Joint Geospatial Enterprise Services – Research Program

Abstract

Today's military geographic information systems (GIS) are stand alone capabilities and existing Command, Control, Communications, Computer, Intelligence, Surveillance and Reconnaissance (C4ISR) systems contain very limited geospatial capabilities that are disconnected from emerging net-centric geospatial technologies and geospatial databases. Future battle command and Intelligence, Surveillance and Reconnaissance (ISR) services (i.e., Future Combat Systems (FCS) Battle Command services, Distributed Common Ground System – Army (DCGS-A), and Joint Command and Control (JC2)) require timely, relevant accurate terrain situational awareness. A Joint-Geospatial Enterprise Service (J-GES) capability is required to enable a dynamic, tailorable Common Operational Picture, Situation Awareness, and decision aids.

 The JGES –Research Program (JGES-RP), managed by the U.S. Army Engineer Research and Development Centers; Topographic Engineering Center, will establish an experimental J-GES architecture to enable critical testing, evaluation, and experimentation of critical geospatial services. This program will provide an essential environment to verify and validate prototype services developed by Army and industry and provide mechanism for early transition of emerging technologies and net-centric C4ISR geospatial services. Additionally, the J-GES-RP will partner with industry to enhance commercial Geospatial Information Systems (GIS) technology to support warfighter's geospatial enterprise services needs; and collaborate with emerging DoD/Joint network architectures and C4ISR services (including emerging Army tactical C4ISR network centric-architecture (e.g. FCS, DCGS-A, NCES, JC2, …).This paper discusses the JGES-RP requirements, current status, and how ESRI technology is being leveraged to meet these requirements.

Today's Observation

Today's military geospatial information systems contain very limited geospatial capabilities and do not fully utilize the emerging net-centric or enterprise geospatial technologies and geospatial database capabilities. No current geospatial enterprise architecture or services capability exists to optimally generate, manage, exploit, and disseminate geospatial data as required to support the full range of military operations from peacetime to crisis support and through major combat operations. Additionally, within and across the Department of Defense (DoD) Services, there is no standard concepts of operations (CONOPS) and operational architecture to support interoperability with geospatial information.

The following DoD systems provide geospatial support to the warfighter: Digital Topographic Support System (U.S. Army), Topographic Production Capability (U.S. Marine Corps), Multispectral Imagery Production System and Geospatial Imagery Production System (U.S. Air Force), and Family of Systems (U.S. Navy). The

government current acquisition environment has allowed geospatial systems to exist in a stove-piped environment within DoD and within the services. These systems and others have various applications, formats, and databases that are incompatible, proprietary, and redundant.

The current battlespace environment has revealed shortfalls that exist within our current geospatial processes and capabilities. The Army has moved forward to transform itself with new force structures, systems, and technological capabilities to improve its effectiveness and efficiencies. The Army has recognized that the Future battle command and ISR services (i.e., FCS Battle Command services, DCGS-A, and JC2) require timely, relevant accurate battlespace environment situational awareness and requires robust terrain data that is rapidly updatable from many sources, which does not exist today. The Army has authored and approved a Joint Geospatial Enterprise Service - Initial Capability Document (J-GES ICD). This document is now being reviewed by the Joint Requirements Oversight Council. The J-GES ICD promotes standards, data models, and the use of geospatial technology to enable complex sharing, updating, analyses, and synchronization of geospatial data. The J-GES concept (See Figure 1) is to establish an enterprise architecture that will enable horizontal integration at all echelons to support collaborative assessment (especially at lowest echelons) in minutes versus days to provide actionable intelligence. The national assets have the best global and the warfighter on the ground has the best local understanding of the terrain. J-GES promotes utilizing geospatial technologies to enable data management, collection, exploitation, visualization, and dissemination of geospatial data/information from any available national or tactical sources (sensors, soldiers, distributed and disparate databases, Personal Digital Assistance (PDA), etc.). This capability will allow a dynamic, tailorable Common Operational Picture and tactical decision aids to allow rapid analysis and situational awareness based upon best available geospatial data across the echelons (especially from Soldiers on the ground).

Figure 1 Joint Geospatial Enterprise Service Concept

The Army has initiated the Joint Geospatial Enterprise Services – Research Program (JGES-RP) which is being managed by the U.S. Army Corps of Engineers, Engineer Research and Development Center, Topographic Engineering Center. This effort will establish an initial J-GES architecture to enable critical development of geospatial services and provide an early transition of emerging technologies and network-centric C4ISR geospatial services; partner with industry to enhance commercial GIS technology to support complex J-GES needs; and collaborate with emerging Joint network architectures and C4ISR services (including emerging Army tactical C4ISR network-centric architectures (e.g. FCS, DCGS-A, NCES, JC2, etc.))

