

RF Interference and Optimization in 5G Systems



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Your panelists for today's webinar:

- Kelly Hill, Executive Editor, RCR Wireless News
- Rex Chen, Director of Business Development & Product Management, LitePoint
- Emilio Franchy, Senior Product Manager, Anritsu

5G RF Interference and Optimization Report

Highlights

- Midband spectrum is the current priority for U.S. 5G deployment, with hundreds of megahertz of new spectrum recently auctioned and in various phases of development and/or deployment.
- While midband spectrum boosts 5G speeds and capacity, there are a number of challenges to consider in deployment, either due to service rules or RF characteristics.
- Despite the new allocations that have been made in the midband, several telecom industry groups have voiced concerns that there will not be enough midband spectrum to satisfy the future needs of mature 5G systems—but exclusive-use spectrum arrangements are likely to get harder and harder to accommodate, particularly in the midband.



A Teradyne Company

Editorial Webinar: RF interference & optimization in 5G systems

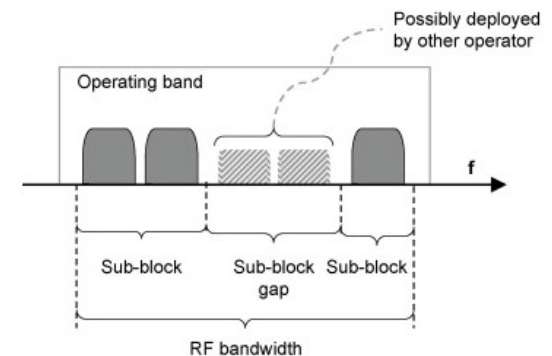
Rex Chen

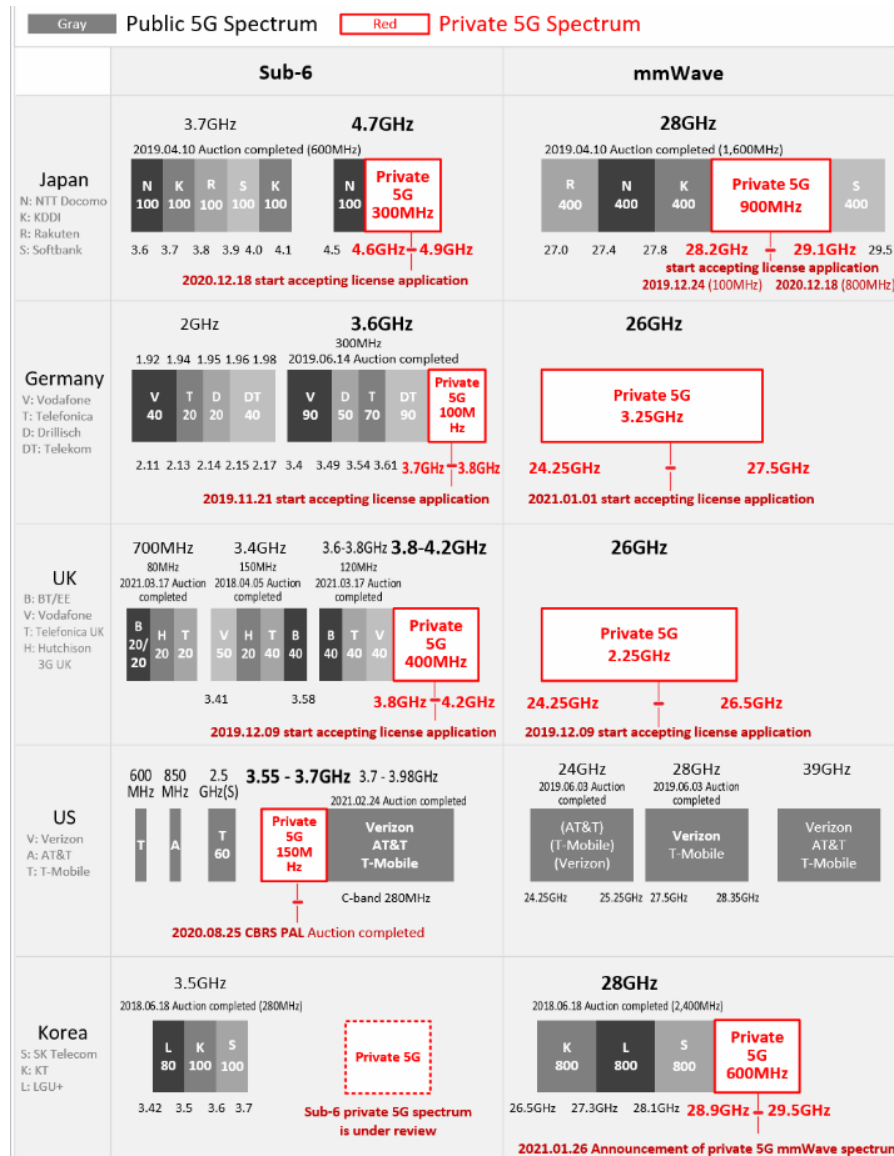
Director of Business Development & Product Management

