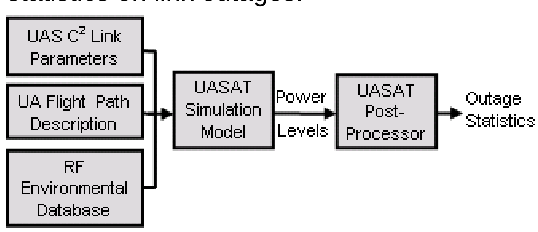
Unmanned Aircraft Spectrum Analysis Tool

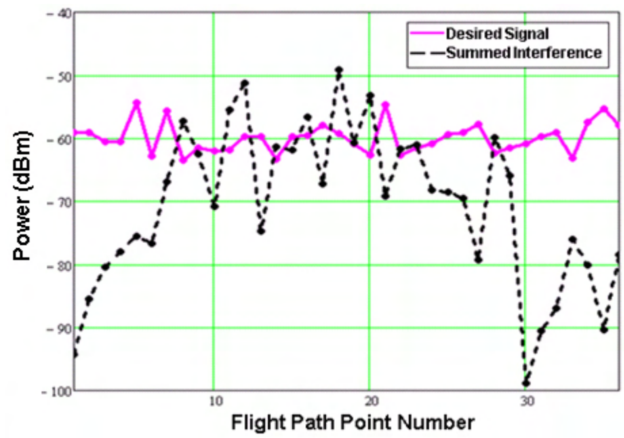
Unmanned aircraft (UA) are critically dependent on the command and control (C^2) radio links that enable pilots to operate them. Those links are susceptible to radio-frequency (RF) interference (RFI) from other systems operating in the same frequency bands. Under certain operational conditions, degradation of C^2 link reliability could result, with possible safety implications. Anticipated growth in commercial, governmental, and recreational use of small UA systems (sUAS) in the National Airspace System is apt to increase the likelihood of such outages unless adequate mitigation measures are implemented. In order to estimate the likelihood of sUAS C^2 link outages resulting from unintentional RFI, CAASD has developed the UA Spectrum Analysis Tool (UASAT) with support from the Unmanned Aircraft Program Office of the Federal Aviation Administration (FAA).

The core of UASAT is an automated simulation model that employs the user-defined parameters of a UA system (UAS) C^2 uplink (including the location of the ground control station, the flight path of the UA, 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 UA 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 automated UASAT postprocessor analyzes the recorded results for all channels in the band of interest to calculate statistics on link outages.

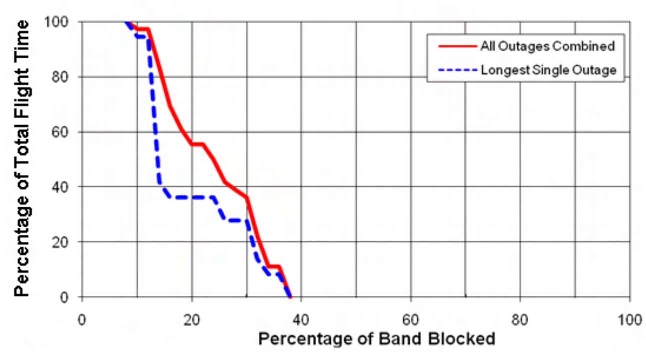


The Simulation Model gives the user a choice of RF propagation models (Smooth-Curve Smooth-Earth, Longley-Rice, or Free Space Loss). It calculates each received undesired-signal level on the basis of the emitter power, the two computed antenna gains, the path loss, and cross-polarization loss. Then it 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 UA receiver, and the aggregate undesired-signal power entering the receiver passband, for each RF channel and each sample point along the flight path.



The Postprocessor takes output files from the simulation model and produces statistics about predicted outages during a UA 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.



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