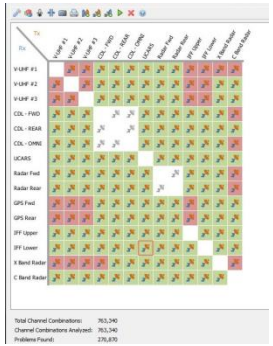
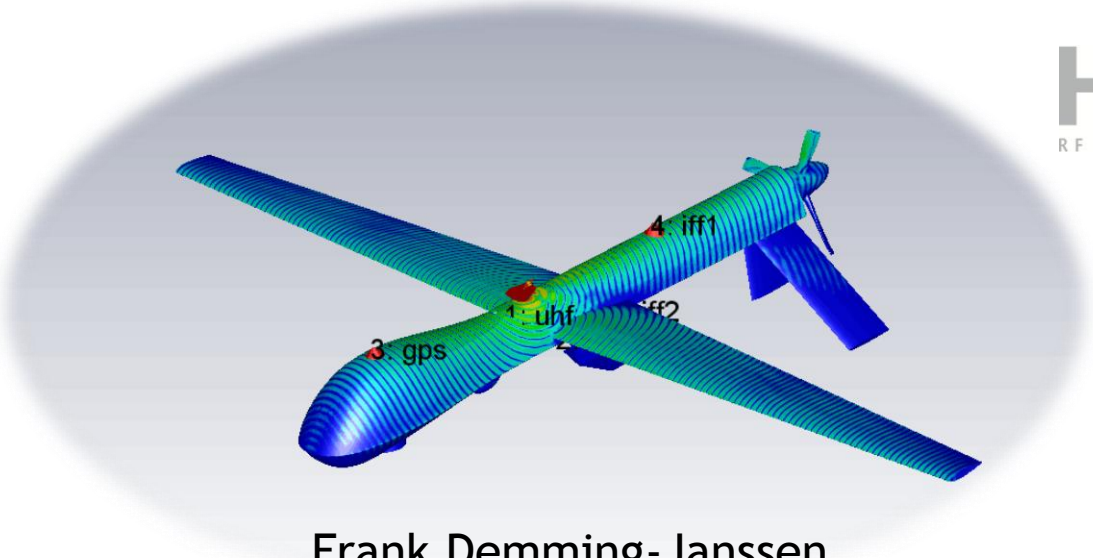
Prediction of Co-site interference in complex RF environments





HITECH
RF & Microwave solutions

Frank Demming-Janssen
CST AG

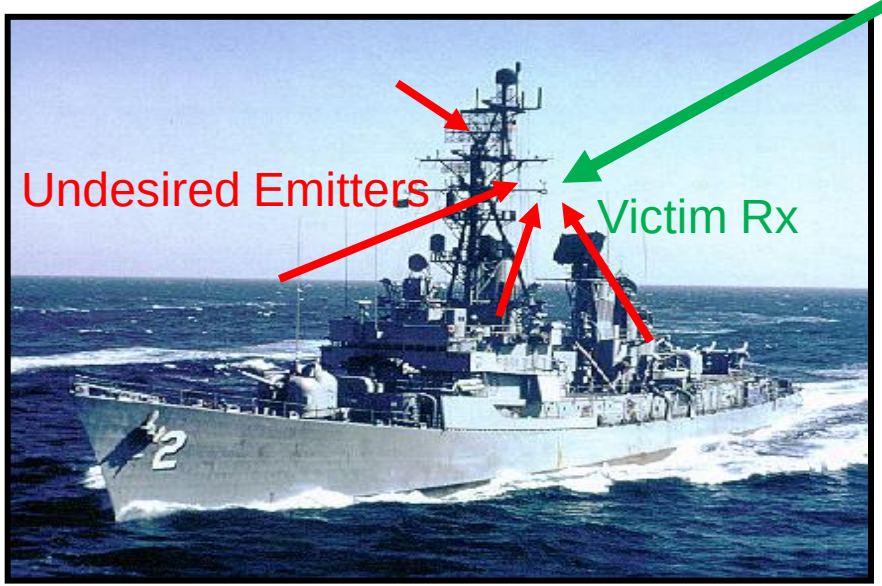
DELCROSS TECHNOLOGIES

CST

The Cosite Scenario

- Multiple RF systems co-located in a common environment
- Diverse system characteristics
  - Frequency bands (10 KHz to 40+ GHz)
  - Power levels
  - Modulation types

Desired Signal



- Victim Rx trying to “hear” desired signal from remote Tx
- At the same time, local emitters are transmitting
  - at operating frequency
  - at spurious and higher harmonics
- Local emitters can interfere with desired signal reception

= Cosite Interference

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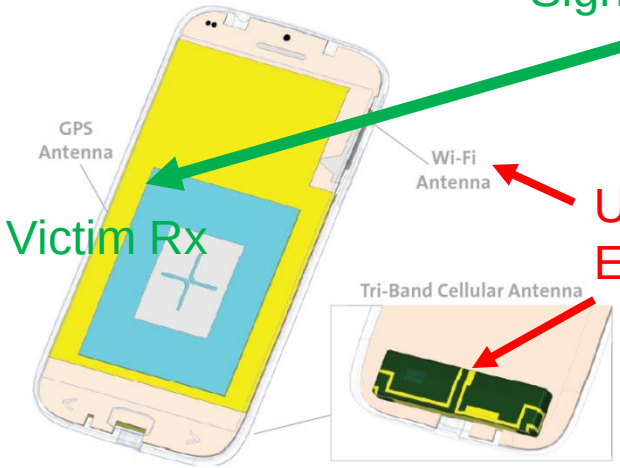
http://commons.wikimedia.org/wiki/File:Navstar-2.jpg