Challenges
There is a lack of existing infrastructures: to support and enable the design, experimentation, analysis, testing, and validation of a robust Geospatial Enterprise Services (GES) architecture for the Army and Joint Services. Limited GES capabilities to enable complex data sharing, updating, synchronizing geospatial data horizontally and vertically among echelons, DoD and Intelligence agencies exist today. Key science and technology challenges center on providing strong standards, data models, data management, conflation, dissemination, and integration tools that support the transformation of geospatial data and information to knowledge and ultimately actionable intelligence for both the Commander and the Soldier. Addressing these challenges ultimately will provide a better understanding of the impact of geospatial information on Battle Command and raise both the awareness and priority of geospatial information and services within Army leadership.

The JGES-RP needs to address the multiple architectures (National: Global Information Grid and Tactical: JC2, FCS and DCGS-A) that exist, being developed, and future.
A lack of standards (data formats, data model, data dictionary, etc.) has resulted within the C4ISR and Modeling and Simulation communities which are not completely synchronized with efficient usage of geospatial data. This has lead to the development of unique databases and applications that will support only one system or data that can not be used by others.
The realization is that we can not transport the large data set across the communication network. The JGES-RP must consider how to work the issues between thick and thin client. The Army must overcome the concept of pushing data when not required; focus on providing the end product which is actionable intelligence.
The Army lacks the ability to rapidly build geospatial databases. The shortage of archived geospatial data (e.g., Feature Data; 1:50K) requires the warfighters to utilize any available source to obtain the situational awareness of the battlespace environment. Iraq data has been in production for approximately 14 years.
The geospatial services (data collection and exploitation services) must be provision for the Soldier focusing on the urban fight. The J-GES concept must not burden the warfighter with routine and repetitive data dissemination tasks. The capability to automate the posting of geospatial update to a data synchronization services and alert/warning indicators based on need are required. The ability to define an operational picture based on what is important to the warfighter and the mission need.

Joint Geospatial Enterprise Services-Research Program - Solution

JGES-RP is a transformation initiative that brings together geospatial services, data, and applications focused on leveraging and enabling geospatial enterprise capability supporting network-centric warfare. JGES-RP will not only help to understand and establish the standards for cross domain geospatial information - sharing, data management, application and process integration, and other tools, it will also put them into practice. Indeed, current initiatives have already promised to make more information available to those who need it, when they need it. These initiatives are not geospatial focus, but information and data centric in concept.

The JGES-RP includes initiatives that will provide the information and prototype for data model, standards, geospatial services and initial geospatial enterprise architecture to support Network-Centric Enterprise Services (NCES) required to support network-centric operations. Each initiative represents a strategic investment in present and future capabilities that will empower the warfighter. JGES-RP will prototype geospatial technology to provide access to the warfighter to find data, services, and tools supporting geospatial operations and requirements. JGES-RP is another catalyst for network-centric transformation, serving warfighters, support and business units across the DoD, and ultimately including relevant non-DoD U.S. Government entities.

Because cycle times (time from operational readiness to obsolescence) are so short in the technology environment, the JGES–RP is an essential tool for understanding and evaluating geospatial enterprise solutions. Prospective JGES-RP initiatives are evaluated

on the ability to use commercial-off-the-shelf solutions, fill existing gaps, and interoperate in a network-centric environment); on how an initiative will interact with others to meet established goals or standards; and the operational end result produced by the initiatives when geospatial enterprise services are working together. In this outcome-based environment, some initiatives are higher risk in terms of the time between when they are stood up in the Program and when their capabilities are realized. Others are low risk and operational right now and do not need a great deal of work to be JGES-enabled. Each JGES-RP initiative supports current Program of Records (POR) geospatial capability. JGES-RP will coordinate with POR to provide accelerated geospatial enterprise technology insertion. JGES-RP is not a program in the conventional sense. It is a transformational initiative, intended to expand upon and leverage DoD's network-centric capabilities. Nor is JGES-RP a system, it is a group of technology initiatives, experiments, and prototyping activities.

