Interference Excision in Wideband SATCOM

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Distribution Statement A. Distribution Unlimited.
Interference in SATCOM

• Radio Frequency Interference (RFI) is an hour-to-hour problem in commercial wideband SATCOM.
  – 20,000 interference incidents per year (2.3/hour)
• Degree of RFI problem varies by:
  – Frequency band.
  – Geographic location.
  – Time of day.
• RFI examples:
  – Cross-polarization interference.
  – User on wrong frequency.
  – User on wrong satellite.

RFI is one of the largest issues impacting QoS for commercial SATCOM customers.
Interference Excision Techniques

• Signal processing techniques allow multiple interferers to be excised from a desired signal in varying degrees depending on the nature of the signal and the interferers.

• Examples:
  – Adaptive Filters (e.g., LMS, RLS, etc.)
  – Tunable Filters (e.g., bandpass, bandstop)
  – Spatial Filters (e.g., directional antennas, steerable arrays)
  – Optical Cancellers (multiple variations)
  – Other

• The various techniques are not necessarily mutually exclusive and may in fact be complementary.
Adaptive Noise Cancelling: Principles and Applications


Fig. 1. The adaptive noise cancelling concept.

- When certain conditions are met, “noise in the primary input can be essentially eliminated without signal distortion.”
Correlated Interferers

• Bandlimited interfering signals are, in varying degrees as gauged by their bandwidths, auto-correlated and therefore predictable.
• If an interfering signal is relatively stationary, it can be accurately predicted and subtracted out (i.e. excised) by an appropriate adaptive technique.
• Non-stationary, highly dynamic interfering signals require non-classical interference excision techniques.
Interference Excision Techniques
Figures-of-Merit (1/2)

- Insertion Loss – How much does the technique degrade the desired signal when no interference is present?
- A Priori Knowledge – What, if anything, does the technique need to know about the desired signal or the interferer?
- Convergence Time – How many signal + interference samples are required to provide the realized excision?
- Misadjustment – How much noise does the converged filter add to the desired signal after convergence?
- Tracking – How well can the device track non-stationary interference?
Interference Excision Techniques
Figures-of-Merit (2/2)

• Signal Separation Requirements
  – Relative power levels between desired signal and interferer.
  – Relative bandwidth limits between desired signal and interferer.

• Computational Complexity – e.g., FPGA gate count, DSP resources, processor speed, etc., needed to host the interference excision technique.

• SATCOM Signal and System Agnostic – Transparent operation with any SATCOM modem, modulation, bandwidth, coding, etc.

• Latency – End-to-end delay through the interference excision device. The lower the latency the better.

• Number of Interferers – How many simultaneous interferers can be handled by the excision technique?
Present and Future Architectures

PRESENT DAY

Terminal → Interference Excision Appliqué → Modem

POSSIBLE FUTURE

Terminal → Modem with Interference Excision Built In
Summary

• Interference is an increasing problem in both wideband and narrowband SATCOM systems.
• Viable implementations of interference excision techniques are emerging to combat the problem.
• Future SATCOM modems will need interference excision capabilities built-in to remain competitive.
• Legacy SATCOM modems will use interference excision appliqués to combat interference.
• Interference excision is a key component of SATCOM resilience.