
Organizing National Level Imagery and Mapping

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If there was one lesson learned from the Persian Gulf that still rings clear, it was that today's modern battlefield has moved into the information age, where good intelligence and battlefield awareness are often more critical than the quantity and quality of tanks or technical aircraft.

—Congressman Floyd Spence
Chairman of the House
National Security Committee

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One category of battlespace information particularly relevant to operational commanders is the physical environment. Imagery, imagery intelligence, and geospatial information (mapping, charting, and geodesy) portray that environment and are thus important bands along the battlespace information spectrum. They enable commanders to place myriad battlespace data into a framework based on time and location. Fusing all data sources in this manner allows for the development of an awareness of the battlespace in order for decisions to be made faster than an enemy can act—the core concept of knowledge-based warfare. Accordingly, intelligence and information are the basis of dominant battlespace awareness.

The National Imagery and Mapping Agency (NIMA) was established by Congress in 1996 to furnish imagery, imagery intelligence, and

geospatial information in support of national security objectives. It is the combat support/intelligence community agency charged with merging imagery and mapping from separate intelligence and defense organizations. NIMA has broad authority over the U.S. imagery and geospatial information system (USIGS) and the production/dissemination of imagery, intelligence, and geospatial information which permit commanders on all levels to acquire access to common references and information.

One challenge facing NIMA is to construct imagery and geospatial databases with a global framework on which to build a common view of the battlespace. Within the information

geolocational information plays a role in each of the emerging JV 2010 operational concepts

domain, NIMA is one step toward achieving the information superiority envisioned in *Joint Vision 2010*.

This article examines the impact of NIMA on military operations with emphasis on the synergy of merging imagery and geospatial databases: richer information that is timely, relevant, and accurate. Moreover, commanders must appreciate the new information infrastructure in order to achieve dominant battlespace awareness. Also, geolocational information plays a role in each of the emerging *JV 2010* operational concepts: dominant maneuver, precision engagement, focused logistics, and full dimensional protection.

Geospatial Information

Image intelligence remains as vital today as it was during the Cold War. For example, the Armed Forces used it to accurately deliver precision munitions during the Persian Gulf War. The intelligence and defense communities, along with policymakers, need it to understand an increasing range of activities. In addition, satellite imagery is a significant source of NIMA mapping products which thus makes it essential to the mapping community.

The Cold War set terms for image intelligence development that focused more on collecting information than exploitation and dissemination. Cost was secondary because the products were unique in providing critical information for national and military users. Technology available at the time supported largely separate system solutions. Distinct non-integrated programs also continued because of the procurement process, where acquisition oversight was not prescribed. However, security constraints prevented users from being brought into the decision process to balance needs, technological opportunities, and cost.

World events and technological change have shaped image intelligence. First, the demand for information has replaced the push of collection technology: users select the needed information. Technology has arrived at a point where collection is no longer a constraint. Multiple platforms, including commercial imaging systems, let users determine their collection requirements. Second, the information revolution shifted the emphasis from satellite collection to information distribution. One can configure systems to collect, process, transmit, and disseminate. Moreover, differences between image collection and exploitation have been overcome by giving comparable attention to both functions. Third, cost is a concern. Innovations allow the private sector to provide a greater share of image intelligence hardware and software. The task is deciding which system to pursue.

NIMA absorbed the activities of the Defense Mapping Agency, the Central Imagery Office, Defense Dissemination Program Office, and the National Photographic Interpretation Center within the Central Intelligence Agency. The agency also subsumed imagery exploitation, dissemination, and

processing functions of the Defense Intelligence Agency, the National Reconnaissance Office, and the Defense Airborne Reconnaissance Office as well as components of the Central Intelligence Agency. While NIMA is a combat support agency, its unique responsibilities and global mission make it part of the intelligence community.