Desired Signal



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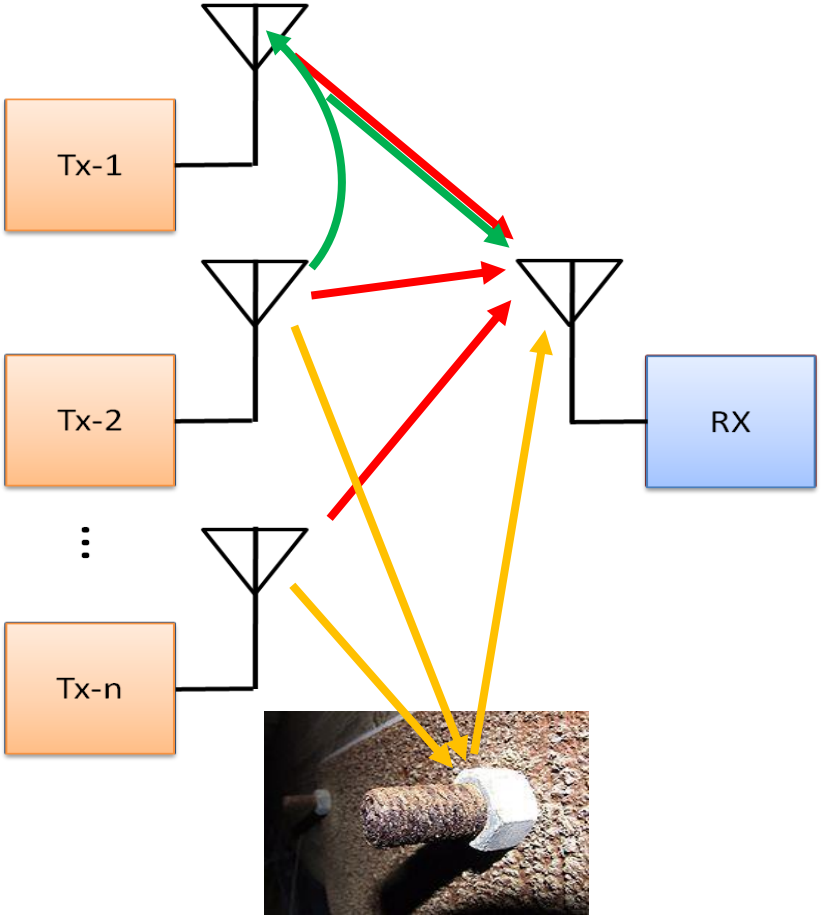
Mechanisms for Cosite Interference



- There are many mechanisms for coupling between the Tx's and the Rx:
  - Antennas
  - Cables
  - Enclosures
- Coupling can be direct between a Tx and Rx…
- Or it can be more complex…
- Or even devious! (*e.g.*, rusty bolt effect)

Predicting Cosite EMI - the workflow

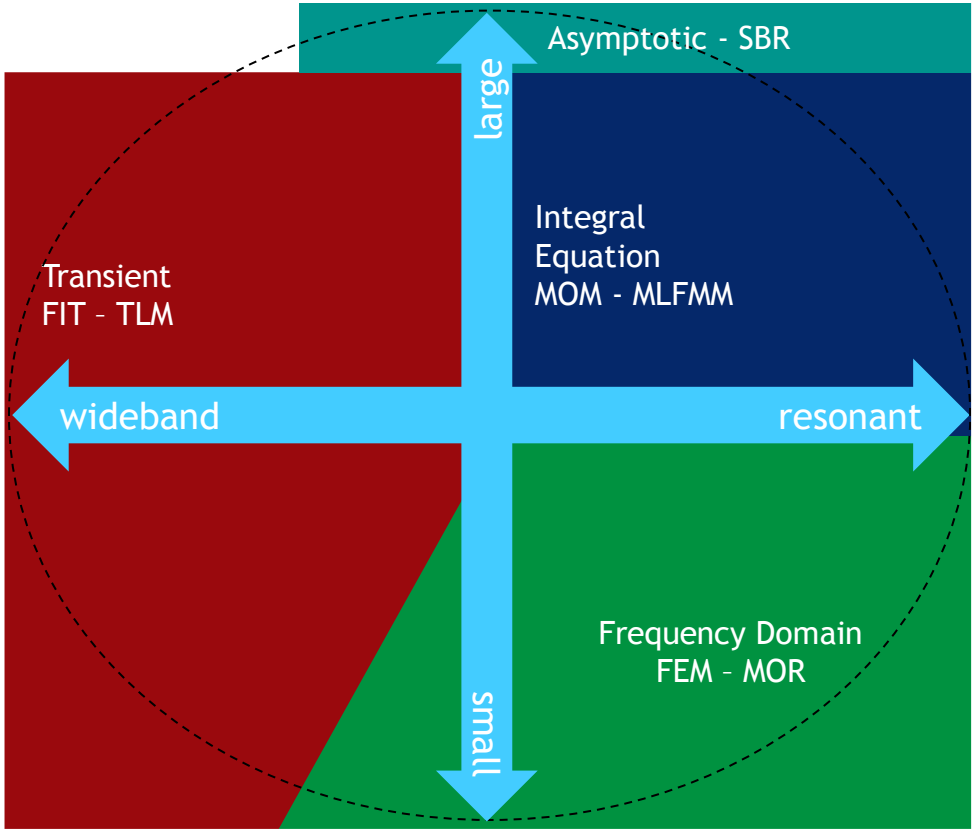
- Calculate Coupling path using 3D EM Solvers
  - Using numerical simulation techniques like FIT/FDTD, FEM, MoM or A-Symtotic Methods
  - CST Microwave Studio

- Calculate System Cosite Interference based on the coupling + Radio System Specification
  - Just basic math required .. But LOTS of it and LOTS of Data -> Data management tool needed
  - Delcross EMIT