2022

RF interference & optimization on 5G Systems

- Spectrum
 - A “finite” asset with each country making own decision
 - Licensed or Unlicensed
- 5G system performance
 - Spectrum allocation
 - Interference with neighboring spectrum (e.g. cellular CBRS vs. Aircraft altimeter)
 - TDD vs. FDD duplex
- RF interference
 - Width of channel bandwidth (e.g. 5, 10, 20, 100 MHz)
 - Carrier aggregation -> complex RF testing with many CA combo's
 - In TDD mode, when two overlapping cells are out of sync
 - Downlink and uplink from different cell towers may interfere
 - Cellular vs. Wi-Fi coexistence





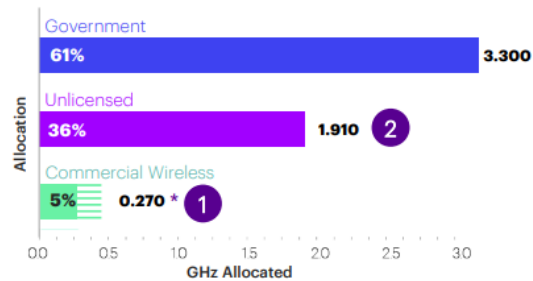
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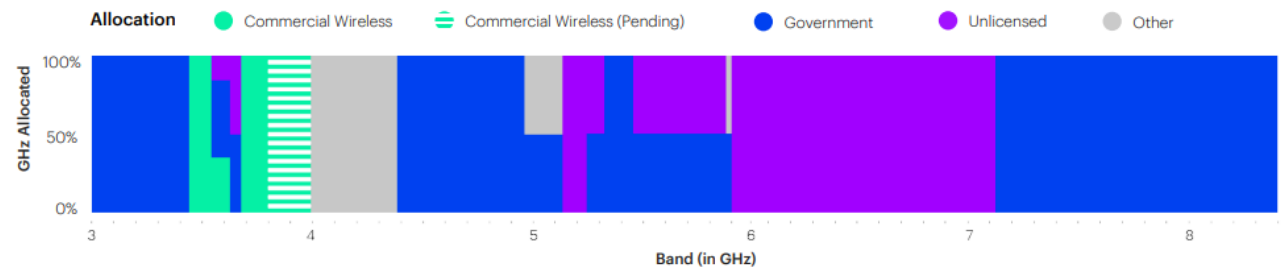
US spectrum allocation (mid-band)

