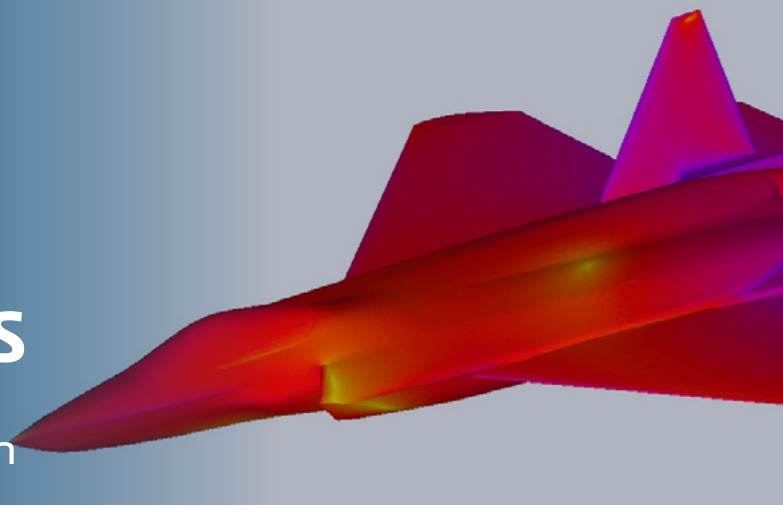
E3 ANALYSIS AND MITIGATION FOR AEROSPACE & DEFENSE PLATFORMS

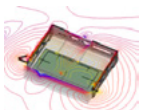
SIMULIA Electromagnetic Solutions to Accelerate E3 Analysis and Certification



Protecting aerospace and defense platforms—from commercial aircraft and rotorcraft to launch vehicles, satellites, UAVs and naval systems—against the full spectrum of electromagnetic (EM) threats is essential for safety, availability and mission success, as well as for demonstrating compliance with demanding qualification and certification requirements.

CST Studio Suite® provides advanced time- and frequency-domain Electromagnetic Environmental Effects (E3) simulation capabilities. This robust toolset enables engineers to identify vulnerabilities early, guide effective mitigation strategies and generate the evidence needed to support E3 analysis and certification in line with military standards such as MIL-STD-464D and NATO AECTP-500, as well as civil aviation and space regulations.

From general electromagnetic compatibility (EMC) and co-site interference to specialized challenges such as electromagnetic pulse (EMP), electrostatic discharge (ESD), lightning strikes, high-power microwave (HPM) systems and radio frequency hazards (RadHaz—including HERP, HERO and HERF), SIMULIA solutions help engineers design platforms that remain resilient to adverse EM effects, keeping safety-and mission-critical assets secure, reliable and operationally ready.

CHALLENGE	SOLUTION BENEFITS
 **Component-Level EMC** Ensuring EMC of avionics racks, mission equipment bays, payload units and cable harnesses at component and subassembly level remains a persistent challenge across air, space, ground and naval platforms. Units must not only pass bench tests, but also remain compliant and robust in their installed configuration under realistic loading, cabling and mounting conditions. Without early, simulation-driven insight into enclosure behavior, I/O coupling and harness terminations, programs risk late design changes, costly test iterations and unexpected integration problems.	• Model equipment and subassemblies with lumped networks, SPICE models or encrypted 3D components, including filters, connectors and terminations. • Use EMC Wizard and dedicated post-processing to accelerate virtual component tests, identify emissions and susceptibility issues and align with military and civil EMC requirements. • Apply hybrid full-wave and transmission-line simulation with GPU acceleration to analyze detailed racks and internal cabling without sacrificing turnaround time.