Geospatial enterprise services support the transformation to network-centric warfare. Network-centricity is the web-enabling of a global cyberspace that leverages existing and emerging technologies. It ensures user-centric information-sharing, information-fusion, sense-making, and decision-making across the battlespace environment. Network-centricity provides a common language to move beyond traditional closed communities of interest like command and control or intelligence to full information exchange across the battlespace environment. Network-centricity is sharing of the data; it is post once, process, and used.

The positive effect of GES on the warfighters and the benefit of JGES-RP are truly transformational. Over time, providing a geospatial enterprise capability horizontally and vertically to deliver power to the edge will impact every aspect of the warfighter's mission. Warfighters will be able to access and use common standards, existing data sources, data model, services, and tools. Achieving information superiority and decision superiority are just two aspects that will be obtained with JGES. When the JGES capabilities are actively deployed to warfighters in the field, JGES-RP will help JGES provide the network-centric foundation for decision superiority by making information and services available on a network that people depend on and trust.

JGES-RP will enable the JGES to allow users to retrieve information as needed instead of massive amounts of information being delivered to them regardless of their requirements. The JGES provides user access to a network of physically disparate databases using advanced military language-capable discovery tools. Shared situational awareness critical for achieving decision superiority and speed of command are improved by business process changes such as only handling information once, and posting data with minimal upfront processing. JGES-RP is the catalyst that will provide the momentum for JGES to be realized.

The applications, services and tools addressed in the JGES-RP environment are architecturally defined as residing within the distributed computing and applications layers of multiple architectures (Global Information Grid (GIG), Network-Centric

Enterprise Services (NCES), DCGS Integrated Backbone (DIB), and System of Systems Common Operating Environment (SOSCOE)).

The JGES-RP will:
- Provide insight into JGES ICD Concept
- Establish a prototype J-GES architecture to enable critical development of geospatial services
- Demonstrate the capability of integrating and disseminating timely, accurate, and relevant geospatial information and analysis services horizontally and vertically among echelons and agencies
  - Evaluation of timeliness and relevancy of geospatial data
- Highlight gaps in technology and Tactics, Techniques, and Procedures (TTPs) for future research and experimentation
  - Assess impact of new technologies and R&D initiatives
- Provide understanding of Doctrine, Organizations, Training, Leader Development, Materiel, Personnel and Facilities, and new technologies
  - Evaluation infrastructure to support development of geospatial policies and procedures including military TTPs.
- Facilitate the early transition of emerging technologies and network-centric C4ISR geospatial services
- Partner with industry to enhance commercial GIS technology to support complex J-GES needs
- Provide a test & evaluation platform for FCS, DCGS-A, JC2, and other technologies being developed to support JGES Architecture
- Provide a prototyping capability to rapidly develop solutions for near-term operational needs

Joint Geospatial Enterprise Services-Research Program Spiral 1
The JGES-RP Spiral 1 using Army S&T resources completed an initial prototype demonstration capability in a matter of months that provided insight into JGES concept development, technology gaps, and collaboration. The initial technology focus areas included:
- Discovery services (data, applications, knowledge) using metadata portal concepts
- Battlespace environment and terrain reasoning services
- Geodatabase synchronization
- Soldier as sensor using mobile GIS technology
- Feature foundation data sharing in relational database systems
- High resolution sensor exploitation
- 3-D visualization
- Spatially and temporally explicit link analysis

Spiral 1 Objectives/Goals
JGES-RP has three primary objectives. It will provide a prototyping environment for FCS, DCGS-A, JC2, Future Force, and related efforts; it will provide a prototyping capability to rapidly develop solutions to near-term operational problems; lastly it will enhance technology transition from research to systems and operations.

The JGES-RP will demonstrate the feasibility of the basic prototype enterprise architecture functions. Demonstrate the capability of integrating and disseminating timely, accurate, and relevant geospatial information horizontally and vertically among echelons and agencies. The JGES-RP will establish a geospatial enterprise prototyping environment for integration, testing, verification of emerging geospatial information technologies, and emulation of GES technical architecture critical to key DoD activities (e.g., FCS, DCGS-A) using distributed geospatial databases and services. A prototyping environment is required to experiment, prototype, and evaluate the different concepts, systems, and architectures to be used to achieve the JGES goals. This prototyping environment will be an open and flexible environment that can be used across the geospatial community of interest.

The functional goal of the JGES-RP Spiral 1 prototype demonstration is to show near-real-time updating of the military situation via advanced geospatial enterprise technology which enables military planners and tactical operators to react to changes in the battlespace environment. The vignettes described are designed to demonstrate the envisioned functionality and capabilities of JGES and the positive impact it will have on the conduct of military planning and tactical operations.

