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800 MHz Interference: What Is It, How Do We Mitigate It and What Does the Future Hold?

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Types of Interference

- **Out-of-Band Emissions**
  - Occurs at the cellular base station transmitter
  - Practically non-existent after rebanding (guardband filtering)
- **Receiver Intermodulation***
  - Non-linear mixing of external carriers in receiver front end
  - Interference is created inside the receiver
  - Can be operator-only mixes or Sprint/A/B cross products
- **Receiver Blocking (Overload)**
  - Only one frequency necessary to cause problem

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*Spectral regrowth also occurs in the receiver and is created by a single interfering carrier. It is a form of intermodulation.

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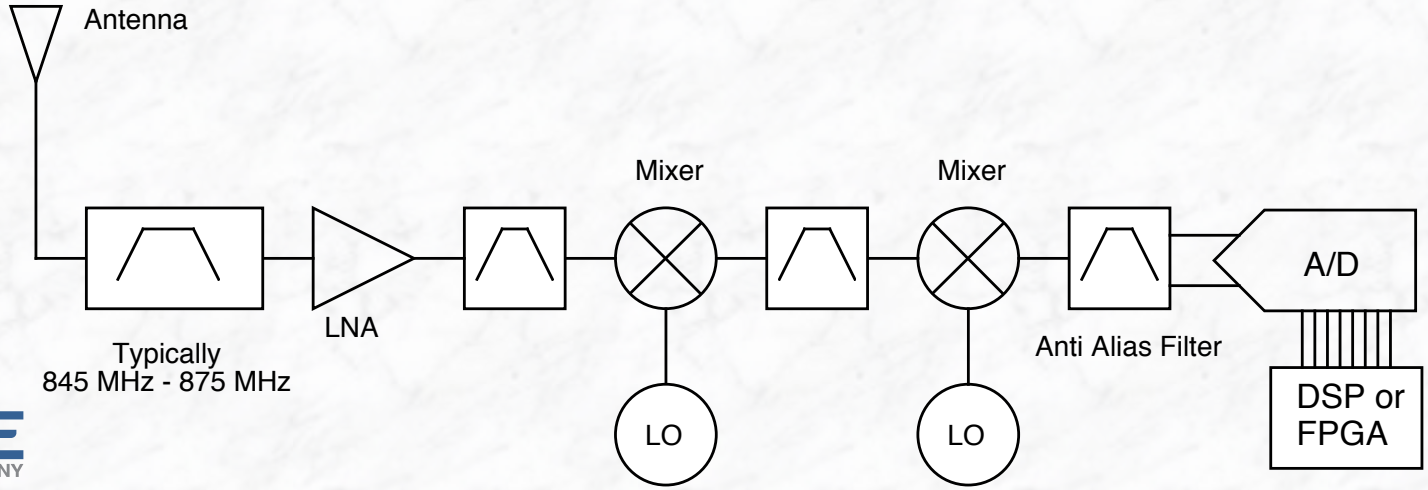
Typical Receiver Front End

- **Bandpass Filter is the Weakness**
  - Typically passes 845-875 MHz
  - Ideally should be limited to 851-861 MHz
- **LNA is Usually Where IM Occurs**
  - Higher third order intercept is better
  - But amplifier with higher intercept draws more current



