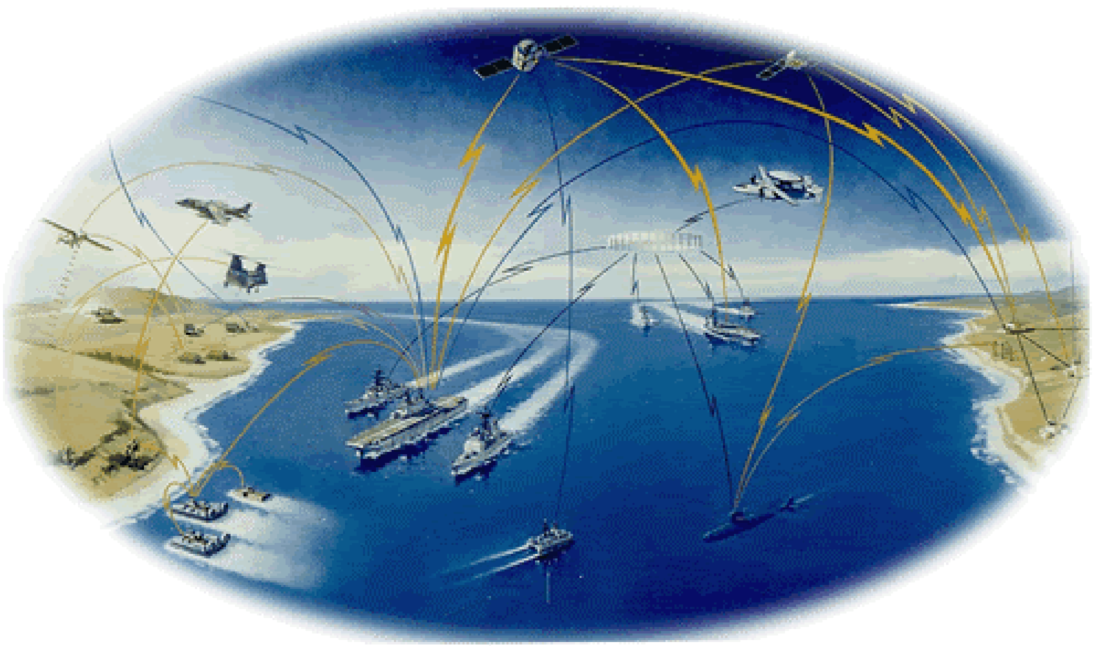
U.S. Navy
Geospatial Information Roadmap



Oceanographer Of The Navy
Navigator Of The Navy
CNO-N096

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Chapter 1

Introduction

The U.S. Navy relies on Geospatial Information in everyday operations to ensure Safety of Navigation. In addition, it provides operational system support, a geospatially referenced framework for mission planning, rehearsal, and execution, and most importantly the accuracy to put bombs on targets. In the past, most Geospatial Information has been available in hardcopy form (paper maps, charts, imagery, etc.). Advancements in technology have resulted in a digital Geospatial environment demanding equipment upgrades and user training. The U.S. Navy has led the way by setting the bar of excellence in a digital Geospatial environment by requiring development of the Digital Nautical Chart (DNC®) in support of fleet electronic navigation goals. We have employed Geographic Information Systems (GIS) as situational awareness tools and have seen first hand the tremendous potential and applicability of a digital Geospatial environment.

Because of its importance to our mission, the Secretary of the Navy directed that a Navy strategy be defined for handling, disseminating, collecting, acquiring, storing, and exploiting Geospatial Information. Setting a Navy standard will avoid potential interoperability issues during times of crisis. This document will define our Navy role in obtaining and employing Geospatial Information and set guidelines for Geospatial Information and Services (GI&S). The plan provides a background for using digital Geospatial Information and related systems in a warfighting environment and looks to applications now and in the future. It will begin with basic definitions and applications of Geospatial Information, identify how the Navy uses this information, how Navy organizations play a critical role in helping the Geospatial community, and most importantly, how we apply that information in our everyday planning and execution of missions. In addition, this document will relate an innovative N096 developmental concept for bringing value-added geospatially-located knowledge into a single common environment and out to the warfighter.

As a community, we must ensure information and knowledge superiority in order to execute dominance over the battlespace. Digital Geospatial Information provides timely complete and accurate information to the commander and forms the foundation upon which all other battlespace information is layered. This will be the key to how we plan and fight wars now and in the future.

Chapter 2

Oceanographer of the Navy/Navigator of the Navy

2.1 Background

The Oceanographer of the Navy (N096) is responsible for coordination and implementation of the Naval Oceanography Program. This includes: Meteorology and Oceanography (METOC), GI&S, and precise time, time interval and astrometry (PTA). In addition, the Oceanographer assists the Assistant Secretary of the Navy with respect to related plans, programs and policy matters and serves as spokesperson for naval oceanographic matters.

Roughly 10% of the Oceanographer's funding is focused on [6.4/6.5] research and development. In determining priorities for investing these funds, the Oceanographer invokes a Strategy for Research and Development (R&D). The primary objective of the N096 R&D Strategy is to accelerate successful transitions from research to operational use by "pulling" the most promising science and technology advances and directing them towards fleet and joint applications. Used for long range programming, planning, and budgeting, as well as for selection of individual R&D projects, the Strategy invokes three basic principles:

1 – All R&D sponsored by the Oceanographer of the Navy will be in direct support of the Naval mission as established by formal Naval doctrine and policy. This connectivity between R&D and operations is of paramount importance.

2 – Well-established, mission-oriented criteria will be applied, in establishing R&D investment priorities.

3 – R&D investments will be expressed in terms of long-lasting or perdurable product lines, which are tied to naval missions with a strong transition potential from Science and Technology (S&T) programs.

As we have rapidly entered the digital Geospatial Information world, digital information has become second nature in everyday planning and execution. Electronic navigation on the bridges of all Navy ships is on the horizon and will be a reality by 2004. As initial plans for electronic navigation were being formulated, the Chief of Naval Operations (CNO) realized that a single focal point for navigation issues would be essential to ensure a smooth successful transition. In November 2000, the CNO designated an additional billet of Navigator of the Navy to N096. The Navigator of the Navy acts as the principal point of contact for development of navigation plans and policy for safety of life, navigation charting data standards, manpower and training, and navigation charting system certification issues.

2.2 Geospatial Policy Issues

The Navy has many applications and uses for Geospatial Information. For the most part, Navy units use finished products or digital information for mission planning and execution, as a source for automated weapons systems, as a digital reference for electronic navigation, plus many others. In addition, Navy information providers collect, acquire, exploit, process and produce Geospatial Information for customers. The following sections discuss standards for all aspects of dealing with Geospatial Information within the Navy.