- 3 GHz - 8.4 GHz

Lower-Mid Band Spectrum Allocation Comparison in GHz

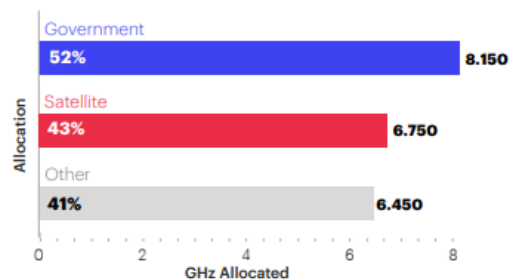


Current Lower-Mid Band Spectrum Allocation by Use

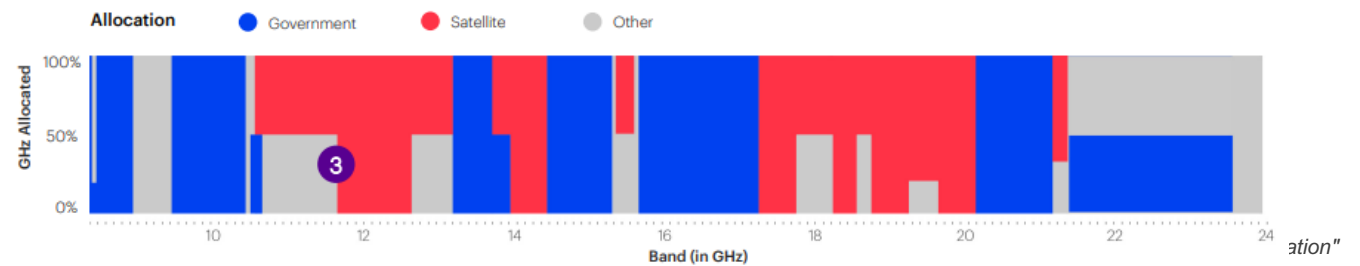


- 8.4GHz – 24 GHz

Upper Mid-Band Spectrum Allocation Comparison in GHz



Current Upper-Mid Band Spectrum Allocation by Use



New Frequency Highlight, FR1

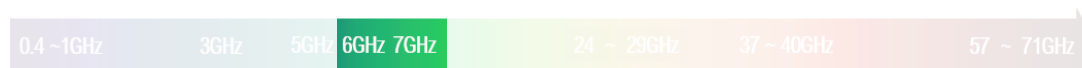
• What's new to FR1 in Rel-17

– Sub-7 GHz up to 7.125 GHz

○ 6 GHz band (**Unlicensed**)

- **5.925 - 7.125 GHz**, 1200 MHz BW (**n96**, U-NII-5-8, from Rel-16, ex: US)
- **5.925 - 6.425 GHz**, 500 MHz BW (**n102**, U-NII-5, ex: EU)

○ ITU WRC-23 to consider 6.425 - 7.125 GHz for IMT (Licensed, China interested)



38.101-1, Rel-17, v17.6.0

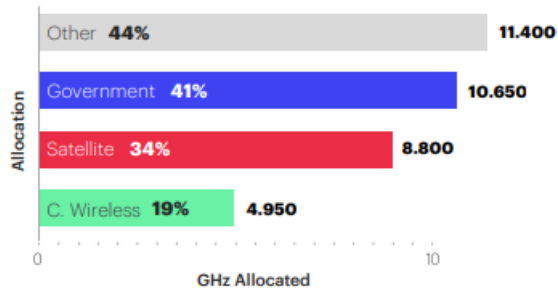
Frequency range designation	Corresponding frequency range
FR1	410 MHz – 7125 MHz
FR2	24250 MHz – 52600 MHz

n96 ¹⁴	5925 MHz – 7125 MHz	5925 MHz – 7125 MHz	TDD ¹³
n97 ¹⁵	2300 MHz – 2400 MHz	N/A	SUL
n98 ¹⁵	1880 MHz – 1920 MHz	N/A	SUL
n99 ¹⁶	1626.5 MHz – 1660.5 MHz	N/A	SUL
n100	874.4 MHz – 880 MHz	919.4 MHz – 925 MHz	FDD
n101	1900 MHz – 1910 MHz	1900 MHz – 1910 MHz	TDD
n102 ¹⁴	5925 MHz – 6425 MHz	5925 MHz – 6425 MHz	TDD ¹³
n104 ^{17,18}	6425 MHz – 7125 MHz	6425 MHz – 7125 MHz	TDD

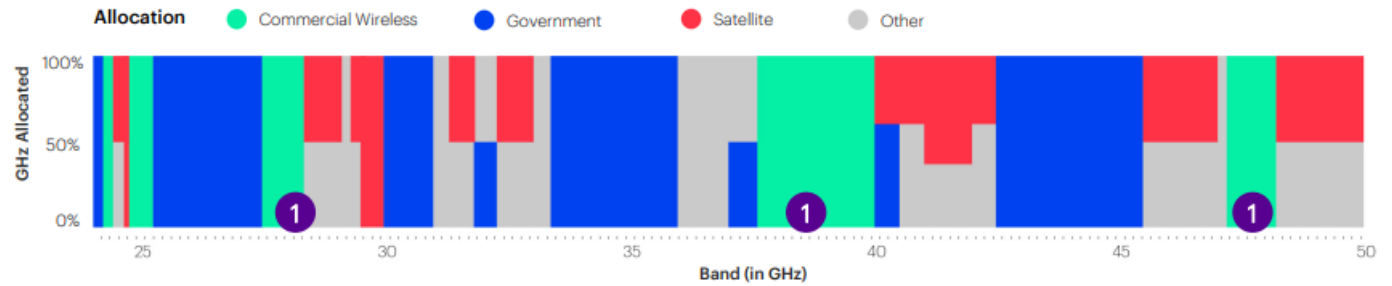
US spectrum allocation (high-band)