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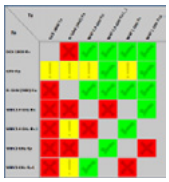
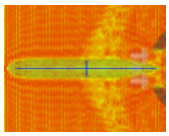
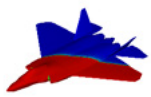
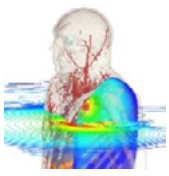
 **Co-Site Interference Mitigation** Placing multiple antennas, radios and sensors in close proximity on crowded platforms such as aircraft, ships, ground vehicles and satellites creates complex co-site interference problems. Transmitters, receivers and digital subsystems can desensitize, overload or disturb each other through near-field coupling, scattering from the platform structure and coupling onto cables. If these interactions are discovered late during testing, programs face expensive relocation of antennas, redesign of RF chains and degraded link performance.	• Simulate near- and far-field interaction between antennas, structures and onboard electronics to predict coupling paths and interference margins early. • Use full-platform coupling analysis to identify critical transmitter–receiver pairs, vulnerable frequency bands and regions with limited isolation. • Perform fast what-if studies on antenna locations, filtering and power levels to resolve co-site issues before committing to flight or sea trials.
 **External EM Environments** Across airborne, naval, ground and space systems, military standards such as MIL-STD-464D define external electromagnetic environments that platforms must withstand, including lightning direct and indirect effects, high-level RF fields, EMP/HEMP and static discharge. In civil aviation, applicable environmental and EMC standards specify corresponding severe test conditions for airborne systems. Ensuring that safety- and mission-critical functions remain available under these environments is essential for platform qualification and airworthiness, and for providing credible evidence in support of E3 compliance and certification.	• Predict lightning attachment, current paths and indirect effects using electrostatic and transient EM simulations linked to cable and equipment models. • Evaluate high-level RF environments and shielding effectiveness at platform level to verify performance against specified external EM environments. • Analyze induced currents and voltages on harnesses and enclosures across multiple environments to identify vulnerabilities and guide design improvements. • Reuse a single high-fidelity model to assess different scenarios and domains, reducing physical test campaigns and integration risk.
 **EM Threats & System Hardening** Modern aerospace and defense platforms, especially in the military domain, are exposed to severe electromagnetic threats such as EMP/HEMP, high-power microwave sources, high-level RF fields and advanced RF/ultra-wideband devices. Hardening is vital to maintain command, control, communication, navigation and safety functions under deliberate attack. In civil aviation and space programs, the same shielding, filtering, bonding and grounding concepts are used to increase robustness, de-risk E3 certification and qualification, and meet requirements such as MIL-STD-464D and applicable civil aviation environmental and EMC standards.	• Simulate severe EM threat environments to predict fields, currents and voltages on structures, cable harnesses and subsystems against program-specific limits. • Virtually evaluate shielding, bonding and grounding concepts by analyzing field penetration through apertures, seams and interfaces for different platform types. • Assess the effectiveness of filters, surge protection and cable routing using hybrid full-wave and transmission-line simulations. • Compare alternative hardening concepts to achieve the required protection level with minimal mass, volume and cost.
 **Radiation Hazard Analysis** Ensuring personnel safety and platform compliance within Radio Frequency Hazard (RadHaz) constraints requires rigorous analysis across military and civil environments. Crew, passengers, ordnance and fuel systems may all be exposed to fields from onboard and external RF emitters. Accurately predicting exposure levels, induced currents and sensitive locations is essential to identify unsafe conditions, justify safety margins and demonstrate compliance with applicable exposure and RadHaz requirements as part of safety cases and certification activities.	• Simulate HERP, HERO and HERF scenarios in 3D to predict field strengths, induced currents and power deposition around RF emitters. • Use voxel- and CAD-based human models with frequency- and temperature-dependent tissue properties to assess RF exposure, SAR and temperature rise for crew and ground personnel in line with ICNIRP and IEEE C95.x exposure limits. • Evaluate coupling to ordnance and fuel installations and compare induced quantities with RadHaz requirements in MIL-STD-464D for HERP, HERO and HERF.

E3 as an Integrated Strategy

Addressing Electromagnetic Environmental Effects (E3) early in the design cycle is essential to identify vulnerabilities, reduce systemic risk and keep platforms resilient against the full spectrum of EM challenges—from component-level EMC and co-site interference to external EM environments, severe EM threats and radiation hazards. CST Studio Suite enables this approach by shifting much of the E3 work from late physical testing into the virtual domain, reducing prototype loops and focusing laboratory campaigns on final verification rather than troubleshooting.

Why Choose SIMULIA?

- SIMULIA electromagnetic solutions provide a comprehensive solver portfolio for EMC, E3, co-site and RadHaz analysis across aerospace and defense programs.
- A unified environment for 3D EM, circuits and systems enables model reuse from component design through platform integration and verification.
- Integration with CAD, PLM and the **3D**EXPERIENCE® platform maintains a consistent, traceable data backbone for geometry, requirements and simulation results.
- High-performance computing—including multithreading, GPU, distributed and cloud execution—helps engineering teams evaluate large, detailed models within demanding program schedules and certification timelines.

Find out about CST Studio Suite and join the SIMULIA Community to learn more.

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