1 – Product Requirements: The Oceanographer of the Navy validates all Navy-wide ("Big" Navy) geospatial requirements (requirements such as platform system requirements, Navy-wide format requirements, special product requirements, etc.). Navy-wide systems and related product requirements must be documented in associated Operations Orders, Operations Plans, Concept of Operations Plans, etc. Geospatial requirements related to specific geographic areas must be vetted and validated through the appropriate Combatant Commander for that region.

2 – Data Acquisition: Digital Geospatial Information must be certified and accredited by a known source prior to use. Interoperability standards for digital Geospatial Information are set by the United States Imagery and Geospatial Services (USIGS™) organization. This organization (defined in section 3.1) is a body representing the joint community to ensure that information acquired is from a trusted source. In 2002, NIMA changed the name of this organization to the National System for Geospatial Intelligence (NSGI).[1] Data standards are set by the Defense Information Systems Agency (DISA).[2]

3 – Processing, Exploitation and End-product: As with acquisition, it is important to ensure that final products are available, compatible and interoperable with Navy and all joint users. Some Navy-specific information may require different, non-compatible community formats, but production should always include the capability to provide digital information in a format that can be ingested and used by other services and organizations as specified by NSGI (the community trend is to plan an open information environment that is not reliant on specific format definitions, but allows the user to download in the format of their choice).

4 – Training: Paper charts and associated navigation tools will soon be non-existent, or at best, a manual backup. Successfully shifting to a digital information environment is a huge undertaking that will require diligence and effective planning. This transition will require that personnel throughout the Navy be adequately educated in the basics of digital information and trained on developing application systems. N096 has taken the lead to ensure that Navy education and training programs (enlisted and officer schoolhouses, Naval Academy, Naval Post-Graduate School, etc.)

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[1] NIMA has not yet formally trademarked NSGI, but it is now used as the accepted NIMA community organization.
[2] DISA publishes Defense Information Interoperability Common Operating Environment (DIICOE) guidelines and basic standards to ensure interoperability of systems and data used on the systems.

understand the critical importance of and effectively implement adequate courses to ready our fleet for the transition. Courses and training have also been developed within the METOC community to help bring information directly to the piers. This will expose the fleet to digital Geospatial Information and provide on-the-job education to what is on the immediate horizon. In addition, N096 has coordinated with the National Imagery and Mapping Agency (NIMA) to develop a GI&S Mobile Training Team Course to educate and train users. Topics would include (but are not limited to) basic training and education on electronic navigation, GI&S and hands-on training using related Geographic Information Systems (GIS).

Chapter 3

Geospatial Information and Services (GI&S)

3.1 Background

GI&S defines the concept for collection, information extraction, storage, dissemination, and exploitation of data referenced to a precise location on the earth's surface. This data can be aeronautical, topographic, hydrographic, littoral, cultural, geodetic, geomagnetic, gravimetric or imagery-based (commercial and national source), affecting all aspects of the battlespace. Geospatial Information is used in military planning, training and operations including: navigation, mission rehearsal, modeling, simulation, and precise targeting. Previously known as "Mapping, Charting, and Geodesy (MC&G)", the reference has since been changed to GI&S to accommodate technology advances including digital format.

A key parameter of digital Geospatial Information in our warfighting environment is that it must be interoperable with all services and allied/combined forces if we expect to seamlessly work in a joint environment. Specifically, we must work together to feed the Common Relevant Operational Picture (CROP)[3] and Common Operational Picture (COP)[4] in a warfighting environment. NSGI is the body that ensures this interoperability. NSGI members include Services, agencies and any organization that wishes to adhere to format/standard requirements; it is facilitated by NIMA. NIMA, the Executive Agent and Functional Manager for Tasking, Processing, Exploitation and Dissemination (TPED) of both imagery and Geospatial Information, holds regular meetings with the NSGI community. These meetings consist of the Geospatial Intelligence Board (GIB) and Geospatial Intelligence Council (GIC). The GIC serves as the senior-level Department of Defense (DoD) and Intelligence Community (IC) central authority for oversight of NSGI architectures (Director, NIMA chairs the GIC). The GIB (formally the USIGS Community Evaluation Group – UCEG) serves as the senior Action Officer level forum within the NSGI community. The GIB will resolve issues

[3] JV2020
[4] CJCSI 3151.01 dated 10Jun97

such as CONOPS, requirements, architectures, standards and resource management. The GIB will forward any issues requiring Senior Executive or Flag-level attention to the GIC. To address common model and data standards, NIMA is developing an NSGI Conceptual Data Model – NCDM (formally UCDM) for Geospatial Information. The NCDM is considered an NSGI key to achieving interoperability for a shared geospatial framework and creates a standard set of data definitions and relationships from which to reference and build. The overall purpose will be to develop uniform processes and procedures for collection, coding, conflation, storage, management, and exchange of Geospatial Information.

The NSGI community, at the direction of the U.S. Government (USG), recently finished a nine-month project to define a common global geospatial framework, identify and reduce stovepipe technologies and information among Services and agencies, and address a Concept of Operations and Master Plan to achieve this global coverage. The culmination of this project was published as the Geospatial Transition Plan (GTP) by NIMA.[5]

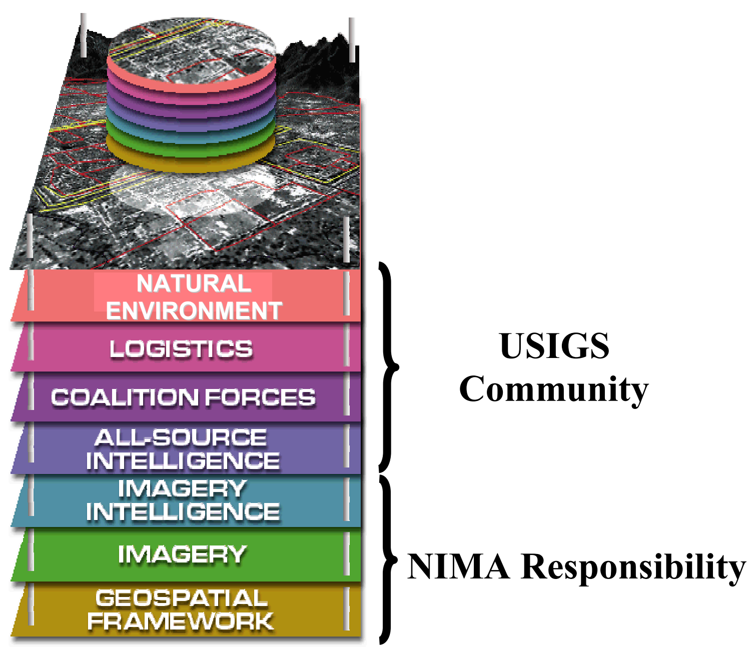

Figure 1. Thematic Layers of information fused to form a Common Operating Picture – a critical key for operational success

