THE DISPATCH

Volume 2, Issue 1 Defense Threat Reduction Information Analysis Center March 2012

Inside this Issue

Program Manager's Corner

This issue of the DTRIAC Dispatch begins our second volume of quarterly newsletters. Due to a renewed interest in system hardening against electromagnetic pulse (EMP), this issue details EMP and DTRIAC's vast data repository for research and modeling and simulations. Additionally, this issue highlights improvements slated this year for our STARS users.

Inside, you'll find a lengthy article that highlights what the Next Generation STARS will bring to both RD&E and operational customers. DTRIAC's vision is to "Provide an information advantage for DTRA by identifying and delivering ***information of value*** using tailored, open architectures, secure information integration, and data sharing enterprise solutions to benefit the ***entire*** CWMD community of interest." The current STARS is incapable of accomplishing that mission and unable to meet today's user demands. With that in mind, we are implementing a variety of enhancements that will provide a night-and-day difference in terms of system utility for the end user.

DTRIAC has seen many changes over the years; however, it still suffers from being viewed by many as a legacy IAC for DNA. It's been a challenge to break away from the "legacy IAC stereotype." By year's end, the DTRIAC will become more of an IAC for the entire agency.

We had a number of great article contributions for this issue, and they are much appreciated. If you have any articles that would be a good match for the DTRIAC Dispatch, please contact me at craig.hess@dtra.mil or at (505) 846-2071. Next quarter's issue will feature the Defense Nuclear Weapons School (DNWS) located on Kirtland AFB NM. As always, I hope you find something of value or interest in this issue, and please continue to communicate to us how we can better serve you.

Thanks,
Lt Col Craig Hess
DTRIAC Program Manager

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This Quarter in History

January 27, 1951:
The government detonates the first atomic test at the new Nevada Proving Ground.

February 1, 1951:
The first nuclear explosion is telecast by KTLA (a Los Angeles broadcasting company). The crew secretly stationed themselves on the top of a Las Vegas hotel and trained their cameras towards the Nevada Test Site. RANGER EASY was seen on screen as a flash of bright light at 5:30 am.

January 24, 1961:
During a B-52 airborne alert mission, structural failure of the right wing resulted in two weapons separating from the aircraft during aircraft break-up at 2,000-10,000 feet altitude. One bomb's parachute deployed and the weapon received little impact damage. The other bomb fell free and broke apart upon impact. No explosion occurred. Five of the eight crew members survived.

Next Generation STARS

The existing DTRIAC Scientific and Technical Information Archival and Retrieval System (STARS) is supported by very capable but dated commercial software that was installed in 2006. This software was designed to support a customer base with a lending library approach while the DTRIAC's core mission and operation is considerably different. The DTRIAC vision is to "Identify and deliver information of value…to benefit the entire CWMD community." To best serve the DTRIAC and the larger DTRA information consumer, it was necessary to reassess DTRIAC's approach to information technologies (IT). A new Next Generation STARS is being built this year with four iterative releases of new functionality. That functionality is driven by user requirements so that the solution fully meets DTRIAC mission needs instead of allowing technology to define business processes.

Features and Benefits

Current Status

- COTS product expensive to modify and maintain
- Custom card catalog entry (metadata): no common translation with other library systems
- Exact search required: ABC_123 only returns exact matches
- Can only search on catalog metadata
- Closed access point (requires STARS account)
- No way of understanding contents of library
- Cannot federate with other DoD libraries such as DTIC

Next Gen STARS

- Open source software easy to modify, provides cost savings, and includes vast industry support for continuous enhancements
- Common language that supports DoD-wide federated search by using common metadata terms
- Fuzzy search: ABC_123 returns ABC, 123, ABC_123, ABC-123… and highlighting of "hits"
- Search metadata and full text document/media contents
- Faceting (Clustering) shows library contents based on EM-1 taxonomy or other metadata
- Using CAC and NCES security services, anyone authorized can search

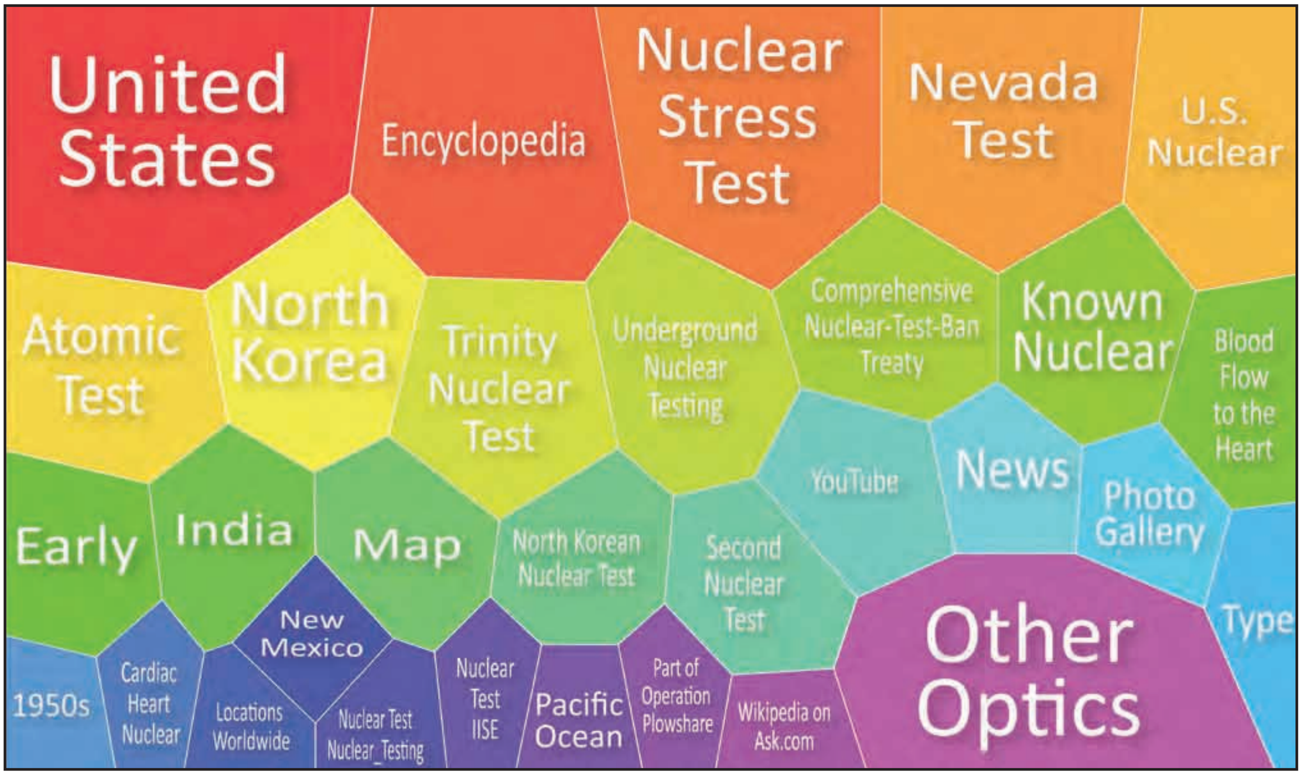
Better than Google!

While that may not be an entirely accurate statement, it's not far off the mark. Similar to Google, Next Gen STARS uses a software product to index the entire DTRIAC collection. Furthermore, Next Gen STARS provides a robust full-text search capability against both the metadata (the card catalog entry for each collection record) and the actual source document. Because DTRIAC has well-defined metadata already captured, describing the contents of the DTRIAC collection, IT can offer end users well-known categories to assist in finding the information they require. When you search with Google on the Internet, you'll find some generic categories (images, maps, news, etc.) but DTRIAC can go to a much better defined set of categories that better match its collection (cratering, ground shock, particulate clouds, etc.).