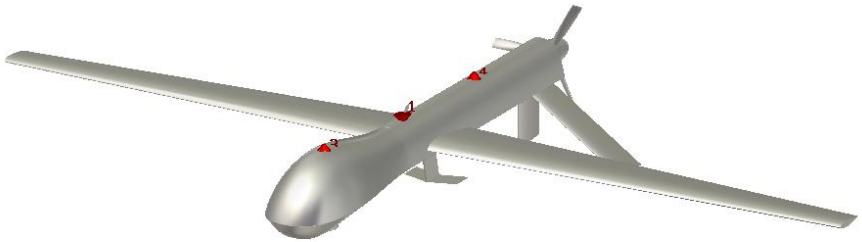
Simulation Methods for Antenna Coupling

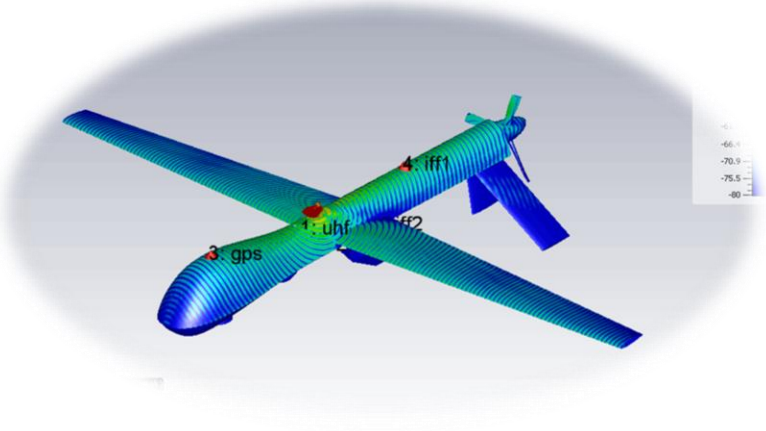
Transient and Integral Equation Methods are best suites for Antenna Coupling simulation

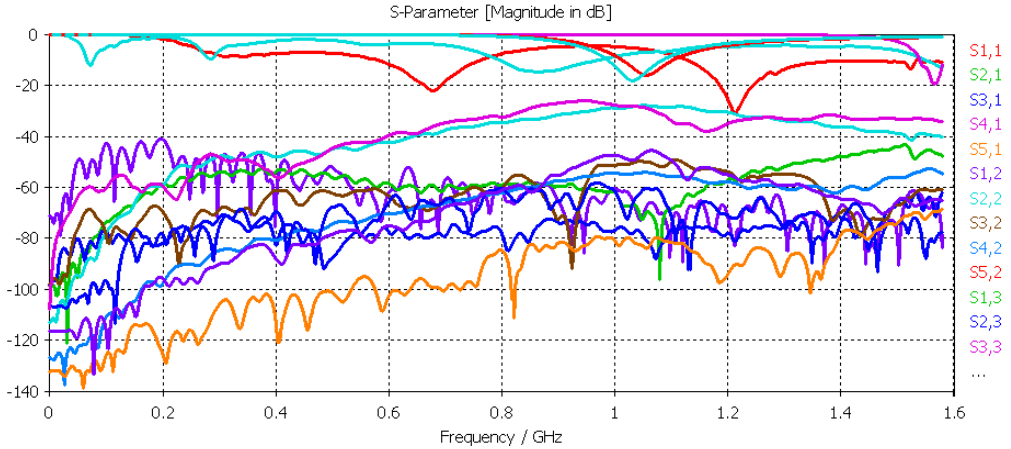
Asymptotic – SBR can be used if system gets electrical to large



