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NEW TRENDS IN TECHNOLOGY AND THEIR APPLICATIONS:
DIGITAL DATABASES, GEOGRAPHICAL AND LAND
INFORMATION SYSTEMS

The Global Geospatial Information and Services Initiative

Submitted by the United States of America**

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** Prepared by Roberta E. Lenczowski, Defense Mapping Agency, Fairfax, Virginia.

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INTRODUCTION

Recent unprecedented changes in the global political and technological environments have levied new challenges for Mapping, Charting and Geodesy (MC&G) producers and users. The Defense Mapping Agency (DMA), through its total quality leadership, has articulated seven major task areas to chart its future course. The leadership team's goal is to make DMA combat support relevant to the Nation and its users of the 21st Century.

DMA's future lies in its ability to populate a massive database or federated databases, within a "data warehousing" architecture. That vision, and the road map to achieve it, will facilitate joint interoperability for the Command, Control, Communications, Computer and Intelligence (C4I) community. Standards for the entire spatial reference model will cement the structure of this architecture. A technology-extensible approach will provide to the spatial data consumer the most current and appropriate knowledge, at the right time, and with the needed accuracy. The Global Geospatial Information and Services (GGIS) initiative encompasses a DMA commitment to information production, information management, information dissemination, and information servicing.

Global Geospatial Information (GGI) is defined as worldwide, precise, spatially co-referenced information about the earth, arranged in a coherent structure to support measurement, mapping, visualization, monitoring, modeling, terrain evaluation, and spatial reasoning applications. It will be compatible with sophisticated geographic information system technologies to facilitate import and export of standard data sets and to enable manipulation, update, and value adding.

BACKGROUND

Today, DMA produces multiple series or versions of maps and charts and other well-defined digital or hardcopy products. DMA has published voluminous military specifications, military standards and handbooks to specify the content and format of those products. The utility of the paper product to aid decision-making during mission planning or mission execution will not be obsolete for some time. Over the past twenty years, however, the accelerating demand for digital products reflected the improved speed of data processing, the increased complexity of software applications, and the decreasing cost of high-powered hardware. Typically, the digital product adequately satisfied the data needs of only one customer, or one system, or a limited suite of applications.

Focus is changing. Throughout the geospatial data community, traditional digital data sets are being examined to determine with what reliability they can be used for a variety of information needs. The data must be robust enough to support extensibility. At the same time, with the defense community's drive toward multifunctional, multi-media terminals in a battlespace providing fused information for the integrated tactical picture, the data must be consistent enough to support the integrated global "infosphere." Extensibility and fusibility must characterize data exchange.

Changing technologies encourage re-engineering. New generations of hardware have attained eighteen month cycles and the sophistication of software and application program interfaces is matching or exceeding that pace. Battlespace change is dynamic. DMA's response is aggressive.

(1) Precise weaponry exploits both the Global Positioning System (GPS) and inertial navigation. DMA must improve the accuracy of the digital products used for targeting, planning, and training or simulation.

(2) The emerging world order, with its frequent regional cacophony, grapples with networked operations that range from humanitarian to counter-proliferation. DMA must improve responsiveness in both production and delivery of time-critical digital data.

(3) DoD policy, accepting technical challenge across the spectrum of research and development, directs a joint doctrine to enforce common views of the battlefield. Although the common view may require common tools or applications, it is attainable only with consistent input. DMA must invest in standards, confirmed by the joint community, which assure data content, meaning, quality, encapsulation and delivery.

(4) Conscientious life-cycle management within the defense information infra-structure forces evaluation of all existing and planned production and exploitation systems. DMA must migrate to open and flexible architectures which effortlessly accommodate adding hardware and software improvements and which routinely allow modification of production processes as customer requirements change.

(5) Global communication networks have established traditional cable, fiber optic and/or satellite links worldwide connecting all facets of the private and public sectors. DMA must travel the information highways, especially in support of navigation safety and crises.

(6) Throughout the defense community, working groups gather to examine models for database management design which will support real-time and mission critical information processing and dissemination. DMA must design, populate, and manage user accessible databases of global geospatial information.

Those six topics influence this paper's discussion of the GGIS concept. DMA has a mission-defined responsibility to support a defense and federal community with mapping, charting and geodesy. That support must be relevant to the present requirements and must anticipate the future refocus. All described elements of the technologies challenge the GGIS initiative.

Definition of Global Geospatial Information

GGI Is Worldwide

The Agency's strategic plan for digital data production embeds global objectives. By the year 2005, DMA expects to have complete elevation information for both landmass and seafloor. Vector representation of global data is scheduled before the century's turn to support aeronautical, nautical, and topographic needs. Worldwide contiguous or discrete data sets of orthorectified, geocoded imagery will provide DMA's initial immediate response to flash-fire crises.