- 24 GHz - 50 GHz

High-Band Spectrum Allocation Comparison in GHz



Current High-Band Spectrum Allocation by Use



New Frequency Highlight, FR2

- What's new in FR2 in Rel-17

- mmWave FR2-1: 24.25 - 52.6 GHz
 - n262, 47.2 - 48.2 GHz (1 GHz BW, most hold by T-Mobile(+Sprint) and Dish Network)
- mmWave FR2-2: 52.6 - 71 GHz (in Rel-17, mid 2022)
 - n263, 57 - 71 GHz (14 GHz BW) for **Unlicensed**



38.101-2, Rel-17, v17.6.0

Frequency range designation		Corresponding frequency range
FR1		410 MHz – 7125 MHz
FR2	FR2-1	24250 MHz – 52600 MHz
	FR2-2	52600 MHz – 71000 MHz

Operating Band	Uplink (UL) operating band BS receive UE transmit	Downlink (DL) operating band BS transmit UE receive	Duplex Mode
	$F_{UL,low} - F_{UL,high}$	$F_{DL,low} - F_{DL,high}$	
n257	26500 MHz – 29500 MHz	26500 MHz – 29500 MHz	TDD
n258	24250 MHz – 27500 MHz	24250 MHz – 27500 MHz	TDD
n259	39500 MHz – 43500 MHz	39500 MHz – 43500 MHz	TDD
n260	37000 MHz – 40000 MHz	37000 MHz – 40000 MHz	TDD
n261	27500 MHz – 28350 MHz	27500 MHz – 28350 MHz	TDD
n262	47200 MHz – 48200 MHz	47200 MHz – 48200 MHz	TDD
n263	57000 MHz – 71000 MHz	57000 MHz – 71000 MHz	TDD ¹
NOTE 1: [This is for unlicensed band operation]			

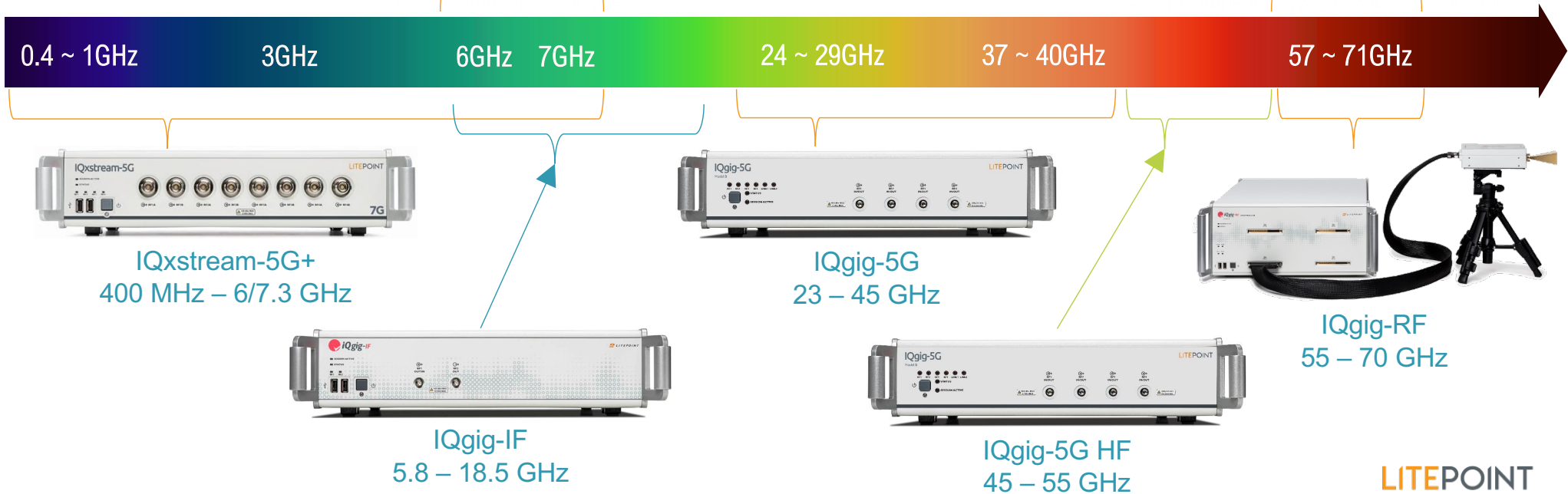
LitePoint Products from 400 MHz to 70 GHz

