To Boldly Go ...

Single Integrated Space Picture (SISP)

By Denise Jones

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Scene 1

(MAJ Smith, Functional Area 40 (Space Officer) special adviser to the commander, is speaking to what appears to be a holographic image arising out of a three-foot disc on the floor. Within this holographic image is a rotating topographic map-like surface with a clear view of the exoatmospheric environment.)

MAJ Smith. *(speaking to the three-foot disc on the floor:)* Command One, what's my status?

Command One SISP Terminal. *(voice emanating from inside the holographic image:)* Satellite Cgi-Bin has been changing its orbit pattern every third orbit. It appears to be searching in sector Tango Charlie.

(Scene changes to show the holographic image "replay" of Satellite Cgi-Bin's latest orbit passes over the area of interest.)

MAJ Smith: When will Satellite Cgi-Bin be able to image Alpha Company?

Command One SISP Terminal: At 0900 tomorrow.

MAJ Smith: What are your recommendations?

(Scene changes again to show the holographic image "fast forward" to 0900 tomorrow, showing the orbit of Satellite Cgi-Bin, and the interfering storm cover.)

Command One SISP Terminal: Do nothing. Cloud cover, Space and ground storms will prevent clear imaging by Satellite Cgi-Bin sensors. By the time the storms and clouds move out, Alpha Company will have completed its mission.

MAJ Smith: Thank you Command One. Please continue to monitor the situation and notify me if there are any changes requiring defensive actions. Now, can you tell me when Bravo Company will have clear communications for downlink of latest OPORD (operations order)?

(Scene changes again to show the holographic image "fast forward" by 23 minutes, showing a cartoonish communications link extending from the satellite communications bird, down through the gap in the storm system, to Bravo Company.)

Command One SISP Terminal: The storms and cloud cover will provide a window for downlinking in approximately 23 minutes.

MAJ Smith: Thank you, Command One. I'll report out to the commander.

(Scene fades to the commander's office ...)

Imagine a futuristic tool, similar to the computer and holodeck used by Captains Kirk and Piccard aboard the Enterprise that could instantly provide holographic images of terrestrial areas of interest and the associated exoatmospheric environment for situation assessment and planning optimization. Although the original Star Trek series ran nearly 40 years ago, scientists are still unable to build some of the futuristic concepts first introduced in those early episodes. This article describes some of the thought processes behind and the progress to date for the Space and Missile Defense Command's (SMDC's) Single Integrated Space Picture (SISP) technology concept.

The idea for a SISP was born out of the technology premise that a single display could be used for Space command and control (C2) situation monitoring, situation assessment (often referred to in combination as Space situation awareness or SSA), and for planning and executing Space C2 operations. This effort involves monitoring, assessing, and managing a larger battlespace than ever before (the exoatmosphere is huge); interfacing with many types of data sources and sensors supplying various types of information, formatted in different ways, arriving at different rates; synthesizing information related to geopolitical situations, positional identifiers, orbital dynamics, intelligence products, environmental

3D Volumetric Displays: Conceptual

3D Volumetric Displays: Prototypes

conditions, and naturally occurring and manmade phenomena; and providing this expert capability in hyper-real-time in an intuitive, easy-to-use display. Does this sound like another science fiction adventure story? Read on to see how the SMD Technical Center is meeting this challenge.

Information Overload

A couple of issues from regional conflicts in the past decade have direct bearing on the approach taken for the SISP concept. First, there is an overload of information that decision makers must contend with. Command and/or decision headquarters typically have an assortment of computer terminals and communication devices providing various types of written reports, maps, radar scans, information updates, and screen displays. Human processing of this written and visual data is interrupted with person-to-person or telephone conversations and meetings. In time-critical situations, it is difficult to make an "optimized" decision and still take into consideration all the "facts" and information available.

