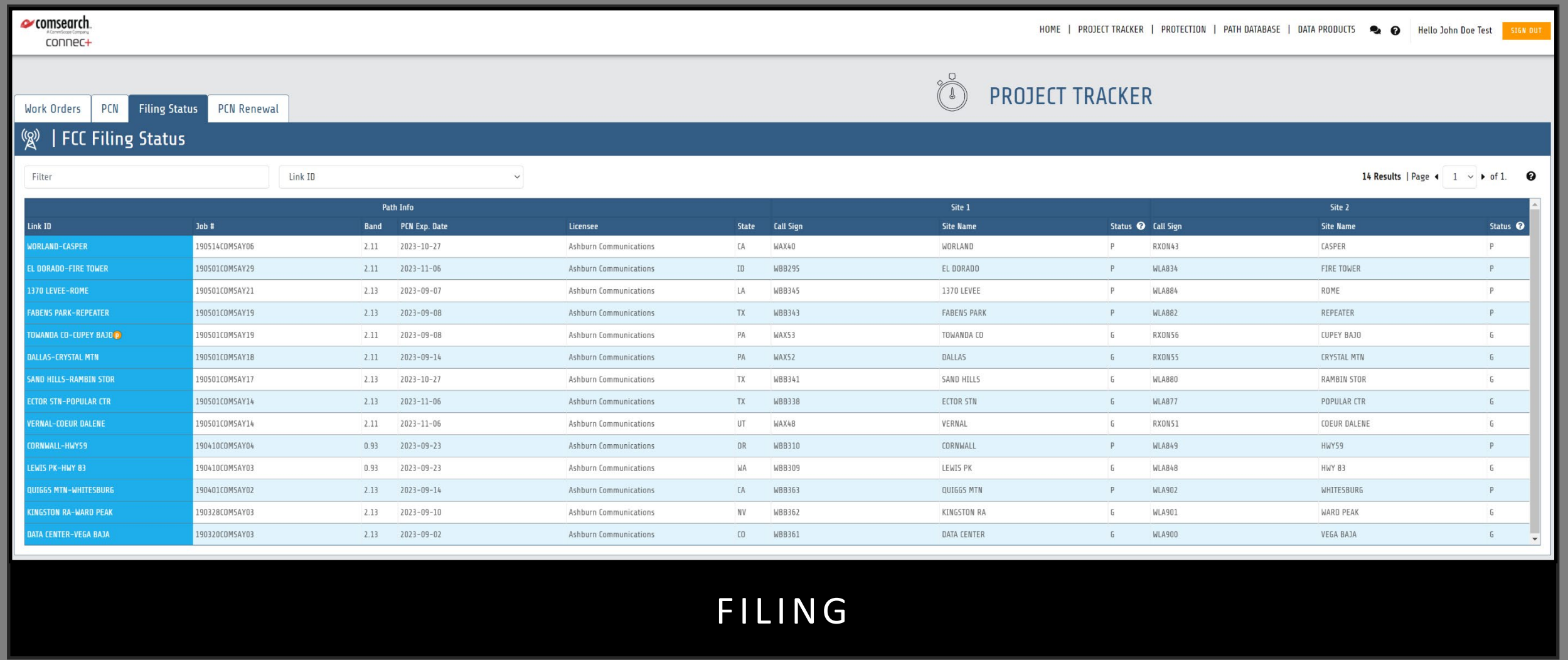
COMSEARCH CONNECT | CUSTOMER PORTAL



Project Engineer	Licensee	# of Paths	Link Details	Job Number	Comsearch Engineer	PCN Date	Est. Clear Date	PCN Exp Date	PCN Status
John Doe	Ashburn Communications	1		190514COMSAY06	Karuna Nuon	2023-04-27	2023-04-27	2023-10-27	Ready for Filing
Jenny Smith	Ashburn Communications	1		190501COMSAY29	Timothy Rockett	2023-05-07	2023-05-21	2023-11-07	Ready for Filing
Jenny Smith	Ashburn Communications	2		190501COMSAY19	Timothy O. Crutcher	2023-03-09	2023-03-23	2023-09-09	Ready for Filing
Jenny Smith	Ashburn Communications	1		190501COMSAY18	Dong Shin	2023-03-15	2023-03-29	2023-09-15	Ready for Filing
Jenny Smith	Ashburn Communications	1		190501COMSAY17	Timothy O. Crutcher	2023-04-27	2023-04-27	2023-10-27	Ready for Filing
Jenny Smith	Ashburn Communications	2		190501COMSAY14	Michele DuVall	2023-05-07	2023-05-14	2023-11-07	Ready for Filing
Jenny Smith	Ashburn Communications	1		190410COMSAY03	Timothy Rockett	2023-03-24	2023-04-07	2023-09-24	Ready for Filing
Jenny Smith	Ashburn Communications	1		190401COMSAY02	Timothy Rockett	2023-03-15	2023-03-29	2023-09-15	Ready for Filing
Jenny Smith	Ashburn Communications	1		190328COMSAY03	Timothy Rockett	2023-03-11	2023-03-24	2023-09-11	Ready for Filing
Jenny Smith	Ashburn Communications	1		190410COMSAY04	Timothy Rockett	2023-03-24	2023-04-07	2023-09-24	In Progress

PCN

COMSEARCH CONNECT | CUSTOMER PORTAL



Path Info						Site 1			Site 2		
Link ID	Job #	Band	PCN Exp. Date	Licensee	State	Call Sign	Site Name	Status	Call Sign	Site Name	Status