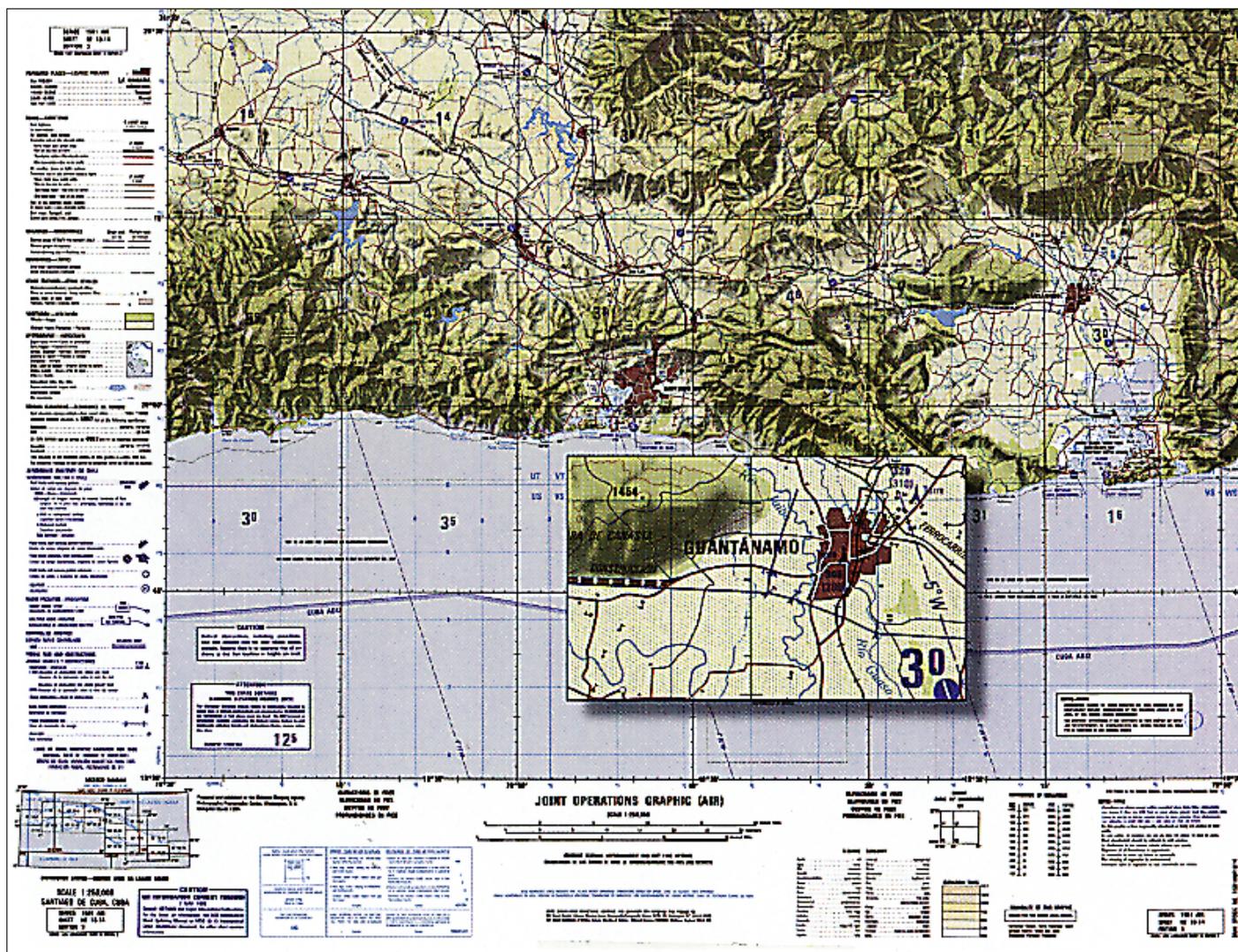
Information Databases

One measure of effectiveness in consolidating imagery, imagery intelligence, and geospatial information databases is the evaluation of its impact on products, using the attributes of intelligence quality as a guide. Joint Pub 2-0, *Joint Doctrine for Intelligence Support to Operations*, describes these attributes, which provide standards for assessing activities and products. Operations may fail because of shortcomings in any attribute.



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Timeliness. Commanders will benefit from the improved response to information requests that will result from converting vertically-integrated imagery and mapping production systems to a "client-server" system. In this architecture, imagery and geospatial data will move from collection through exploitation and distribution (such as magnetic media) in a totally softcopy, digital format. This architecture supports interoperability with the defense information systems network (DISN), which means that geospatial



Joint operations graphic.

information will eventually be disseminated electronically.

