

OTA Test Methodologies for Resilient Drone Communication using Bluetest Reverberation Chambers

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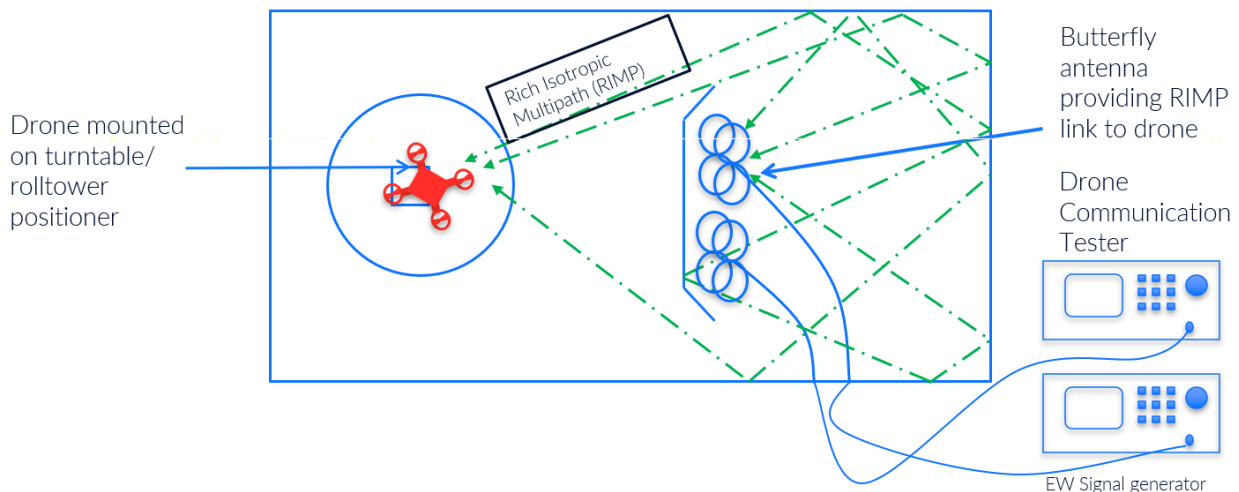


Figure 1: Conceptual diagram of a drone test in a reverberation chamber.

Introduction

Unmanned aerial systems (UAS), commonly referred to as drones, have rapidly transitioned from consumer novelties and commercial workhorses to critical instruments in modern warfare. Their cost-effectiveness, agility, and operational range make them formidable assets on the battlefield. However, their reliance on wireless links—both for command and control (C2) and video transmission—is a key vulnerability.

In environments with electromagnetic interference, the resilience of these wireless links can determine the outcome of a mission. Today adversaries equipped with electronic warfare (EW) tools are targeting these command-and-control channels with increasing precision. Therefore, the need for rigorous, repeatable, and realistic Over-The-Air (OTA) testing is more urgent than ever.

This White Paper outlines a practical approach to testing drone communication systems using reverberation chamber (RC) technology from Bluetest. This unique measurement system provides a fast and repeatable way to test real-world device performance under diverse and challenging RF conditions.



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Drone Vulnerabilities in the Electromagnetic Spectrum

On the battlefield, drones often rely on commercially available RF technologies such as Wi-Fi, LTE, or custom protocols in ISM bands. The same affordability that makes drones attractive also makes them susceptible to jamming, spoofing, and interference. A well-placed jammer or a high-power burst in the right band can disable a \$500 drone that's otherwise capable of damaging or disabling multimillion-dollar assets like tanks or aircraft.

A resilient drone system must maintain control and video links under multipath fading, interference, jamming and extended-range conditions. Characterizing this resilience requires a test environment that reflects real-world dynamics without compromising reproducibility.

The Case for Reverberation Chambers

Bluetest's reverberation chambers—RTS25 and RTS95—offer a statistically isotropic and homogeneous RF environment, making them ideal for testing wireless robustness in a controlled yet realistic setting. Unlike anechoic

chambers, where orientation, positioning, and connectorization of the device under test (DUT) become critical variables, reverberation chambers simplify and streamline the test process.

Key advantages of RC testing for drones include:

- **Multipath Emulation:** Easily generated by RC environment, allowing omnidirectional evaluation.
- **Position & Orientation Independence:** Ensures repeatable results even with setup variations.
- **Real-World Device Testing:** Enables evaluation of off-the-shelf drones without modifying firmware or hardware.

A typical setup might place the drone in an RTS95 chamber, while the controller and video goggles reside in an RTS25 chamber. The chambers are interconnected via coaxial cables and a programmable attenuator. This allows fine-grained simulation of link degradation due to distance—where a 6 dB increase in path loss approximates a doubling of physical distance in line of sight (LoS) conditions.



Figure 2: Bluetest's RTS95 and RTS25 chambers.

Evaluating Interference and EW Susceptibility

By injecting controlled interferers into either chamber, engineers can assess how well a drone system maintains operation under jamming scenarios. Test engineers can evaluate performance degradation as a function of both interference type (continuous wave, burst, modulated) and relative path loss. This is a crucial metric when developing countermeasures or hardening communication protocols.

It is possible to inject the drone communication link and/or the EW interferer signal either as a Rich Isotropic Multi Path (RIMP) signal or using a directive antenna that provides a strong direct coupled signal. Signals supplied as pure RIMP signal do not depend on the antenna pattern of the drone. If a signal is supplied through a direct coupled link, the antenna pattern of the drone will influence the result.

Conclusion

The resilience of drone communication systems is mission-critical in modern warfare and gray zone conflicts, where electronic threats like jamming and spoofing are increasingly prevalent worldwide.

Bluetest offers a toolset to characterize, stress-test, and optimize these systems. The reverberation chambers provide a fast, repeatable way to test real-world device performance under diverse and challenging RF conditions.

This enables drone developers, defense agencies, and EW specialists to engineer next-generation aerial platforms with unprecedented resilience in the contested spectrum.