Although GGIS will manage all digital data produced as part of the process to provide standard products, merely harnessing the zeal to meet these global goals will not satisfy the broader objectives. As demanding as these goals will be upon the production capability of the Agency, there are also visionary objectives: improve the pace of production and global population; improve the accuracy and, thus, the fusibility of the data sets; refine and discipline the content of the data by standardizing definitions.

GGI Is Accurate, Precise and Current

The challenge for geospatial information suppliers like DMA is to provide user accessibility to accurate data, which they can leverage into trusted information for various needs. As participants in the information infrastructure proliferate with newer analytical tools, their concern about available data sets is broadening. Most data sets carry auxiliary information regarding absolute and relative accuracies. Because so many data sets, however, were intended for specific systems and are now being extended to new uses, requirements specific to an application must be understood. As a result, "measures of trust" are being defined for each application. That levies against the producer an obligation to provide even more data about the data: source, currency, lineage, etc. GGI will invoke spatial metadata standards in its data delivery.

Not only will DMA tell potential data users about the quality of that data but DMA will also move to improve the accuracy of its geospatial data. Although the earliest production of the vector formatted products, like DNC and VMap, will be from existing cartographic sources, DMA will rapidly migrate production from cartographic to photogrammetric sources to ensure that vector position accuracy is derived from triangulation rather than from cartographically displaced symbols. Such implicit data accuracy will provide the precision required for the geospatially fused battleview. Air to air, air to ground, ground to sea, strategic and tactical operations will be presented with consistent perspectives even at the varying resolutions of data used.

GGI Is Spatially Co-referenced

The spatial accuracy and precision promised by GGI with its spatially co-referenced data sets relies upon exploiting geodesy. All DMA products are referenced to a common datum: the World Geodetic System (WGS) 84. Refinement of the WGS 84 geoid would augment support to inertial navigation and enable the definition of a World Height vertical reference. Modernizing procedures for collecting photo-identifiable first order surveys would expedite an extensible, global control network for photo-triangulation.

The more accurately data is produced, the more likely data sets, even collected at different times or for different uses, will fuse. Geocoded raster and vector data will align for visualization and will support consistent analytical evaluation, especially if the metadata accompanying those data sets is comprehensive.

GGI Is Arranged in a Coherent Structure

For DMA, the state of the future will require strict adherence to a suite of standards. Some will be industry standards, others will be Federal Information Processing standards. Some will be national, some international. Still others will be DoD MC&G standards for which DMA will bear development and implementation responsibility. A general data model, applicable horizontally and vertically among all DoD users of varying-resolution geospatial features, must be collaboratively completed. Within those standards, defined or selected through open working groups, GGI will seek its stuctural coherency.

Similarly, DMA will use standard media, including the standard conventions for directories and indices, to forward deploy its data sets. Magnetic tape, whether 9-track or cartridge, CD ROM, or newer industry standardized media solutions will be used consistent with the users' terminal capabilities. When communications networks are used, DMA will prepare its digital data compliant with necessary transmission protocols.

GGIS Supports Varied Applications

Within the next decade, MC&G environments for the producer and the user will have changed as dramatically as they have in the past ten years. Virtual reality, with associated data management capability, with real-time operations on very high resolution, descriptive geospatial information, and with analytical derivation of inferences or deductions, will dominate mission rehearsals and planning. The C4I for the Warrior booklet describes providing real-time decision-aiding capability achieved through artificial intelligence and decision-support systems. Those systems will ingest and rapidly fuse intelligence source. They are expected to have flexible planning tools, wargaming, simulation and multimedia technology. Other dispersed sites, at the command level and below, will have authority to populate, to manage and to distribute specific features or attributes within virtual and re-definable local databases.

DMA will distribute stable foundation data upon which the consumer can build reliable inferences. DMA's digital data will feed data greedy Geographic Information Systems (GIS) and graphic interfaces. DMA's digital data will be accompanied by importers and display tools. To assure that the marketplace encodes MC&G algorithms satisfactorily, DMA will certify tools to be catalogued in the Defense Information Systems Agency (DISA) software reuse archives. Some tools may sanction reliable value-adding in the deployed environment.

Notional Architecture

Today's Picture

DMA produces over 230 products, each described in a published specification. More than 70 of these are digital products. The three production components of DMA follow a planned program based upon meeting the regional precedences and product priorities established by the Services and Unified Commands. For the most part, the digital products are tracked with library and card-catalog database management techniques. DMA employs a quite simple databasing approach in which location of media and minimal descriptive information about the data sets is retained on-line.