Next Generation STARS (continued)

Heat Maps

Another new feature in Next Gen STARS will be a "Heat Map" that shows the contents of the entire collection and of your search results. A heat map is a graphical representation of data where the individual values contained in a matrix are represented as colors. Because we have rich metadata associated with the DTRIAC collection, we can create a map that reflects the categories of data. The Heat Map figure shown here reflects results of a generic search on "nuclear testing."



DoD Metadata Standards

The DoD Net-Centric Data Strategy is the plan to make the Department's information resources Visible, Accessible, Understandable, Trusted, Interoperable and Responsive. In order to share data across the DoD Enterprise, a common language must be used to describe that data. That language is the DoD Discovery Metadata Specification (DDMS). DDMS defines attributes to describe the Security, Title, Creator, Publisher, Date, Subject, Source and more that can be applied to each data asset in all DoD information systems.

Next Gen STARS will transform the current catalog of metadata describing the DTRIAC collection to DDMS. This will enable net-centric information sharing with other DoD and DoE information repositories and allow DTRIAC to execute federated searches against many other collections.

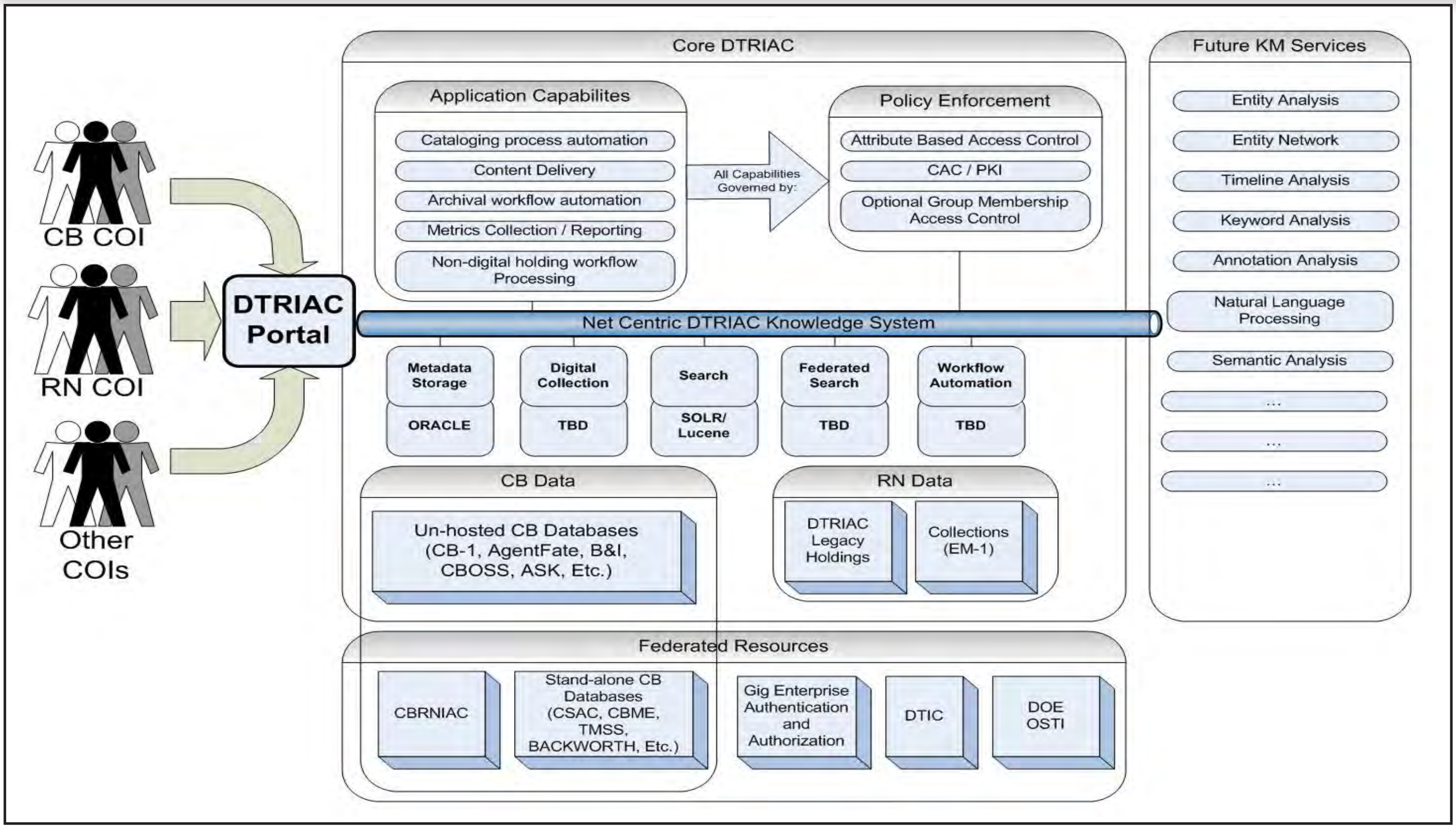
Future State DTRIAC Architecture

The Next Gen STARS solution will adhere to open technology development (OTD) standards as recommended by the DoD CIO in 2006. OTD greatly helps the DTRIAC develop a more collaborative and distributive culture with online support tools and much greater technological agility.

By following OTD guidelines, DTRIAC architecture is modular by design to allow for easy addition (or subtraction) of user capability and technology. The modular components in the system use robust industry standard interfaces (such as XML) to communicate and avoid proprietary interfaces that may become obsolete or change outside of DTRIAC's control. This approach reduces technical and financial risk, avoids vendor lock-in to any one particular solution, and enables new technology insertion without system re-engineering.

The DTRIAC future state architecture figure describes the modular approach that can accommodate data from virtually any DTRA mission area and provide that mission area with search and analysis capability unavailable to it today. Future Knowledge Management Services such as entity analysis, natural language processing, and semantic analysis will prove invaluable and a dominant feature of Agency's Information Analysis Center.

Next Generation STARS (continued)



Schedule

Next Gen STARS will be rolled out by the end of 2012, using an agile development approach. Through prototyping and incremental releases, user feedback will be solicited, captured, and prioritized during each phase to ensure the new solution meets user needs. Much new capability will be added, but no current functionality will be lost.

Conclusion

Next Gen STARS will allow DTRIAC to provide far more effective support to the RD&E and warfighter communities. The injection of sound knowledge management principles and technologies creates a framework allowing reuse of services, providing data sources that get richer with use, harnessing collective intelligence, and enabling use of customer self-service to meet growing community needs.

The underlying architecture allows Next Gen STARS to become a single portal to CWMD data and information not just within DTRIAC but across DTRA and the CWMD community. The adopted service-oriented architecture allows a core set of services to transparently manage enterprise-wide data and provide a structure to add additional analytic capabilities. In this information paradigm, the emphasis shifts from owning and storing data to ensuring users can find relevant data, discover new information and relationships, and make decisions with confidence.