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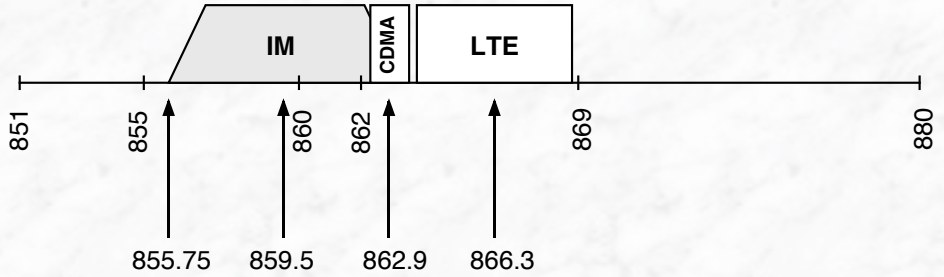
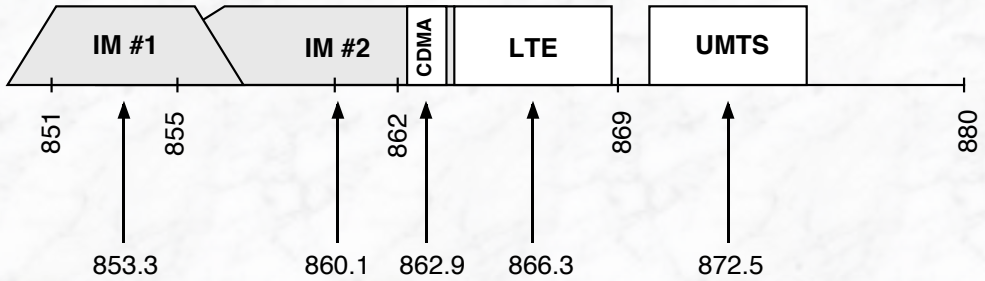
Receiver IM Examples (3rd order)

- **Sprint Alone, 2A-B Product CDMA & LTE**



- **Sprint & A-Band UMTS (Two of Three Products)**



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*Third product is A+B-C type, roughly 12.25 MHz wide and centered on 856.7 MHz.

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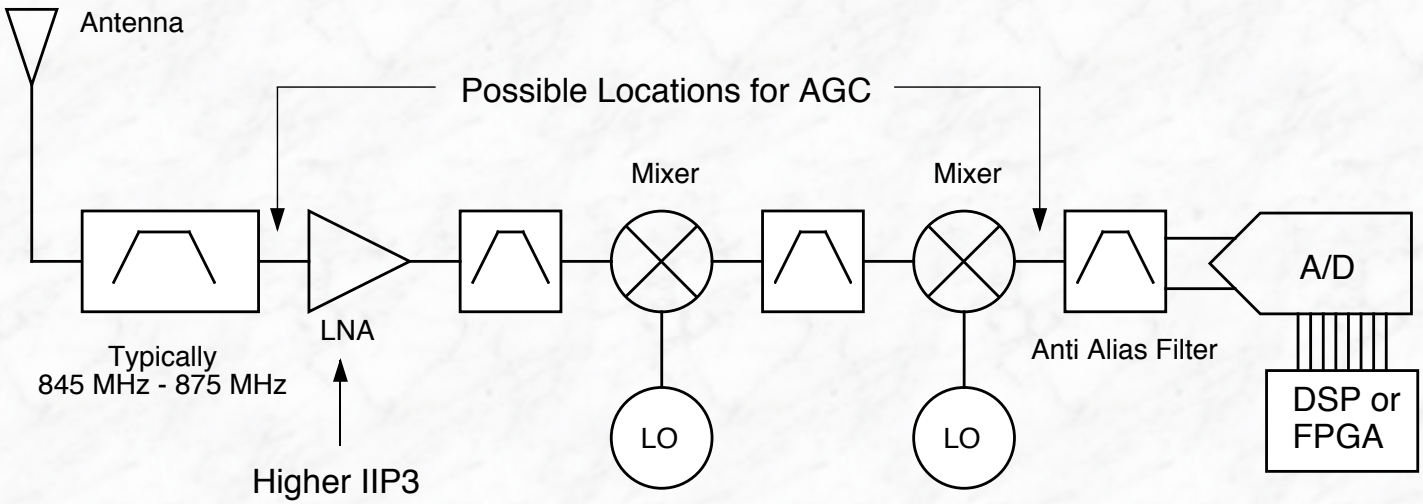
Non-Filter Solutions

