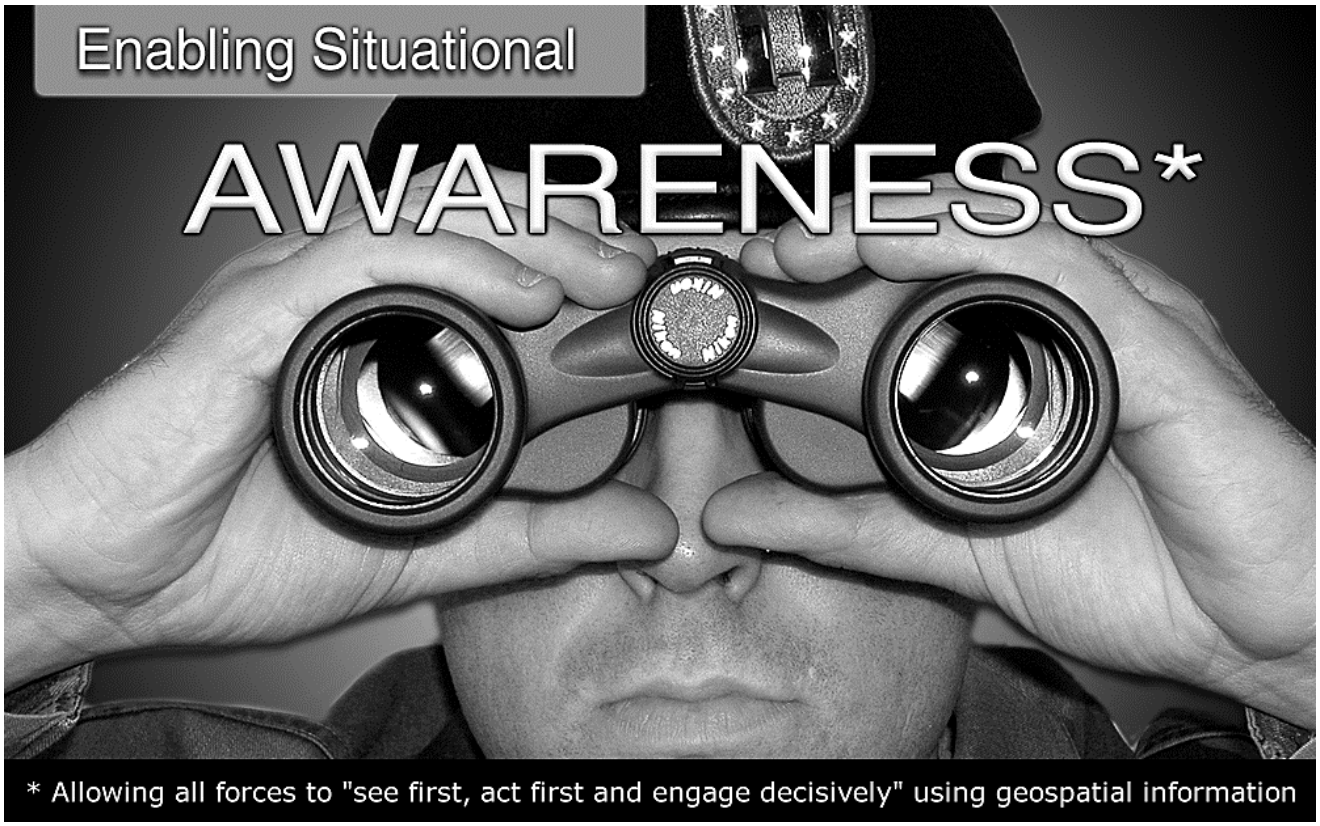


Abstract:

A PC on nearly every desk is both a blessing and a curse. Nearly all warfighters have access to use and exploit geospatial data. This now enables all warfighters to visualize terrain as it pertains to them. Thus, topographic engineers are no longer the providers of geospatial intelligence to tactical decision-makers. These combat enablers have pushed us to explore new roles and challenges in order to wring useful "information" from the "data:"

- To destroy the mindset that anything geospatial is merely topographic engineering and subordinate to other engineering functions (mobility, countermobility, survivability, and general engineering).