3.2 The Layered Information Approach

NIMA, through NSGI and under USG direction, proposed a layered approach to address a common global network of information coverage. In total, these layers

[5] NIMA's Geospatial Transition Plan was published in August 2001 and is available through NIMA or N096 GI&S Branch Head

represent critical pieces in effective mission planning and execution. Fusion of the thematic layers forms the basis for a COP/CROP. NIMA controls and populates the Geospatial Framework, Imagery, and Imagery Intelligence layers, using NSGI/NCDM as a common thread for interoperability and data content. Figure 1 shows all proposed layers including one called “Natural Environment”. The Natural Environment layer will be populated by the NSGI community. The Navy and Air Force have specific expertise and mission focus to provide significant volumes of information in support of this layer. Within the Navy, the Naval Oceanographic Office (NAVOCEANO) and Fleet Numerical Meteorology and Oceanography Center (FNMOC), considered experts in oceanographic and meteorological models and forecasts respectively, are coordinating with other Services and agencies to potentially populate the Natural Environment layer with temporal and dynamic METOC information. This perishable information will provide critical thematic layers needed for effective mission planning (e.g. go/no-go criteria with respect to atmospheric and ocean conditions). In addition to the Natural Environment Layer, Navy will help feed information into all other layers as appropriate.[6]

3.3 Foundation Data

NIMA’s Geospatial Framework is defined by Foundation Data (FD). FD is a trusted near-global framework of medium-resolution geospatial content used for planning operations including movement and concentration of troops and supplies. It consists of smart digital (vector) information that can be filtered to remove irrelevant components, generalized for overview purposes, analyzed for impact of the environment on operations, symbolized as appropriate, and viewed on computer screens or in hardcopy. FD consists of controlled and orthorectified imagery, elevation data, bathymetry, vector features including air and nautical navigation safety, and other data such as gravity and magnetics. It is independent of missions, relatively stable, accurate, and tied to a common geometry. FD provides a trusted framework for a common global geospatial picture of the environment (Figure2). It is composed of the following NIMA digital Geospatial Information products:

1 – <u>Imagery/Controlled Image Base (5 meter)</u>: An unclassified seamless dataset of orthophotos at 5-meter resolution. CIB® supports various weapons, C4I theater battle management, mission planning, digital moving map displays, terrain analysis, simulation and intelligence systems.[7]

2 – <u>Digital Terrain Elevation Data (Level 2)</u>: DTED2 is a uniform matrix of terrain elevation values at one arc-second (approximately 1000-meter) post spacing. DTED® provides basic quantitative data for all military systems requiring terrain elevation, slope and gross surface roughness information. This product depicts a basic geographic relief of the terrain.

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[6] Navy (N096) is currently developing a concept called 4-D Cube which incorporates a fusion of METOC data and information with other value-added information that will feed COP/CROP. 4-D Cube will be discussed in Chapter 4.

[7] Digital Point Positioning Data Base (DPPDB) collection & processing plan offers the additional source for extraction of CIB at a 1-meter resolution. This will further populate the foundation with higher resolution information

3 – Digital Nautical Chart (DNC®): A vector-based digital database with selected maritime significant physical features from hydrographic charts. The format is suitable for computerized marine navigation and Geographic Information Systems (GIS) applications.

4 – Digital Point Positioning Data Base (DPPDB): High resolution stereo models of geodetically controlled photographs covering a specific geographic area. Associated hardware and software allows users to derive accurate targeting coordinates for any feature depicted.

5 – Foundation Feature Data (FFD): Thematic layers of information available for overlay onto other Foundation Data sources.[8] Layers include:

- Data Quality
- Boundaries
- Hydrographic Features
- Population
- Transportation
- Vegetation

FFD layers can be turned on and off as the user dictates in preparing planning graphics.

6 – Navigation Safety, Geodesy and Geophysics: Safety of Navigation publications (both aeronautical and hydrographic) and all associated publications are included in this category (this includes all required publications under U.S. Title 10 code).

In addition to the components of FD identified, Vector Map Level 1 (VMAP1) will be made available for those areas where no FD coverage is available. VMAP1 provides vector-based geospatial medium resolution data at a 1:250,000 scale. VMAP data is separated into ten thematic layers that are topologically structured.

FD is digital information available on CDs (or online via NIMA or NAVOCEANO web portals) comprising that base set of information that would deploy with the battlegroup. This is the geospatial framework available for basic mission planning. It can be used separately or as layers of information, allowing the user to tailor a view to mission-specific needs. FD forms the basis for the CROP/COP.

3.4 Mission Specific Data Sets (MSDS)

MSDS provides the "bread and butter" of effective mission execution. It provides Geospatial Information at higher resolution or density of data than available from FD in specified locations. Basic planning can be accomplished using FD, but as planners begin formulating specific execution plans, they will require more information or application of intelligence to the view or possibly a closer view of specific areas of

[8] NIMA, as a result of recent crisis response, has developed a concept called Geospatial Intelligence Feature-Level Database (GIFDB), which populates features over select countries with whatever commodity information is available. The GIFDB serves as a subset of information for FFD development.

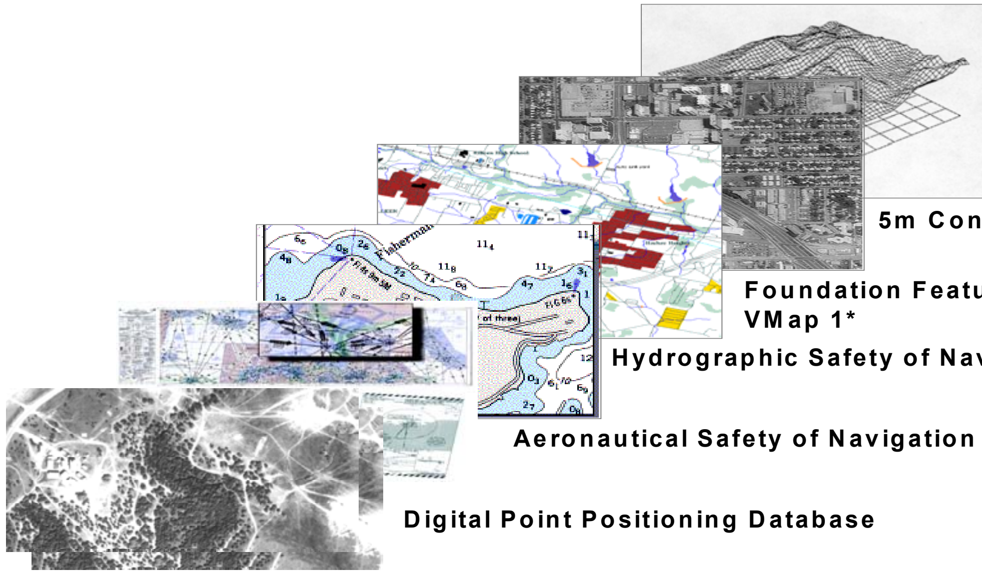

Figure 2. Foundation Data Components
***as FFD becomes available, VMAP1 will be eliminated**

