Introduction to Interference
Disclaimer

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Radio Frequency Interference

• RF interference is an electromagnetic disturbance generated by an external source that affects the RF receiver’s circuitry
  – Can be unintentional or intentional, from sources in-band or out-of-band

• RF interference between GNSS systems are carefully managed through bilateral coordination process set up by the ITU

• However, recent trend with technology is creating to higher spectrum demand
  – Increased potential for RF interference from sources other than GNSS systems
Optimizing spectrum allocations

• ITU Radio Regulations divide radio spectrum into separate "allocations" to reduce the potential for interference between different types of radio use
  – eg GNSS and TV have separate frequencies
• To minimize interference, "guard bands" between very different services have been used in the past
Out-of-Band Emission

• Out-of-band emission is an emission on a frequency or frequencies immediately outside the necessary bandwidth which results from the modulation process, but excludes spurious emissions.

• It raises the noise floor of the GNSS receivers and the Carrier signal-to-Noise ratio (CNR) is reduced, impacting GNSS receiver performance.
Spurious Emission

• Spurious emission is an emission not deliberately created or transmitted on a frequency or frequencies which are outside the necessary bandwidth

• Examples include harmonic emissions and intermodulation products

• These are described in the next two slides
Harmonic Emission

• $N$-th harmonics for a signal whose fundamental frequency is $f$, has a frequency $N^*f$
• Generally not a significant interference mechanism
• Example: Signal at 787.71 MHz could cause potential 2$^{nd}$ harmonic interference into the L1 band from mobile user equipment
Intermodulation Products

• Intermodulation products are caused by amplitude modulation of signals containing two or more different frequencies, caused by non-linearities in the front end of a GNSS receiver.

• Intermodulation products can end up in the GNSS band and desensitize a GNSS receiver frontend.

• Example: 3\textsuperscript{rd} order intermodulation products from an adjacent band signal plan.
Adjacent Band Interference

- Two frequency bands next to each other
- Applicable in cases when high powered “terrestrial” service is planned adjacent to the quiet “satellite” bands to create overload
- The frontend of the receiver is compressed or overloaded
- Front-end filtering can help reduce this effect which can be difficult with high power adjacent band source

Center frequency 1575.42 MHz
Before You Suspect Interference

• Please check if receiver functions with similar radio spectrum environment;
  – If not, it may be something in receivers themselves (not due to interference events)
  – Receiver manufacturers may help before checking with your national regulators

• There may be radio emission sources you are unaware of;
  – Cable equipment which not properly installed can be potential radio emission sources
  – Switching Power Supplies?
  – Cable TV Leakage?
Summary

• This presentation introduced the concept of spectrum interference and described three possible source of interference to GNSS
  – Out of band emission
  – Spurious emission
  – Adjacent band interference

• They can all cause performance degradation
  – Therefore they must be carefully considered to ensure interference-free environment for current and future GNSS