OUT-OF-BAND RADIATION IN INFORMATION PROCESSING EQUIPMENT MEASUREMENT OF COMMUNICATION SYSTEMS

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Abstract

In work investigating methods for detecting and analyzing OBR, using statistical method for evaluating the quality indicators of developed OBR mitigation methods based on mathematical modeling. Is propose methods of using SDR receivers to detect and analyze electromagnetic emissions and reducing OBR to improve the security of electronic devices can be applied in the field of measurement and in organizing the protection of information systems.

The growth of electronic devices and the growing demand for data processing have led to an in-creasing risk of out-of-band radiation (OBR) in information processing equipment. This has led to concerns about the reliability and security of communication systems, there is a growing need for effective solutions to prevent the use of OBR in information processing equipment. Out-of-band electromagnetic emissions (OOB-EME) are electromagnetic signals emitted by electronic devices and systems that fall outside the intended frequency range of the device. OOB-EME can cause inter-ference with other electronic devices or systems, leading to operational errors or complete system failures.

Traditional mitigation strategies for OOB-EME interference include shielding, filtering, and grounding. Shielding involves enclosing the electronic device or system in a conductive material to block electromagnetic signals. Filtering involves using passive or active filters to suppress OOB-EME signals. Grounding involves connecting the electronic device or system to a common ground to reduce common-mode interference. The effectiveness of these traditional mitigation strategies can vary depending on the specific application and design of the electronic device or system. There-fore, there is a need to develop new and innovative methods for measuring and mitigating OOB-EME interference in electronic devices and systems, with a particular focus on the cybersecurity as-pect of OOB-EME. The use of software-defined radio (SDR) receivers has been proposed as a potential solution due to their cost-effectiveness and flexibility in measuring and mitigating OOB-EME interference.

The microwave frequency range is typically defined as the frequency range from 3 MHz to 300 GHz. Within this range, various types of microwave radiation are used for different applications, including communication, navigation, and medical imaging. In this research, phase, amplitude, wavelength, and frequency are key parameters to consider when measuring Out-of-Band Electromagnetic Emissions (OOB-EMR) and interference. These parameters can provide important information about the characteristics of electromagnetic radiations and the extent of their potential impact. Phase refers to the relative position of a point on a wave cycle to a reference point. In other words, it describes how far along a wave is in its cycle is used to calculate interference patterns when two waves meet. Amplitude is the maximum displacement of a wave from its equilibrium position. In other words, it describes how high or low the peaks and troughs of a wave are, and is related to the energy of a wave, with higher amplitudes corresponding to more energy.

Frequency refers to the number of cycles of a waveform per unit time, it is a measure of the speed of the waveform. In this research, the frequency of OOB-EMR and interference can be used to identify the type of waveform and its potential to interfere with the desired signals. Understanding the phase, amplitude, wave-length, and frequency of OOB-EMR and interference can help to mini-mize their impact on the desired signals and environment (figure 1).

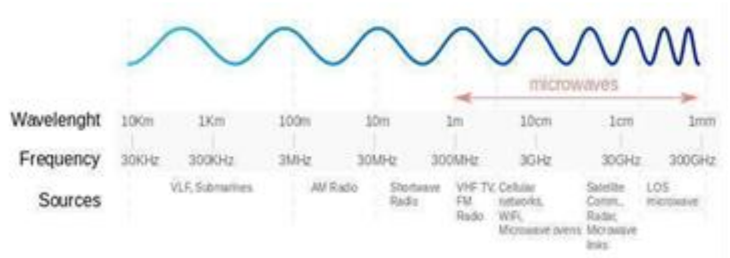

Fig. 1. Phase, amplitude, wavelength, and frequency of OOB-EMR and interference

The measurement bandwidth required for measuring OOB levels de-pends on the frequency range of the OOB signal and the specific application of the electronic device or system. For example, in the case of wire-less communication systems, the OOB signal is typically in the range of a few MHz to several GHz, requiring a measurement bandwidth of at least a few GHz.
Traditional measurement devices such as spectrum analyzers have limited bandwidth, typically ranging from a few hundred kHz to a few GHz. Therefore, these devices may not be suitable for measuring OOB levels in high-frequency applications such as 5G communication systems.