- **Higher IIP3 LNA**
  - E.g., results in 80 dB IMR per TIA-603 versus 70 dB
  - Tradeoff with battery life
- **Attenuators for AGC (or variable gain amps)**
  - Switch attenuators in or out depending on detected signal



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Strong Signal IM (SSIM)

- **Vendors test & spec radios for intermodulation rejection measured from a baseline equal to the RX sensitivity**
- **E.g., if receiver has 75 dB rejection and -120 dBm sensitivity, interfering signal is only -45 dBm**
- **But the problem cell sites create signals at ground level way above -45 dBm; -20 dBm or higher is common**
- **Two radios with identical 75 dB IM std. rejection may have vastly different SSIM rejection at -20 dBm**
- **SSIM rejection never appears in the mfr's datasheet**
- **But it's important, ask for it!**

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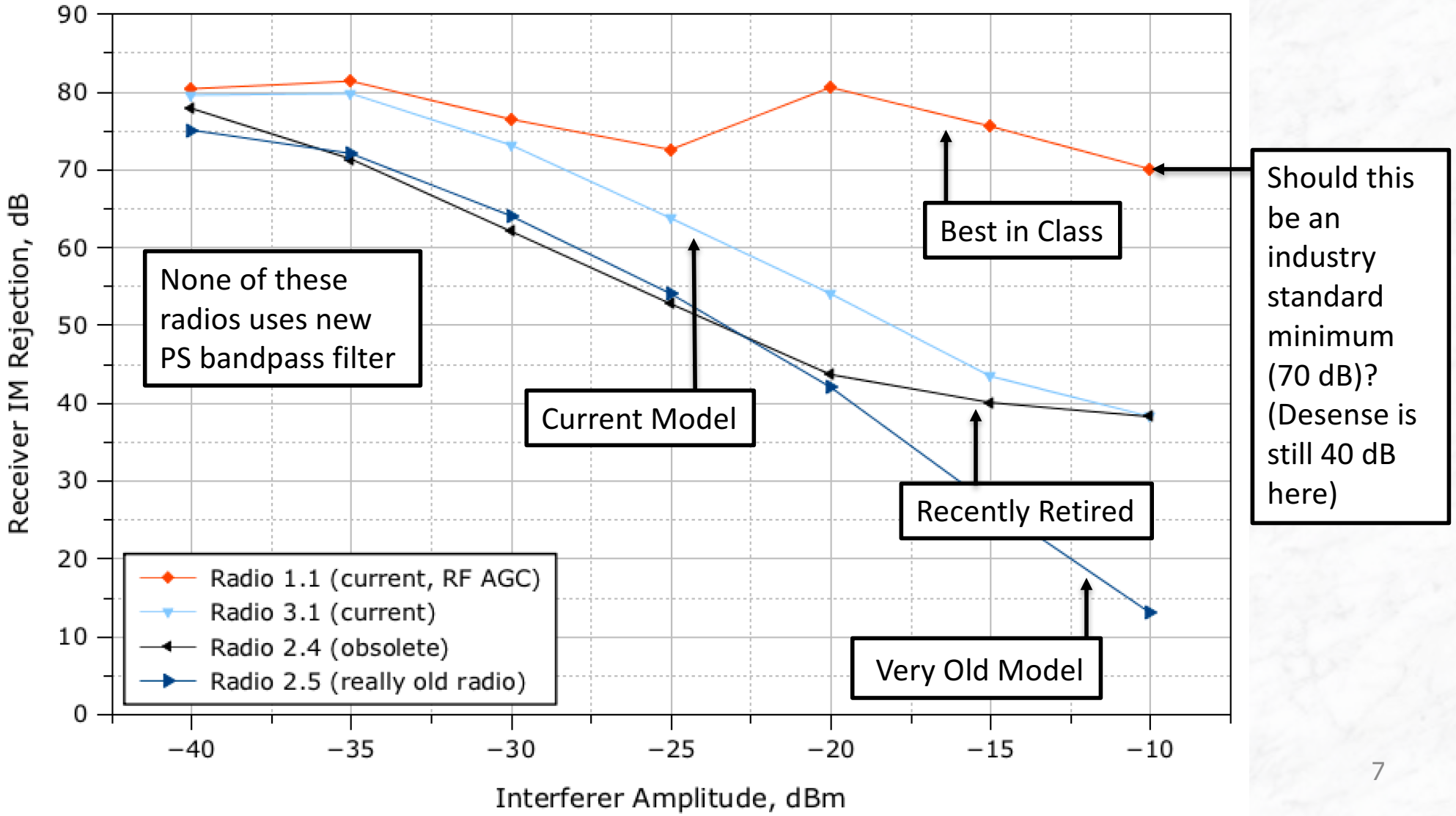