- To confront and attack the mindset that this leveraging ability is just too hard to comprehend;

- Eradicate the belief that geospatial information and services (GI&S) is just "making maps;"

- Given this new empowering all warfighters, what is the role of topographic engineers as data providers within the tactical footprint?

- Address and minimize training shortfalls in understanding, interpreting, and exploiting this data to the commander's benefit.

Enabling Situational Awareness With Geospatial Data*

*All engineers allowing commanders to "see first, act first, and engage decisively."

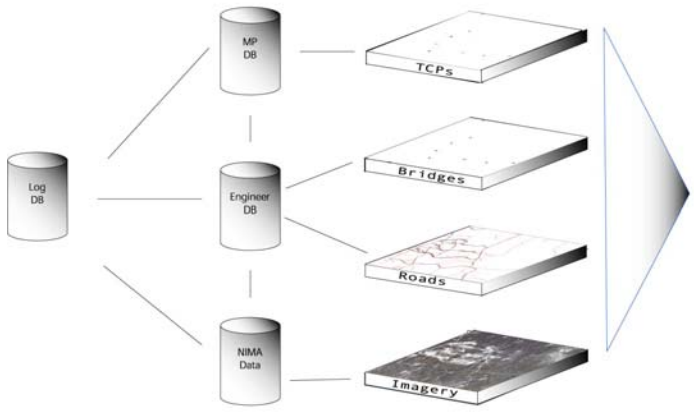
What is it?

Geospatial information is data made meaningful when tied to the earth's surface. When viewed graphically, elements can be further attributed (data added) and analyzed; new information can be gleaned by viewing previously unseen relationships to other data elements. Moreover, this information can be displayed in a common relevant battlespace view. Below are three illustrations of geospatial information and how it might be used:

1. Standard hard copy products are geospatial information. A 1:50,000 Topographic Line Map (TLM), for instance, is a meaningful graphical view of coverages and elements tied to the earth's surface. In fact, it communicates universally and provides a common view of the battlespace--that common view, however, is often limited to a HMMWV hood as leaders huddle around. Moreover, product use requires very little training beyond that received in basic formal education.[i] This process can now be streamlined significantly by using a scanned hardcopy product (normally Compressed ARC-Digitized Raster Graphics (CADRG)) which can be used as a digital background display; related static overlays can also be shared electronically.

2. Another example of geospatial information is value adding and feature attribution. This can be the time-honored task of hanging a 1:250,000 Joint Operations Graphic (JOG) in a TOC and adding pushpins and icons. Common picture and simple tasks?--if you are in the TOC all the time. What about erroneously reproducing that overlay with a grease pencil? This can often be accomplished more swiftly and accurately with software that displays these source point features from a database on a common display (such as CADRG).

3. Imagine common situational awareness across warfighter communities, each populating their own connected databases. Different



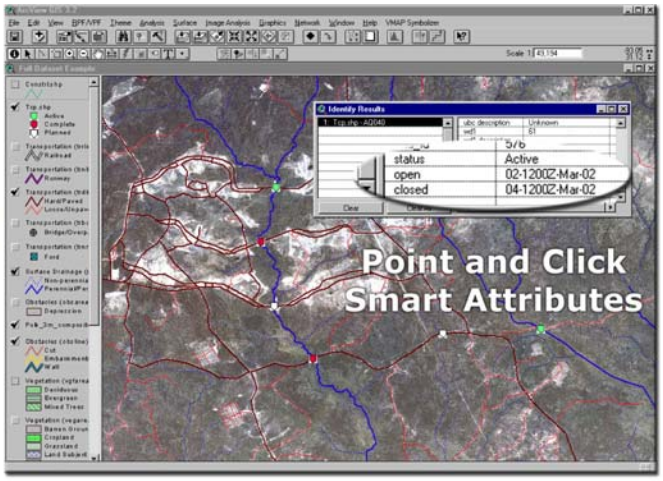


Figure 1. Connected databases allowing point-and-click object information. In this example, we clicked on a TCP to reveal additional information such as open/closing times.