Antenna Coupling Example - UAV

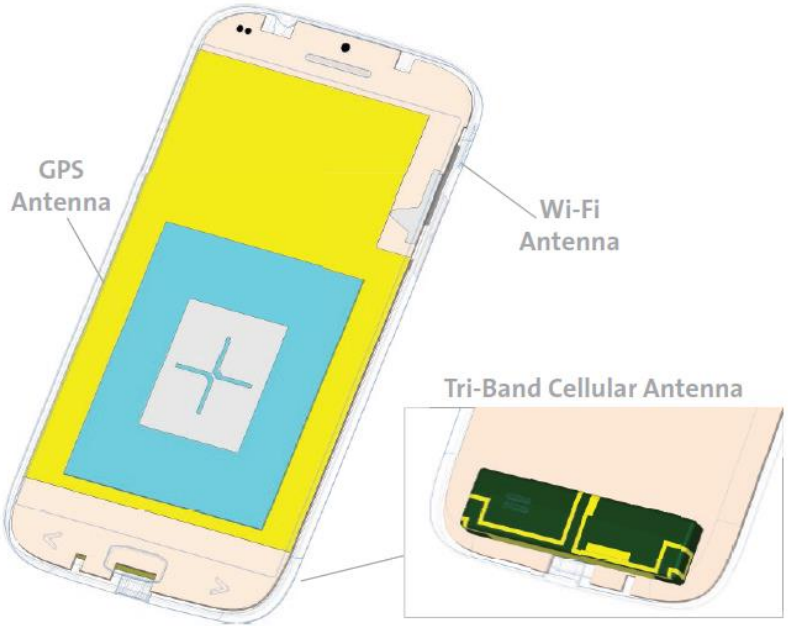


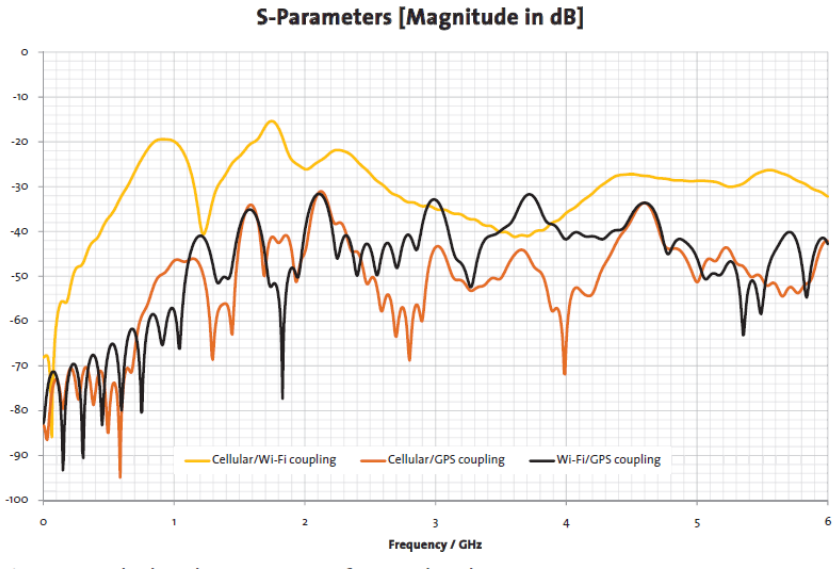




Coupling Simulation
TD-Solver
2h per port

Coupling Example – Mobile Phone





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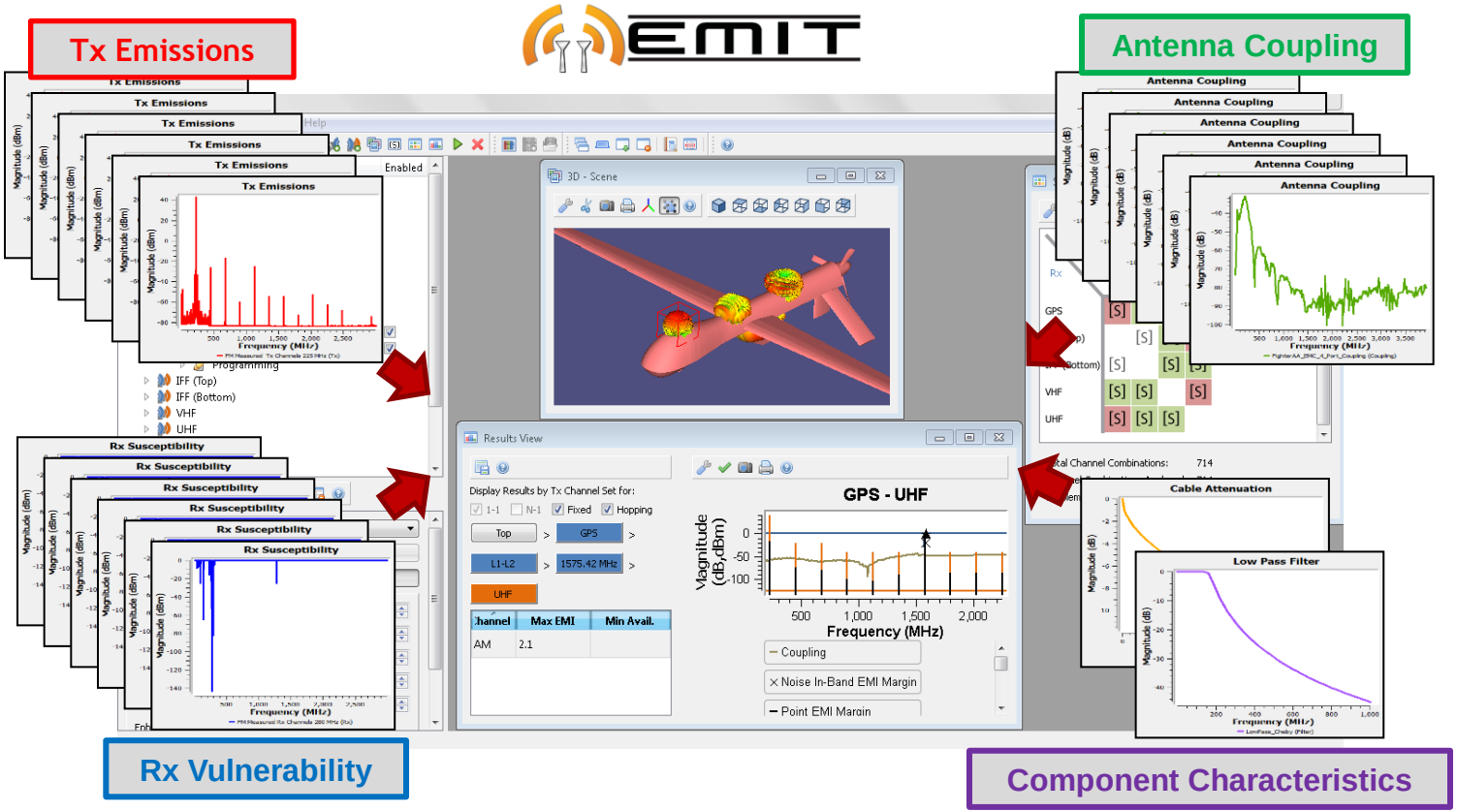
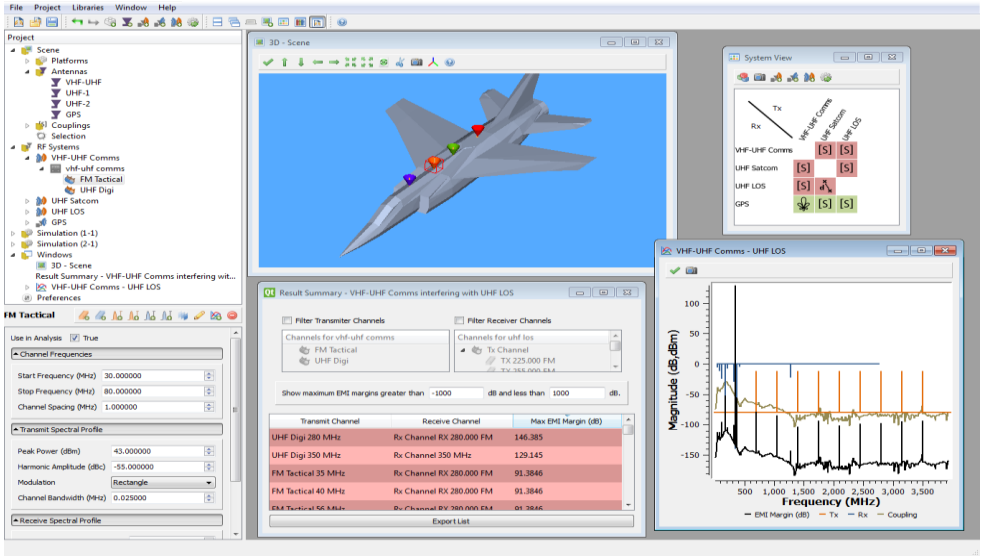
Predicting + Solving Cosite EMI