Distribution of these data sets is on standards-compliant hard media: 9-track magnetic tape, 8mm cartridge tape and CD-ROM. CD-ROM production mimics the historical model of producing and warehousing map sheets. Magnetic tapes and the 8mm cartridges are distributed either in initial quantity through the Automatic Initial Distribution plan or on an ad hoc basis upon certified request. Although some data may be distributed across existing communication link-ups, except for the Notice to Mariners and the Electronic CHUM, DMA does not have routine communication transmission of products. Fig. 1 illustrates the situation as it exists today.

Embedded in DMA's modernized digital production process is a massive MC&G database, which will be progressively populated to satisfy the regional precedence and priority requirements. It is designed to hold feature and terrain data, extracted primarily from photogrammetric source, prior to its finishing into several of the standard products identified in the previous diagram. Taking more direct advantage of this and other production databases, before constraining the data into only one representation of information, is an achievable goal for GGIS. Eliminating or relaxing those constraints, which can be demanded by media limitations or which may have been decreed by specific, non-interoperable systems, will require reeducating both the producer and the consumer communities.

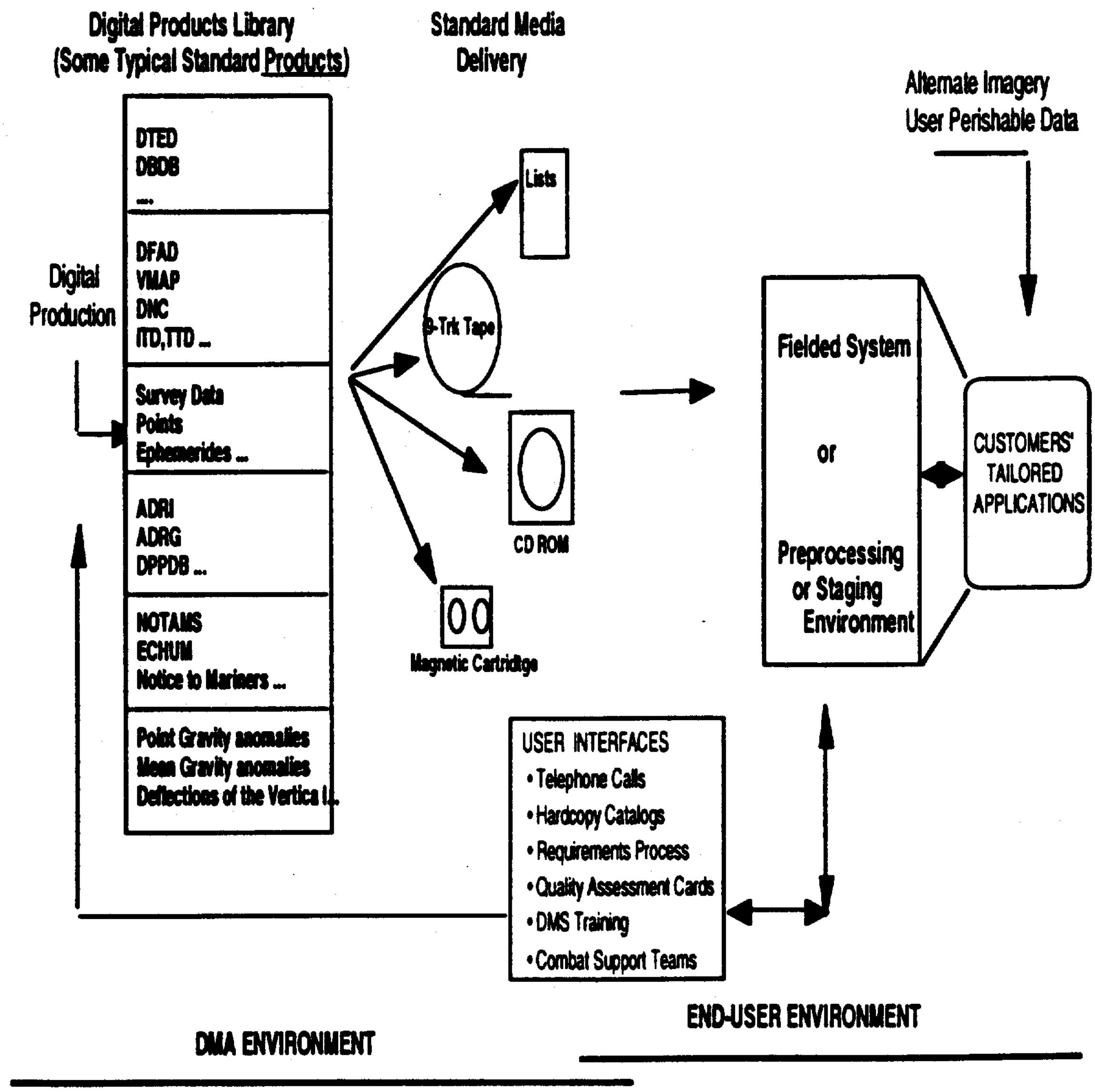

Fig. 1 Diagram of today's DMA and end-user product interface

Vision of the Future

Anticipated change. Eliminate inconsistent multiple representations of features. Move smoothly from the topographic view of the shoreline to the hydrographic view of that shoreline. Feather without gross abruptness from one resolution of spatial data to another. Accommodate time-varying characteristics of some spatial features. Embed each object with all its topological relationships so that decluttering and generalization is robust. Invest each element of the geospatial domain with as much integrity as is appropriate, balancing consumer demands with production realities. "Package" Agency expertise for the spatial information users.

Nearly all aspects of the current picture will experience change as DMA moves toward GGIS. Requirements from the customers will, of course, reflect the regional precedence approved by the Chairman, Joint Chiefs of Staff (CJCS). However, content in terms of the features and attributes will be more carefully defined. A "one size fits all" product definition will be replaced by a data tailoring capability, although the standard product can be delivered as long as users' legacy or new systems need one. DMA will explore, with a series of "pilot" projects, the methodologies best suited to providing necessary service that allows consumers to be better users and to successfully feed-back important field-gathered data.

Internally, DMA will focus on a data environment rather than on product finishing. Fig. 2 provides a notional impression of some architectural elements that warrant further consideration in this discussion: the data partitions, the standard tailoring support, the expanded commitment to service.

Implementation of the GGIS concept will address both the physical and the logical clustering of spatial data. In Fig. 1 the products are clustered by type and in Fig. 2, the data partitions or categories align with that same kind of clustering. The figures represent the logical associations of traditional product types. A different approach might be to define the partitions as vector, raster and textual, aligned with the ways in which digital data is encapsulated physically. Yet another approach could be with respect to spatial functionality: aeronautical, hydrographic, and topographic. The pros and cons of each perspective will be more relevant as the concept matures into preliminary design considerations. That discussion is outside the scope of this paper. Interest here is on the data characteristics, user-accessibility, and customer support.