Discover
- Store and Manage Data
- Single Sign-On Access
- Full Text Search and Browse
- Federated Search
- Collections

Understand
- Statistical Analysis
- Entity Extraction
- Entity Analysis
- Advanced Visualization

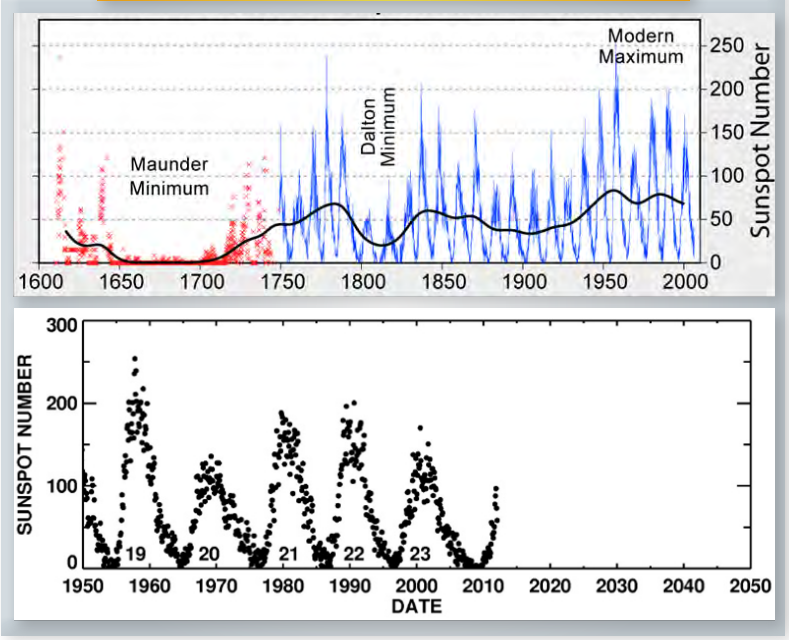
Action
- STINFO Support
- SME Interaction
- Database Access

Space Weather

One may not instinctively make the connection between the DTRIAC collection and Space Weather, but the DTRIAC maintains key information regarding the potential effects of space weather on DoD systems.

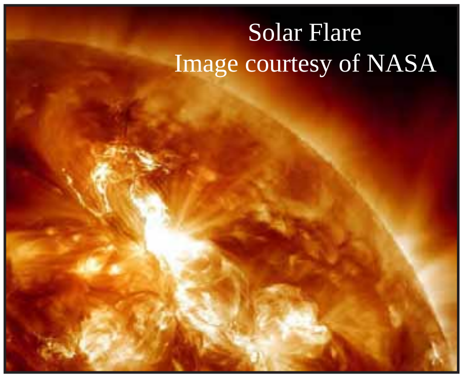
Specifically, the Electronics Radiation Response Information Center (ERRIC) database is among the largest repositories of data sets of electronic component responses to nuclear and space radiation. ERRIC has played a crucial role in the research and development of hardened systems and continues to do so not only for nuclear radiation concerns but also as we consider the ramifications of space radiation on our critical systems.

400 Years of Sunspot Observances



As a part of magnetically driven solar activity, solar flares are sudden brightenings observed over the Sun's surface or the solar limb, which are interpreted as a large energy release of up to 6 × 1025 joules of energy each (about a sixth of the total energy output of the Sun each second). Each flare ejects clouds of electrons, ions, and atoms through the corona into space; these clouds typically reach Earth a day or two after the event.

Solar flares affect all layers of the solar atmosphere (photosphere, chromosphere, and corona), when the medium plasma is heated to tens of millions of kelvins, and electrons, protons, and heavier ions are accelerated to near the speed of light. They produce radiation across the electromagnetic spectrum at all wavelengths, from radio waves to gamma rays, although most of the energy goes to frequencies outside the visual range, and for this reason the majority of the flares are not visible to the naked eye and must be observed with special instruments. Flares occur in active regions around sunspots, where intense magnetic fields penetrate the photosphere to link the corona to the solar interior. Flares are powered by the sudden (timescales of minutes to tens of minutes) release of magnetic energy stored in the corona. The same energy releases may produce coronal mass ejections (CME).


Solar Flare
Image courtesy of NASA

X-rays and ultraviolet radiation emitted by solar flares and CME can affect Earth's ionosphere and disrupt long-range radio communications. Direct radio emission at decimetric wavelengths may disturb operation of radars and other devices operating at these frequencies.

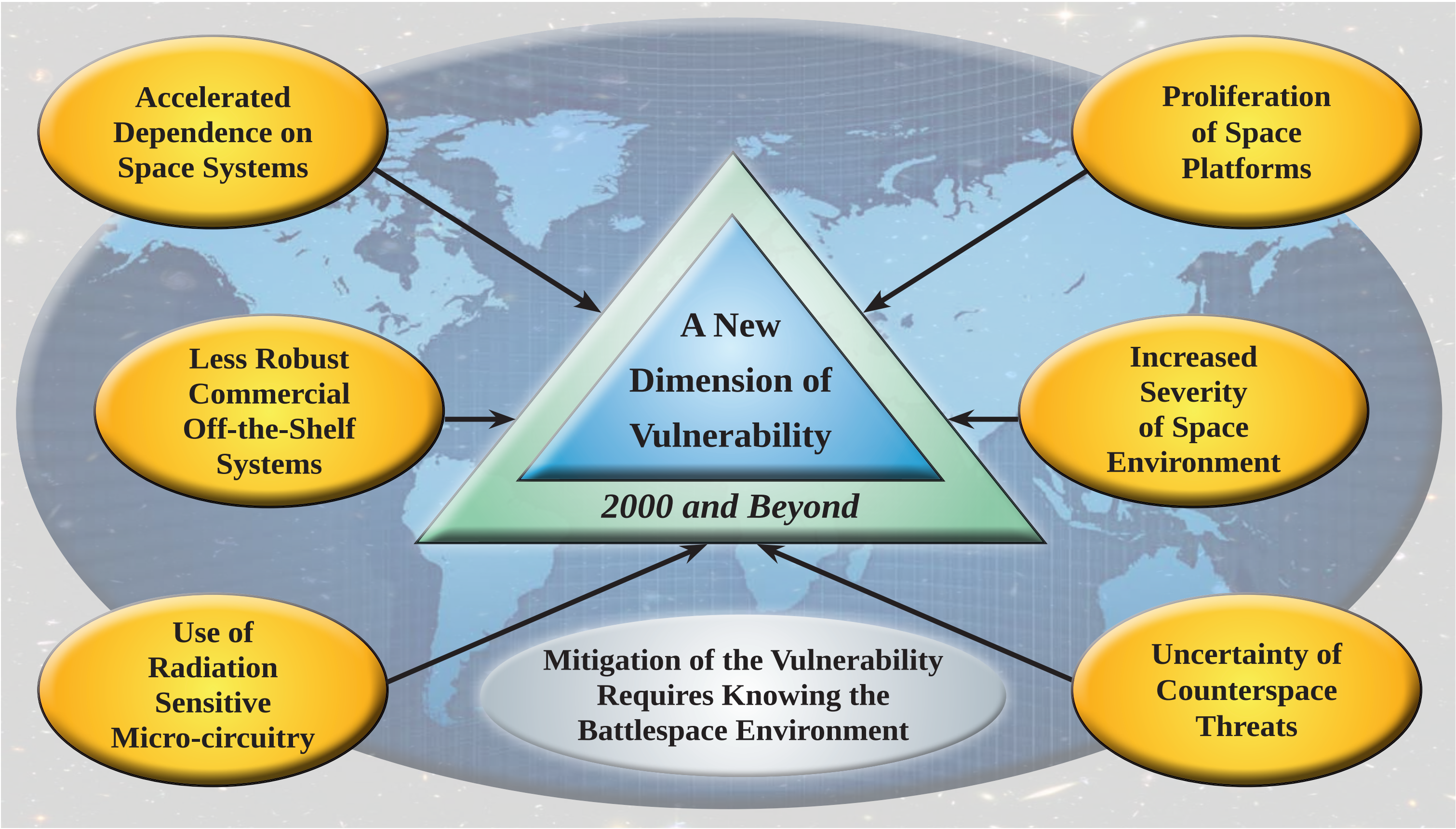
Solar variation is the change in the amount of radiation emitted by the Sun and in its spectral distribution over years to millennia. These variations have both aperiodic and periodic components; the main periodic fluctuation being the approximately 11-year solar cycle (or sunspot cycle). In recent decades satellites have measured solar activity; previously, solar activity was estimated using "proxy" variables. Scientists studying climate change are interested in understanding the effects of variations in the total and spectral solar irradiance on Earth and its climate.