The next issue concerns physiological and psychological factors found in a wartime environment that result in less-than-optimum decisions and human error. Although fatigue and stress are not unique to the battlefield, the errors they cause provide fodder for the members of the press, but even more tragically may result in injury or death to our troops or allies.

Interoperability wraps up the trio of issues being addressed in the initial technical concept for the SISP. Even with today's modern technology, warfighters are still confronted with communication and interpretation problems in the dissemination and utilization of information.

Approach

Discussions with several of the information technology (IT) experts within SMDC led to the approaches taken toward realizing an SISP. Without using IT jargon and buzzwords, the creation of a SISP (and addressing the issues presented earlier) can be condensed into answering three basic questions:

1) How can SISP minimize information overload on the user?
2) How can SISP improve decision-making?
3) How can SISP be made interoperable with existing and future data sources and users?

Get the Picture

Of course you've heard the expression: "A picture's worth a thousand words." During recent world events, the network news channels made use of news announcers talking over photo or video images with superimposed headlines and broadcast station designators; all while a text trailer ran across the bottom of the screen bringing different news snapshots. This approach gets lots of information to the audience by evoking different senses, different skills, and different emotions.

Visually representing large amounts of data is rapidly becoming the norm, both on television and on the Internet. A study conducted by SMDC went even further to prove that actual three-dimensional, volumetric representations could be easily assimilated to facilitate rapid and more accurate problem solving than two-dimensional representations. By the close of the last decade, SMDC had investigated quite a few technologies promising to be the "Holy Grail" of volumetric displays.

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Some of these concepts have matured to prototypes for the medical and transportation industries.

Although there is proof of its benefits to problem solving, there is little evidence the Department of the Army or other Department of Defense agencies are actively maturing the technologies necessary to provide true volumetric displays to the military community. In the meantime, while Hollywood producers continue to tempt us with their awesome visual effects, gaming tycoons wow us with their virtual reality games, and fiction writers weave the spell of synthesized three-dimensional images ... where is the contribution of the computer industry? (Bill, Steve, if you build it, we will come ...) The bottom line is that three-dimensional volumetric displays may have to be spawned within the commercial sector and purchased as an end-item by the military. In the meantime, other promising technologies will be evaluated to address the information-overload and presentation challenge, such as immersion technologies and biometrics.

Improve Decision-Making

The majority of computers found in major command operations centers today merely serve as information repositories. Users analyze the information (some relevant and some not) and present the results to decision-makers, who then attempt to make the best decision given the available information. The limiting factor of course is the user's ability to evaluate lots of information within a short timeframe (tracing back to the information overload dilemma discussed earlier), sometimes while literally under the gun! Stress, fatigue, or a moment of daydreaming can cause essential information to be overlooked or misinterpreted.

To alleviate these symptoms, it is time to treat the command operations center computer as an analyst merged with an expert decision-maker. In order for a computer to search for and analyze massive amounts of data to generate an optimized decision, the computer must contain specialized software applications. These applications must draw from the knowledge and experience of top-notch analysts and seasoned commanders. But unlike humans, the computer could provide analyses and optimized courses of action in seconds, not minutes, hours, days, or months, as may be the case with human analysts.

Now is the time to roll out some of the impressive IT jargon — terms such as collaboration, data mining, expert systems, chaos theory, neural networks, and adaptive algorithms top the list. The IT field is fertile with techniques for optimizing decision-making. These IT fields are gaining a second look by military technologists as enemy targets and environments become more complex. And, these technologies are actively being evaluated for use within the SISP.

Interoperability

Lack of interoperability may be caused by using different languages (message protocols), by failing to understand the meaning when the same language (message protocol) is used, or by using dissimilar communication media (radios). Using the telephone industry as an example, notice how the type of telephone and network hardware (rotary, pushbutton, ISDN, cordless, cellular, copper, fiber-optic, etc.) and the service provider (AT&T, Singular, BellSouth, etc.) have little effect on whether or not you can conduct a conversation with another individual who is using a different type of telephone equipment and service provider. However, if the individual with whom you're trying to communicate is speaking Arabic and you don't understand a word of Arabic, then you're having an interoperability problem.