The improvements in imagery collection, data extraction, and information dissemination also will provide more timely responses to commanders. Congress made NIMA responsible for imagery requirements management, tasking collection, coordinating processing and exploitation, and ensuring dissemination and archiving. To enable the image flow, NIMA was also empowered to prescribe the technical architecture and standards for imagery processing and dissemination and to ensure compliance with such a framework.

NIMA is not charged with developing, procuring, or operating imagery collection systems. Those tasks fall to the National Reconnaissance Office, Defense Airborne Reconnaissance Office, and service intelligence elements. NIMA is not replacing current organizations for tactical military exploitation and use of imagery products but will be an intermediary between them and the high end of the imagery spectrum.

In August 1996 the director of NIMA remarked that a major task was to determine which imagery exploitation systems should be retained. The goal is to move from a series of imagery exploitation systems and programs to a single integrated base. From the unification of imagery management and

processes, and with the move to a prescribed technical architecture and standards for image processing and dissemination, NIMA anticipates that within a few years users will have access to images and maps not older than 30 days as opposed to a year or more.

Improved responses also will come from greater use of commercially generated imagery. The Defense Mapping Agency bought more than a million square miles of commercial satellite positioning and tracking imagery after the Gulf War and before NIMA was established. NIMA is the DOD purchasing agent for commercial multi-spectral imagery, which is composed of images collected in wavelength bands that exhibit false-color scenes when

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combined, such as with the land remote sensing satellite or LANDSAT system. Acquisition and archiving of multi-spectral imagery data eliminates redundant and uncoordinated imagery purchases at higher cost.

While funding for intelligence and defense is declining, the rationale for establishing NIMA focuses on providing greater capabilities to commanders, not only cost savings. Testimony by the Deputy Secretary of Defense and services reveals the object of establishing the agency: to increase the effectiveness of commanders in terms of timeliness and completeness of information. Savings may be realized in time but are not the central factor.

Objectivity. As conceived NIMA eliminates the organizational barriers among members of the imagery com-

commanders must know the quality of geospatial information

munity. As a result, it has the potential to develop creative synergistic solutions to demands for imagery and imagery-derived information: generating combinations of information with richer content. By using this approach, and by consolidating current databases wherever they exist, the agency will offer information of higher value, in shorter times, and with greater relevance for every commander. Its framework for fusing battlespace data will be more comprehensive, with greater fidelity to the real physical environment.

Accuracy. An improved response to information requests will be manifested by accurate geospatial information. The early vector-formatted products originated from existing cartographic sources. (Vector products use points, lines, and areas to portray features while raster products use arrays of image pixels to portray maps.) For higher vector position accuracy production is shifting from cartographic to photogrammetric sources whereby positions are derived from triangulation rather than cartographically-displaced symbols. This accuracy will provide the precision required for the future battlespace where forces aided by precision-guided munitions

and global positioning system (GPS) will be the norm.

Commanders must know the quality of geospatial information. Toward that end, most data sets carry auxiliary information on relative and absolute accuracies. But many digital data sets were intended for specific systems and now are applied to uses that require their own "measures of trust" (namely, metadata). To address this requirement, the data sets will be produced with spatial metadata standards, in essence providing data on the data such as source, currency, and lineage.

To ensure that imagery and geospatial data fuse, all data must be referenced to a common datum. While most products are now referenced to the World Geodetic System (WGS) 84, having everyone on a standard in the imagery and mapping community will ensure co-referenced data sets. Geocoded raster and vector data will align for visualization and support evaluation, particularly if the metadata of the data sets is comprehensive. The requirement for data referenced to WGS 84 is operationally and tactically critical because the global positioning system is similarly referenced.

Completeness. Given a single focal point for imagery, imagery intelligence, and geospatial information, commanders will benefit from full support through customer support teams (CSTs) in the field. These teams first determine customer needs and then work within NIMA to meet them. They can also identify emerging requirements and cultivate a "smarter consumer/smarter provider" environment. The customer support office provides guidance in prioritizing customer requirements and serves as a link to production offices to satisfy demands in a timely and efficient manner.