Variations in total solar irradiance were too small to detect with technology available before the satellite era, although the small fraction in ultraviolet light has recently been found to vary significantly more than previously thought over the course of a solar cycle. Total solar output is now measured to vary (over the last three 11-year sunspot cycles) by approximately 0.1%, or about 1.3 W/m^2 peak-to-trough from solar maximum to solar minimum during the 11-year sunspot cycle. The amount of solar radiation received at the outer surface of the Earth's atmosphere averages 1,366 W/m^2. There are no direct measurements of the longer-term variation, and interpretations of proxy measures of variations differ. The intensity of solar radiation reaching Earth has been relatively constant through the last 2,000 years, with variations estimated at around 0.1% to 0.2%.

Space Weather (continued)

Modulation of the solar luminosity by magnetically active regions was confirmed by satellite measurements of total solar irradiance (TSI) by the Active Cavity Radiometer Irradiance Monitor (ACRIM) 1 experiment on the Solar Maximum Mission (launched in 1980). The modulations were later confirmed in the results of the Earth Radiation Budget experiment launched on the Nimbus 7 satellite in 1978. Satellite observation of solar irradiance continues today with ACRIM3 and other satellite measurements. Sunspots in magnetically active regions are cooler and thus appear darker than the average photosphere and cause temporary decreases in TSI of as much as 0.3%. Faculae in magnetically active regions are hotter and therefore appear brighter than the average photosphere and cause temporary increases in TSI. The net effect during periods of enhanced solar magnetic activity is increased radiant output of the sun because faculae are larger and persist longer than sunspots. Conversely, periods of lower solar magnetic activity and fewer sunspots (such as the Maunder Minimum) may correlate with times of lower terrestrial irradiance from the sun.

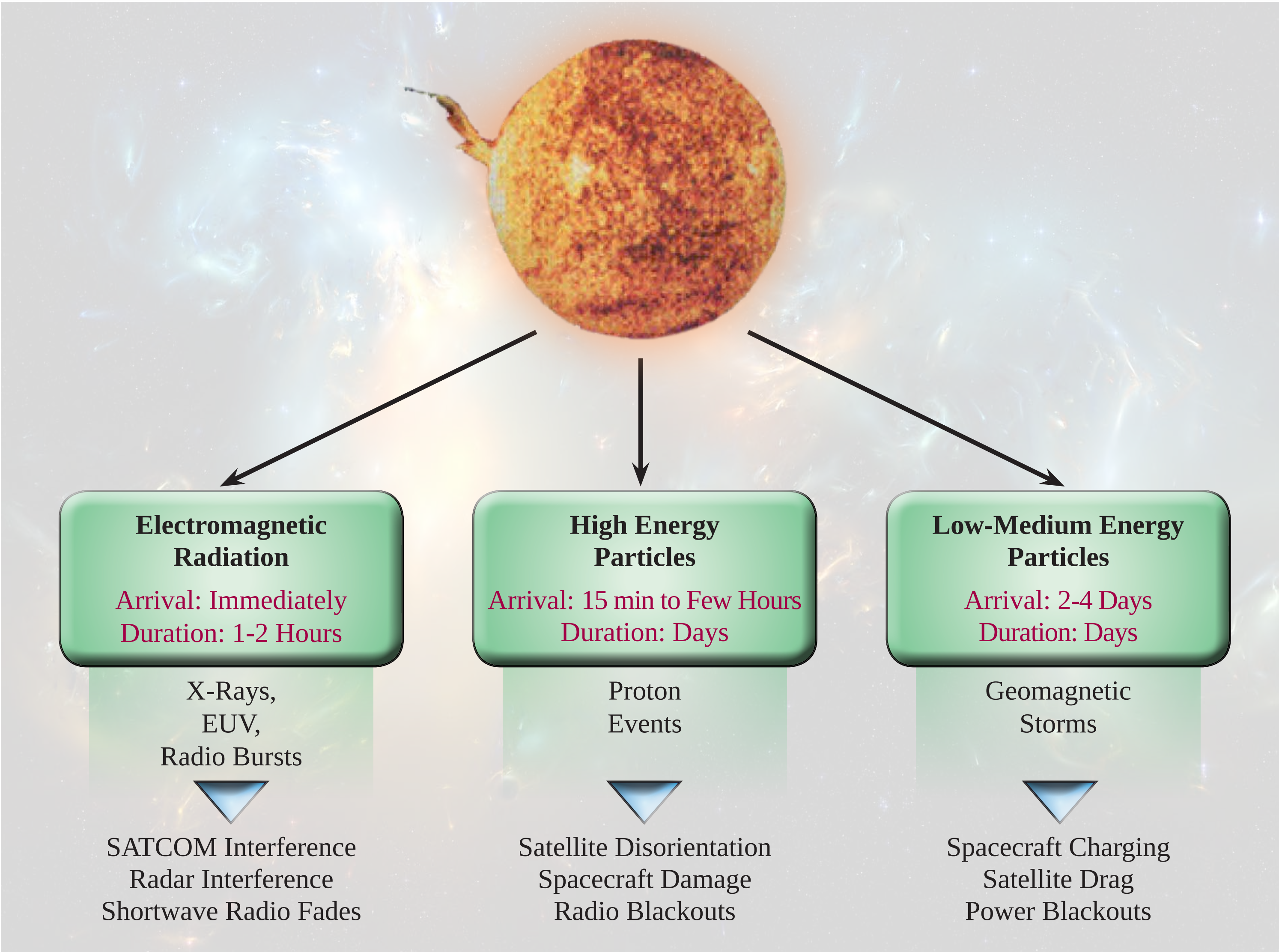
Why is knowing the space environment important? Our increased dependence on space-based systems to meet warfighter objectives and needs, coupled with the increasing use of microelectronics and a move to nonmilitary specifications for satellites, increases our vulnerability to loss of critical satellite functions or entire systems. The space environment is a hostile environment for satellites.



The origin of space environmental impacts on radar, communications, and space systems lies primarily with the Sun. The Sun is continuously emitting electromagnetic energy and electrically charged particles. Superimposed on these emissions are enhancements in the electromagnetic radiation and in the energetic charged particle streams emitted by the Sun. These solar radiation enhancements have a significant potential to influence DoD operations.

Generally the stronger a solar flare, the denser, faster, and more energetic a particle stream; or the sharper a solar wind discontinuity or enhancement, the more severe will be the event's impacts on the near-Earth environment and on DoD systems operating in that environment. Unfortunately, the DoD system impacts do not occur one at a time, but most likely occur in combinations of more than one effect. The stronger the causative solar-geophysical activity, the more in number of simultaneous effects a system may experience. Each of the three general categories of solar radiation has its own characteristics and types of immediate or delayed DoD system impacts.

Space Weather (continued)



DoD systems are not the only ones affected by solar-geophysical activity. Some of these “non-DoD” impacts can indirectly affect military operations. For example, system impacts from a geomagnetic storm can include induced electrical currents in power lines that can cause transformer failures and power outages, and magnetic field variations that can lead to compass errors and interfere with geological surveys.

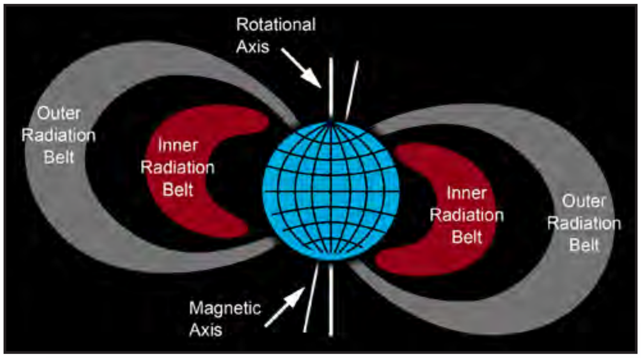
To account for all of these potential effects, DTRIAC maintains the Electronics Radiation Response Information Center (ERRIC) database. ERRIC is a large repository database (over 11,800 data sets) of electronic component responses to nuclear and space radiation. Specifically, the information stored in the ERRIC database contains device information (type, manufacturer, sample size), piece-part identification (lot number, serial number, and date of manufacture), test information (testing facility, date of test, test descriptions), and supplemental information.