This leads to the conclusion that the different languages (message protocols) being used across military networks are the greater causative factor to preventing interoperability rather than the types of communication hardware. (This brings up an interesting debate on whether or not commercial hardware and providers could provide better solutions than military radios and networks. This debate, however, is beyond the scope of the SISP effort.) The invention of a super or universal language (metalanguage) that everybody could speak (commercial standards) is a need to which the Extensible Markup Language (XML) may be the solution.

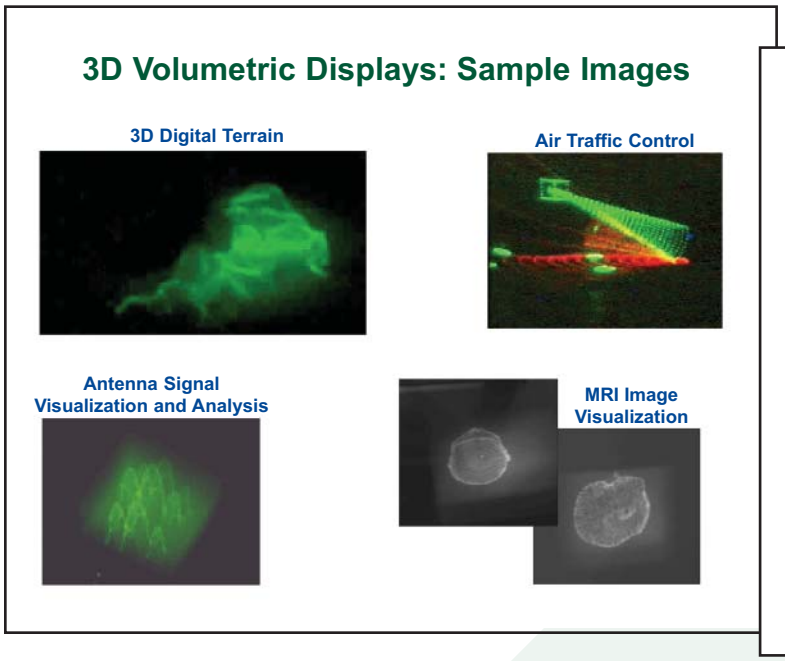
Contract Initiation and Status

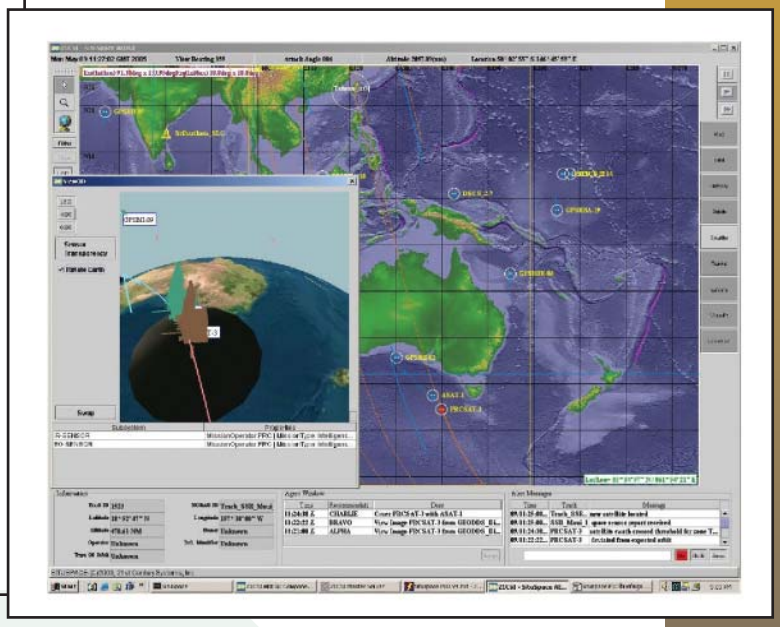
In FY01, the Army approved a Phase I Small Business and Innovative Research (SBIR) effort to develop a concept for a SISP, using a metalanguage, intuitive screen displays, three-dimensional displays [on a flat screen video monitor], with embedded intelligence for Space situation assessment, and evolvable to Space planning and execution activities. In FY02, two Phase I contracts, valued at $70,000 each were awarded to FGM, Inc., of Colorado Springs, Colo., and 21st Century Systems, Inc., of Herndon, Va. Each contractor had unique strengths that they brought to the SISP effort. FGM is a small-business leader in XML with considerable defense applications; their focus was developing a comprehensive XML schema and addressing the issues associated with using XML. 21st Century Systems has considerable expertise in developing decision support systems; their approach focused on the decision support aspect of the SISP.