5.925 – 6.425/7.125 GHz

- 500 MHz/ 1.2 GHz BW
- Incumbents – satellites, fixed/mobile services

57 – 71 GHz

- 14 GHz BW
- Incumbents – WiGig, wireless backhaul
- 5G NR-U potential



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The background of the slide is a composite image. The upper portion features a blue field filled with binary code (0s and 1s). Some of the digits are highlighted with small, semi-transparent colored boxes in shades of orange, red, and purple. The lower portion of the slide shows a dark, silhouetted city skyline at night, with numerous skyscrapers and buildings illuminated from within, their lights reflecting on the dark surface below. The overall aesthetic is technological and modern.

Thank you

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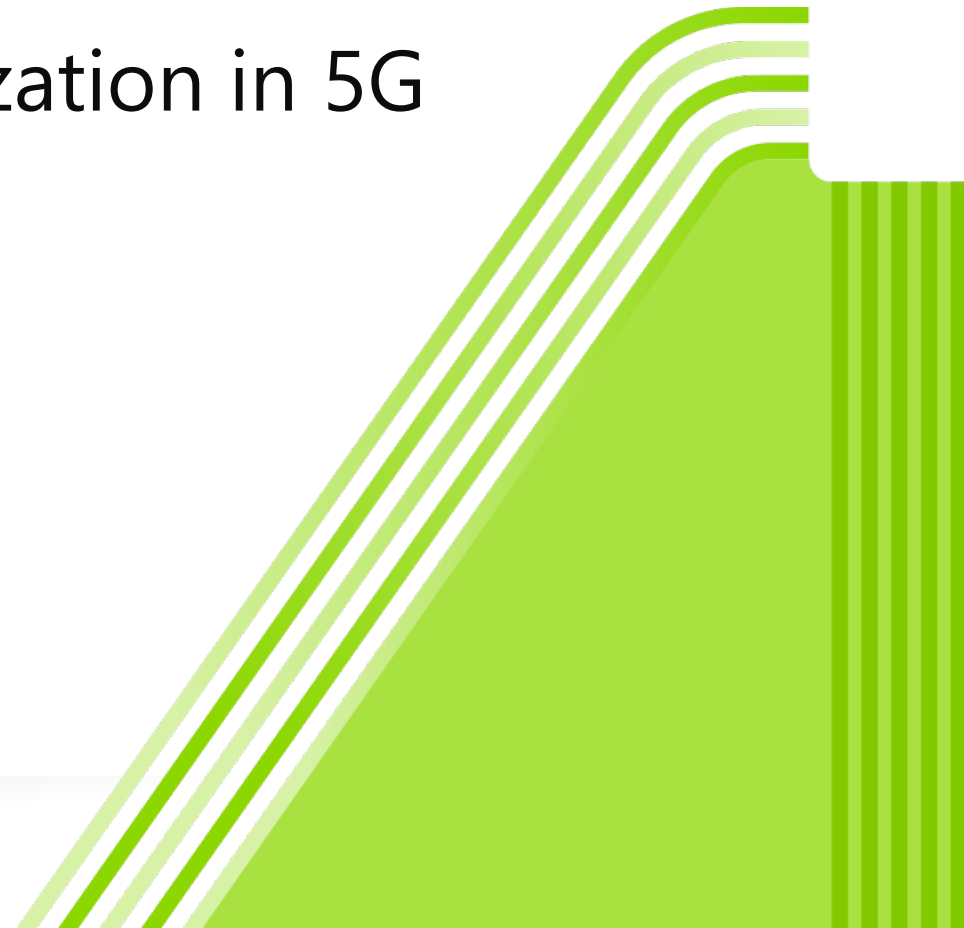
RF Interference & Optimization in 5G Systems