The information is critical for system designers analyzing the capabilities of these or similar components in meeting systems specifications on all space-borne assets operating in natural or enhanced radiation environments of space. ERRIC supports the Radiation Hardened Microelectronics Program. Maintained by DTRA through DTRIAC as the successor to the Component Response Information Center and formerly operated by the Army Research Laboratory, ERRIC makes data readily available to the nuclear and space effects on electronics hardening and hardness assurance communities.

DTRIAC Archives Aid in Understanding Nuclear Effects

With the end of the Cold War and the termination of nuclear testing, it has become increasingly difficult to identify a strategy for nuclear defense. During the Cold War, with two super powers squared off against each other and both armed with nuclear weapons, it was clear who the enemy was and the possible nuclear scenarios that would require a planned response.

In today's world amid a proliferation of potential nuclear threats, strategy is not so clear cut. The environments, threats posed, and nuclear weapons today are likely to be different from those in the past, and it is also not possible to test systems against potential new threats. Therefore, successful strategies must depend on recovering data from archives of previous tests and applying it to current environments.



Van Allen Radiation Belt
NASA Image

One scenario of interest is the explosion of a nuclear weapon in near-Earth space. There appear to be more than a few nations that may be capable of such an event. For the United States, this would be a very unsymmetric event. While the United States depends heavily on our space assets, many potential one-shot nuclear powers have negligible reliance on space assets. So the effects of high-altitude nuclear explosions (HANEs) are being reevaluated based on current systems and capabilities. One of the recognized HANE-produced hazards to space systems is a dramatic increase in the trapped electron population in the Van Allen Belts.

The only data the United States has on HANEs come from the tests performed in 1958 and 1962 and it is unlikely this data will ever be supplemented. By today's standards our understanding of the space environment and nuclear detectors used to measure it were rather crude. Fortunately Dr. Joe Janni at the Air Force Weapons Laboratory (AFWL) began a project in the mid-80s to collect experimental results from the measurements made on the 1958 and 1962 tests. He was quite successful in collecting as much data as possible, but tying all of it together to produce a coherent picture of the trapped electron environment after a HANE was a daunting task. The measurements Dr. Janni recovered were collected into a single Artificial Trapped Electron Database (ATEDB) and organized into consistent data sets. However, the data reduction techniques were not as advanced, and the results contain large uncertainties. With the end of the Cold War and the suspending of much of the DoD nuclear research, the Air Force Research Laboratory, successor to AFWL, transferred Dr. Janni's collection to DTRIAC. Many of the documents collected by Dr. Janni's team, along with documents collected by DNA itself, are archived at DTRIAC.

In order to improve predictive models, DTRA has initiated a task with Applied Research Associates, Inc. (ARA) to try to reduce the uncertainties in the ATEDB and improve prediction of potential events. The excellent archives within DTRIAC have allowed us to go back to the basic data on satellite and detector designs, satellite orbits, and HANE characteristics and reconstruct such things as calibration curves and satellite locations. The archived documents have already allowed us to reconstruct a great deal of the scenario around the STARAD satellite measurements made during the last two of the 1962 tests. STARAD data are important because it was the only satellite that measured differential electron energy fluxes.

These measurements are required to reconstruct the energy spectrum of the trapped electrons. Recently, researchers also were able to obtain detector descriptions for the Explorer XV satellite from a report in the DTRIAC archive. Like all research, references in the archive report led us to unclassified documents in university and NASA archives that afforded a much better understanding of the collected data.

Because the DTRIAC archive contains both classified and unclassified data specific to nuclear tests, we can obtain the best coherent picture of the events of interest. The clear point of departure for the research we are undertaking is to reevaluate past tests so that they may be used for future strategies and decision making.

This information has been augmented with open literature searches to obtain all of the technology of interest. In a world without nuclear tests, an archive like DTRIAC is the only way we can draw the greatest utility from our legacy nuclear testing.

Proposal for a USAF Nuclear Enterprise System Survivability Office

Dr. Wallace T. Clark III of the Air Force Nuclear Weapons Center (AFNWC) has proposed a single office tasked with ensuring that Air Force weapon systems can operate and survive in the environment created by a nuclear weapon detonation. He proposed that the office would be located on Kirtland AFB, New Mexico, associated with the Air Force Nuclear Weapons Center (AFNWC) and cooperate with all nuclear weapon effects (NWE) organizations including the National Nuclear Security Administration (NNSA), the Air Force Research Laboratory (AFRL) and the Defense Threat Reduction Agency (DTRA).

A single office would be initiated by conducting a 12-month in-depth survey to determine the threats to Air Force systems within an NWE envelope followed by prioritizing the system's vulnerability and susceptibility. As the threats to systems are catalogued and understood, the office would prioritize the risks balanced with cost, schedule, and performance to mitigate the risks, and then support the programs' necessary (replacement, testing, development, or procurement) to alleviate the risks.

Nuclear Weapons Effects

The major effects generated by a nuclear weapon detonation are blast, thermal pulse, radiation (X-rays, gamma rays, neutrons, and electrons), electromagnetic pulse (EMP), and upper atmosphere ionization. Depending upon the height of burst (HOB), blast effects are manifested as ground shock, water shock, crater generation, and large amounts of dust and radioactive fallout. All effects pose problems for the survival of military systems and supporting civilian systems.

Airburst
BLUESTONE Shot
30 June 1962

There are four general HOB categories: subsurface, surface, air, and high altitude. The cratering, blast, thermal, and nuclear radiation effects of subsurface and surface bursts will destroy the majority of systems in the vicinity. If suitably prepared, however, Air Force systems can survive aboveground bursts, which will be discussed here.

Air Burst: An air burst is a detonation in air at an altitude under 30 km but at sufficient elevation that the fireball does not contact the surface. Blast results will cause considerable damage and injury. Burns to exposed skin may be produced over many square kilometers and eye injuries over a greater area. Initial nuclear radiation will be a significant hazard with smaller weapons, but the fallout hazard can be ignored as there is essentially no local fallout from an air burst. The fission products are generally dispersed over a large area of the globe unless there is local rainfall resulting in localized fallout. Near ground zero there may be a small area of neutron-induced activity hazardous to personnel.

High-Altitude Burst: In altitudes above 30 km, the detonation-generated initial soft X-rays dissipate as heat in a much larger volume of air molecules. The fireball is larger and expands more rapidly. Ionizing radiation travels for hundreds of kilometers prior to absorption. Significant ionization of the ionosphere and severe disruption in communications can occur. High-altitude bursts lead to the generation of an intense EMP, which can significantly degrade performance of or destroy electronic and electrical equipment.

High-Altitude Burst
BLUEGILL Shot
26 October 1962

Nuclear weapon effects on electromagnetic signal propagation affecting command, control, communications, computers, and intelligence (C4I) must be a concern to countries expected to use or defend against nuclear weapons. C4I technology is primarily affected by high-altitude nuclear effects that could interrupt satellite-to-satellite communications, satellite-to-aircraft links or satellite-to-ground links.

The EMP generated by the detonation of a single nuclear weapon at high altitude can be a threat to C4I systems within a thousand-mile radius. High-altitude EMP (HEMP) can disable communications systems and power grids at enormous distances from the burst. EMP is probably the most serious NWE to Air Force systems; it can deny, disrupt, degrade, and destroy ground and aircraft electrical and electronic systems.