The SISP concept was first presented to Dr. V. Garber, director for Interoperability, Office of the Under Secretary of Defense, Acquisition, Technology, and Logistics and his staff in March 2002.

In FY03, the Army approved a Phase II SBIR ($730,000 over two years, with up to $250,000 matching funds available for follow-on work) to be awarded to 21st Century Systems, Inc., to take the SISP beyond the concept prototype to the technology prototype phase. 21st Century Systems will subcontract with their Phase I rival, FGM, Inc., to further the XML work for the SISP.

In July 2003, 21st Century Systems demonstrated their SISP prototype, aided with voice-activated commands and responses, to an approving audience at





SMDC, Huntsville, Ala. A representative from Dr. Garber's office was also present for the demonstration and provided words of encouragement. His office has been tracking the SISP progress as a possible technology insertion into the DoD Family of Interoperable Operating Pictures. Although quite ambitious for a Phase II effort, the intent is to integrate the SISP into the SMD Battle Lab's Advanced Warfighting Environment for play in future exercises.

Challenges

As with any new concept or program, there are technical challenges, financial challenges, and political or nontechnical challenges. Usually, it's the technical challenges that are the easiest to solve.

Technical

From a technical perspective, the use of XML may prove to be an excellent alternative to traditional military message protocols. The XML has all the features of a super language, and its inherent richness compensates for its minor challenges. One of the less obvious challenges is that each user of the language must be using the same schema or rules for describing the fields of information within that domain (in this case, the Space domain). Since XML is written in the English language, each digital user only needs an English language interpreter. But what about those instances in the English language when the rules waiver, like in the case where "insure" and "ensure" are both acceptable terms and spellings to mean the same thing?

The other challenge in using XML is the tremendous amount of Space it takes to pass a string of information such as a satellite element set (ELSET). The best case when using ASCII text is 160 characters of information to pass an ELSET. Using XML, that ELSET can easily grow to more than 10,000 characters because of the various types of information that are packed into that message. This added information is useful for such things as granular updates and message verification — something that a minimum ASCII text message cannot accommodate. In a bandwidth-constrained environment, the problem is obvious. On the technology horizon, are data compression technologies specifically geared to the XML environment? These technologies are being evaluated for incorporation into the SISP.

One of the other technical challenges is in the area of currency and synchronization. Although not unique to the Space domain — all common operating pictures share this challenge with marginal success — it certainly presents some interesting timing constraints caused by the velocity of Space objects in relation to slower flying objects such as rotary-winged platforms. For instance, in the amount of time it takes to fuse together all the information to build a "Single Integrated Space Picture" to be transmitted to other users, the Space object could have moved several kilometers, thus making the picture old; but the recipient of the picture would use it as though it were new and current. (Recall that using old air pictures has contributed to friendly fire incidents.) To its credit, XML helps keep data current on limited bandwidth by enabling granular updates rather than requiring full updates. Advances in hyper-real-time simulation and decision-making are also being evaluated to address this challenge.

