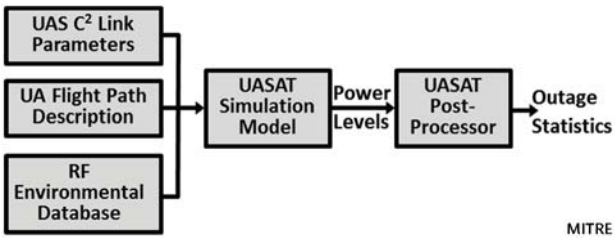
Unmanned Aircraft System Airspace Integration: Spectrum Analysis

Unmanned aircraft are critically dependent on their Command and Control (C^2) radio links to their pilots. Those links are susceptible to Radio-Frequency (RF) Interference (RFI) from other systems operating in the same frequency bands. The Unmanned Aircraft Spectrum Analysis Tool (UASAT) helps to identify and quantify the risks.

Anticipated growth in commercial and governmental use of small Unmanned Aircraft Systems (sUAS) in the National Airspace System (NAS) raises concerns about the robustness of C^2 links and potential mitigation measures. In order to estimate the likelihood of sUAS C^2 link outages resulting from unintentional RFI, The MITRE Corporation's Center for Advanced Aviation System Development (MITRE/CAASD) has developed UASAT with support from the Unmanned Aircraft Program Office of the Federal Aviation Administration (FAA).

The core of UASAT is a simulation model that uses situation specific parameters of an Unmanned Aircraft System (UAS) C^2 uplink (including the location of the ground control station, the flight path of the unmanned aircraft, and the link's RF characteristics) and a database providing a detailed description of the RF ground environment. The model utilizes that information to calculate and record the desired-signal strength at the unmanned aircraft receiver and the aggregate undesired-signal power entering the receiver passband for each RF channel and each sample point along the flight path. After a simulation is complete, the postprocessor analyzes the recorded results for all channels in the band of interest to calculate statistics on the potential for link outages.




Photographer Joseph M. Buliavac, navy.mil

Simulation Model

The simulation model gives the user a choice of RF propagation models (Smooth-Curve Smooth-Earth, Longley-Rice, or Free-Space Loss). It calculates the undesired-signal level based on the emitter power, the two computed antenna gains, the path loss, and cross-polarization loss. Then it computes each emitter's received Spectral Power Density (SPD) by dividing the received power by the emitter bandwidth. This SPD is spread across all the UAS channels in the band of interest that are overlapped by the emission bandwidth. Finally, the model adds the contributions of all the undesired signals in each channel to compute the aggregate undesired-signal level in that channel.

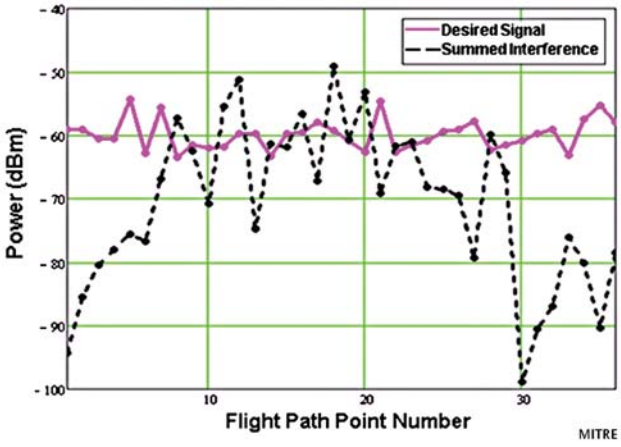
Using the algorithms discussed above, the model calculates and records the desired-signal strength at the unmanned aircraft receiver and the aggregate undesired-signal power entering the receiver passband for each RF channel and each sample point along the flight path.

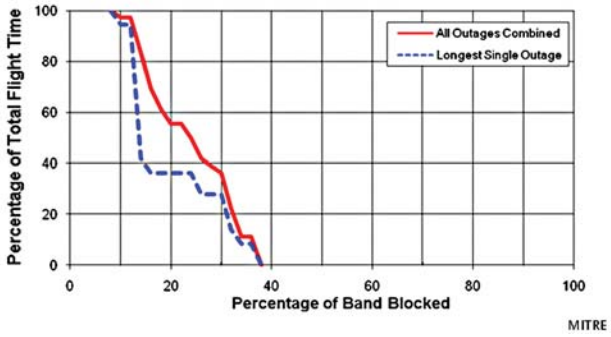
Postprocessor

The postprocessor takes output files from the simulation model and produces statistics about predicted outages during an unmanned aircraft flight. If the desired signal fails to exceed the aggregate undesired-signal power by the user-defined threshold at a particular point in a particular channel, then the link margin becomes negative, the channel is deemed to be blocked, and an outage is declared. The postprocessor analyzes the recorded results for all channels in the band of interest to ascertain the percentage of total flight time during which RFI blocks various fractions of the band and the relative duration of the longest single outages.

Impact and Applications

UASAT is a valuable prediction tool that can be used to identify and quantify unmanned aircraft control-link outages resulting from unintentional RFI. UASAT has been used to assess potential RFI from incumbent radio systems to sUAS C^2 links in several frequency bands and geographical locations. The tool has also been utilized to estimate the aggregate RFI impact of licensed non-Government emitters on C^2 links of sUAS in the 150–175 megahertz band in North Dakota as part of the Limited Deployment of Cooperative Aircraft Project (LD-CAP).





Contact: mitreaviation@mitre.org
www.mitrecaasd.org