Predicting + Solving Cosite EMI

Many potential methods to achieve electromagnetic compatibility (EMC):

- Antenna placement
- Use of a different type of antenna
- Decreased transmit power levels
- Adding filters
- Frequency planning



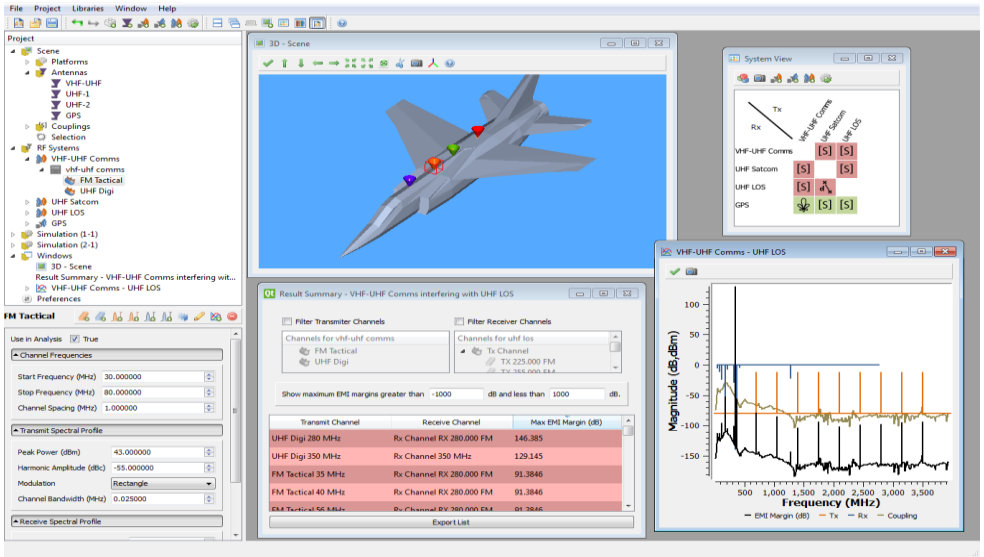
EMI calculation needs to start in the design phase and will cont. during the full project

Predicting + Solving Cosite EMI

One of the biggest challenge in making useful cosite EMI predictions lies in managing all of the input data, models, output data, and results.

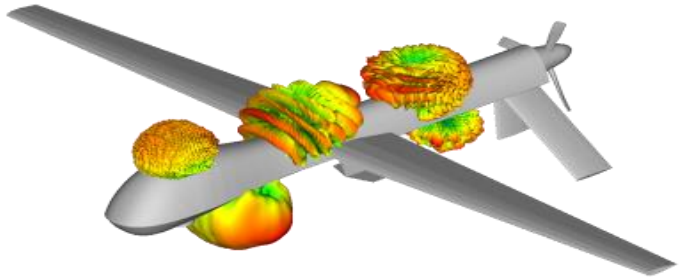
- Different types and fidelities of input data with varying availability
- Cosite evaluation usually cannot wait on high-fidelity system data
- Data management and cosite models must allow incremental refinements
- Result post-processing is critical for identifying and mitigating cosite EMI problems.

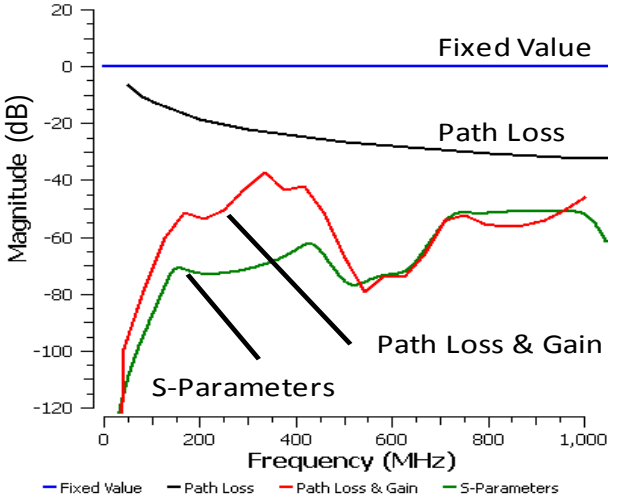
EMIT provides an approach to data management and simulation for cosite EMI predictions.