Proposal for a USAF Nuclear Enterprise System Survivability Office (continued)

Proposed Nuclear Weapons Effects Network

DTRA has proposed the establishment of a multi-location government industry network that will build and sustain the NWE community through an intrinsic collaborative process, emphasizing re-initiation of balanced modeling and simulation with experimentation. The Nuclear Weapons Effects Network (NWEN) would encourage cooperation between organizations and individuals without establishing a bureaucracy. Network participants would include:

- Defense Threat Reduction Agency (DTRA)
- United States Strategic Command (USSTRATCOM)
- Air Force Global Strike Command (AFGSC)
- Aeronautical Systems Center (ASC)
- Air Force Research Laboratory (AFRL)
- University of New Mexico (UNM)
- Air Force Institute of Technology (AFIT)
- Little Mountain Test Facility (attached to Hill AFB)
- The Navy's Strategic Systems Programs (SSP)
- Naval Air Station Patuxent River (Pax River)
- Sandia National Laboratories (SNL)
- Los Alamos National Laboratory (LANL)
- Lawrence Livermore National Laboratory (LLNL)
- The National Reconnaissance Office (NRO)
- Air Force Nuclear Weapons Center (AFNWC)

However, the proposed NWEN does not take responsibility for ensuring Air Force systems, or the civilian infrastructure on which military systems depend, can operate through NWE conditions.

Need for Nuclear Enterprise System Survivability Office

A number of military organizations have publically stated the need to assure operability of nuclear weapon systems.

- General Norton A. Schwartz, Chief of Staff of the Air Force (CSAF), wrote in his CSAF Vector 2011 that his first priority is to "Continue to strengthen the Air Force nuclear enterprise." A coming year focus area is to "strengthen our nuclear enterprise and work with other key agencies to…guarantee a[n]…effective nuclear capability."
- Two priorities of USSTRATCOM are to "Deter nuclear attack with a safe, secure, effective nuclear deterrent force" and "Prepare for uncertainty."
- AFGSC's mission is to "Develop and provide combat-ready forces for nuclear deterrence and global strike operations, safe, secure, effective."
- A portion of Air Force Material Command's mission statement reads "world-class sustainment of all Air Force weapon systems."
- The AFNWC mission is to "ensure safe, secure, and reliable nuclear weapon systems to support the National Command Structure and the Air Force warfighter." Its vision is to be the "Air Force's Center of Excellence for all nuclear weapon systems activities."

The proposed office will assist in guaranteeing an effective nuclear capability. In addition to launching mission aircraft with their weapon systems, launching air tankers and Airborne Warning and Control Systems (AWACs) (both, possibly, with protective fighter aircraft) may be required to complete an aircraft-based Air Force nuclear mission. Each aircraft launch and vectoring may necessitate the use of ground radar, air traffic control, and tanker trucks. Operators and maintenance personnel are required for each system and function.

The list of possible NWEs that could distress a nuclear mission include cratering, blast, thermal and nuclear radiation, skin burns, eye injury, fallout, and EMP. An NWE can shape a nuclear mission during many of its phases, from preflight through return to base. To guarantee an effective nuclear capability that operates through a nuclear weapon event, it is necessary to ensure nuclear weapon system survivability in an NWE environment.

Proposal for a USAF Nuclear Enterprise System Survivability Office (continued)

Kirtland AFB as Proposed Location

A single office tasked with ensuring Air Force weapon systems and the supporting civilian infrastructure can operate and survive in a nuclear environment is essential. Using the NWEN, such an organization need not be large; in fact, to remain agile a small organization is preferred. It will be advantageous to have this organization located on a military installation, near AFNWC; the Department of Energy national laboratories; educational facilities with relevant expertise; and legacy technical facilities, equipment, and expertise.

As the proposed location, Kirtland AFB provides access to:

- A flight line
- Electromagnetic susceptibility test resources
- SNL–Albuquerque Office
- A DTRA office
- AFNWC
- The Giant Reusable Air Blast Simulator (a 20' long shock tube)

Trestle, Kirtland Air Force Base
New Mexico

Additionally, Kirtland AFB is near UNM and less than a day's drive to the White Sands Missile Range test facilities.

Kirtland is also home to the SNL Z and AFRL Shiva Star pulsed power facilities, the AFRL High-Energy Measurement Laboratory, an anechoic chamber capable of testing fighter aircraft (numerous F-16 tests) and ground systems (Abrams M1 tank), and SNL's hardened electronics program: Qualification Alternatives to the Sandia Pulsed Reactor. Finally, Albuquerque is where many of the few remaining Air Force-associated people with expertise in NWE reside.

Kirtland AFB was once the home of several outdoor full-scale threat-level illumination (TLI) EMP hardness test facilities; the most prominent was the Air Force Weapons Laboratory's (AFWL) 'Trestle.' The B-1 was the last aircraft tested on Trestle, in 1988. Other Kirtland TLI facilities included the Vertically Polarized Dipole, Horizontally Polarized Dipole, and AFWL RAND EMP Simulator (ARES).

Dr. Clark's proposal does not advocate rebuilding deconstructed and decommissioned facilities—it advocates using the existing facilities of the NWEN to their best advantage. The proposed office's first task would be to conduct a survey to determine the NEW threats to Air Force systems from NWE and then determine the path ahead.

Dr. Clark has advocated for a single Air Force nuclear enterprise system survivability office funded through the Future Years Defense Program with sufficient monies available for evaluations, assessments, and testing. The office would have the authority and responsibility to assure the survivability of Air Force systems through an NWE environment. Locating the office on Kirtland AFB would facilitate necessary access to the DTRA NWEN. However, a high probability of reduced funding in the next several years will result in the proposed office utilizing the 'crawl; walk; run' paradigm. Initially, the proposed office would:

- Conduct an in-depth susceptibility and vulnerability survey to determine the NWE threats to Air Force systems and prioritize the results.
- Work with DTRA and DTRIAC to establish the NWEN by visiting and reviewing active and defunct facilities capable of NWE modeling or testing to determine abilities, and catalog data library depth and breadth.
- Visit Air Foce system program offices responsible for equipment required to operate within an NWE environment. Review and determine the amount of testing, procedures, or operational instructions required.
- Interact with the Defense Science Board Task Force on the survivability of DoD systems and assets to EMP and other NWE.
- Attend and participate in conventions, symposia, and meetings concerning NWE.

By creating a new office as proposed by Dr. Clark, operation and surviability of Air Force weapon systems after a nuclear weapon detonation may be ensured; thereby, helping meet the Air Force leadership's visions for the future.

Electromagnetic Pulse Information in the DTRIAC Collection

DTRIAC has an enormous collection of records dealing with electromagnetic pulse (EMP). A simple STARS search on "EMP" yields more than 13,000 results; sorting through this can be frustrating to someone new to the field.

Seminal Documents

DTRIAC has a key collection of seminal documents that can assist the new EMP researcher and provide a starting point for understanding EMP.

DTRA's fundamental document of nuclear weapons effects and environments, *Capabilities of Nuclear Weapons: Effects Manual One* (EM-1), is an ongoing effort that has been described in other DTRIAC Dispatch articles. Chapter 10 is the principal source of information for those working on EMP issues, but there are several other chapters that may be of interest to the researcher depending on their area of interest. Electromagnetic environments are described in: Chapter 9, "Electromagnetic Wave Propagation"; Chapter 11, "Transient Radiation Effects on Electronics (TREE) Phenomenology"; and Chapter 12, "Electromagnetic Wave Degradation." Chapters 21 and 22, "Damage to Missiles" and "Damage to Space Systems," respectively, describe a number of EMP-related effects on specific systems.