interest. Examples would include: higher resolution imagery and information on specific buildings within a city to support a Non-combatant Evacuation Operation (NEO), amplifying information and imagery for a specific beach location in support of amphibious landings or special forces missions, etc. MSDS is divided into five levels that progress to a higher resolution or densification of information (or both), with the highest resolution/densification being at a “level five”.

There are two variants of MSDS: Standard and Tailored.

1 – **Standard MSDS** is defined as those areas of the world considered constant hot spots (regions that may become volatile at any moment) or planned exercise area requirements (enabling our forces to train as they would fight). They would be based upon pre-defined profiles: General/Strategic Planning, Tactical Planning, Mission Planning, Mission Rehearsal, and 3-D Site Models (with resolution and/or densification changing based upon the profile). These would correspond to a *readiness* form of MSDS. Identifying valid standard MSDS requirements will enable our forces to effectively plan and more rapidly respond during time of crisis.

2 – **Tailored MSDS** is defined as data sets produced for areas of interest during time of crisis or special MSDS produced to a customer’s unique needs (such as additional information or annotation not usually provided to tailor support to a specific mission). Tailored MSDS corresponds to a *responsiveness* form of MSDS. These

areas would not be previously anticipated or identified, but would be produced "just in time" to execute a mission as a crisis develops.

Though there are two types or variants of MSDS, there are actually five versions (or flavors) of MSDS being developed. These versions apply to all possible mission environments and include:

1 – **Aeronautical MSDS:** Identifies MSDS for the aeronautical application: support for air missions, special aircraft system support, Naval Gunfire Support, targeting support, etc.

2 – **Land MSDS:** Directly applicable to land missions, this version is made up of Digital Topographic (DTOP) levels 1-5.

3 – **Littoral MSDS:** Defines the littoral region inside of the 20-meter depth curve to the first lines of communication on the shore. Shallow Water Tactical Ocean Data (TOD 3)[9] is also included in this version of MSDS.

4 – **Urban MSDS:** Defines urban areas within land MSDS areas based upon features such as population, building types, road and water networks, etc. to aid in execution of urban missions.

5 – **Ocean MSDS:** Defines ocean areas outside of the 20-meter depth curve and is based upon existing Tactical Ocean Data Levels 0, 1 and 2 (TOD 0,1 and 2).

All versions of MSDS have been identified and validated by the Services and submitted for development by NIMA. Prototypes will be available in FY02 for testing and evaluation by the Services and will be demonstrated during joint exercises. When fully developed, all versions of MSDS will provide a seamless, close-in view of the battlespace that can be used in conjunction with FD. Figure 3 shows an example of how a user would apply MSDS to FD in a mission planning environment. In the interim, NIMA produces digital products in a "just-in-time" mode during crisis for customers with valid requirements. In addition, to address the littoral environment, NIMA is coordinating efforts with Navy and the Marine Corps to develop an interim Digital version of legacy Combat Charts.

3.5 NIMA GI&S Training

The Defense Mapping School, a component of NIMA College provides tailored training and education in all areas of GI&S.[10] Courses are driven by Service and internal NIMA requirements and are comprised of basic background and software instruction. Sample courses include:

Basic Lithographer Course

[9] TOD3 is currently under development by NIMA and will be available in FY03.
[10] Defense Mapping School, as part of a recent NIMA reorganization, has changed its name to National Geospatial Intelligence School (NGS).

Digital Nautical Chart Production
FalconView Course
Geospatial Analyst Training Program
Geospatial Information & Services for the Warrior
Geospatial Information & Services Staff Officer Course
Geospatial Information Systems
Image Interpretation Course
Introduction to Digital Mapping
Naval Geospatial Information & Services Orientation Course
Remote Sensing and Geospatial Information Systems

…plus many more[11]

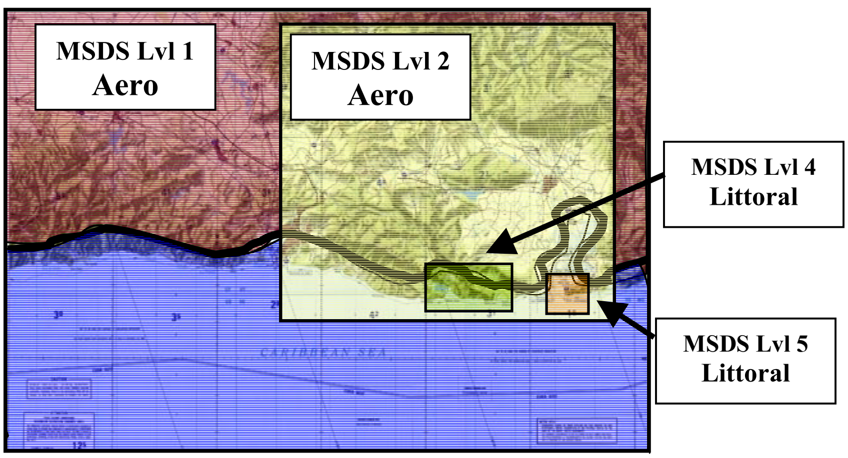

Figure 3. MSDS warfighter application. Smallest scale MSDS (MSDS Level 1) defines the entire area of interest. MSDS levels 2-5 drill down to higher resolution and/or densification of data.