C-Band PIM

Emilio Franchy

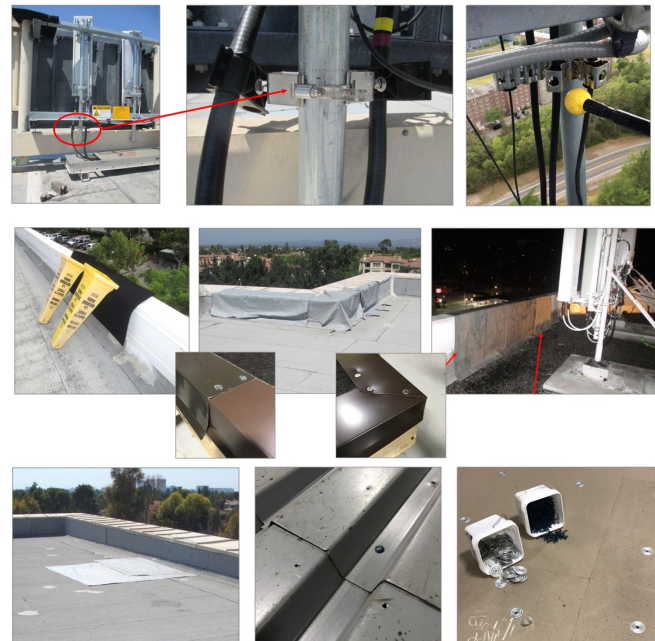
Sr. Product Manager

October 12, 2022



Common Sources External PIM Sources

- **Cable support brackets**
- **Parapet walls / flashing**
- **Fasteners under roof membrane**



*The most likely PIM source that will affect 3.5 GHz TDD systems

3.5 GHz Integrated 5G Antenna/radios



AIR 6428

● Capacity

64 T/R branches
25 kg
400 MHz instantaneous BW
340 W output power
192 antenna elements
Passive cooling

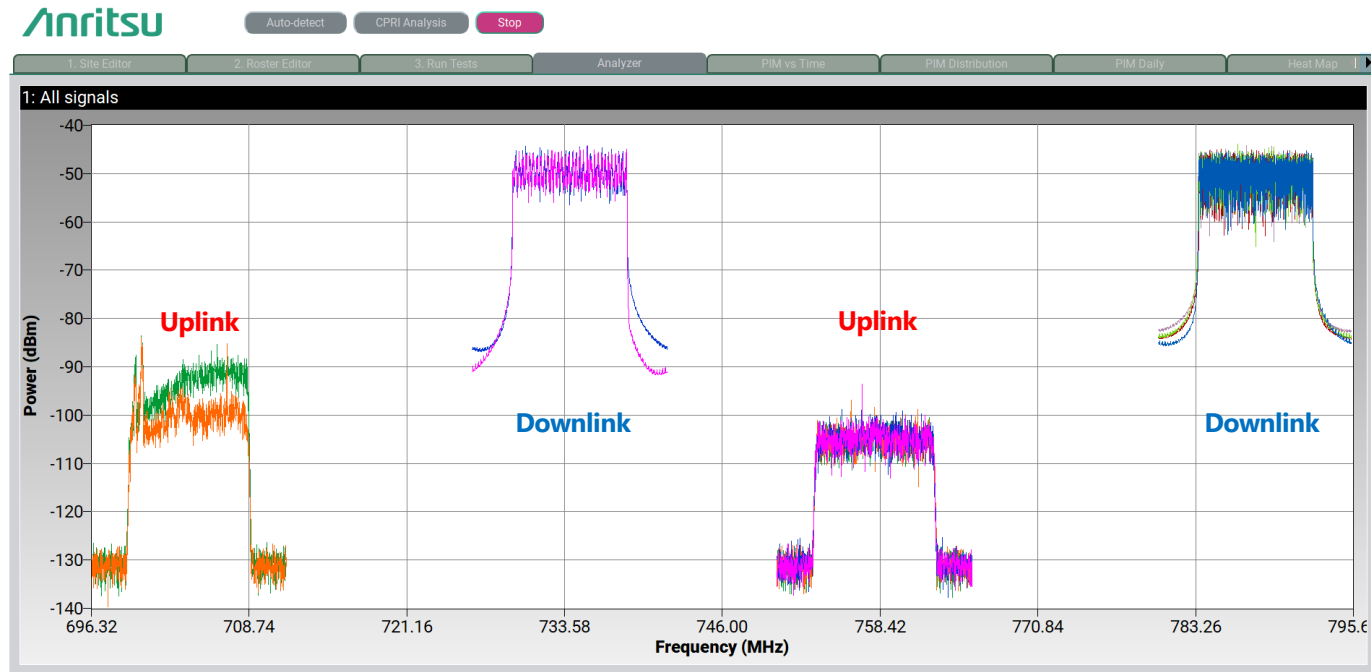
- Co-located sites will have both traditional macro sites & integrated 5G radios
- Co-located sites will be FDD & TDD
- 3.5 GHz radios will use TDD (shared frequency band for both Tx & Rx)
- Co-located FDD systems can generate PIM that affects 3.5 GHz bands
- **3.5 GHz PIM issues solved by fixing FDD PIM problems**
 - **Use existing PIM PCS test models for PIM field test**