The demonstration utilizes a simplified conceptual view of a brigade combat team to visualize the distribution of services (terrain reasoning, discovery, operation picture, map, etc.). The demonstration focuses on presenting soldiers as sensors collecting geospatial data and warfighters reacting on the actionable intelligence in near real time to improve mission effectiveness.

The Spiral 1 prototype demonstration included the following vignettes: (1) Mobilization, (2) Intelligence Analysis, (3) Mission Planning & Rehearsal, (4) Assured Mobility, and (5) Direct action (See Figure 2). The JGES-RP Spiral 1 prototype demonstration consists of the above vignettes tied together by an overall campaign scenario. Each vignette is intended to demonstrate the effectiveness of JGES architectures in the conduct of military operations. The geospatial enterprise services will support data management, battlespace visualization and situational awareness from the senior levels of command to the individual warfighter.
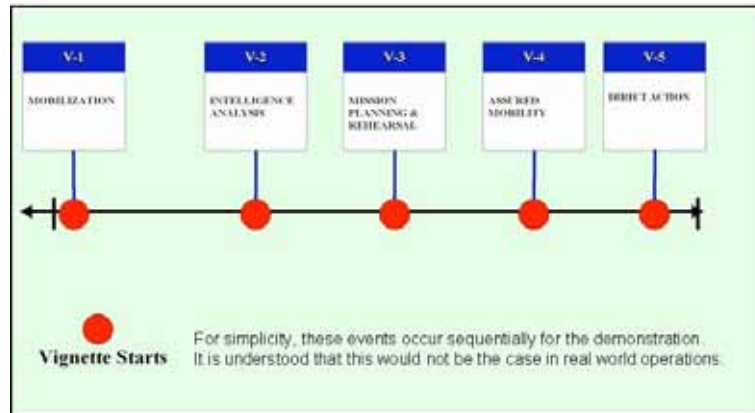
Figure 2 Demonstration Vignettes

Prototype Demonstration Overview

The deployment model for the demonstration is set up to emulate a 3rd Infantry Division (3ID) deployment to the Iraq Theater. The demonstration will encompass data synchronization from multiple vantage points. It shows how geospatial data ingested into a JGES environment will be synchronized throughout the force hierarchy based on filters (Area of Interest, Intelligent Agent, and Feature Class/Layer) applied for the demonstration scenario. The force structure is centered on the 3ID as a Unit of Employment (Mobile) to tie-in with the 3ID Overwatch activity and to bring a sense of realism to the demonstration. Within its command structure, the 3ID is able to leverage geospatial information collected at the National level represented by NGA and the Army Geospatial Knowledge Center (AGKC) and other command elements such as CENTCOM and 18th Airborne Corps HQ. Subordinate to 3ID is the 2nd Unit of Action which is the first Unit of Action (UA) within the US Army to be deployed. Subordinate to the 2nd UA is Battalion Task Force (BN TF) 1-64 and the 422nd Civil Affairs Battalion. Although the BN TF has a lighter infrastructure footprint it will be synchronized with its command elements to ensure a common view of the battlespace (See Figure 3).
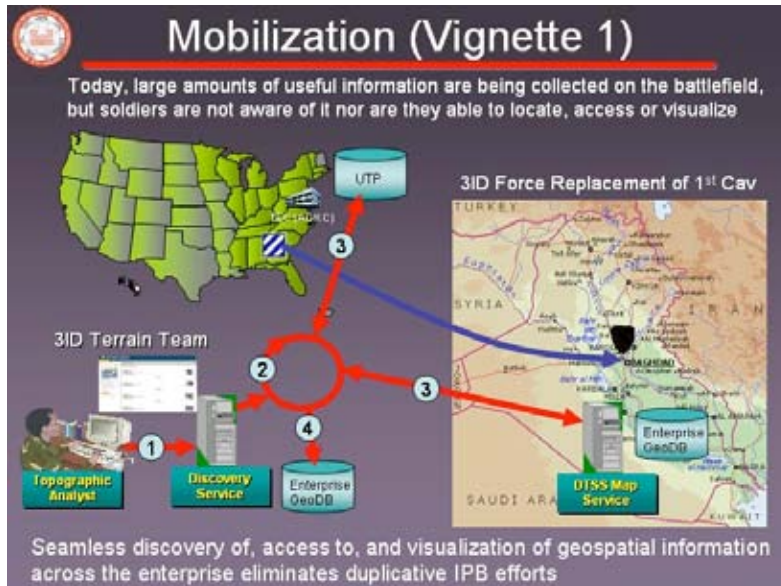
Figure 3 Mobilization