warfighter communities (maneuver, engineer, and logistician) could leverage this information to their own end and each could populate their own databases allowing them to remain the subject matter experts. Since these data stores are interconnected, changes to the data would be reflected across all the communities. Also, each warfighter could build a current, customized and relevant common view of the battlespace. Using an example of theater traffic planning, engineers could populate a database of bridge classification, route classification and route construction status. Military Police would then be able to build decisions of TCPs and route closures based on timely engineer's data. Finally, logisticians, connected to these same databases could build their relevant view and analyze the data to reveal the most current route information for optimal haul management. [ii] This can all be accomplished within current systems allowing users to point and click their way through web or PC interface (a click on a bridge symbol reveals construction status and MLC; a click on a TCP reveals controlling authority and hours of operations, for example). This is not futuristic; this ability is here today--often at minimal unit cost and little training investment.

Since 80% of all data has a spatial element[iii] (i.e., geographically located), everyone can contribute and benefit. As all engineers are "terrain visualization experts," this terrain has expanded beyond the bare earth over which we run our tracks. Rather, it is a network of related features, structures, and intelligence. The ability to collect, manage and exploit the data makes this system an ideal and potentially ubiquitous management tool--not a tool belonging solely to an analyst in a dark topo van, but data we all can share and see, suiting our individual uses. The end tool may be a web platform--technology has shown us this needs minimal training. However, the lion's-share of the training requirement resides in data management and pure analysis. Common views and limited attribution can be accomplished by the user on a web-like interface.

This breaks the mold that Geospatial Information and Services (GI&S) is *just* making maps. Rather, it "is neither a product nor a system but rather a concept for the collection, production, archiving, dissemination, and exploitation of information about the earth.[iv]

Data Frustration.

It is a foregone conclusion that the earth is entirely and uniformly mapped with high-density data—it is not. In fact, only 30% of the earth is mapped with 1:250,000 JOG-scale elevation (DTED1 or ~100 meter spaced elevation values). The Shuttle Radar Topographic Mission (SRTM) will reveal elevation data density inherent in a 1:50,000 TLM (DTED2 or ~30m spaced values). This data density will span 80% of the earth's surface; however, delivery is not complete even after the February 2000 touchdown. This does not make the engineer's job any easier when he/she charged with explaining "well, that icon is only showing an approximate line of sight since we don't have sufficient data…."

Another gap exists in installation data. One of your platoon leaders receives his/her digging permit and begins construction only to dig-up a key telephone line. Why is this?

Where does the technology fit?

Under the aegis that "all engineers are terrain experts," we as a regiment are responsible for providing information from pertinent geospatial data to the commander. As sure as a scraper does not belong in the breech, the need for geospatial information transcends the entire operational spectrum. Geospatial

information provides a wide array of user-derived intelligence to all forces to "shape, prepare and respond[v]." In relative terms, Combat Power = ((Maneuver + Firepower + Protection)x Leadership) ^{Info}. Therefore, a geospatial *information* requirement spans the gamut of possible efforts against asymmetric threats.

Managing geospatial information is a departure from classic intelligence functions (HUMINT, IMINT, MASINT, and SIGINT). Most intelligence activities rely on close-holding data. In contrast, geospatial information can only survive in a shared and distributive environment--only then can we work off a common battlespace gameboard.

Technology in and of itself is not the final solution. In a recent topographic conference, each unit briefed they were running a "mother of all databases" for map data and geospatial data (map data being NIMA Digital products on a shared network or server; geospatial data meaning attributes stored on a shared network or server). However, certain details were painfully omitted: how will these databases communicate with each other? Who can plug in? Classification?--many warfighters are forced into an UNCLASS/LIMDIS environment (many battalion S2s are without dedicated SIPRNet connections)--can they access UNCLASS data elements residing on the classified net?

Who are the players?

"Terrain visibility is a basic leadership skill…it includes…data collection, database development, analysis, display, distribution, and database management."[vi] Is anybody's seat feeling warm? Are we all comfortable with the prospect that our junior officers can establish a database and dynamically link to their data and other data stores, providing the commander with the most current situational awareness and integration into the Military Decision Making Process (MDMP)?

