Presentation Title: CERA Simulation of Space Environmental Effects on Battlespace Architecture

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A/V Requirements: Projection from Sparta-provided laptop (includes CERA SWIT Run Demonstration)

The SPARTA-developed C4ISR End-to-End Resource for Analysis (CERA) application is a physics-based analysis M&S toolset used for the simulation, evaluation, and optimization of space and missile platforms, sensors, and subsystems, with an emphasis on space-based architectures and system performance in realistic DoD user scenarios. SPARTA recently added a new CERA Space Weather Impact Toolset (SWIT) capability to model & simulate the effects of the space environment (i.e., ionospheric scintillation and solar radio burst emissions) on missile-warning radars and UHF satellite communications.

The CERA Toolset includes the capability to model and simulate the Battlespace architecture for military space systems, to include satellite constellations, platforms, subsystems, sensors, ballistic missiles, interceptors, aircraft, ground movers, ships, unmanned aerial vehicles, decoys and ground-based platforms and sensors (missile-warning radars & satellite communication terminals). Signal Discrimination is modeled in terms of Data Rate and Energy-per-bit to Noise-density ratio. Within CERA's 3D environment, antennae radiation patterns are displayed and communication links between platforms are schematically represented as dashed lines (with color indicating Signal to Noise Ratio, and direction of information flow).

In order to visualize and account for the impact of space weather on key assets and systems, SPARTA modified CERA to accept space weather data and reports in formats compatible with those produced by the Air Force-developed Space Situational Awareness Environmental Effects Fusion System (SEEFS), which was recently integrated at the Air Force Weather Agency (AFWA) at Offutt AFB to generate space weather system impact products to eventually support JFCC/SPACE and other DoD space users via SIPRNet. Specifically, CERA SWIT can model and visualize the quantitative impacts of ionospheric scintillation on GEO ComSat communication footprints/links and missile warning radars, as well as the impacts of radio frequency interference (RFI) due to solar radio emissions on satellite communication links and radars.

Notional (hypothetical worst-case) space weather impact datasets were manually scripted based on an operational understanding of space physics phenomena and the resultant impact (effect) on simulated DoD systems (dual-phased array missile-warning radar & UHF-EHF satellite communication links). Next, CERA's Communications and RADAR physics-based models were modified to account for space-environmental system effects. New graphical user interfaces (GUIs) and the supporting infrastructure were implemented to facilitate the import, ingest, and processing of space weather impact data. Finally, CERA's 3-D visualization capabilities were modified, enhanced, and extended to illustrate the impact on system (Communications and RADAR) performance. These new CERA capabilities can be evolved to enable an operational DoD user to make informed near real-time decisions in the space order of battle.

CERA's communications model includes all aspects of communications: Transmission (Power, line & pointing Losses, Antenna Gains), Propagation (gas absorption and rain attenuation), and Reception (Antenna Noise Temperature, Cosmic, Galactic, Solar, terrestrial, and atmospheric Noise terms, as well as loss terms similar to transmission).