The demonstration illustrates how a mounted unit (A Company/TF 1-64) can synchronize data that is captured from within its command structure and can coordinate efforts with units within the division such as engineers to perform combined arms operations. The 10th Engineer Battalion is attached to the 3ID. Special Forces will also play a role in the demonstration by producing and consuming geospatial data within this network. SOCCENT has operational command of the 3rd Battalion of the 5th Special Forces Group. An Operational Detachment Alpha (ODA 585) is operating in the same AO as 3ID and will share geospatial information based on a mutually shared area of interest. The Intel Analyst will use link analysis, and Analyst notebook to reveal a pattern of insurgent activities. By combining geospatial capabilities with Intel tools the activities pattern can be visualized and improve situation awareness (See Figure 4).
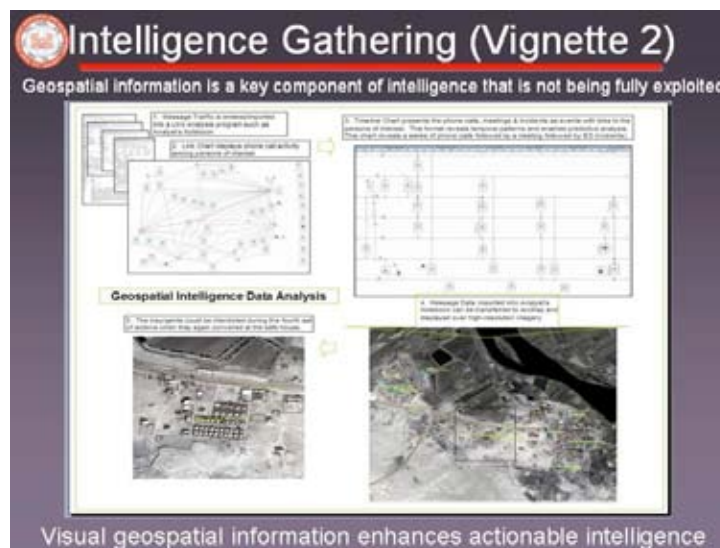

Figure 4 Intelligence Analyses

The troop commander can perform mission planning that is synchronized across the echelons. The movement projection service provides the best route based on the latest geospatial data. The troop commander and aviation support can visualize the route in 3-D using the visualization services on the enterprise (See Figure 5).

Figure 5 Mission Planning

The ODA team will use a mobile PDA device that will synchronize while connected to the network and the demonstration will also illustrate how the team can benefit from and integrate with JGES while operating in a disconnected mode. A dismounted Civil Affairs Team (CAT) will also act as a provider to the geospatial information provided by JGES via a PDA device. As the Civil Affairs Battalion is connected to the network and is synchronized with other JGES repositories, the demonstration will show how information collected by CAT can be exploited by 3ID. 3ID will adjust their avenue of approach (using movement projection service while enroute) based on the new geospatial data provided by the PDA from the civil affair and dismounted Soldier, and suspected IED alert derived from BuckEye (change detection sensor) imagery (See Figure 6).
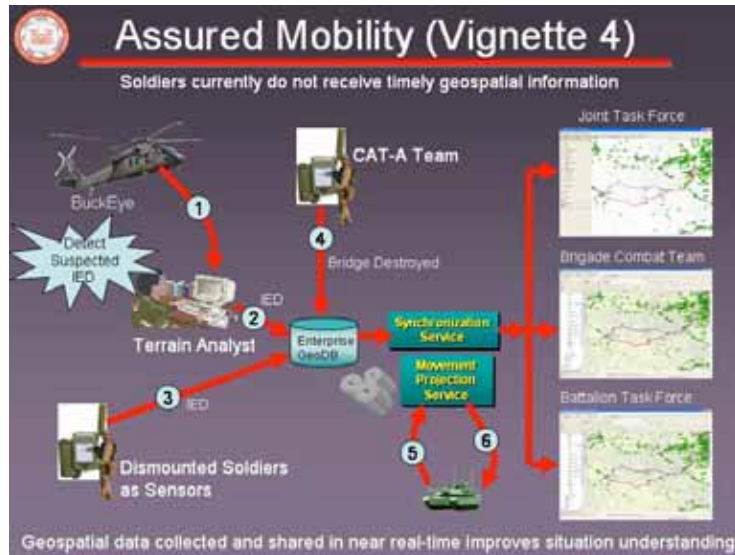
Figure 6 Assured Mobility

