Whitepaper: Noise**Robust**

Ensure best in class operation for radio equipment located in noisy environments with the Repeatit NoiseRobust functionality.
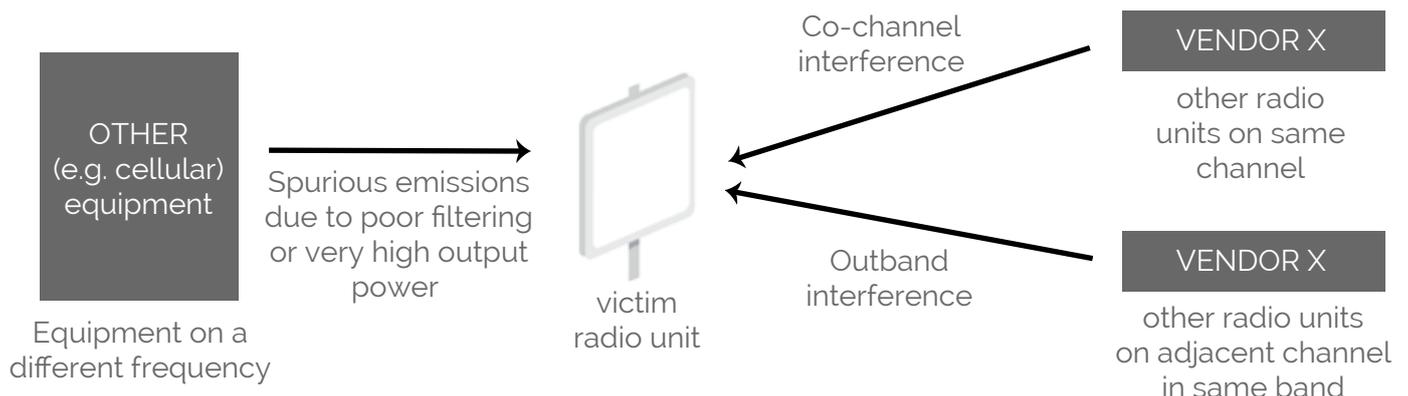
In order to ensure high quality, stability and availability on a wireless link and to maximize the chance that advertised bit rates are achieved, a network operator needs to make sure that the link's physical layer performs as good as possible.

Range and throughput are dependent on physical factors such as spectrum bandwidth, power and antenna gain. The theoretical link performance for a certain range can easily be evaluated by a link budget tool such as Repeatit's Link Budgetizer.

Once the radio units are mounted and the antennas are tuned, the actual radio performance is, however, not only dependent on range and signal strength. In many cases, the signal might be very good, but the link struggles due to high levels of noise and interference. This can originate from many different sources, for example:

- Other equipment in the vicinity that operate on the same channel(s).
- Imperfections in power amplifiers and filters or simply lack of proper filtering in nearby radio units. This results in wide band noise or spurious emissions ending up in the own radio receiver.
- Poorly shielded equipment (often seen on radio units with plastic cover or on standard off the shelf Wi-Fi gear) where oscillators, wires, processors, clocks and Ethernet circuits are popping up as narrowband interference in the receiver.

Noise and interference cause receiver blocking, packet errors and sensitivity degradation. The figure below shows the main types of interference that a victim radio unit could experience in a crowded site.

OTHER (e.g. cellular) equipment

Spurious emissions due to poor filtering or very high output power

victim radio unit

Equipment on a different frequency

Co-channel interference

Outband interference

VENDOR X

other radio units on same channel

VENDOR X

other radio units on adjacent channel in same band

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Summary of the interference types shown in the figure on previous page:

- Co-channel interference. This means that other radio units are configured to operate on the same channel. These radios could be mounted on other sites with antennas directed towards the victim radio. The result is normally receiver blocking or degraded sensitivity.

- Adjacent channel interference (also commonly referred to as out-band interference). The interfering transmitter is in this case located within +/-10MHz from the own carrier frequency, and the result is often degraded sensitivity and in bad cases even receiver blocking or packet errors.

- Spurious emissions. This is often caused by poorly shielded equipment that causes "spikes" to pop up in the spectrum (could be caused by oscillators, processors, wires etc.), intermodulation (IM) products caused by imperfection in amplifiers and filters and/or by poor filtering. Spurious emissions could also be caused by equipment that transmits at power levels that the own Linear Noise Amplifier (LNA) is not designed to cope with. A nearby cellular transmitter could either block or damage a poorly designed receiver.

What is Repeatit NoiseRobust?

NoiseRobust is a family of hardware and software functionality that Repeatit has developed for the Trinity 800 and Trinity 823 series in order to ensure best in class operation for radio equipment located in noisy environments. NoiseRobust reduces the impact of the above described problems in the following ways:

- Co-channel interference is in unlicensed bands best handled by good Radio Resource Management (RRM). The victim radio needs to be able to identify and classify interference sources and then select the optimal configuration (channel, coding/modulation, retransmission schemes etc.). If the victim is disturbed by another Repeatit radio, a SyncMaster can be added to the installation. The SyncMaster allows for Tx/Rx windows to be aligned with GPS precision and multiple nodes can re-use the same channel (no co-channel interference).

- Adjacent (out band) interference is also using RRM functionality, but Repeatit has also designed the 800/828 Radios with high-gain Linear Noise Amplifiers in order to suppress noise and avoid blocking. The LNAs used in the design can improve receiver sensitivity significantly.

- Spurious emissions can be hard to protect the victim radio unit against, especially if IM products are popping up in the spectrum. However, the Trinity-800 and Trinity-828 radios have been designed with the following in mind:

    o State of the art filtering to protect both the own and other equipment. This is especially important when there is cellular equipment present on the site. It is of outmost importance that the unlicensed equipment does not desensitize nearby cellular transceivers.

    o High gain LNAs that are designed to push down the noise levels and at the same time cope with high levels of power leaking in from nearby transmitters.

    o Metal casing, which protects internal components and mixers from interference.

Summary

To sum up, NoiseRobust is both about hardware design and software features. The hardware design comes with high class filtering, high gain LNAs and high quality Power Amplifiers in our state of the art radio front-end to ensure high linearity in power amplification, optimized sensitivity and minimized energy leakage at the site. Longer distances, higher throughput and much more stable links in interfered environments are the ultimate outcome of the Repeatit NoiseRobust feature.

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