WORLAND-CASPER	190514COMSAY06	2.11	2023-10-27	Ashburn Communications	CA	WAX40	WORLAND	P	RXON43	CASPER	P
EL DORADO-FIRE TOWER	190501COMSAY29	2.11	2023-11-06	Ashburn Communications	ID	WBB295	EL DORADO	P	WLA834	FIRE TOWER	P
1370 LEVEE-ROME	190501COMSAY21	2.13	2023-09-07	Ashburn Communications	LA	WBB345	1370 LEVEE	P	WLA884	ROME	P
FABENS PARK-REPEATER	190501COMSAY19	2.13	2023-09-08	Ashburn Communications	TX	WBB343	FABENS PARK	P	WLA882	REPEATER	P
TOWANDA CO-CUPEY BAJO	190501COMSAY19	2.11	2023-09-08	Ashburn Communications	PA	WAX53	TOWANDA CO	G	RXON56	CUPEY BAJO	G
DALLAS-CRYSTAL MTN	190501COMSAY18	2.11	2023-09-14	Ashburn Communications	PA	WAX52	DALLAS	G	RXON55	CRYSTAL MTN	G
SAND HILLS-RAMBIN STOR	190501COMSAY17	2.13	2023-10-27	Ashburn Communications	TX	WBB341	SAND HILLS	G	WLA880	RAMBIN STOR	G
ECTOR STN-POPULAR CTR	190501COMSAY14	2.13	2023-11-06	Ashburn Communications	TX	WBB338	ECTOR STN	G	WLA877	POPULAR CTR	G
VERNAL-COEUR DALENE	190501COMSAY14	2.11	2023-11-06	Ashburn Communications	UT	WAX48	VERNAL	G	RXON51	COEUR DALENE	G
CORNWALL-HWY59	190410COMSAY04	0.93	2023-09-23	Ashburn Communications	OR	WBB310	CORNWALL	P	WLA849	HWY59	P
LEWIS PK-HWY 83	190410COMSAY03	0.93	2023-09-23	Ashburn Communications	WA	WBB309	LEWIS PK	G	WLA848	HWY 83	G
QUIGGS MTN-WHITESBURG	190401COMSAY02	2.13	2023-09-14	Ashburn Communications	CA	WBB363	QUIGGS MTN	P	WLA902	WHITESBURG	P
KINGSTON RA-WARD PEAK	190328COMSAY03	2.13	2023-09-10	Ashburn Communications	NV	WBB362	KINGSTON RA	G	WLA901	WARD PEAK	G
DATA CENTER-VEGA BAJA	190320COMSAY03	2.13	2023-09-02	Ashburn Communications	CO	WBB361	DATA CENTER	G	WLA900	VEGA BAJA	G