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700 MHz vs. 800 MHz Comparison

- **Docket WT 12-40 increased ERP of 800 MHz cellular from 500 W per carrier to 1,000 W/MHz in some cases**
- **One stated objective was to harmonize with 700 MHz but final rules show some differences. See Table.**

Parameter	700 MHz, Parts 27.50(b), 27.55(c)	800 MHz, Part 22.913(a),(b),(c)
ERP Urban Area	1,000 W/MHz	1,000 W/MHz
Max PFD*	3,000 µW/m^2	3,000 µW/m^2/MHz
Protection area	1 km from cell site	98% of 1 km from cell site

*For a 0 dBi antenna, a PFD of 3,000 µW/m^2 is equivalent to -13 dBm at the antenna terminal

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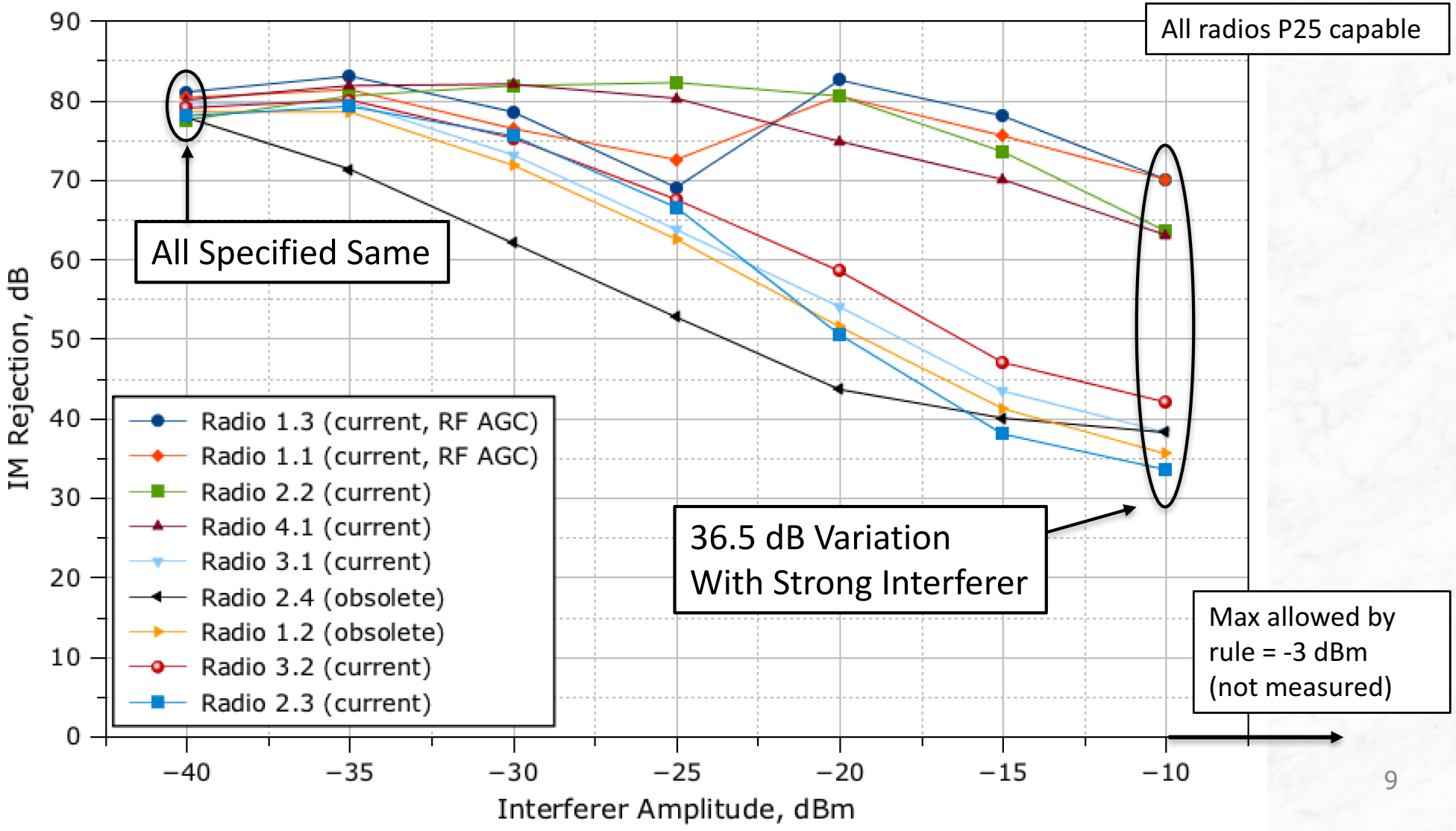