3.6 Commercial Imagery

Commercial imagery is just beginning to be exploited by the warfighter. In prior years, commercial imagery was at best, at five to ten-meter resolution and, in many cases, although good enough for broad mission planning, not good enough to use for mission execution. With the launch of IKONOS, unclassified 1-meter resolution imagery is now available. NIMA acts as the Executive Agent for commercial imagery purchases and can get better prices for images ordered. In addition, NIMA will pay for the licenses to ensure that once ordered the first time, images can subsequently be used by all DoD customers. There are some significant considerations that must be taken into account when using commercial imagery:

[11] A full catalog listing is available at http://www.nima.mil/ dms/ngs_organization.html

1 – Commercial Vendors are businesses that are 'first come, first served'. This means that the normal turnaround for one image could be in terms of weeks to months;

2 – Commercial imagery may not meet the accuracy standards that National Technical Means imagery does. It can be dangerous to rely on a commercial source in mission planning unless there is a trusted agent validating the imagery and metadata;

3 – Be satisfied that sensitivity considerations and Operational Security (OPSEC) have been taken into account, i.e. there are many occasions when the military might not want a commercial vendor (or those associated with commercial vendors) to know locations that are being collected for mission planning.

The most reliable way to procure commercial imagery is through NIMA. As the Executive Agent and Functional Manager for imagery, imagery intelligence and Geospatial Information, they will provide any assistance needed to verify data accuracy and quality.

Chapter 4

GI&S – What the Navy Brings to the Table

4.1 Introduction

Although NIMA is a primary producer and the Executive Agent for digital Geospatial Information, there are naval commands that provide information critical to the operational mission. The Oceanographer of the Navy is responsible for Geospatial Information policy within the Navy. The Meteorology and Oceanography (METOC) community, under Commander, Naval Meteorology and Oceanography Command (CNMOC), produces and manages littoral, meteorology and oceanography geospatial data and information provided to users. The following sections provide information on specific concepts and information provided by Navy commands and how they interact with other battlespace planners.

4.2 4D Cube - The Ultimate Battlespace Environment

N096 has developed an innovative concept to fuse METOC information with other sources of intelligence for mission planning and execution, providing that information in a dynamic four-dimensional environment to the warfighter. The 4D Cube is a "virtual warehouse" of information that allows the warfighter to develop battlespace awareness in a three-dimensional environment over time (the fourth dimension). This dynamic information would feed the COP/CROP, acting as an enabler for effective mission planning and execution.

JV2010 and 2020 address the common operational and common relevant operational pictures from which we as strategic, operational and tactical decision-makers will plan. NSGI, through NIMA, has begun production of a geospatial framework of static information (Foundation Data) that will form the basis for the COP/CROP. Additional intelligence and value-added information must be fused with the static information to complete the dynamic picture.

The 4D Cube concept uses NIMA Foundation Data and adds static METOC information to complete the foundation. It then, through web-enabled architecture, fuses mission-applicable dynamic METOC and intelligence information from sources such as: near-realtime sensors (through-the-sensor technology), manned, remote or unmanned collection platforms[12], on-scene processing, updated force and threat information, etc. to create a subset of value-added information that is needed. In essence, 4D Cube applies knowledge and intelligence to raw forms or views of information to yield a fused view of the battlespace ready for immediate application. Key to the success of 4D Cube is reference standardization in both time and space. The recommended reference frames are World Geodetic Survey 84 (WGS84) and Universal Coordinated Time (UTC). This concept eliminates excess data flow and dedicated bandwidth requirements, and provides actionable information directly to the warfighter.

Data resources will be managed by METOC commands in a web-enabled environment interoperable with the COP/CROP. Figures 4 and 5 show the basis for the 4D Cube.

4.2.1 METOC Data and Information Providers

Specific information for 4D Cube is produced and managed by the following providers:

1 – Fleet Numerical Meteorology and Oceanography Center (FNMOC): provides an integrated view of the air-ocean environment from the top of the atmosphere to the bottom of the ocean, placing special emphasis on the air-ocean interface. Models and products provide METOC data and information that directly enhance forecasting tools afloat and feed digital information into the 4D cube and ultimately, the CROP/COP.

2 – Naval Oceanographic Office (NAVOCEANO): Acquires and analyzes global ocean and littoral data to provide specialized, operationally significant products and services for warfighters and civilian, national and international customers. NAVOCEANO also manages oceanographic and marine mammal data/information databases and annotated imagery (intelligence expertise in the littoral environment), processes raw oceanographic data for NIMA DNC®, TOD, and ocean models to enhance forecasting tools afloat. The NAVOCEANO Warfighting Support Center (WSC) is a cell that directly supports an operational mission environment, providing tailored geospatial products directly to the warfighter. In addition, NAVOCEANO has

[12] Collectors could include Intelligence, Surveillance & Reconnaissance (ISR) platforms, Unmanned Aeronautical Vehicles (UAVs) and manned reconnaissance planes.

co-production agreements in place with NIMA for DNC® and are developing formal agreements with NIMA for co-production of Littoral MSDS.