FILING

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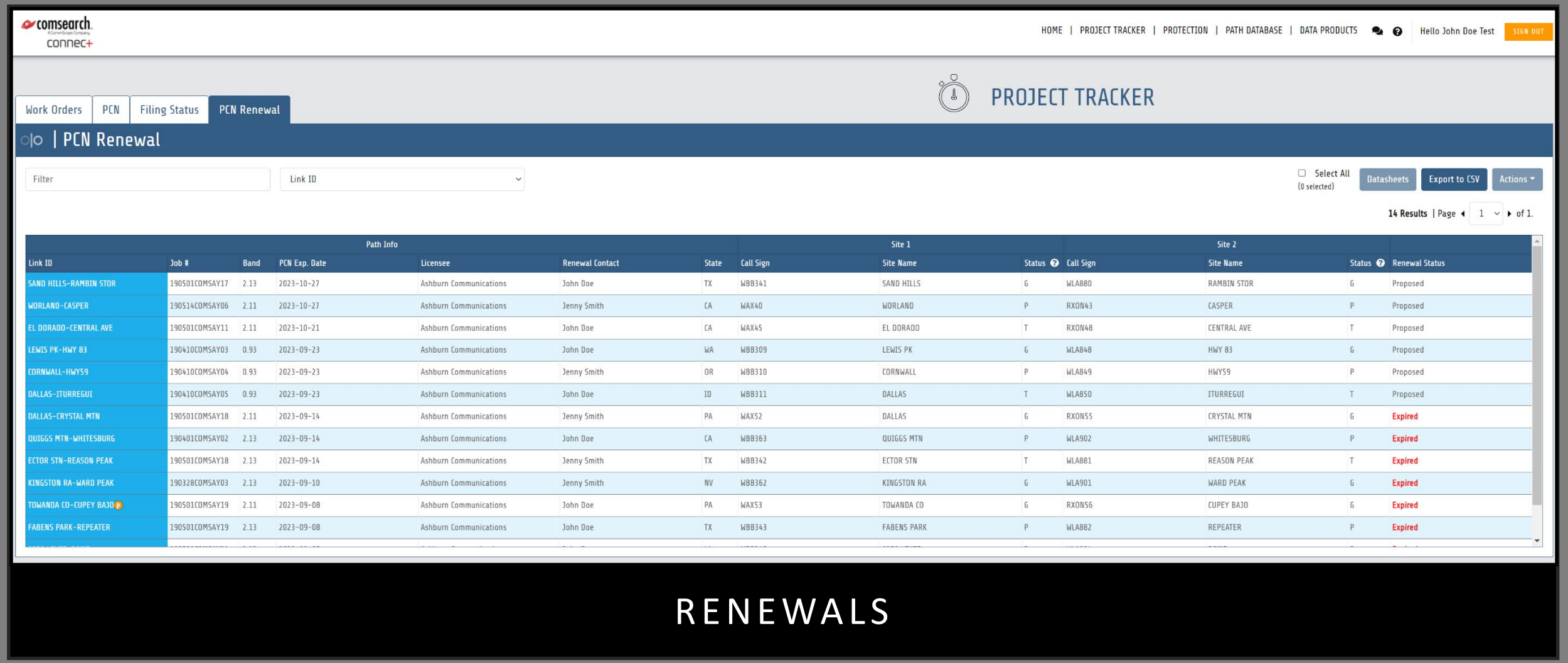