Users in intelligence, defense, and civilian agencies can submit their concerns to the NIMA Customer Advisory Board on proposed actions. The board is co-chaired by the Vice Chairman of the National Intelligence Council and Deputy Director for Operations (J-38),

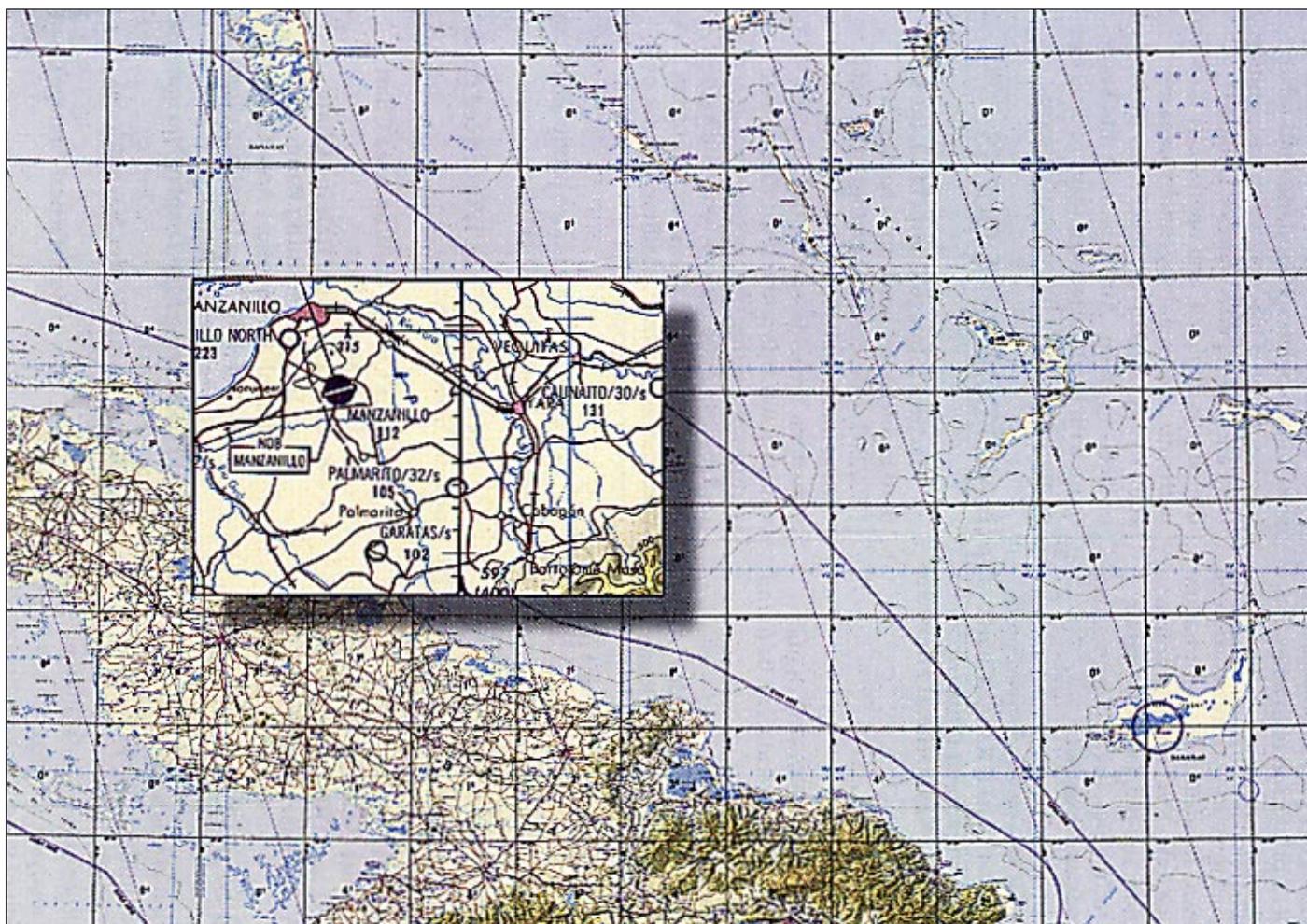
Joint Staff. During its implementation, the NIMA support strategy was periodically reviewed by the senior steering group under co-chairmanship of the Under Secretary of Defense (Acquisition and Technology), the Vice Chairman of the Joint Chiefs of Staff, and the Deputy Director of Central Intelligence.

