RF Co-Site Interference Simulation in Complex Electromagnetic Environments
Degradation in the performance of an RF system due to other electronic or RF systems typically co-located on the same platform
RF Interoperability on UAS

- IFF Up
- IFF Lwr
- DME Up
- DME Lwr
- TACAN Up
- TACAN Lwr
- GPS L1&L2
- VHF Up
- DF-V/UHF
- UHF Lwr
System Assembly and Modeling (SAM)

Drag and drop antennas & platform models in the same DS Schematic...

…or 3D Assembly

Previously defined anchor points for the antennas and for the UAS platform

Antenna alignment on UAS
Interference Task

Workflow for RF Interference Simulation

• Definition of the Coupling Matrix
• Definition of RF Systems
• Analysis of received power and possible interference
Interference Task

Workflow for RF Interference Simulation

- Definition of the Coupling Matrix
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Definition of the Coupling Matrix

Power coupled from system to system

• S-Parameters

Simple models inaccurate

Coupling from 3D full-wave simulation

• Distinct frequency dependence over broad band
• Tightly coupled systems
3D Simulation Setup

All ports excited in order to compute the full S-Matrix
3D Simulation Challenges (I)

S-Parameters [Magnitude in dB]

High Accuracy

Broadband
3D Simulation Challenge (II)

CST time domain solver based on FIT

- Approx. 150 million mesh cells
- Frequency Range: 0 – 1.65 GHz
- Small details to catch
- Excitation: 11 Ports
Simulation Time

CST time domain solver based on FIT

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- Excitation: 11 Ports

<table>
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<tr>
<th>Configuration</th>
<th>Time</th>
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<tr>
<td>1 Workstation</td>
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<td>1 NVidia Tesla K40 GPU</td>
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Return Loss for Installed Antennas on UAS

Frequency Range

1) DF-V/UHF: 30MHz-400MHz
2)-3) DME: 962MHz-1213MHz
4) GPS L1: 1575.42MHz
5) GPS L2: 1227.6MHz
6)-7) IFF: 1030MHz & 1090MHz
8)-9) TACAN: 969-1213MHz
10) UHF: 225-400MHz
11) VHF-L/H: 30-88/108-174MHz
Antenna Coverage and E-Field on UAS

TACAN Up Farfield @ 1087.5MHz

TACAN Up Electric Field @ 1087.5MHz
GPS Antenna Coupling

S11,4: Coupling to VHF-Up, nearby to GPS antenna
GPS Antenna E-Field, Close Proximity to VHF-Up
Load S-Parameters into Interference Task

1. S-Parameters from SAM SP

2. DS S-Parameters Task
Interference Task

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Interference Task Overview

Navigation Tree

Violation Matrix

System Overview

Parametric RF Systems
Radio Library for Interference Task

- Drag & drop radios from and into the library
- Pre-defined radios and user-defined radios
- Radios can be stored in a central library (network location)
- Library can also be exported and imported for other users
- Search functionality for names and tags
Interference Task: RF Systems on UAS

Upper Antennas

Transceiver
Receiver
S-Par/Coupling

Lower Antennas
Parametric Receiver Definition

Receiver Sensitivity [Magnitude in dBm]

Frequency / MHz

Sensitivity / dBm

-110 to -10 dBm

-100 to 0 dBm

224.985 to 225.015 MHz

UHF-Lwr-Rx:1

Parameter List (LHF-Lwr-Rx):

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<th>Name</th>
<th>Expression</th>
<th>Value</th>
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<tbody>
<tr>
<td>Name</td>
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<tr>
<td>Ramp Shape</td>
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<td>Sensitivity (dBm)</td>
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<tr>
<td>Spurs</td>
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</table>
Parametric Transmitter Definition

- Power (dBm): 40
- Noise floor (dBm/Hz): -134.0
- Harmonics:
  - Harmonic level (dB): -10
  - Bandwidth (MHz): 0.1
  - Spur: 0.1
Interference Task

Workflow for RF Interference Simulation

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Interference Task: Violation Matrix

[Sensitivity - 10 dB]

[Graph showing interference matrix with sensitivity levels]
VHF-L/H Vs. GPS L1

VHF-L: 30-88MHz
VHF-H: 118-174MHz

GPS-L1: 1575.42MHz
VHF-H Vs. GPS L1 - Results

10th Harmonic
VHF Tx channel 159 (157.5MHz)

Rx IB Interference
VHF-L Vs. GPS L1 - Results

Rx IB Interference

BroadBand Noise
VHF-L: Harmonics from 15 to 25
VHF-L (25 Harmonics) Vs. GPS L1

Rx IB Interference

18th Harmonic
VHF Tx channel 231 (87.5MHz)
Summary

RF Interference
• Can degrade the performance of RF systems or even stop them from functioning

Coupling Matrix from Simulation
• 3D full-wave, Received power
• Time domain with GPU

System Analysis by Interference Task
• System definition
• Violation matrix
Additional Materials

Previous Webinars:

- Getting Ahead with the Interference Task
  - [https://www.cst.com/events/webinars/2017-02-23-interference](https://www.cst.com/events/webinars/2017-02-23-interference)

- Simulation of RF Interference in Electronics

Acknowledgement

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