5G NR C-Band (3.1 GHz – 3.98 GHz) – n77 (3.3 – 4.2 GHz)

3.1 – 3.45 GHz <i>Future Auction</i>	3.45 – 3.55 GHz Mid-Band	3.55 – 3.7 GHz CBRS Band	3.7 – 3.8 GHz C-Band A Block	3.8 – 3.9 GHz C-Band B Block	3.9 – 3.98 GHz C-Band C Block
TDD	TDD	TDD	TDD	TDD	TDD
UL/DL	UL/DL	UL/DL	UL/DL	UL/DL	UL/DL

- All 3.10 GHz – 3.98 GHz carriers will use TDD (Time Division Duplex)
 - 3.10 – 3.45 GHz announced at MWC 2022 as future FCC auction
- Main U.S. carriers have agreed to synchronize their Tx/Rx patterns to minimize interference
- No PIM interference from TDD systems if synchronized
- Potential PIM interference will come from the lower FDD bands
 - IM2 & IM3 PIM products

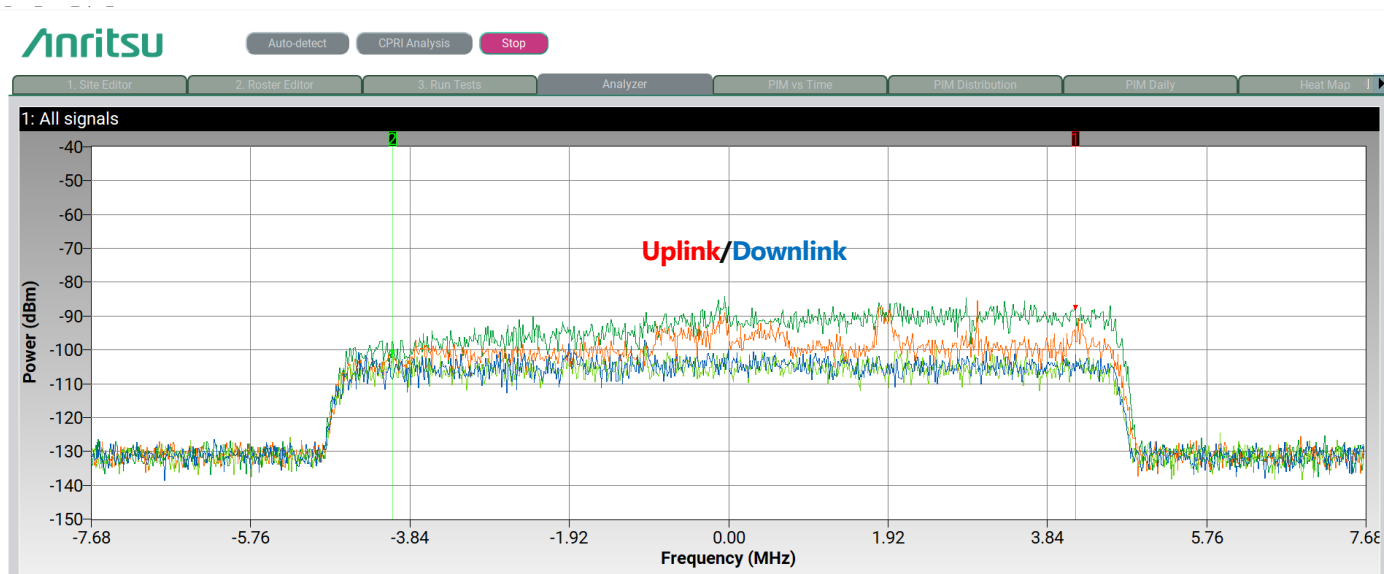
FDD – Frequency Domain



FDD system

Dedicated frequency spectrum for Uplink (Rx) and Downlink (Tx)

TDD – Frequency Domain (5G C-Band)