Data "warehousing" strategy. Either by using software that modifies legacy data to achieve the desired fusibility or by populating the data partitions from a common photogrammetric source, DMA will strive to provide its users with spatially consistent data. DMA will invoke a "data warehousing" approach to its visionary architecture in which legacy data, residing in various ADP environments, can be assembled to support various clients through a distributed and hierarchical server design. Because GGIS is envisioned as residing in a data warehouse architecture, each data type partition may consist of distributed databases in heterogeneous environments. Those databases may be relational, hierarchical, object-oriented, or flat, but the

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database management system for the data warehouse must be able to manage this broad-base data resource and present it to the user as a "federated" accessible system. User-accessibility to the valuable spatial data store is a critical design consideration. Appropriate interfaces, complying with standards in the Common Operating Environment (COE), must be clear and concise presentations of quite complex information.

The partitions in the "data warehouse" can be populated by legacy data of the appropriate genre. During migration to a future state when all data is consistently generated from photogrammetric source, middleware, which allows the harmonization between legacy and transfer formats, may be used to stage data requested. In this way, the appropriate selection from multiple options in today's products can be extracted.

Layering considerations. Within the feature partition, following the design of the existing vector formatted products, there will be layering choices. These thematic layers, or some equivalent grouping, could exist within any one of the appropriate partitions. On the other hand, they may be only a function of the tailoring operation, which might parse out the requested data from an object-oriented, fully topologically-integrated database.

Within that fairly simple statement lurk some very sophisticated or complex spatial operations. Relevant spatial associations (like: contained in, contains, adjacent to, on top of, and under) and temporal contingencies (like: atmospheric models, tide models, weather models) must be allowed in the basic data model. DMA will not fill all elements of the data model. In many cases, the full population of all attributes will require multiple sources from varied production environments assembled through some distributed processing. In addition, the spatial operations on the data cannot violate topological integrity, but they must allow decluttering (that is, layer population) and generalization (that is, more and less resolution).

Pre-defined composited layers for such purposes as "mission planning for tactical air strikes," "amphibious assault plans," "heads-up displays for cockpit use," "scene-matching for cruise missile guidance," or "assessment of cross-country movement" may be delivered upon request. In some cases such composite products may correspond to the digital or paper products of 1994; in other cases, entirely new, tailored data sets will be specified. Just as DMA has worked with its customers to define product specifications, DMA will work with them to define "use-profiles" which will include content needs to the feature, attribute, value, and reliability specificity.

