Radiation punked

ASI's innovative three-part solution helps protect electronic assemblies

By KIMBERLY BALLARD

It is an old problem. A late 19th Century Nobel Prize-winning Polar explorer suspected it; an early 20th Century astrophysicist and mathematician studied it; and a pre-Space Age particle physicist theorized about it.

In 1958, Explorer 1 and Explorer 3 confirmed the existence of the Van Allen Radiation Belt, and four subsequent missions by Sputnik 3, Explorer 4, Pioneer 3 and Luna 1 all mapped this natural radiation belt that surrounds Earth and is held in place by its magnetic field. Along with other colorfully named "cosmic crap" from deep space like subatomic particles, solar flares, cosmic rays and alpha particles, electromagnetic radiation emanating from the Van Allen Belt is randomly flying through space and can at any time zap humankind's brilliantly designed technology and fry it like an egg on a hot griddle, rendering it utterly useless. The list of susceptible cosmic gadgetry includes satellites, space stations, aircraft, missile defense systems, radios, nuclear power plants, computers, cell phones and anything else using electronic hardware and software. In today's world, that is, in fact, nearly everything.

But that's only the first problem. The second concern comes from manmade radiation. An electromagnetic pulse (EMP) resulting from a nuclear explosion can produce damaging voltage surges that will knock out even the most sophisticated U.S. electronics. "During the Cold War, radiation hardening wasn't much of an issue," says Dr. Michael Guthrie, senior scientist at Analytical Services Inc. (ASI) here in Huntsville. "But today, with rogue nations like Iran and Korea having some nuclear capabilities, there is a renewed concern."

Although the nuclear technology possessed by those countries may not be powerful enough to cause fallout or harm anyone physically, Guthrie believes it can do a lot of damage to our electronic infrastructure. "A small one-half to one kiloton nuclear weapon could do significant damage to U.S. communications and disrupt our GPS capabilities," he says. The effects of a single event could upset communications and interrupt every facet of life, while destabilizing U.S. national defenses.

THREE OPTIONS

In the early days of the space program, engineers and designers were aware that electronic systems need to be radiation-hardened – called rad-hard in the industry – in order to prevent serious damage when bombarded with radiation, says Jeff Gronberg, ASI vice president of aerospace engineering. The need is particularly apparent for a satellite, a spacecraft, or anything else orbiting Earth that is exposed for long durations to a radioactive environment. "The most obvious answer was to place a metal shield, like lead, around the hardware and software. This was not only costly, but it presented a number of difficulties, including adding significant weight to these systems," says Gronberg. That is not a popular alternative, as it increases propulsion and fuel requirements.

A second option is to identify rad-hard requirements early in the design and construction process, so that components may be arranged in the assembly to shield them as much as possible from harm. Yet projects that are late in the developmental process find that alternative difficult to achieve. A third idea is to design and build systems, system components and system parts from materials that have already been radiation-hardened. Unfortunately, in modern assembly methods, many resources contribute specially designed components to what is ultimately a hugely complex system. That leaves many planned assets

simply vulnerable. "Some designers didn't know their components or parts weren't radiation-hardened," says Dr. Guthrie, "until it was too late."

ASI was established as a management and technical solutions company supporting the government in the areas of information technology, technical and engineering services, business management and logistics. Two years ago, ASI was testing systems for radiation hardening when it hit on a possible solution to the lack of information. "As a software analysis company always looking for low-cost solutions, we came up with this idea of building a database for the government to use," says Gronberg, "The concept resonated in a large way."

A LOWER-COST BLEND

The idea is to catalog existing product rad-hard data, analyze materials and designs so engineers can determine their rad-hard characteristics, and test to optimize for radiation hardness the materials and designs used. Backed by the Small Business Innovation Research (SBIR) program, ASI calls the concept its Radiation Hardening Initiative (RHI).

RHI uses a suite of three tools – RadCat, RadHat and RadTest – to provide the first comprehensive solution to the rad-hard problem. "ASI is utilizing modern tools, the power of scientific software and the Internet, to address the radiation hardening problem in the early stages of a system's life cycle," Gronberg says.

RadCat is a catalogue of all existing product data that has been tested and found to be rad-hard. Continually collected and compiled into a database, the RadCat information can be accessed online by any systems designer to see if the materials and components of a system are already rad-hard. Since many engineers are often searching for hard-to-find electronic parts and systems, the unique centralized database helps engineers more quickly gain access to already radiation-hardened assets.

RHI's second component is the Radiation Hardness Assurance Toolkit (RadHat) analysis. If an engineer is designing a component system and does not know whether the materials or the design itself are rad-hard, ASI can analyze them, simulate them and model them in a virtual environment to make that determination. Many times, a design that fails in testing can be made rad-hard while under analysis by replacing failing parts with already tested parts, and that process also works in reverse. If analysis shows the new component to be rad-hard either by design or modification, ASI adds it to the database for future use.

The third branch of RHI is RadTest. By facilitating rad-hard testing, ASI helps find alternatives to currently used products, utilize other options in the design and discover ways to shield the system from possible radiation bombardment.

"Testing is very expensive and takes a lot of time. Many designers and engineers don't have a lot of time on delivery of a contract, particularly if their design is failing," Dr. Guthrie explains. That's where Guthrie says the value of the company's RHI system lies. "In the analysis stage," he says, "ASI can help save you money before and during testing by making recommendations in your design that are likely to pass, based on our experience with assets already in our catalogue."

Once the syatem has passed testing and is proven to meet the safety requirements of rad-hard, it is added to the RadCat database for future use. "As you can see, the RHI is a complete information management system," Gronberg says. "Old data is replaced, new data is added, and obsolete data is continually updated, while at the same time, information can be cross-referenced." One of the unique aspects of ASI's creation is the interactivity of the database catalogue with the analysis and testing. All functions work cooperatively.

"There is yet another renewed interest in radiation hardening," Gronberg says. "Long-term exposure to radiation is the No. 1 issue for NASA concerning deep space exploration and man missions to planets like Mars." ASI appears well-positioned to help NASA find low cost, efficient and foolproof methods for protecting man, spacecraft and electronic computerized systems from the constant but random blasts of radiation in deep space.