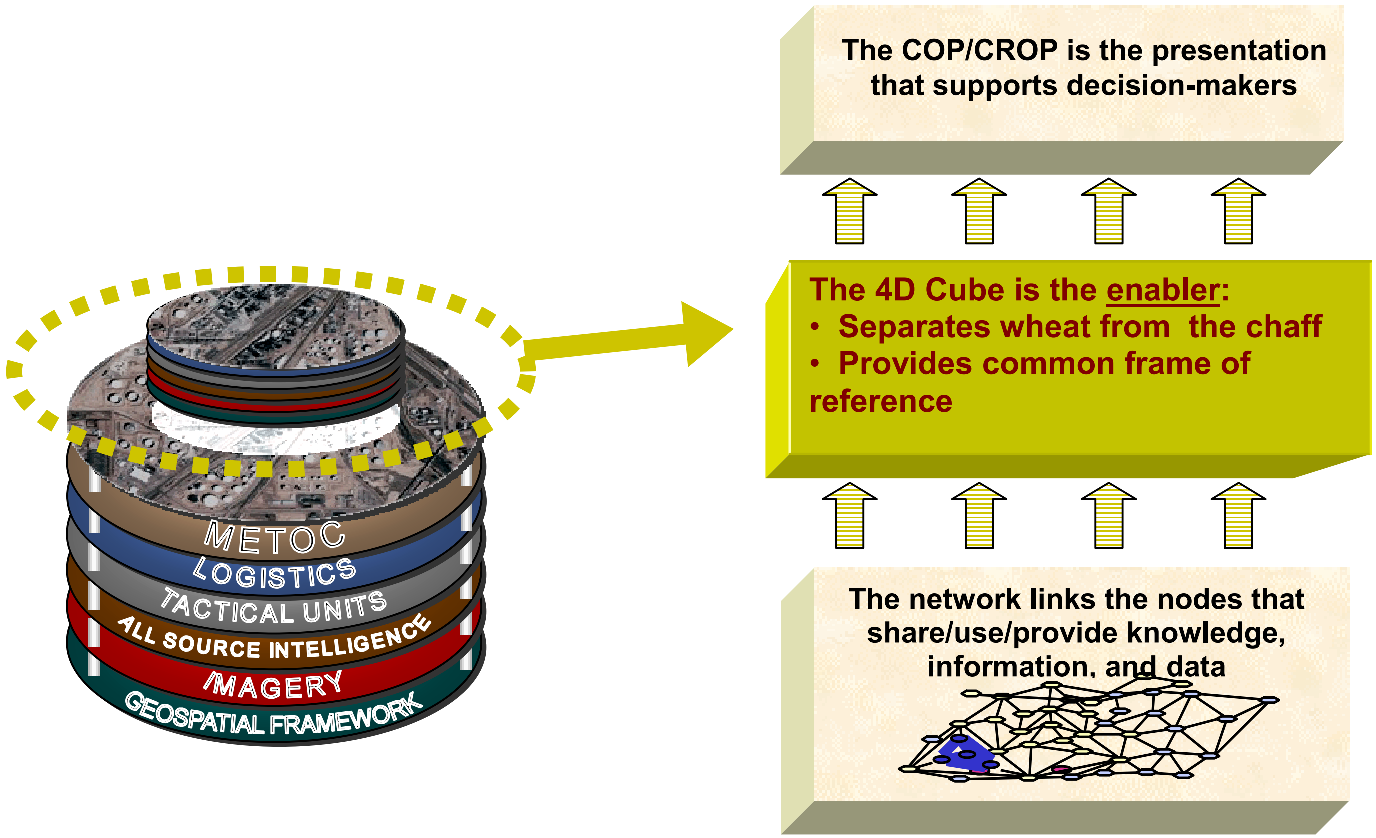

Figure 4. The 4D Cube – feeds COP/CROP, incorporating a static geospatial framework with dynamic all-source information. Provides information for actionable decisions - a critical tool for mission planning and execution.

3 – Space and Naval Warfare Systems Command (SPAWAR): provides information technology and space systems for today's Navy and Defense Department activities while planning and designing for the future. Specifically, SPAWAR develops, delivers, and maintains effective, capable and integrated command, control, communications, computer, intelligence and surveillance systems. SPAWAR is the lynchpin, developing systems that integrate 4D cube information and data from METOC sources and simultaneously supporting NSGI interoperability requirements for input into Global Command and Control System-Maritime (GCCS-M) COP/CROP.

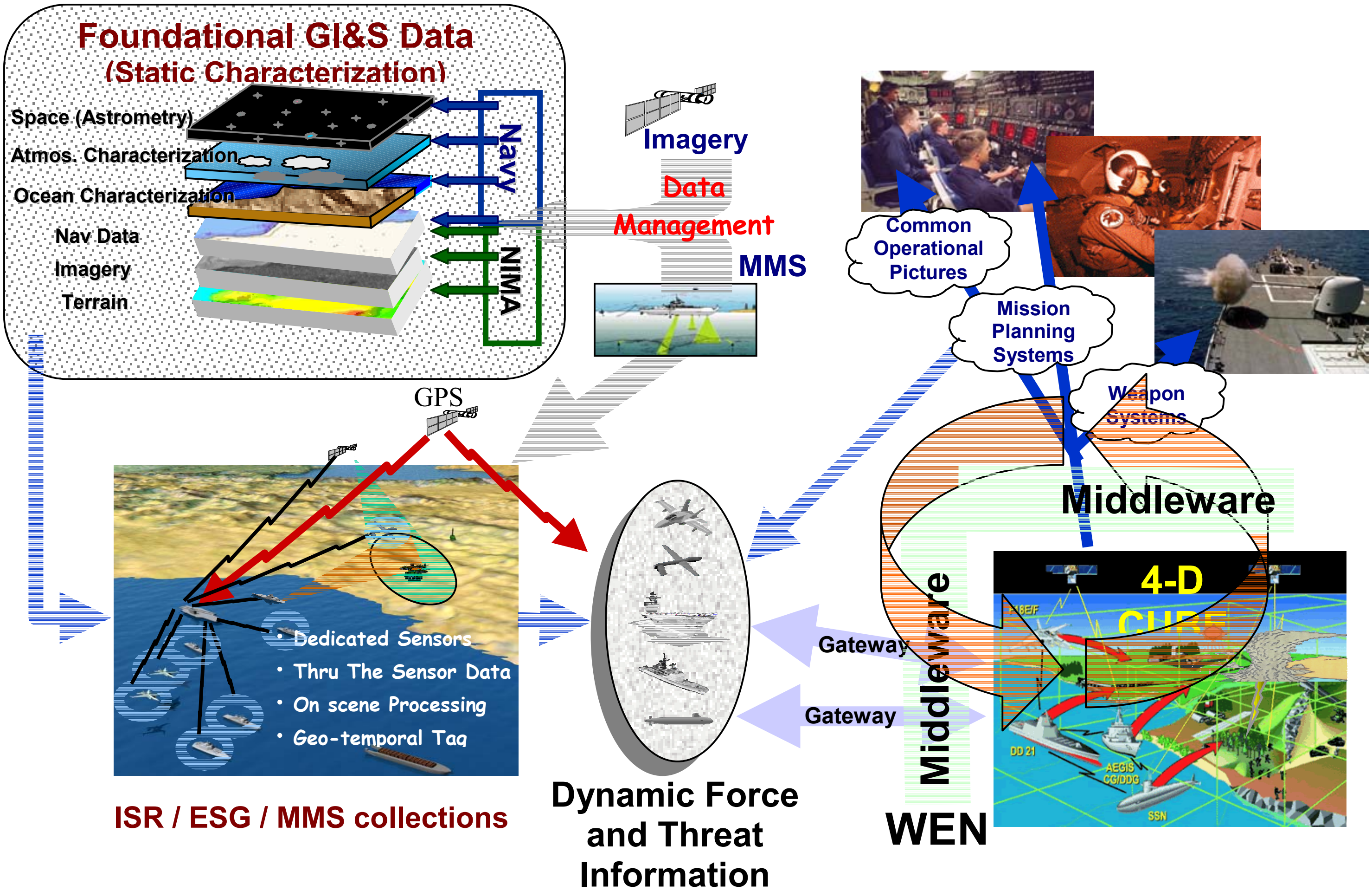

Figure 5. 4D Cube – The Big Picture. This overview shows how various static and real-time information would be fused and processed to yield a dynamic characterization of the battlespace.