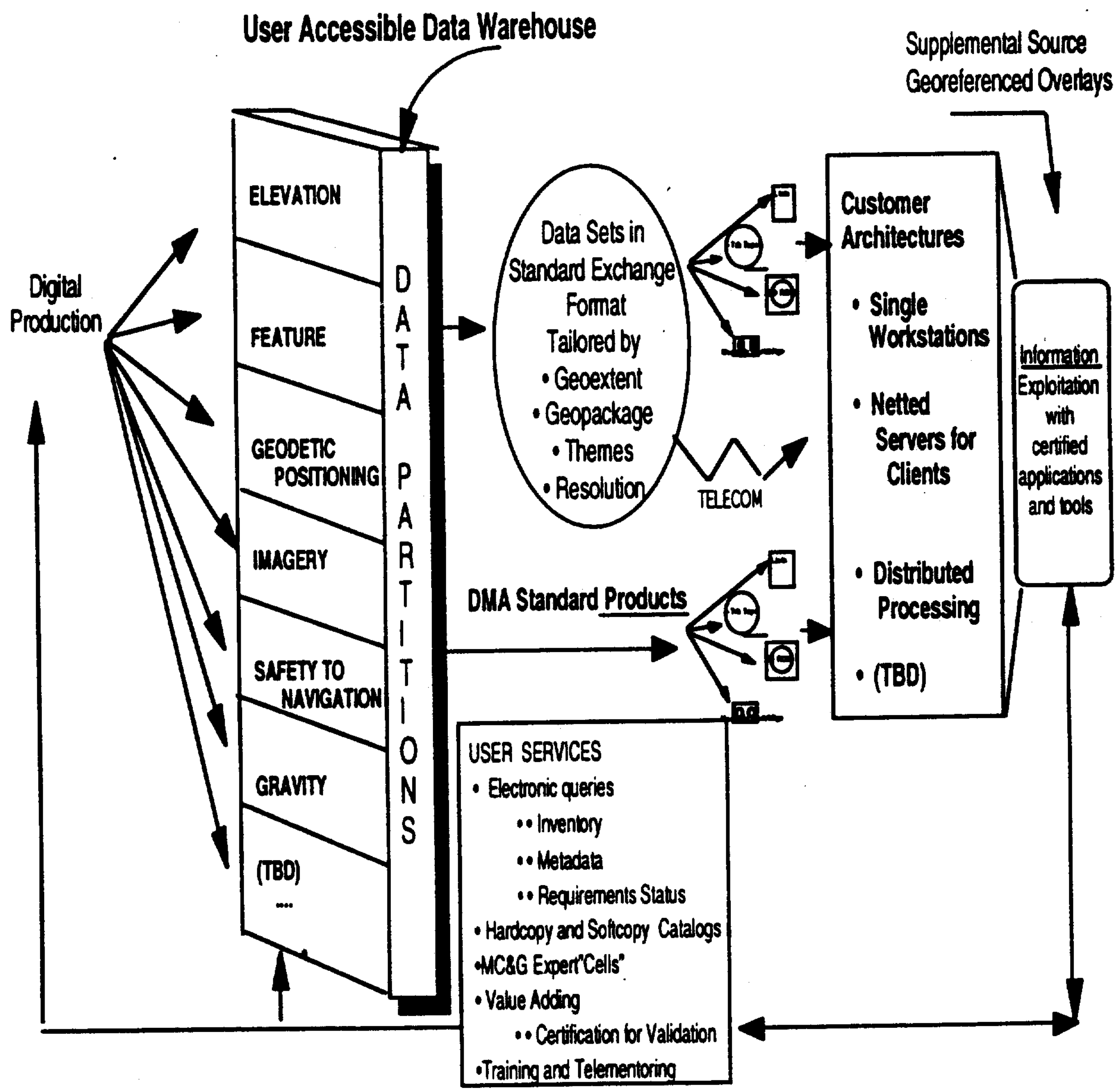

Fig. 2 Notional Layout of the DMA and End-User Interface of GGIS

Tiling consideration. Thematic layering and tiling are characteristics peculiar to specification of particular data sets and are usually mated to system performance. The tiling convention may be as simple as defining regular rectangles or triangles or hexagons or it may be complex enough to accommodate polygons adapted to the number of bytes in the data set. The tiles may nest, as in some quad tree designs, or may be mutually exclusive. If nested, the delivered data set, with or without thematic layers, might be used for different resolution presentations. If mutually exclusive, the entire data sets could be swapped in and out of the user environment as needed. These are conventions which must not interfere with data that appears seamless and remains consistent, scaleable and fusible for the users' applications.