Relevance in the MDMP requires two premises:

- Know your resources (figure 2)
- Know your job

Resources. There are five primary geospatial resources for all engineers:

- NIMA--provides timely, relevant, and accurate Geospatial Intelligence (imagery, imagery intelligence, and geospatial data and information) in support of national security; provides access to Geospatial Intelligence databases; creates tailored, customer-specific Geospatial Intelligence, analytic services, and solutions.
- Defense Mapping School (DMS)--joint Service training school under NIMA; provides geospatial training to DoD, NIMA and the Intelligence Community.
- Topographic Engineer Center (TEC)--research, development, and the application provider of topographic and related sciences to support the warfighter and the national civil and environmental initiatives.

	NIMA	DMS	TEC	GI&S Officers	Topo Units
Data Producer	X			X[1]	X
Data Server	X				X
Data Manager	X				X
R&D/ Solutions			X		
Training	X	X			X[2]

[1]=Although not a data producer per se, GI&S Officers are a direct liaison to NIMA Customer Support Teams to identify requirements and issues
[2]=Theater geospatial expertise

Figure 2. Geospatial resources.

- GI&S Staff Officers--the principle staff officer (normally Corps and EAC) for identifying geospatial requirements, liaison to NIMA (via Customer Support Teams) for production and dissemination.

- Topographic Units--the topographic community (Corps Topographic Companies and mirrored in Division Terrain Teams) doctrinally collects, manages and analyzes the geospatial data. In practice, limited pure data management exists in topographic units. More often than not, after building data and products, they are squirreled away possibly never seeing the light of day. In addition, no formalized training exists in how to model, construct, populate and manage these databases. Regardless, topographic battalions and companies are the theater proponents for geospatial data. They must provide the vision of geospatial data flow within the entire theater to allow all disciplines to benefit.

Job Requirements. To maximize commander situational awareness, all terrain visualization experts (that is, all engineers) must understand three things:

- GI&S fundamentals (datums, grids, coordinates, accuracy issues);

- GI&S products (types, limitations)

- Basic data management (who collects, manages, distributes; how to connect).

As a regiment, we need a vision that engages this leveraging ability across the spectrum of disciplines and combat operations.

How can I get it and what do I need to do?

Geospatial technology is not in its infancy. Plenty of fields are fully utilizing geospatial data and geographic information systems--signal community, intelligence, environmental, etc. What does this mean to the engineer field? I would suggest the following courses of action that can also form staff-officer's checklist:

1. Train and mentor officers. Push your junior officers to move beyond a TerraBase-driven Line-of-Sight analysis.

2. Build your kit bag. Your Battle Captains/S2 should have the following of your AOR (and you should wonder what is going on if they don't):

- NIMA Standard Digital Products:

    - Digital Terrain Elevation Data (DTED) Levels 1 and 2;

    - Vector Smart Map (Vmap) Level 1 (and Vmap2, Feature Foundation Data (FFD), if available);

    - E-Catalog (replaces most old-style telephone book-thick product catalogs; if your S2 is not on automatic distribution, contact DSCR at http://www.dla.dscr/pc9)

    - Compressed ARC-Digitized Raster Graphics (CADRG, or scanned hardcopy "maps" which can be easily ingested into numerous viewers);

    - Controlled Image Base (CIB) (controlled imagery geographically referenced and corrected eliminate distortions);

    - GI&S For The Warrior CD (includes instructional materials, software and software

extensions; available from the Defense Mapping School for free)

- GI&S Fundamentals CBT (available from DLA NSN 7644-01-491-5152, NRN TRNGGISFUNDCBT)

- If your S2 has SIPRNet access, they should know how to download NIMA digital products (CIB, CADRG, VMap) (note: DoD Public Key Infrastructure now allows all US Military, DoD Civilians and contractors access to download NIMA Digital Data to an UNCLASS location--AKO address required for US Army; see https://gis.extranet.nima.mil.