Given on the comparison of previous solutions, highlighting their focus on minimizing elec-tromagnetic interference (EMI) rather than addressing OBR risks discovered that EMI filters, shield-ing, and frequency hopping techniques may not be practical or secure in combating all types of OBR.
Spectrum involves using a frequency scanner to detect the presence of electromagnetic radiation at different frequencies. The frequency scanner will capture the spectrum of the radiation and pro-vide a visual representa-tion of the frequency distribution. This information can be used to identify potential sources of interference or to ensure that a device is operating within its specified frequency range. The frequency scanning process can help in detecting and resolving problems related to elec-tromagnetic compatibility, ensuring efficient operation and protecting against potential harm to people and equipment.

The Intermediate Frequency (IF) spectrum is a range of frequencies that an electronic signal is converted to after it is received by a radio receiver. The IF signal is typically a lower frequency than the original radio frequency, and it is at this intermediate frequency that the signal is processed, amplified, and filtered before being demodulated and converted back to its original form. The IF spectrum is a critical component of radio communication systems, as it allows the receiver to effectively isolate and process the desired signal while re-jecting interfering signals and noise. The frequency filters on IF in dBFS shows 38.95 Hz of frequency and 33.3 dBFS scale (figure 2).

The audio spectrum refers to the range of frequencies present in an audio signal. In audio processing, it is used to visualize the distribution of frequencies within an audio signal. An audio spectrum can be represented as a graph that shows the frequency content of an audio signal in terms of frequency and amplitude.

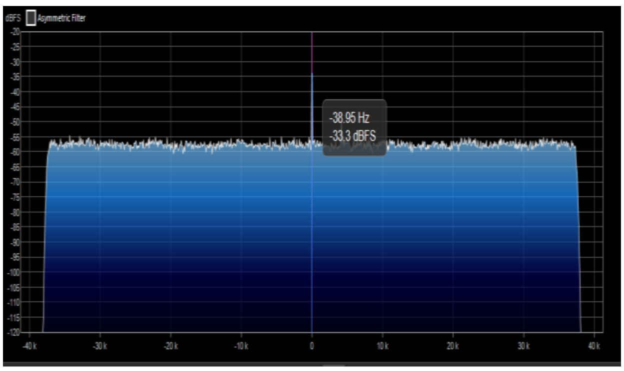

Fig. 2. Intermediate Frequency Spectrum

This representation helps in analyzing the audio quality, identifying any sound distortions, and determining the type of sound being produced. In audio engineering, audio spectrums are commonly used for sound analysis and equalization purposes (figure 3).

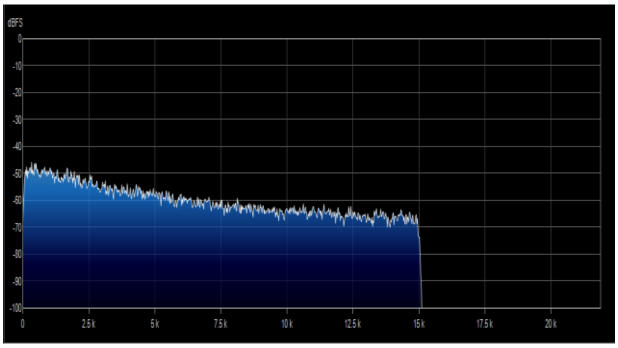

Fig. 3. Audio spectrum

The research findings indicate that the use of SDR receivers and appropriate software tools be effective in detecting and preventing out-of-band radiation in information processing equipment.
Operation of the measuring system hardware components for SDR-based out-of-band radiation detection and prevention.

- SDR receiver: connect to computer and tune to desired frequency range.
- Antenna attach to SDR receiver to capture RF signals.
- Amplifiers amplify the signal from antenna to improve detection sensitivity.
- Filter removes unwanted signals or noise from the captured signal.
- Power supply provide power to SDR receiver, amplifier, and filter.
- Connection and enclosure: connect all components and enclose them in a protective case.

The results suggest that future research can focus on developing more advanced hardware devices that can further enhance the detection and prevention of out-of-band radiation.

The also underscores the importance of using sophisticated tools like Software Defined Radio (SDR) receivers for monitoring OOB-EMR levels. Such tools can enable real-time monitoring of OOB-EMR levels and provide valuable insights into potential security risks.

Conclusion

Is used the hardware implementation required for this research. The SDR receiver, connected to a computer, enabled tuning to the desired frequency range, while an antenna captured RF signals. An amplifier boosted the signal for improved detection sensitivity, and a filter removed unwanted signals or noise. Future research could focus on expanding the study area to include a broader range of electronic devices and electromagnetic environments.

References

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