In contrast, at the present, DMA does not accommodate tailored tiling for the end-user. The product specification defines the unit tile of delivery. If the skirmish is at the juncture of four tiles (1°x1° cells) of digital elevation data, DMA does not window out a minimum bounding rectangle. Megabytes of excess data are delivered to the user for preprocessing into the needed information. In the information, not product, environment of GGIS, data windowing and clipping should be a realistically expected service.

Tailoring options. Such tailoring allows customers to dictate specific data needs. These needs could be based on items such as feature, attribute, geographic or political boundary, and/or scale. Tailoring is not random sampling; interoperability for joint systems will demand that system profiles be established so that the right information -- but only the needed information -- is distributed. Users can specify the data they need by designating features and attributes or by defining the geographic extent. They may wish to define a geographic area by using a bounding rectangle, a user-described polygon, a stored definition of a region of interest, user-designated country codes, or standard tiles. In such an environment, geopackaging of several types of geospatial data could be handled. As an example, a particular system may require the orthorectified image in raster, the transportation vectors, and a variable density elevation grid in a defined geographic area. In a crisis, the set could be delivered electronically, but a more likely scenario is the production of a CD ROM at a distribution site forwarded to the customer.

Adding value to data. Value-adding may be broadly examined from maintenance, updating, and augmenting viewpoints. Traditionally, the producer assumes responsibility for the maintenance plan and confirms with the customer community that the cycles are appropriate. Updating, however, may involve only part of the data included in a complete product. Although there may be cyclic releases like Notice to Mariners or Flight Information Publications, to assure safe navigation, an update could be pertinent irrespective of any schedule. The latter situation is quite relevant to population of the GGIS data warehouse. Just as production focus changes from product finishing to population of a database, maintenance focus must change. Updates to the database need to be incorporated whenever new relevant source is available. Updating is GGIS maintenance.

Value-adding, from the augmenting or supplementing perspective, allows creation of additional layers or attributes or the replacement and enhancement of deployed data with more current data. Those value-added data may be forwarded to be incorporated into the primary data set because they represent updates. In other cases, like intelligence overlays, the data is not part of DMA holdings. The distributed data set format must allow a facile incorporation for system applications.

Data security and integrity. The integrity and security of the DMA data are of paramount concern in considering how to incorporate user feedback. Levels of security classification and access restrictions must be maintained. Those multiple levels of security must be supported by the database design, the database management approach, the operating systems, as well as the network protocols. Appropriate procedures and requirements for a user to be certified as a bona fide contributor will be implemented. The process by which data is validated and incorporated into the database must be as clearly established for the "value-adder" as for the primary production component. Data that fails validation may be maintained separately and provided to the user with the appropriate caveats. The associated metadata must be complete and thorough, as it will be for standard production. It should describe not only the content and format of the data itself, but also provide relevant information about the "value-adder" and the conditions under which it was captured.

Gateway Interface Services

A gateway interface allows the actual handshake between the producer or the holder of information and the customer or the requester for that information. The growth of the telecommunication options and DMA connectivity to a varied, and interested, geospatial market requires that this connection is useable by both the novice and the expert. The interface rides on electronic network backbones and serves as a network geospatial information manager as well as the mechanism for geospatial information exchange using appropriate and standard communication protocols. Three data files are seen as essential to this interface: general information about DMA and its inventory; hierarchically structured data about the data (metadata); and authorized customer profiles. In scenarios, which will be tested by pilot projects, the customer will access the interface gateway via a user profile which will be defined by access privilege, security level, pertinent data/product requirements, and level of expertise.

Various hardware platforms will be supported. The conduit will be the network linkage, but the flow will be supported with needed data format converters or translators into standard data models, the interface or front-end processors for applications, and an associated set of application program interfaces (API) to allow software to function in the platform environment. Since data is platform independent, the interface gateway must be able to utilize APIs for multiple platforms. For initial operations it is assumed that any customer will have a fixed base of operations (designated individuals at pre-known organizations) that can be networked by cable. If the customers become increasingly field based, moving quickly and often from location to location, then wireless network communication capabilities will be required.

Among the early expectations from the evolutionary GGIS concept will be access to a modernized catalog, to safety of navigation data, to a digital gazetteer, to a requirements identification process, and to metadata perusal. Queries in the near term through the interface should furnish DMA metadata such as currency, sources utilized, and accuracy. Follow-on development will include the goal of providing high speed on-line ordering of MC&G data and update information. DMA products will be ordered electronically with status available on request. Profiles would be maintained on each account so that, immediately upon log-in, the customer would be notified of any change data in his pre-identified area of interest.