Commanders will benefit from having a single source of imagery, imagery intelligence, and geospatial information. NIMA prioritizes uniform requirements across the community, eliminates duplication, and uses resources efficiently. Congress also charged NIMA to identify and advocate the needs of a growing pool of diverse customers. Commanders, for example, require training in the use of image and geospatial databases, identifying the type, quantity, and scale of information needed, accuracy requirements, metadata needs, and program management.

A response improvement will also be enabled by emphasis on providing information rather than products. This strategy is part of the core NIMA mission and is made feasible through "data warehousing" or federated databasing architecture whereby user access data is stored in thematic layers. Such a client-server architecture is being adopted.

Relevance. Commanders will benefit from imagery, imagery intelligence, and geospatial information resources that are relevant, current, and properly prioritized for production to satisfy current and foreseeable demands.

As a combat support agency, NIMA is under the control of the Secretary of Defense. But it also gives the Director of Central Intelligence a clear and prominent role in tasking imagery systems and exploiting imagery products. Congress and the Commission on the Roles and Capabilities of the U.S. Intelligence Community have concluded that such an arrangement improves support to defense operations and planning as well as other national users. The President has called for closer coordination of defense and intelligence space work for national security, and this moves in that direction. Furthermore, to assure that relevant geospatial information is produced and maintained, customer support



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Tactical pilotage chart.

teams are in place with users to make sure the right products are produced.

Usability. Commanders will benefit from the general adoption of data specifications across the imagery and mapping production community. Data standards and conventions facilitate sharing information—the ability to electronically exchange mapping and imagery information with anyone, regardless of the system. The advantages are support of global operations, interoperability among DOD systems, and integrated information exchange developments.

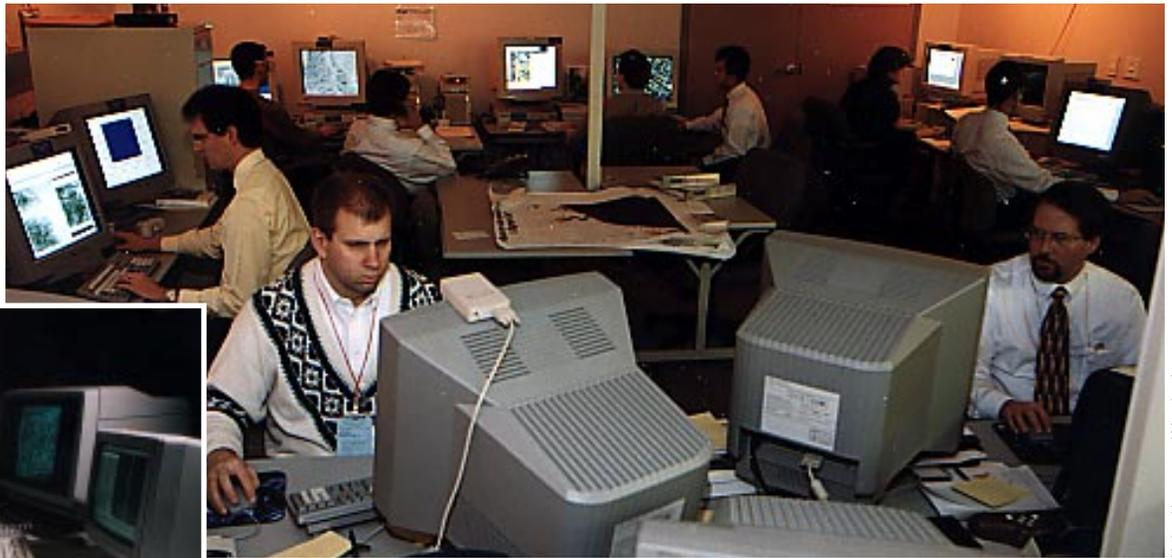
Secondary image dissemination must comply with the national imagery transmission format standard. For mapping information, NIMA has

created a standardization program, the goal being a suite of standards for the exchange, manipulation, and display of digital mapping, charting, and geodetic data. The standards will assist in compatibility and interoperability of mapping, charting, and geodetic databases supporting simulators, command and control, and weapon systems. NIMA has membership on the Defense Standardization Council and manages the mapping, charting, and geodetic data technology program.