4.2.2 The Operational 4D Cube – A Virtual Natural Environment (VNE)

SPAWAR has developed an innovative plan to combine systems, servers and emerging technology to provide a Virtual Natural Environment of data and information directly to the customer. VNE is a prime example of how the METOC community is effectively planning and building interoperable systems to deliver a 4D physical battlespace to the warfighter. VNE will incorporate a database/repository of METOC and other Geospatial Information and data, an applications system, smart web servers and middleware required to provide knowledge and actionable information to users. Specifically, the Tactical Environmental Database Server (TEDS) acts as the data storage resource. TEDS houses static and dynamic METOC data and is managed by regional METOC Centers for their requisite Areas of Responsibility (AORs).[13] Units both afloat and ashore request information and data from TEDS via a Meteorological Broadcast (METCAST) client/server relationship. Users can submit a request for information or create pre-defined system profiles that enable METCAST to automatically pull required information and/or data from TEDS and send it to populate client databases as required. An Application Program Interface (API) acts as a conduit to automatically prepare information/data based on user profiles for subsequent distribution.

The application system used by METOC divisions afloat is called the Naval Integrated Tactical Environmental System (NITES). NITES consists of meteorology and oceanography applications, services and servers including data, forecasting, and weapon system performance prediction capabilities. It is installed on all USS large-deck carriers, amphibious and command ships and enables effective and timely METOC support to the warfighter. The METOC Division can set up profiles to automatically populate their local TEDS as required for operational and tactical applications, forecasts and for use as TDAs for Battle Group or Amphibious Ready Group mission planning and execution.

Figure 6 provides a basic view of how VNE information will flow between the afloat client and a shore-based facility provider.

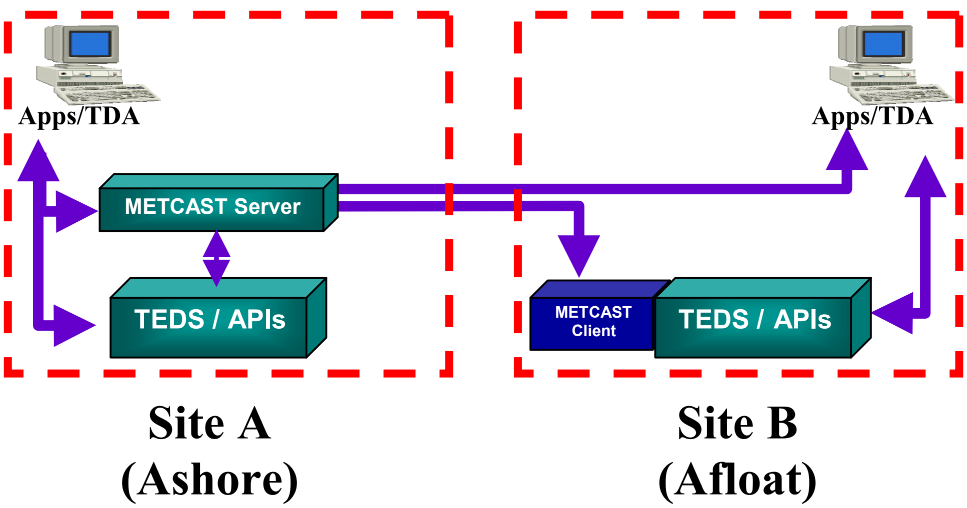

Figure 6. This is a Virtual Natural Environment (VNE) system showing the flow of information from an ashore command to an afloat unit. The data flow is from a shore-based TEDS, via the METCAST Server to either an afloat TEDS or a specified shipboard application/TDA.

[13] Regional centers obtain raw data and information from NAVOCEANO and FNMOC in addition to local products created to populate TEDS.

4.3 Environmental Issues - Marine Mammal Information

Protection of the natural environment both afloat and ashore is a high priority for the Navy. For operations afloat, the Secretary of the Navy's (SECNAV) policy is that the conduct of operations, exercises, and training at sea will comply with all statutory environmental protection laws and regulations. SECNAV further requires Navy commanders implement a programmatic approach to environmental compliance on Navy ranges and operating areas. To meet this requirement, the Navy plans to use Geospatial Information-based standardized databases and data management tools.

Ashore, the Navy manages environmental compliance issues in areas under its cognizance. Compliance issues include the management of natural and cultural resources to protect endangered species and critical habitats. Shore commands use computer aided design and Geospatial Information applications with data meeting specific spatial standards to develop and monitor facility management plans.

4.3.1 Environmental Information Management System (EIMS)

EIMS is being developed by the Navy (CNO N45) to provide Navy operational and environmental planners Geospatial Information-based analytical tools. The intent is to provide access to natural and physical environmental data certified as the best, most complete, and current information available. In addition, EIMS accesses legal, technical, and graphic environmental compliance documents. The customer will retrieve these data through a remote central server to assist Navy planners in identifying important resources that may be affected by planned operations as well as noting applicable laws and regulations governing these resources. This will permit the Navy to conduct training operations while concurrently balancing readiness with environmental compliance and mitigating potential threats to the environment. Although aimed at the strategic planner, EIMS has applicability to operational and tactical planning levels as a situational awareness resource.

4.3.2 Marine Mammal and Protected Species Information

Even though marine mammals have high visibility with the general public, there are numerous other endangered and protected species also of concern to the Navy.

The Navy Environmental Protection Safety and Occupational Health Office (CNO N45) is sponsoring development of a comprehensive living marine species database and software entitled the Living Marine Resource Information System (LMRIS). LMRIS is envisioned to be a collection of historical and survey-collected information (geographic and temporal) of protected marine species including whales, dolphins, sea birds, turtles, etc. As such, LMRIS would serve as a primary marine species data resource accessible through EIMS. LMRIS is not a predictive tool but provides a basis for estimating environmental impact on potential operations in exercise areas. Currently, LMRIS is in its initial phase of development. Future management of LMRIS will be undertaken by NAVOCEANO.

4.4 Through-the-Sensor Technology

Budgetary constraints, not to mention physical space restrictions have precluded us from developing separate systems that further exploit raw environmental information for use in operational and tactical decisions afloat. Technology and innovation allows us to exploit existing sensors and extract environmental information for use in forecasting our mission environment. There are several projects being developed that demonstrate this "through-the-sensor" technology.

4.4.1 Tactical Environmental Processor (TEP)

TEP takes advantage of the Aegis AN/SPY-1 radar. TEP takes a passive tap from SPY-1, including clutter. TEP has the capability to optimize radar performance, characterize surface and environmental clutter, and provide real-time ducting characteristics. In addition, TEP can collect real-time environmental measurements up to a range of 200 nautical miles from the source. Environmental information can then be used and/or incorporated into other METOC programs to maximize use of near real-time observations and produce a more refined and accurate fleet forecast. Figure 7 shows an example of how TEP will work in the fleet.