3. Send your Senior NCOs & junior officers to external training at the Defense Mapping School (DMS). DMS provides extensive training (free of charge; unit pays TDY and travel costs) in familiarization, use and exploitation of geospatial data and imagery; most courses utilize military scenario practical exercises. DMS also conducts numerous Mobile Training Teams (MTTs). After training, they should know the fundamentals of:

- Data accuracy. Since the field is now becoming enabled with pulling together and using multiple data sources, it is important to understand how to manage error. Error has always existed in many map products (a 1:50K TLM circular accuracy is specified as 50 meters). So, how does an AN/PSS-11 PLGR work and why does it rarely match my 1:50K TLM?

- Datums, grids, coordinate systems. What are they? Why are datum shifts so important? Is a 750m datum shift from Toyko-B to WGS84 significant…at night?

- Foundation Data Concept. What is the concept behind building current products?

- Digital products. What is this alphabet soup of CIB, CADRG, VPF, UVMap, FFD? What are their uses, limitations, etc. Where do I get these products? How are these products downloaded?

- How do you build a line of sight analysis in TerraBase and/or FalconView? How do you build overlays, add icons dynamically linked to a larger database?

4. Establish Databases. Begin using databases that can talk to other data stores and allow for multiple puts and takes. Have your staff officers stop running the solitary (and large) spreadsheet of spatial data and share to enable others. Do this by learning database design and sharing selective elements.

5. Know the right people. Your Battle Captains/S2 should know how to contact:

- Division Terrain Team/Corps Topographic Company

- Corps GI&S Officer

- Theater Topographic Battalion

- NIMA Technical Representatives/ Liaisons

- Defense Mapping School

Where do I go from here?

Reiterating that geospatial information and terrain visualization is an engineer function, the regiment needs continue to lead the fight in institutionalizing geospatial information as decision architecture applicable to many

functions. Fundamental geospatial concepts must continue to be taught in the institutional education base (OBC, CCC) and incorporated into other Service schools and senior leader courses. In company-grade curriculum, additional emphasis on exploiting the data is required. Insist simulations and simulators provide real digital terrain, not notional, synthetic terrain.

Still uncertain is how many of these data elements are managed. Topographic units are charged with this responsibility, but there currently is no formalized training in data and database management.

Geospatially-enabling data allows engineers and the military community to most effectively manage scarce resources. Previously unseen relationships and force multipliers can be readily seen using these currently available systems of products and software--often times free to the warfighter. Understanding the fundamentals will allow supported commanders to make the best-informed decisions regarding people, materiel, and, ultimately, the mission.

If you would like to learn more about GI&S, you can contact DMS at phone number 703-805-2237 (DSN 655) or via web at http://www2.nima.mil/dms.

CPT(P) Jack Haefner is an instructor at the Defense Mapping School, Ft. Belvoir, VA. He has served in the 27th Engineer Battalion (Combat)(Airborne), the 94th Engineer Combat Battalion (Heavy), and the 535th Engineer Company (Combat Support Equipment).

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[i] You may have heard "say goodbye to the 1:50K Topographic Line Map." Nothing could be further from the truth. We are not on the battlefield yet with Pocket PCs running displays with the resolution inherent in a 1:50,000 TLM. The change is *how* these products are produced. What is dying is the method of manually scribing many different layers (vegetation, drainage, etc), producing plates, and offset printing. Current production calls for maintaining these coverages in digits and either separating them for offset printing or producing on a plotters.

[ii] These illustrations are solely Topographic Engineer functions. The ability to collect, manage and display data with geospatial software or in a Geographic Information System (GIS) should be no different (given additional training investment) than using other common decision-making tools such as spreadsheets. Since all engineers are "terrain visualization experts," then use and exploitation of geospatial information is in our bailiwick of "knowing your job."

[iii] ESRI Online Training, "Geographic Information Systems (GIS): Geography Matters," http://www.gis.com/whatisgis/whatisgis.pdf

[iv] Ibid

[v] National Military Strategy of the United States of America: Shape, Respond, Prepare Now: A Military Strategy for a New Era, www.dtic.mil/jcs/nms/index.html, 1997

[vi] FM 3-34.230, section 1-19 and 1-20