TDD system

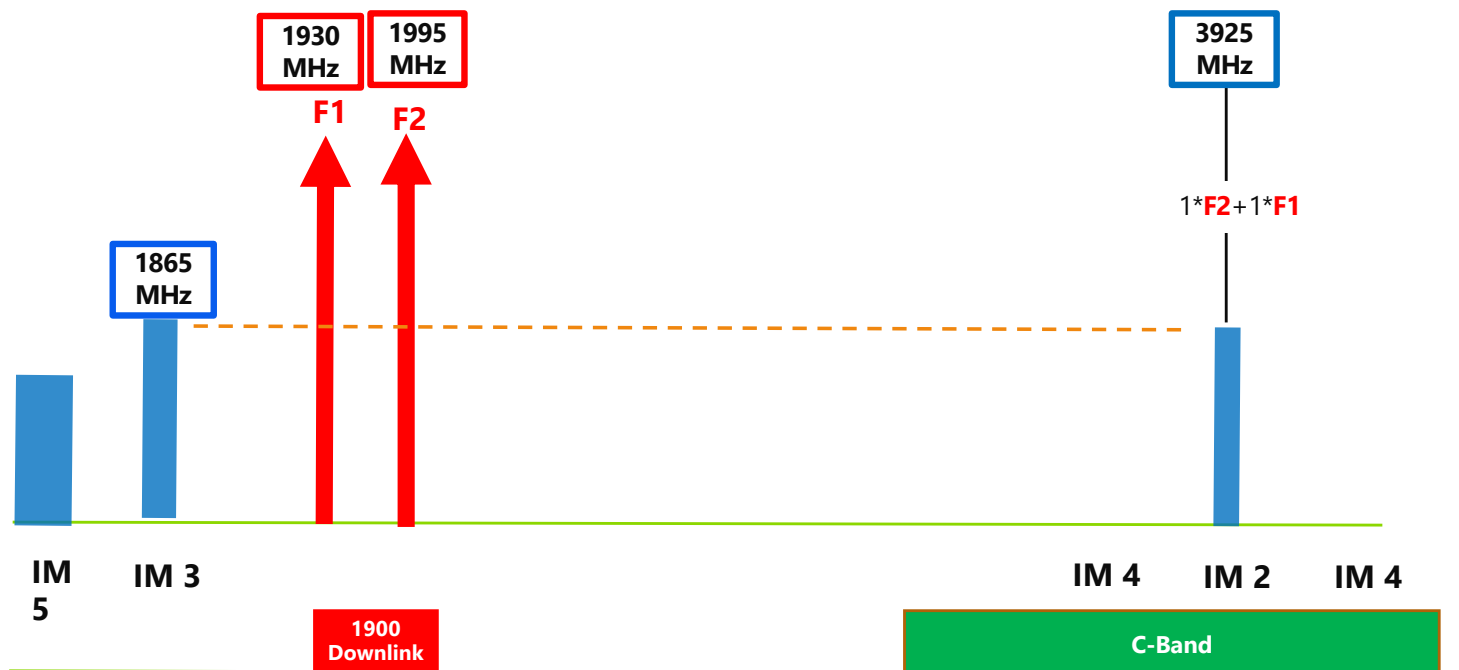
Shared frequency spectrum for Uplink (Rx) and Downlink (Tx)

Gated Sweep for C-Band TDD signals



- Time Domain view of TDD signal
 - Higher level signal is the downlink
 - Lower level signal is the uplink
- PIM from FDD carriers will affect Uplink in C-Band

IM2 problems from PCS in C-Band



PIM in 5G NR C-Band (3.1 GHz – 3.98 GHz)

3.1 – 3.45 GHz <i>Future Auction</i>	3.45 – 3.55 GHz Mid-Band	3.55 – 3.7 GHz CBRS Band	3.7 – 3.8 GHz C-Band A Block	3.8 – 3.9 GHz C-Band B Block	3.9 – 3.98 GHz C-Band C Block
TDD	TDD	TDD	TDD	TDD	TDD
UL/DL	UL/DL	UL/DL	UL/DL	UL/DL	UL/DL

IM2 - 1900 MHz
PCS

IM2 - 1800
MHz DCS

(IM2 & IM3) : 700 MHz + PCS (1900 MHz)

(IM2 & IM3) : 600 MHz + AWS (2100 MHz)

IM3 : 850 MHz + AWS (2100 MHz)

IM3 : 600 MHz + 850 MHz + PCS (1900 MHz)

IM3 : 600 MHz + PCS (1900 MHz) + AWS (2100 MHz)

PIM generated by lower Band FDD systems (IM 2 & 3 which is the most problematic, high amplitude): $IM2 = F1 + F2$; $IM3 = \{(2 \times F1) + F2\}$ or $\{(2 \times F2) + F1\}$



Questions?



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