Communications Backbone

GGIS will be brought on line in an environment that will be rich with communication capabilities. Significant deployments of Synchronous Optical Network (SONET) equipment by the domestic common carriers will have created a transmission network of 2.4 Gbps (Gigabits per second) pipes. This network will cover much of the US as well as the major US trading partners. The Asynchronous Transfer Mode (ATM) service set will be provided on these SONET facilities. ATM will support a wide range of commercial service offerings including "virtual private lines" at speeds of 46, 155, and 622 Mbps and switched, on-demand virtual circuits at the same set of speeds. These commercial off the shelf service capabilities will be integrated into DoD networks as Defense Information Systems Agency (DISA) upgrades those networks. ATM "feeders" at lower speeds (1.544 Mbps) will also be available.

Transportable satellite terminals accessing commercial transponders will provide the capability of extending 46 Mbps ATM based services into theater. Narrowband ATM (1.5 Mbps) will see early stages of deployment both in the tactical arena and to Naval units afloat. While all these commercial facilities will be able to operate encrypted to prevent interception, most will not be jam resistant. Modems over the various commercial and government voice networks will perform well over most connections at 9.6 kbps, and at 19.2 kbps over connections between major business centers.

The set of information vying for space on the limited amount of available bandwidth to reach into theater and to forces afloat is such that in many cases little or no capacity may be available for MC&G data. It is therefore necessary to adopt a GGIS Electronic Data Delivery strategy that is conservative of bandwidth and can suffice even in an off-line mode. Data transfers must be prioritized so that vital MC&G information is delivered expeditiously and that non-critical MC&G data transfers do not interfere with priority message traffic over communication networks.

"Take and Update". The basic approach to the electronic delivery of Global Geospatial Information is to implement a "Take and Update" strategy. Under this strategy soft copy versions on standard media containing appropriate subsets of GGI files will form the "take" portion of the delivery system. The "update" portion of the system will consist of the ability to gain access to the GGIS gateway(s) via the complete range of DoD selected commercial telecomm networks. Both secure and non-secure networks will be connected to the GGIS.

Road Map

The Quest for Standards

Adherence to standards will facilitate the Agency mission to provide geospatial information supporting worldwide military operations. Through its Standards Secretariat, DMA has laid out an approach for populating standards, specifications, and software modules for data, applications, and technical infrastructure. DMA will lead MC&G standardization efforts, in collaboration with other DoD components, for all areas of mutual interest to preclude duplication of effort, to integrate information exchange developments, to optimize resource expenditure and to ensure interoperability among DoD systems. DMA is committed to establishing compatible exchange standards for its co-producers and its customers.

This explicit commitment to data exchange standards for the DoD community gives DMA a prominent profile cooperating with the emerging strength of a national spatial data infrastructure (NSDI). Standards within NSDI will provide the rules and community-accepted conventions by which information moves from producer to producer, from producer to user, and from user to producer. Similarly, the international community acknowledges that digital geographic information is the essential element in planning both civil and military geospatial activity. To enable exchange of interoperable data and information, standards are sought, or developed if lacking, and invoked in system designs. DMA has long played a role in the international military community establishing standard product specifications against which co-production agreements have been written.

Since 1987, DMA's Research and Development program has included initiatives to develop a comprehensive suite of standards for the exchange, manipulation, and display of digital MCG&I data. In March 1993, Mil-Std-2407 (Vector Product Format (VPF)) was issued and approved for use by all DoD Departments and Agencies. VPF is an exchange standard based on a georelational data model. Efforts toward complete raster and text exchange standards are still within the prototyping stages. For raster images, whether panchromatic, multi-spectral or graphic, the intent is to comply with the National Imagery Transmission Format Standard (NITFS) which has been directed throughout DoD for all secondary image dissemination. For digital text format standards, industry efforts as well as government funded work on authoring software and retrieval engines will lead to an acceptable standard which is Continuous Acquisition and Life Cycle Support (CALS) and Standard Graphics Markup Language (SGML) compliant. Electronic documents will allow "readers" to cull relevant information using standard queries. Standards work is not a one-time effort to trim and divest. That work constitutes the necessary first, and sometimes faltering, steps toward comprehensive life-cycle management of data.

DMA actively supports international and national standards efforts. DMA is the US representative to the Digital Geographic Information Working Group (DGIWG), which is publishing Version 1.2 of the Digital Geographic Exchange Standard (DIGEST). DMA also represents DoD on the Federal Geographic Data Committee and shares its technical expertise in the working groups. During the next decade various standards will emerge. Some will be complementary; others will be conflicting. Where possible, harmonization efforts, which may include translators between exchange formats and which will abet migration toward common definition of data elements, will be encouraged.