The Guide to Nuclear Weapons Effects Technology Information (NWETI) contains data that DTRA (referred to as Defense Nuclear Agency [DNA] at the time) gathered from experts from the nuclear effects testing era. These "greybeards" were asked to provide guides to the effects data for future researchers, and the resulting guide has a section on ionizing and electromagnetic radiation. This section is further broken down into information on

- EMP – electromagnetic pulse,
- HANE – high-altitude nuclear effects,
- SGEMP – system-generated EMP,
- TREE – transient radiation effects on electronics,
- thermomechanical effects on electronics, and
- system nuclear hardening design and testing issues.

The EMP Awareness Course Notes, DNA 2772T, represents the consensus of a course development panel and other contributors of what "everyone should know" on a general basis about EMP hardening. The third edition was written with primary emphasis given to introducing the generation and systems effects of EMP from high-altitude bursts. A supplement to this report discusses source region EMP, magnetohydrodynamic EMP, SGEMP, and the impact and relative importance of each of these effects for tactical, strategic, and exoatmospheric systems.

TREE Handbook Volumes I and II (DNA 1420H-1 and DNA 1420H-2) were created for the engineer designing electronic systems that must survive a nuclear-burst environment. The information in this report is very specific and only covers areas directly related to electronic parts, circuits, and systems. The nuclear-burst environments discussed include all radiation effects except for EMP effects that are externally generated. The first volume of this report discusses

- the differences between simulated and measured environments,
- the interaction of transient radiation with matter,
- discrete semiconductor devices,
- circuit hardening, and
- network-analysis techniques.

Volume II continues the discussion of the nuclear-weapon-burst environment, further discussion of the interaction of transient radiation with matter, overall system hardening, and internal EMP.

Additionally, the Journal of Defense Research (JDR) has a special edition on SGEMP.

Electromagnetic Pulse Information in the DTRIAC Collection (continued)

Other Possible Search Terms

Since DTRIAC has such a large collection of records when searching on "EMP," it may be useful for the user to search for a specific type of EMP. For example, the user may try some of the following search terms:

- Nuclear EMP (NEMP)
- Internal EMP (IEMP)
- Source region EMP (SREMP)
- System-generated EMP (SGEMP)
- Magnetohydrodynamic EMP (MHDEMP or MHD EMP)
- High-altitude EMP (HEMP)
- Dispersed EMP (DEMP)
- In-place EMP
- EMP-induced surface charge and current density
- EMP simulators

Remember, if the user is interested in the effect on a specific system or component, combining the search terms with the Boolean operator "AND" will help refine search results.

Authors to Check Out

It is also sometimes helpful to search for authors who researched in a specific area. The experts that DTRA gathered for the NWETI Guide, Ionizing and Electromagnetic Radiation Effects Section are:

Subject Area	Subject Matter Experts
Introduction & Overview	Edward Conrad
Electromagnetic Pulse (EMP)	William Radasky, William Karzas, Michael Messier, Ralph Stahl, George Carpenter
HANE & Radiation Environments	Robert LeLevier, C. Bryan Gabbard, Ralph Kilb
System Generated EMP (SGEMP)	Thomas Stringer, Charles Eklund, Ralph Stahl, Dolores Walters, Dan Higgins
Systems Testing History	Robert Poll, Victor van Lint, William Radasky
Thermomechanical Effects on Electronics	Edward Conrad, Ralph Stahl
Transient Radiation Effects on Electronics (TREE)	Victor van Lint, James Raymond, Samuel Clay Rogers, Harold (Hap) Hughes

DTRIAC also has numerous notes authored by Dr. Carl Baum. Dr. Baum was a senior scientist at the Air Force Research Laboratory, Directed Energy Directorate at Kirtland Air Force Base, New Mexico. He was an editor of several interagency note series on EMP and related subjects. Dr. Baum has won several achievement awards and is currently a distinguished professor at the University of New Mexico. A complete set of his notes can be found on the web at http://www.ece.unm.edu/summa/notes/.


Dr. Carl Baum

Another author who was a pioneer in the theory and understanding of EMP whose reports might be helpful to researchers is Dr. Conrad Longmire. Dr. Longmire was a theoretical physicist who worked at Los Alamos National Laboratory from 1949–1969. He performed several of the key design calculations on the very first thermonuclear weapons designed by the U.S. During Operation FISHBOWL high-altitude nuclear tests, Dr. Longmire successfully deduced why the EMP was so much stronger than had been previously calculated. Dr. Longmire was able to derive the calculations that are still used today. DTRIAC has several reports on EMP written by Dr. Conrad Longmire.


Dr. Conrad Longmire

If you still cannot find what you need the helpful staff at DTRIAC can always assist you with your research. Please contact them at dtriac@dtra.mil.

Satellite System Nuclear Survivability

DTRIAC represents DTRA's institutional knowledge and forms its repository for a range of data and resources for combating weapons of mass destruction. As part of its charter, DTRIAC supports the collection, processing, analysis, and dissemination of scientific and technical (S&T) data for DTRA's mission areas. This article highlights recent S&T efforts at DTRA/RD-NTSR to explore options for data mining, archiving, and retrieval/utilization of unique data, including past benchmark underground test (UGT) data, critical to maintaining the database for the development of survivable satellite systems and to support ongoing efforts in nuclear effects modeling and simulation.

A significant concern in the development of survivable satellite systems, particularly in light of the cessation of underground nuclear testing, has been the need to define a validated capability to qualify systems that must operate in the presence of natural radiation and nuclear environments.

The Satellite System Nuclear Survivability (SSNS) Data Mining Program was conducted last year to organize and increase availability of data taken on the System-Generated Electromagnetic Pulse (SGEMP) Test, Analysis, and Research Satellite (STARSAT); a full-scale satellite test article based on a military communications satellite.

In the late 1970s, DTRA recognized that a system-level SGEMP/Transient Radiation Effects In Electronics (TREE) Program addressing analysis, aboveground tests (AGTs), and UGTs, using a realistic test object in realistic test environments was required to address the then uncertainties in the ability to develop and produce high-confidence, survivable, satellite systems. The STARSAT Program consisted of two UGTs and a series of low-level current injection tests and flash x-ray tests all supported by a strong analytical pretest prediction and posttest analysis and evaluation program. The STARSAT Program goals were:

Technology Goals

- Extend phenomenology database to high fluences
- Evaluate hardening techniques and methodologies
- Evaluate analytical models and tools
- Develop and evaluate testing techniques and methodologies
- Evaluate simulator utility at box and system-level tests

System Goals

- Evaluate hardening technology transfer to and implemented by the spacecraft manufactures (design, manufacturing, test)
- Develop and evaluate system-level test methodology and verification techniques
- Develop confidence in overall hardened system development and verification process