Multi-Fidelity Antenna Coupling Models

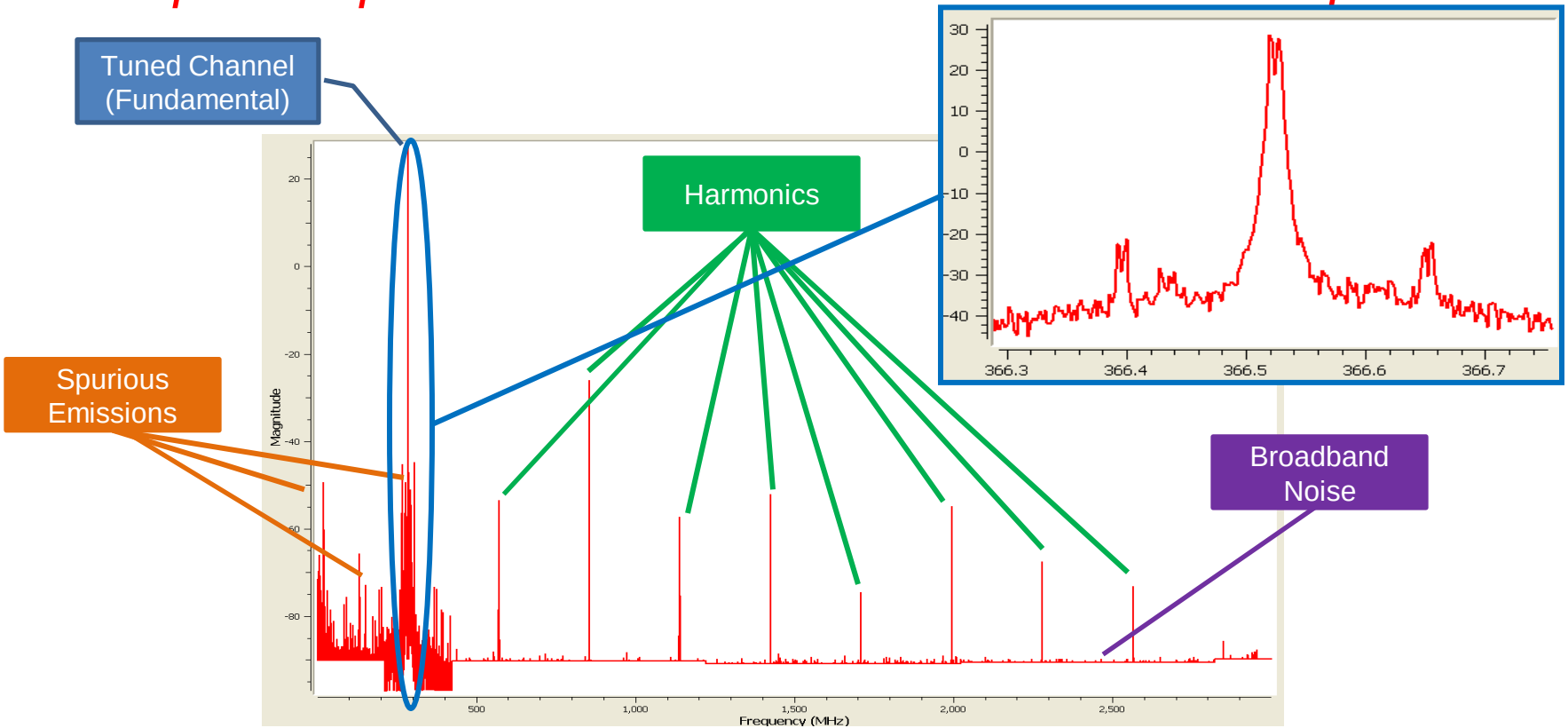
- S-Parameters - wideband coupling from user-supplied S-parameters (from measurements, CEM simulation, etc.)
- Path Loss + Gain - coupling is computed from the path loss and the antenna gain in the direction between antennas
- Path Loss - coupling is based on the free-space path loss between antennas
- Constant Coupling - coupling is assumed constant (at a user-defined value) with frequency





Source (Tx) Characteristics

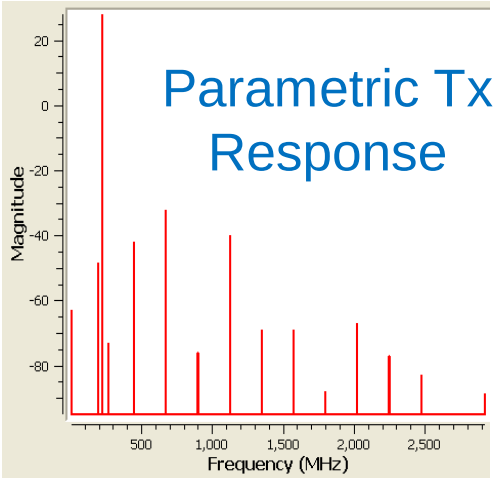
The spectral profile of the Tx for each channel is required.

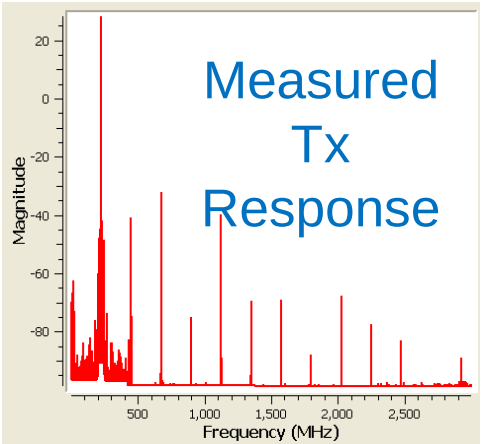


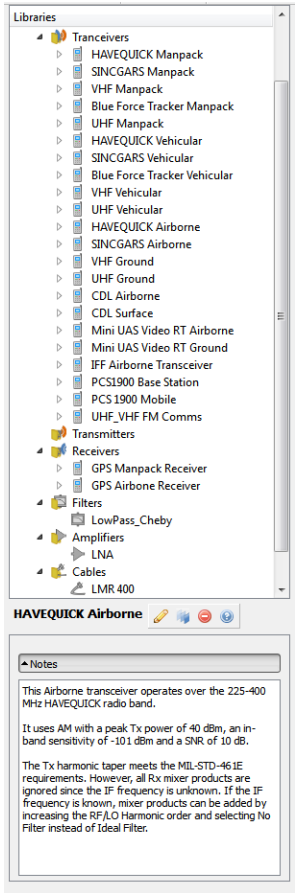
Source (Tx) Characteristics

Source of input data

- Parametric Models:
  - Based on a signal taxonomy
  - Computed using available equipment performance parameters
  - Improved as more data becomes available
- Measurement-based Models:
  - Wideband Tx spectrum measurements
  - Libraries can be exported for sharing with other users
- Library Elements