The troop commander arrives at target and utilizes geospatial data collected from a Tactical Unmanned Aerial Vehicle to visualize target. The direct action is adjusted and shared from team leader to team members via PDA (See Figure 7).
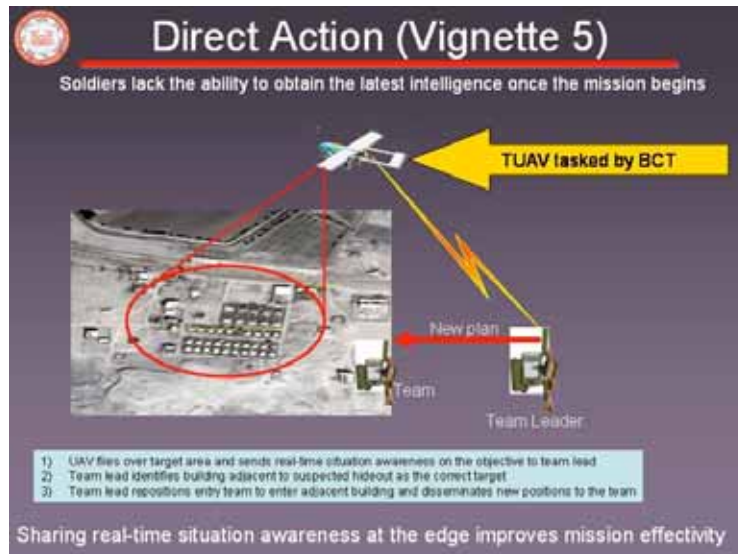

Figure 7 Direction Action

In summary the demonstration utilized the following capabilities to perform the related services shown below (See Figure 8).

Figure 8 Demonstrated Capabilities

Software employed into the demonstration scenario to achieve geospatial services are as follow:

Name	Function
ArcSDE	Store and retrieve spatial data
ArcGIS Server	Provided Terrain Reasoning web services
ArcGIS Desktop	Visualize Theater & Corp level Common Operating Picture
ArcIMS	Metadata Explorer & download data from remote database
ArcPad	Display maps and gather point data
MS SQL Server 2000	Database
Go!Sync	Synchronize data between databases
TerraExplorer Pro	Display 3D fly-thru

Advantages of Joint Geospatial Enterprise Services-Research Program
Successful implementation of the JGES-RP will improve the understanding of the interaction among terrain, weather effects, and environmental information with Battle Command. The availability of a prototype environment will support the analysis and assessment of GES technology. It will also enhance the understanding of J-GES architecture(s) and implementation, as well as provide detailed insight into Doctrine, Organization, Training, Materiel, Leader Development, Personnel, and Facilities issues associated with supporting Joint Forces Battle Command. Finally, the JGES-RP will focus on the GES capabilities that will provide geospatial information and knowledge crucial to supporting situational awareness for the warfighter, soldier systems, and weapon platforms for the Army and Joint Services. It will provide a prototyping environment to support the JGES community.

Way Ahead

Future JGES-RP spirals will focus on direct engagement with Program Executive Offices, military battle labs (or Future Centers) across all Services, and industry to further development and promotion of the use of network-centric geospatial technologies within emerging Battle Command and Intelligence, Surveillance, and Reconnaissance programs. In the near term Spiral 2 which ends October 2005 will address the following:

- Prototype-essential geospatial services
  - o Leverage e-GIS to enable Soldiers to perform field data collection with PDA devices and synchronize with the Brigade Combat Team enterprise geospatial database
  - o Prototype Army Geospatial Knowledge Center discovery portal service to enable Soldiers to locate and access geospatial information across the enterprise
  - o Enhance the synchronization service to enable sharing of geospatial information across the enterprise

- Integrate GES with existing Battle Command, Planning, and Intelligence systems

- Insert viable R&D technology programs (e.g. Data conflation, Urban movement projection service (UTIC), Tracking Services (GeoIntel / Geo-enabled Probes), Theater Geospatial Database (TGD), and Army Battlespace Environment (ABE) data model

Author Information:

Name: Michael M. Coley
Title: Joint Geospatial Enterprise Services – Research Program
Organization: U.S. Army Engineer Research and Development Centers; Topographic Engineering Center
Address: 7701 Telegraph Road, Alexandria, VA 22315-3864
Telephone: (703) 428-6774
Fax: (703) 428-7490
Email Address: Michael.m.coley@erdc.usace.army.mil