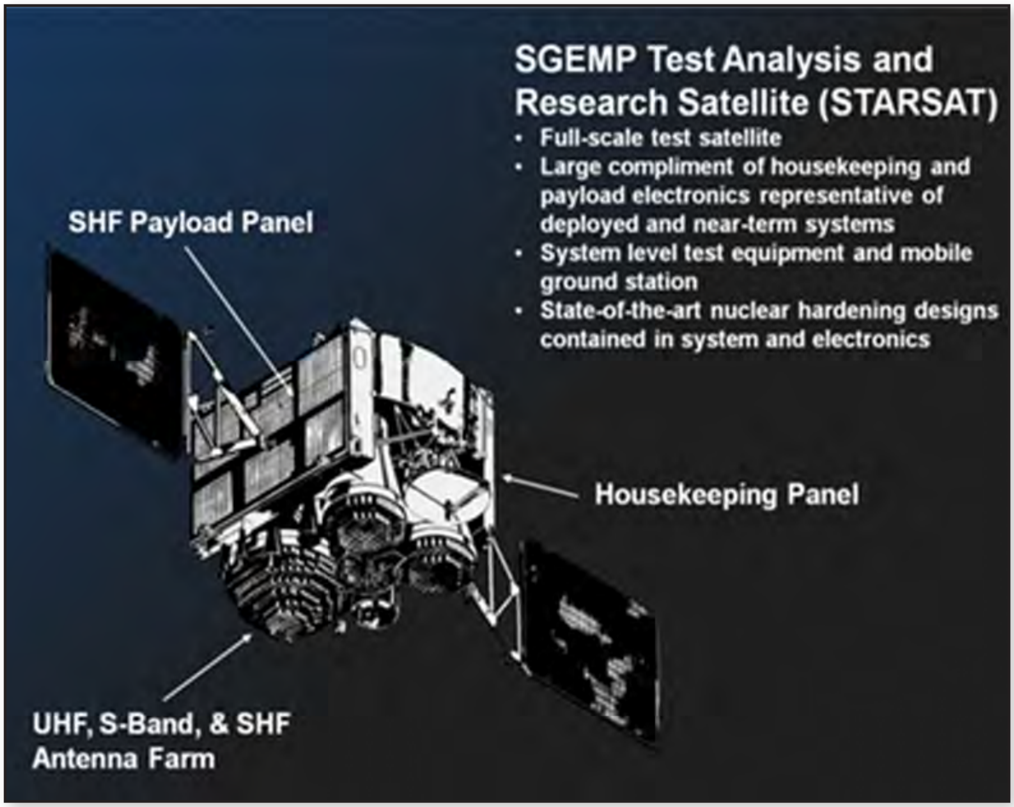
The database that resulted from this effort represents a broad and extensive system-level database on SGEMP and TREE effects in satellite systems (probably never to be repeated) and still remains relevant to the development of current and future survivable satellite systems. It was for this reason that the current data mining effort focused on the STARSAT Program. The approach taken was to carry out the appropriate data mining efforts and to summarize the results in the form of four briefing modules for each principal phase of the STARSAT Program:

1. STARSAT SGEMP Hardening Strategies and Implementation
2. STARSAT Huron King UGT Project
3. STARSAT AGT Project
4. STARSAT Misty Rain UGT Project

Each briefing module is prepared as a stand-alone briefing, although they could be conveniently combined into a single overall briefing. Each module also provides a bibliographical listing of documents, relevant to that phase of the STARSAT Program, most of which are available from DTRIAC. This approach was followed to provide users with convenient vehicles to access the STARSAT Program data. Considerable information was accessed from the authors' personal files, former STARSAT Program colleagues, as well as DTRIAC. Much of this information was in the form of extensive program briefings, photographic archives, reports, etc. This knowledge base was essential to preparing the briefing modules. In addition to the briefing modules, an overview of the STARSAT Program is presented in the paper, "STARSAT UGT Program Review," contained in the DTRA Journal of Radiation Effects Research and Engineering publication of selected papers from the 2011 Hardened Electronics and Radiation Technology Conference, which is available from the DTRIAC library.

Satellite System Nuclear Survivability (continued)

The final phase of the overall STARSAT Program was a unique effort known as the STARSAT Wrap-up Program. Carried out in the early 1990s, the program's objective was to facilitate technology transfer of the unique UGT and AGT results from the STARSAT Program to the scientific and engineering communities. The approach was to preserve and analyze the results of the test and analysis programs in a way that allowed the results and the lessons learned to be applied to the design and hardness verification of future systems.



A principal product of this effort was the HARDSAT analysis tool. As a database, the HARDSAT tool provides an organized repository for the STARSAT data, including categories such as STARSAT design details, time-dependent responses (graphs on PC screen or printer), peak responses (tabular data) at test points, differentiation between SGEMP and TREE effects, etc. It provides a means of analyzing, visualizing, and drawing conclusions from the data and employing the lessons learned to future satellite hardening design problems.

HARDSAT is designed to benefit both the phenomenologist and the design engineer. A detailed list of all the reports are contained in the HARDSAT bibliographic roadmap, listed according to publication date, report title, corporate author, and a brief abstract identifying the type of technical information contained in the report. Many of these reports are available through DTRIAC. There is an unclassified version of the HARDSAT tool, as well as a classified (S//RD-CNWDI) version. The HARDSAT tool is available from DTRIAC via STARS.

In addition to information available from the HARDSAT tool, a literature search for STARSAT Program information utilizing the DTRIAC library resources was also conducted. This resulted in an extensive bibliographical listing of classified and unclassified STARSAT Program documents contained in the DTRIAC files. This listing plus the HARDSAT bibliographical data were combined to form the final STARSAT bibliographical list contained in the briefing modules. Although this database is rather extensive, ready access to the actual data/documents appears difficult. Seamless interfaces with document archives would appear to be very beneficial. In this regard, some attempt was made to look into how such data may be more readily accessed.

A dialog with DTRIAC was established to discuss how the data archival and retrieval capabilities are implemented within STARS. This discussion reviewed of the needs and desires of the user community, particularly those of the system developers, compared with DTRIAC's current functions regarding data storage/cataloging, retrieval capabilities/search engines, electronic formatting, etc. DTRIAC has been implementing an approach referred to as "event guides" to consolidate and catalog information according to a specific subject, program, test series, etc. Such an approach appears to be very desirable by collecting all the STARSAT relatable data and information into a single event guide.

Having web access to such event guides would be particularly attractive to the user community, allowing ready access to the desired database aligned with specific needs.

DTRIAC Collection Additions

DTRA Technical Reports

DTRA-TR-08-7, DISCRETE JUPITER 3 to 7 Consequence Assessment Analysis
DTRA-TR-10-23, DISCRETE RA 2
DTRA-TR-10-71-Vols. 1&2, NuCS Satellite and Missiles Survivability Design Module (THTk), Final Report and V&V Package
DTRA-TR-11-1, Compendium of Proposed NTPR Expedited Processing Groups
DTRA-TR-11-20, Small-World Network Model of Disease Transmission

DTRA Final Test Reports

DTRA-FTR-10-004, Final Test Report for MIDWAY QUINCE
DTRA-FTR-10-007-Vols. 1&2, DISCRETE YI
DTRA-FTR-10-010-Vols. 1&2, HUMBLE SPRUCE Tests 1–12
DTRA-FTR-10-011-Vols. 1&2, HUMBLE NECTARINE 1–5
DTRA-FTR-10-012, THUNDERBOLT Tests 30–33
DTRA-FTR-10-015, HUMBLE MAPLE 2007, Tests 12–20
DTRA-FTR-10-016, HUMBLE GINGKO X
DTRA-FTR-10-018, HUMBLE GINGKO XI
DTRA-FTR-10-020, HUMBLE GINGKO XII
DTRA-FTR-11-002, DIPOLE WEST and KINGFISHER Test Series Summary Report 1999–2005, Air Delivered Conventional Weapons Against Tunnel Targets

Ask the IAC

How are Items Prioritized for Archiving?

There are thousands of items awaiting integration into the DTRIAC electronic archive. With guidance from DTRA STI management, integration priorities have been established. Following this guidance, the DTRIAC staff, lead by Ms. Connie Salus, determines the specific integration priorities based on technical inquiries received.

Currently, the general priorities are as follows:
• New agency publications
• Requested reports (technical inquiries)
• The “Annex” (formerly TRC collection from Headquarters, DTRA)
• Requested collections
• SME input
• CBRNE effects such as any and all test related data, nuclear warfare, EMP, systems and components vulnerability, biological and chemical hazards and protection, agent defeat, high-yield explosive effects, peaceful applications, nuclear power, conventional warfare, geophysical studies, engineering physics, and chemistry
• DTRIAC Warehouse
• DTRIAC Storage Bunkers

Priority is also given to those groups who provide funding to ensure that their material is cataloged and digitized quickly, such as the Air Force Nuclear Weapons Center, the United States Army Nuclear and Combating Weapons of Mass Destruction Agency, and DTRA's Nuclear Technologies and Counter Smuggling Network Directorates.