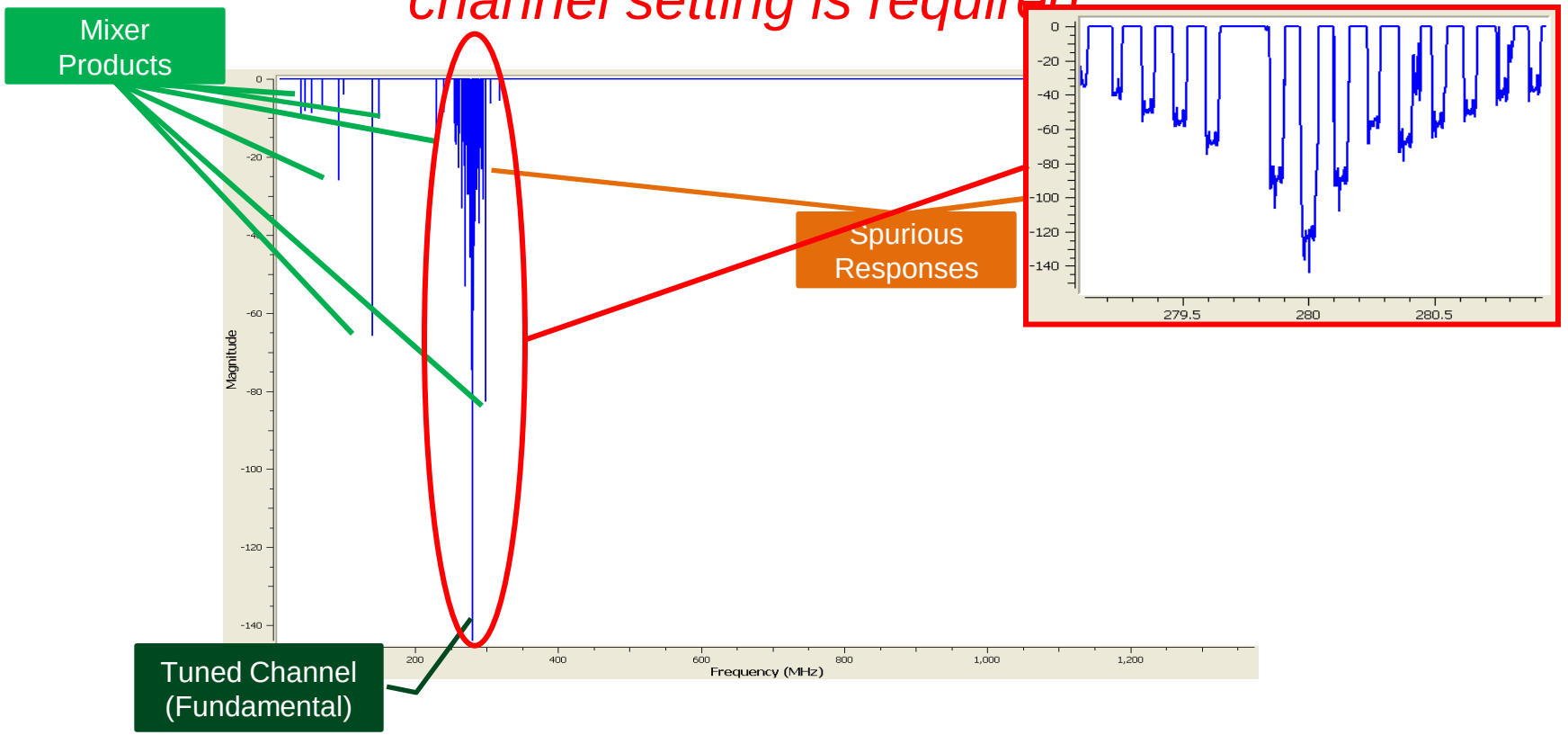






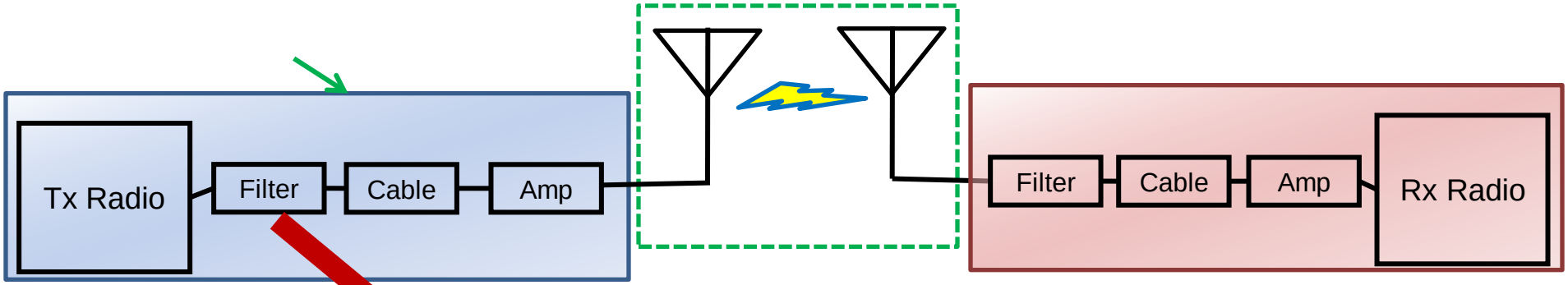
Victim (Rx) Characteristics

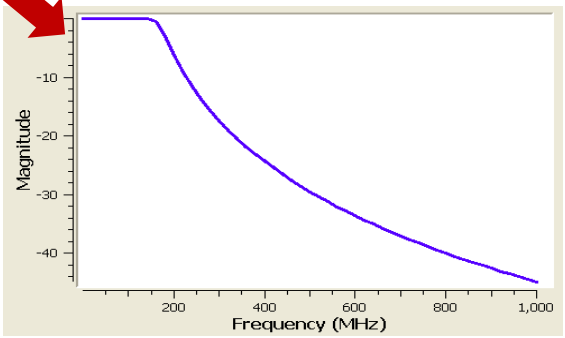
The spectral profile of the Rx sensitivity/susceptibility for each channel setting is required