Path Info							Site 1			Site 2			
Link ID	Job #	Band	PCN Exp. Date	Licensee	Renewal Contact	State	Call Sign	Site Name	Status	Call Sign	Site Name	Status	Renewal Status
SAND HILLS-RAMBIN STOR	190501COMSAY17	2.13	2023-10-27	Ashburn Communications	John Doe	TX	WBB341	SAND HILLS	G	WLA880	RAMBIN STOR	G	Proposed
WORLAND-CASPER	190514COMSAY06	2.11	2023-10-27	Ashburn Communications	Jenny Smith	CA	WAX40	WORLAND	P	RXON43	CASPER	P	Proposed
EL DORADO-CENTRAL AVE	190501COMSAY11	2.11	2023-10-21	Ashburn Communications	John Doe	CA	WAX45	EL DORADO	T	RXON48	CENTRAL AVE	T	Proposed
LEWIS PK-HWY 83	190410COMSAY03	0.93	2023-09-23	Ashburn Communications	John Doe	WA	WBB309	LEWIS PK	G	WLA848	HWY 83	G	Proposed
CORNWALL-HWY59	190410COMSAY04	0.93	2023-09-23	Ashburn Communications	Jenny Smith	OR	WBB310	CORNWALL	P	WLA849	HWY59	P	Proposed
DALLAS-ITURREGUI	190410COMSAY05	0.93	2023-09-23	Ashburn Communications	John Doe	ID	WBB311	DALLAS	T	WLA850	ITURREGUI	T	Proposed
DALLAS-CRYSTAL MTN	190501COMSAY18	2.11	2023-09-14	Ashburn Communications	Jenny Smith	PA	WAX52	DALLAS	G	RXON55	CRYSTAL MTN	G	Expired
QUIGGS MTN-WHITESBURG	190401COMSAY02	2.13	2023-09-14	Ashburn Communications	John Doe	CA	WBB363	QUIGGS MTN	P	WLA902	WHITESBURG	P	Expired
ECTOR STN-REASON PEAK	190501COMSAY18	2.13	2023-09-14	Ashburn Communications	Jenny Smith	TX	WBB342	ECTOR STN	T	WLA881	REASON PEAK	T	Expired
KINGSTON RA-WARD PEAK	190328COMSAY03	2.13	2023-09-10	Ashburn Communications	Jenny Smith	NV	WBB362	KINGSTON RA	G	WLA901	WARD PEAK	G	Expired
TOWANDA CO-CUPEY BAJO	190501COMSAY19	2.11	2023-09-08	Ashburn Communications	John Doe	PA	WAX53	TOWANDA CO	G	RXON56	CUPEY BAJO	G	Expired
FABENS PARK-REPEATER	190501COMSAY19	2.13	2023-09-08	Ashburn Communications	John Doe	TX	WBB343	FABENS PARK	P	WLA882	REPEATER	P	Expired

RENEWALS

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Understanding the Frequency Coordination Process

5. FCC Regulatory Updates (6GHz, 80GHz, 13GHz)

Greg Macey
Manager, Microwave

FCC REGULATORY UPDATES

6 GHz

- FCC certifies 7 AFC providers in February 2024
- VLP device class added in Nov. 2023 (see ET Docket No. 18-295)
  - -5 dBm/MHz EIRP PSD Possibly up to 1 dBm/MHz
  - 14 dBm EIRP
- Heavily used lower and upper 6 GHz microwave licensees share with unlicensed devices

70/80 GHz

- FCC R&O and FNPRM released in January 2024
  - Allows smaller antennas (38 dBi)
  - New certification of construction requirements
  - Implements channel plans
  - De minimis modifications can keep first-in-time rights
  - Approves new aeronautical and maritime shared service
  - Future Notice for satellite earth stations

13 GHz

- FCC froze applications for new microwave sites in Sept. 2022 and Mar. 2023
- 12.7 to 13.25 GHz band proposed to be reallocated for mobile broadband use
- Current fixed links subject to relocation
- BAS may retain a small portion of the band for TV pickup / electronic news gathering

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Thank You!

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