Financial

As any program manager knows, the success of their program depends upon funding continuity. As indicated earlier, the SISP has just entered the first year of a $730,000 Phase II SBIR effort. If some other customer or user of this technology provides funds, the Department of the Army would match those funds up to $250,000, for a total effort of more than $1.2 million.

Beyond the technology prototype phase comes the real work (and funding driver): the Research, Development, Test, and Evaluation phase.

SMDC has an Army unfunded requirement for FY05 to advance the SISP beyond the technology prototype and will submit a robust cost estimate for the FY06-11 budgets. Architectural trades will be pursued to ensure that the SISP architecture is compliant with the Army future direction for Space systems.

Political or Nontechnical

The concept of a SISP to overlay the common air, ground, and maritime pictures has gained support to such an extent that several contractor and military organizations are proposing their own SISP development effort. The downside of this support is predictable when recalling all the years, dollars, and heartache (friendly fire) that have resulted from the various dissimilar development attempts toward a common, interoperable air picture. History will repeat itself as every organization rushes to "build their own" SISP-like capability and interoperability flies out the window. The only way to preclude this is for a knowledgeable person with sufficient financial and political clout to mandate that all SISP and SISP-like development attempts be jointly managed.

But this is merely one facet of the problem: others include contractors lobbying to ensure their business goals are not affected, organizations withholding vital information for constructing a SISP, organizational battles, etc. Perhaps the biggest hurdle is convincing users and battlefield commanders to pull the man-in-the-loop out of the analysis and decision-making process and let an automated SISP capability provide this capability.

Future

The SISP concept prototype has all the right ingredients to achieve true interoperability, provide Space surveillance and situational awareness to the Space operators and commanders, and provide a framework for execution of Space operations, testing, training, exercises, etc. Couple volumetric display technology with intuitive, user-friendly commands, throw in some immersion technologies, a sprinkle of biometrics, and the SISP is a recognizable achievement, akin to the one first used by Captain Kirk aboard the Enterprise.

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taining information superiority for all future activities from major theater wars to small-scale contingencies. The ability to collect and disseminate timely, relevant information to the Soldier on the ground will continue to be a determining factor in mission success.

Today the military relies on a wide variety of commercial Space products and services with the heaviest concentration in the imagery and communication areas. The military currently uses the commercial capabilities in both of these areas for training and operations. The resources used for training provide vital information and capabilities for conducting operational planning and military operations as directed by the President and Secretary of Defense. Since the military philosophy is to "train like you fight," the sudden loss of critical information to support war planning and execution would significantly diminish military effectiveness.

Space will be critical to providing fully capable operational forces of the future. We must be ready to operate in an environment with limited or non-existent communication infrastructure, in areas where little precision mapping has occurred, and in vast expanses where continuous overhead intelligence collection will be key to real-time situational awareness. These operational requirements will place a premium on commercial satellites to provide some to all of the communication, remote sensing, imagery, and navigation capabilities.

Unfortunately, the ability to leverage commercial capabilities for military benefit has both a positive and negative side. On the positive side, the commercial market allows the military to reduce costs by acquiring commercially available products instead of building separate satellite systems for the same purpose. On the negative side, the military must share the commercial satellites with commercial customers. Also, there are limited restrictions on commercial satellite company customers. It is now possible for our adversaries to have access to similar information and capabilities as our own, thereby decreasing our advantage. Additionally, commercial satellites can be more vulnerable because they do not have the same level of protective measures as military satellites.

The military increasingly relies on satellites for the conduct of training and operations. As the availability of commercial Space products increases, the military reliance on commercial products for communication, remote sensing, imagery, and navigation capabilities will only continue to grow. Simultaneously, the military must also strive to ensure that the quality and durability of the information meets military requirements and warfighter expectations. In the long run, however, the real challenge will be for the military to maintain its Space edge with the proliferation of commercially available Space products to all potential adversaries.

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