Other Components

Accommodation for "Outboard" Components at the Tx & Rx



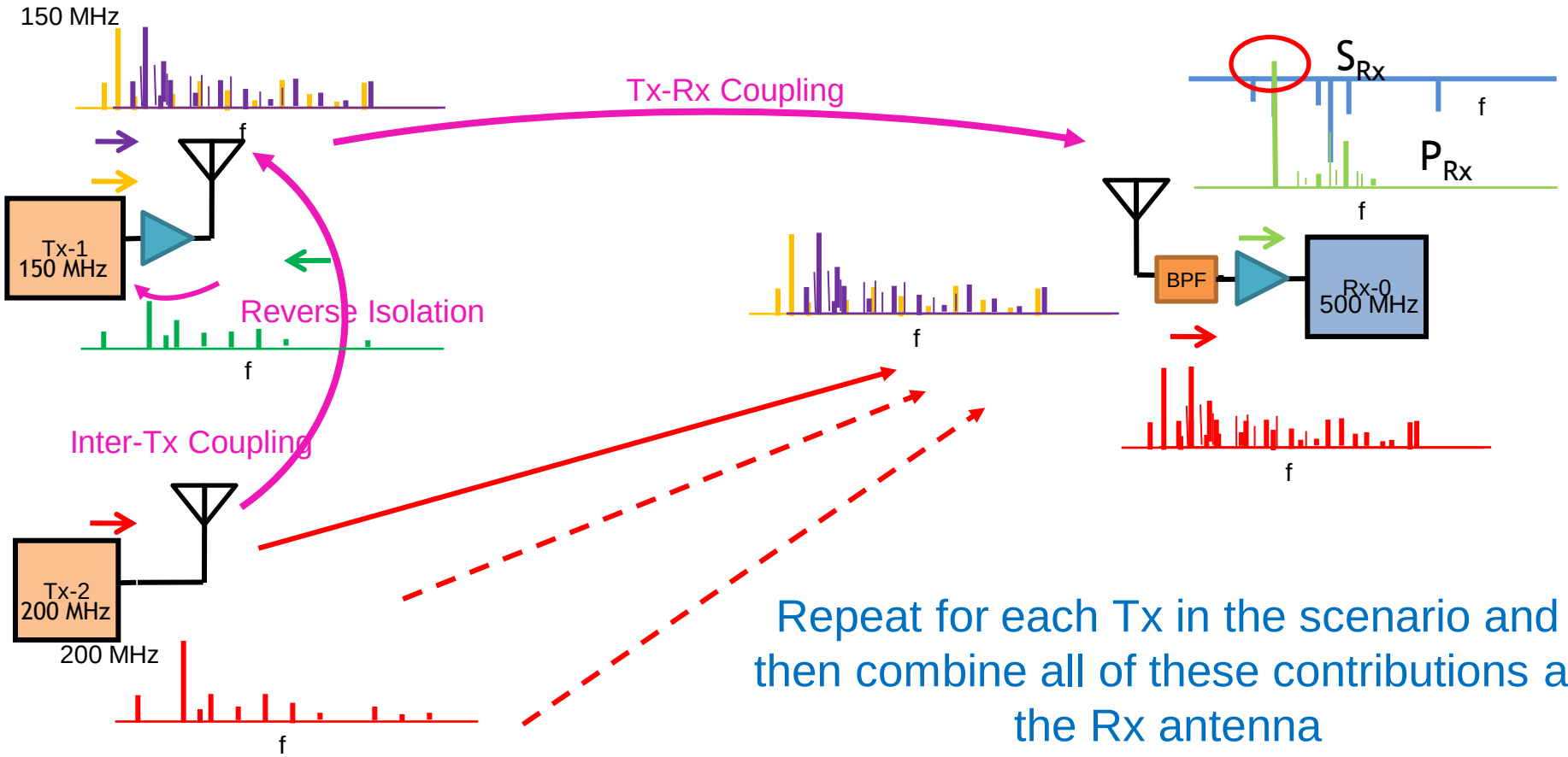


Spectral profile for component's transfer function.

Outboard Components

- Cables
- Amplifiers
- Filters
- Etc.

EMI Calculation: Signal Flow



EMI Calculation: Results Visualization

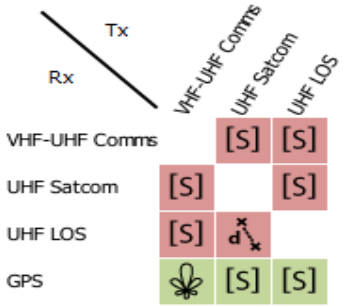
- Realistic cosite scenarios are complex:
  - Dozens of RF systems must be considered.
  - Potentially millions of Tx/Rx channel pairs to consider.
- The results must be managed in a way that permits rapid identification of the root-cause of problems
- Tops down approach for drilling into the results.

- **Present the results to answer questions in the order they are asked:**

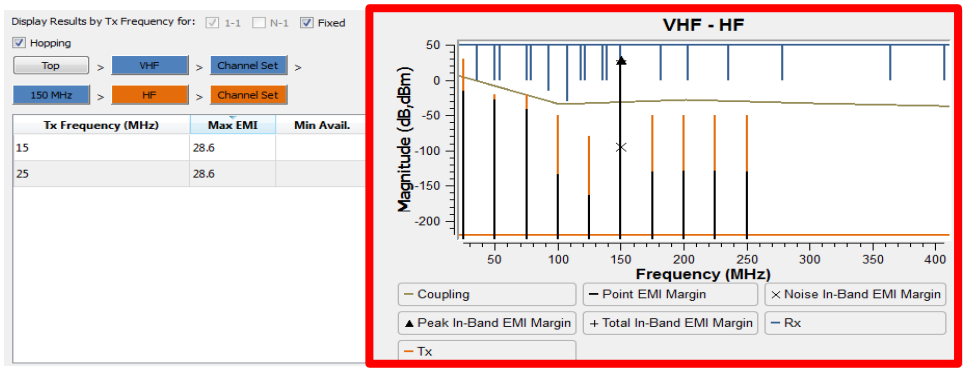
EMI Calculation: Results Visualization

- What systems are interfering with each other? ► System Level “Threat Matrix”
  - What channels are problematic? ► Sub-system level channel summaries
    - What is the root-cause? ► Detailed results plot

System Summary – *Threat Matrix*



Sub-System Integrated Results View



Conclusion

- A Software Framework to analyze realistic co-site scenarios as been presented
- State of the art EM Simulators allow broadband coupling simulations even on large platforms
- Main Focus of the main interference analyze is the data management and result visualization

Thank you for your attention