Pilot Activities

Several pilot projects to demonstrate the feasibility of this vision will be effected during the next two years. The scope and focus of each planned project vary.

One project tests the usefulness of a gateway interface, a "show window" into the DMA data store. Some existing DMA digital products will be identified in a special "pilot catalog" which includes product availability information and product metadata. The catalog will be accessed over a network from which any certified user can submit hierarchical inquiries about these datasets. In this "pilot" project, DMA may actually transmit the datasets, which are relatively small, from one geographic location to another. This approach would support a near real time invocation of an application. Initially, DMA will test this approach between its Headquarters and some of the Unified Commands on the deployed JWICS. The purpose of this pilot would be to gain insights into consumer opinions about how the "window" is coherently presented.

The Joint Warfare Interoperability Demonstration (JWID) series will test realistic scenarios in collaboration with aggressive industry ventures. DMA will support a project this summer by providing appropriate digital data over an area of interest. Internet and MILNET also offer some excellent opportunities for DMA to prepare Hypertext files which can inform interested investigators about DMA and its capabilities. This "info-mercial" strategy will introduce DMA to the expanding geospatial market and will allow DMA to learn about navigating the information highways.

Some Relevant Developmental Work

Near term efforts. There are several relevant developmental activities sponsored by DMA, which will be operational within the next five years. They will contribute to the data sensitive environment sought by the GGIS initiative. Among those are the following: a Modernized Catalog System, the Remote Replication project, the Defense Hydrographic Initiative.

The Modernized Catalog System. The Modernized Catalog System will enable DMA to provide its customer community with a more usable, more reliable catalog of the available inventory of products. Both a softcopy and a hardcopy version will be available. Although the inventory information is focused on standard products that can be ordered using stock number accounting, allowing the computer interface through the softcopy version begins to prepare the community for searching for the availability of data in a paperless and on-line environment. Once this type of interface becomes familiar, adding the dimension of tailored ordering from a data inventory, rather than a product inventory, should be a natural progression.

Remote Replication. Remote Replication will allow in-theater copying and printing of hardcopy. DMA would only naively believe that paper products will rapidly become obsolete. Technology today, however, makes it possible to print small quantities of less-than-lithographic-quality maps in a deployed environment. In a variety of circumstances, this capability could be quite timely and the most cost-effective approach. Fewer copies of a map need to be pre-deployed, saving warehouse space. In addition, DMA anticipates growing dependence upon digital data but recognizes continuing dependence upon paper presentation. The digital data sets deployed on CD ROM, or electronically in a crisis, could be printed only when and where required.

The Defense Hydrographic Initiative. The Defense Hydrographic Initiative includes, among a variety of improvements, the Hydrographic Source Assessment System (HYSAS) and the data population and distribution of the Master Seafloor Digital Data Base (MSDDB). In many ways, MSDDB is a pilot of the GGIS vision. The database architecture includes distributed processing and distributed storage with network connectivity for transferring data, upon demand, from one node to another. HYSAS provides a processing engine that informs those accessing its files about inventory status, metadata, and the status of documented requirements.

Summary

Global geospatial information is the next generation of mapping, charting, and geodesy support. To satisfy its customers in the near, mid, and long term, DMA must direct its powerful production engine to populate more extensive, higher resolution and consistently accurate databases. The GGIS initiative is fundamentally a data management and information delivery endeavor. The GGIS architecture is achievable. It can be implemented with proven and already emerging technology. New database and network technologies will allow the geospatial community to accomplish tasks that only a couple of years ago seemed unattainable. However, the work to develop the necessary standards required for the reference model of the notional architecture demand aggressive leadership and collaborative effort.

Changes in the customer environments will require DMA to pursue the migration from a product-oriented to a data attentive posture. Revealing the multi-dimensioned utility of global geospatial information for the future environments will expose brand new vistas for data exploitation which need not be limited by today's insights. Terminology has been introduced such as "value-adding" and "tailoring" that point to the way MC&G information will be exploited, stored and distributed in the future, as it is presently perceived. This is a dynamic era and that perception itself will evolve as technology offers even more incentive for producers deftly satisfying customer needs.

The delivery of GGIS data sets and services will employ a full range of existing DoD communications networks in a "Take and Update" strategy, with appropriate media for digital data dissemination comprising the "Take" element of the strategy. DMA will pilot several gateway interfaces and will test the connection of those gateways to the network. Results of those ventures will help DMA develop its readiness posture to support traditional and tailored requests and to respond to crises.

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