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What Does this Mean to the PS User?

- **With -20 dBm interferer and 70 dB SSIM rejection, the radio requires -90 dBm to overcome interference**
  - Lots of locations in the service area have at least -90 dBm
- **With -20 dBm interferer and 38 dB SSIM rejection, the radio requires -58 dBm to overcome interference**
  - Only locations immediately around the PS repeater site have at least -58 dBm
- **Poor performing radios will have many outages near 800 MHz cell sites with low antennas.**

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Conclusions

- **Rebanding does not eliminate interference**
  - It creates conditions that make interference manageable
- **Co-existence is a shared responsibility**
  - Radio vendor must produce radio with robust front end
  - Public safety users must specify SSIM rejection performance in RFPs
  - Cellular operator must have limits on power flux density
- **Technology solutions <u>are</u> being adopted**
  - RF AGC systems are very effective without bandpass filters
  - With end of rebanding, bandpass filters also appearing
  - But performance is uneven, some vendors slow to adopt solutions
  - Public safety must ask for better performance
  - If your radio has an Advanced RF AGC feature, turn it on!

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Conclusions, cont'd

- **New Part 22.913 raises issues (WT 12-40)**
  - Increases cellular ERP from 500 W max to 1,000 W/MHz
    - E.g., a 13 dB increase for a 10 MHz LTE carrier
  - Power flux density limit does little to protect public safety
    - 3,000 μW/m^2/MHz
    - If present, results in -3 dBm at antenna terminal (10 MHz LTE)
    - This unusually high PFD will impair even the best radios
    - Even with 70 dB rejection, the desense for -3 dBm interferer is 47 dB
  - High PFDs may not occur in practice, but this exceptionally high PFD limit encourages sloppy network designs that produce unnecessarily high PFDs at ground level

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Conclusions, cont'd

- **Bottom Line: Receiver improvements are appearing, but new Part 22.913 "moves the goalpost"**
- **What can the cellular operator do to help?**
  - Don't raise ERP at low sites that are more likely to have high PFD
  - Employ antennas with suppressed sidelobes
  - Notify public safety licensee (per 22.913(c)), but include PFD prediction at ground level in notification

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