Since subsuming the Defense Mapping Agency, NIMA has operated internationally under co-production agreements, and standard product specifications have been established or are being developed (like the Digital Geographic Information Working Group, which is releasing the Digital Geographic Exchange Standard). NIMA

is leading standardization efforts while cooperating in the development of a national spatial data infrastructure (like the Federal Geographic Data Committee). These standards operate on the following levels:

- *environment*—hardware, operating systems, query languages, graphic interfaces
- *exploitation*—user-nominated modules for projection, grid, and datum transformations
- *data directory*—indexing and cataloging schemes, legend, and marginalia
- *product*—design, accuracy, symbolization, etc. defined by military specifications
- *data dictionary*—spatial data structure, raster and vector, and feature coding scheme
- *format*—the exchange format and export mechanism (International Standards Organization)



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■ *media*—comply with industry standards for 9-track and 8 mm tape or CD-ROM.

Standards will continue to be developed by NIMA as new technology and information emerge.

Readiness. Commanders will benefit from the quality of imagery, imagery intelligence, and geospatial information with one agency managing and maintaining the production

the Joint Staff, commands, services, and defense agencies annually submit prioritized geospatial requirements

processes and inserting technological developments to sustain their modernization. With representation from a single entity, the U.S. Government will be able to team with industry in developing technologies that match common internal NIMA production requirements, thereby sharing the risks and rewards with minimal impact on all involved. It will allow NIMA to influence industry to develop products and services to better match its needs

by exchanging information. Technology breakthroughs will be more quickly realized throughout the imagery and mapping community by a single procurement office. Moreover, NIMA has formed a commercial advocate office for industry coordination.

Global Information Infrastructure

Requests for imagery and geospatial information are sent through NIMA liaison personnel at unified commands or directly to NIMA headquarters. In addition, the Joint Staff, commands, services, and defense agencies annually submit prioritized geospatial requirements to NIMA for the upcoming year as well as new product needs to NIMA headquarters.

NIMA product metadata is available in both standard (hardcopy) and softcopy (CD-ROM) catalogs as well as in limited amounts via Internet (unclassified) or DISN (classified). Its webpage <www.nima.mil> shows the product line and summary product. The *NIMA Softcopy Catalog of Topographic, Aeronautical, Hydrographic, Digital, and Other Products* provides the capability to use a personal computer to browse, select products, develop orders, and access online servers to update catalog data. Maps are available on paper and imagery is produced on film and in hard-

copy prints. Though bulky, these products are in high demand. During the Gulf War, 90 million maps were printed and delivered to the theater. Geospatial data is increasingly being produced digitally in raster or vector format and distributed in both CD-ROM or 8-mm magnetic tape versions.

Planned paths to imagery, imagery intelligence, and geospatial information. Imagery and geospatial products in hardcopy will survive for years. Printing and hardcopy product distribution are being consolidated in a facility with new printing systems and technologies which will improve customer responsiveness. The remote replication system has already proven its value in Bosnia. It can manipulate existing products by overlaying information such as land mines and then print full-size maps on-site. In late 1996 NIMA announced a transfer of responsibility for hardcopy product distribution to the Defense Logistics Agency for improved customer support.

In addition to hardcopy products, commanders will soon have electronic access to imagery, imagery intelligence, and geospatial information in data warehouses. Maps, charts, and images will be downloaded, displayed on monitors, and printed. USIGS is an information framework and infrastructure that will provide commanders with access to imagery and geospatial

information on a global scale through the defense information infrastructure.

USIGS will implement an open-system processing environment via distributed architecture based on government owned and commercially available hardware and software. The environment will be a gateway service for both national and military customers. It will be the single electronic interface between NIMA libraries and users. The services will provide perusal of NIMA holdings, on-line ordering for authorized customers, and on-line transmission of digital data. NIMA libraries will have a logical design to support imagery, imagery products and intelligence, and geospatial information. Customers will be able to tailor data to meet their specific needs.

NIMA holdings in USIGS are accessed through DISN and divided into aeronautical data, geodesy and geophysical data, geographic names, hydrographic data, map catalogs, navigation data, imagery archives, raster graphics, and digital products. Electronic networks access databases on the required security level and include the joint worldwide intelligence communications system, secret Internet protocol router network, and Internet. The processing environments supporting data access are the joint deployable intelligence support system, global command and control system, Intelink (with commercial web browsers), and World Wide Web (see accompanying figure).

Force Multipliers, including more accurate munitions and new doctrines for using military force, are means of improving effectiveness or productivity without increasing force size or costs. By definition the consolidation of imagery, imagery intelligence, and

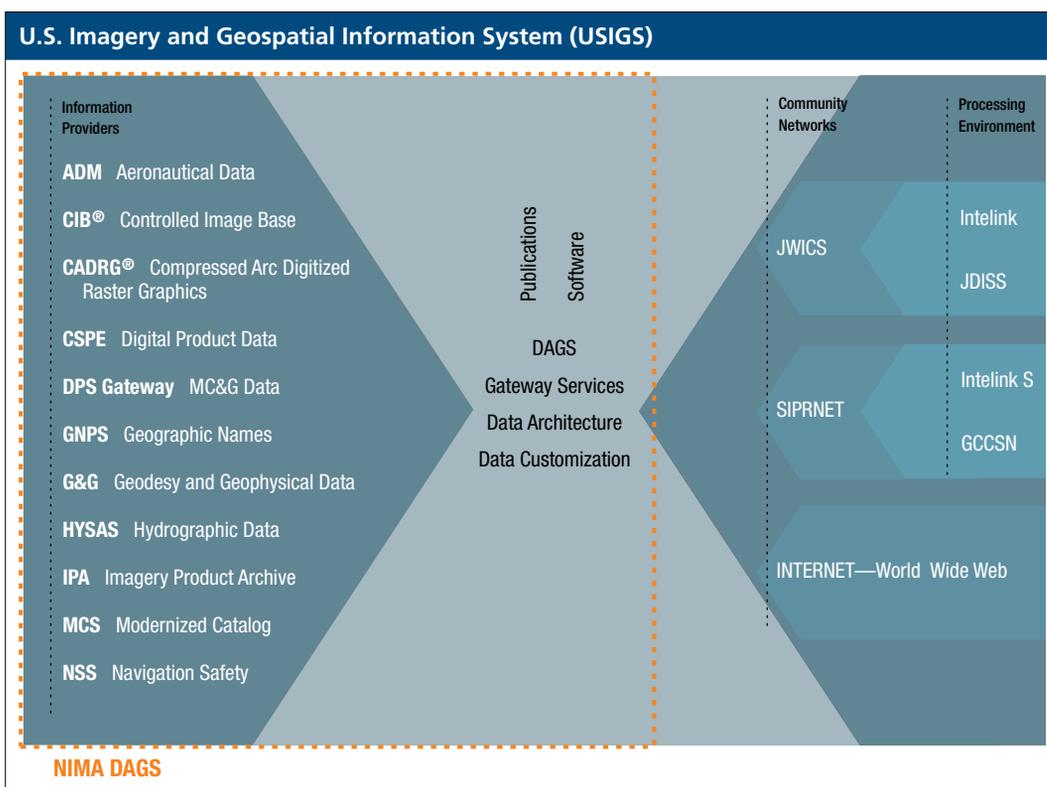
geospatial databases is a force multiplier. It allows quick access to information that is richer in content, more relevant, and more precise and that provides commanders with the same geospatial data in a common framework. Such improvements bear on the operational concepts in *JV 2010*:

- precision weapons need accurate target coordinates
- mobile forces need detailed knowledge of the terrain to achieve dominant maneuver
- understanding lines of communication is necessary for focused logistics
- attaining full dimensional protection requires maintaining battlespace awareness on a common spatial background.

The end of the Cold War world and technological developments fostered the foundation of NIMA. Database consolidation strengthens the agency's mission to provide timely, relevant, and accurate information and intelligence. When products and services derived from the consolidated database structure are analyzed with

attributes of intelligence quality, there are many benefits. Most notable is the potential to develop creative synergistic solutions to demands by operational commanders for imagery and imagery-derived information—mating databases to yield information of richer content. Moreover, commanders on all levels will have improved access to the same information in a global framework through USIGS. The cumulative result is a force multiplier: a stronger, more capable, and adaptable basis for fusing battlespace data. This will enable each commander to better develop battlespace awareness and thereby to do more with no increase in force size or cost.

JFQ



Source: Adapted from *NIMA Data Architecture and Gateway Services Requirements Document* (NIMA 100-97-R-5001), attachment 1 (November 7, 1996).