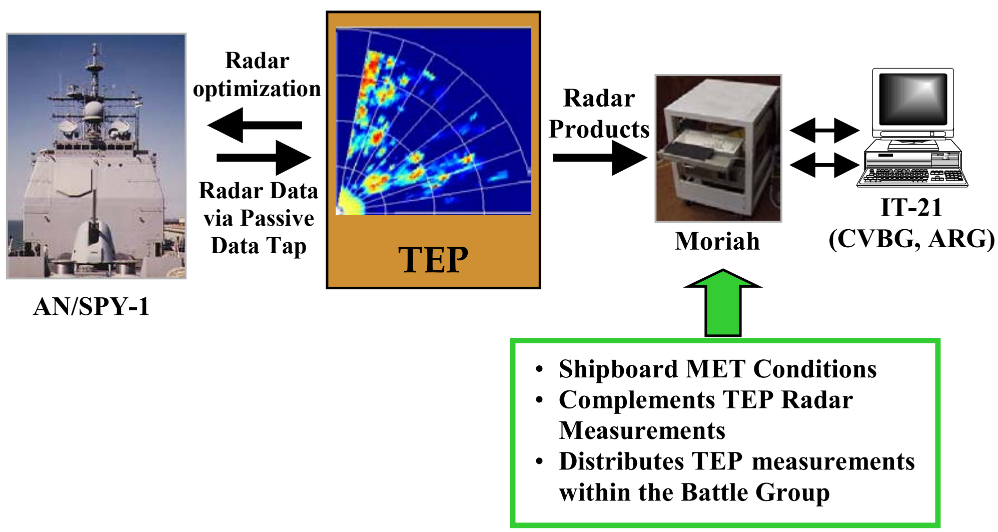

Figure 7. Tactical Environmental Processor – exploits SPY-1 radar to enhance environmental fleet support in near real-time.

4.4.2 NOWCAST

NOWCAST is under development by the Naval Research Laboratory (NRL), Monterey, CA. It is an excellent example of exploiting through-the-sensor information into a common environment with other observations and forecasting algorithms to yield a more accurate product than its components standing alone. In addition, it is intended to automatically provide output to the warfighter on-scene. NOWCAST is a server that intelligently fuses various sensor and data inputs from selected sources and produces a combined near-term forecast (valid out to three to six hours). It is a four-dimensional (4D) product (combining the three special dimensions over the fourth dimension of time) tuned to support the warfighter. Figure 8 shows types of sensor information and observations that will be incorporated into NOWCAST. NOWCAST is intended to provide direct support to the warfighter.

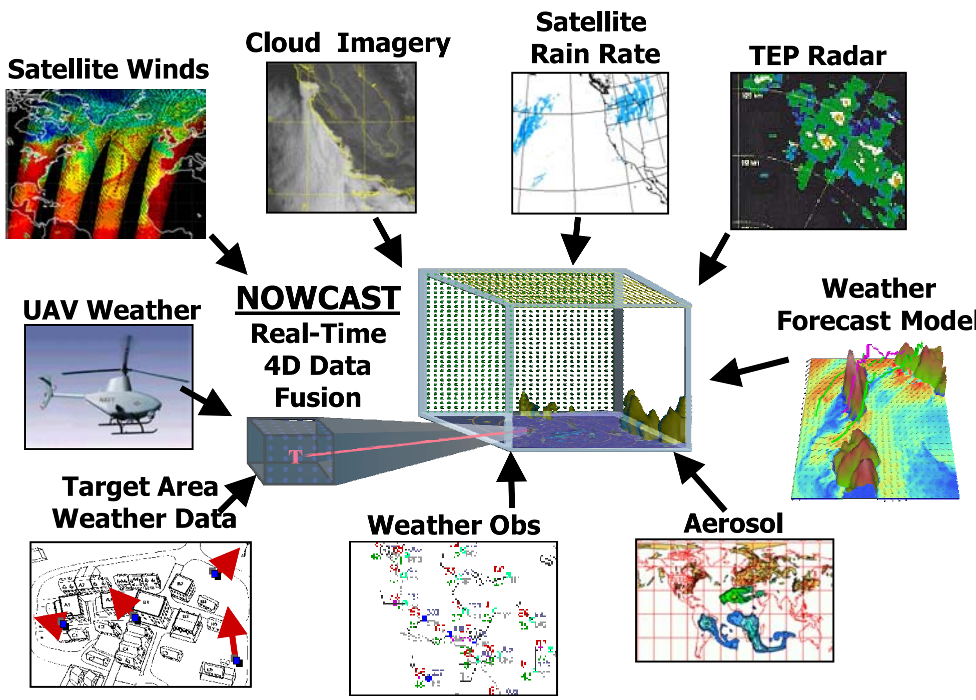

Figure 8. NOWCAST fuses many sources of raw data into a common server to create a powerful forecasting tool

4.5 Modeling & Simulation

In 1996, Department of the Navy was designated the DoD Modeling and Simulation Executive Agent (MSEA) for Ocean Representation by the Under Secretary of Defense for Acquisition, Training and Logistics. The Oceanographer of the Navy accepted this role and is charged with the responsibility of bringing previously listed capabilities into modeling and simulation. This is being done in cooperation with the Defense Modeling and Simulation Office (DMSO) and MSEAs for Air and Space (Department of the Air Force) and Terrain (NIMA).

Nature provides us with an integrated environment. Our methods for measuring the environment create disparate data bases that may remove consistency between components of the environment. Inaccuracies in modeling capabilities add to this problem. DMSO and MSEAs are developing the necessary processes to recreate an integrated consistent natural environment for use in models and simulators used for training, assessment, acquisition and wargaming. These processes, sponsored through DMSO's Integrated Natural Environment Technology Thrust, emphasize an integrated approach to the development of environmental representation technologies for M&S applications.

4.5.1 Integrated Natural Environment (INE) Technology Thrust

The long term goal of INE Technology Thrust is to enable automated generation of an integrated natural environmental representation that is internally consistent, cost effective, authoritative and meets the requirements of the M&S customer. At the heart of the INE Strategy is the concept that an infrastructure of commons services, scenario generation capabilities, and interchange mechanisms can be standardized to produce integrated authoritative representations of the natural environment. The INE Technology Thrust consists of the following technologies.

4.5.1.1 Master Environmental Library (MEL)

The Master Environmental Library is a Defense Modeling and Simulation Office sponsored, one-stop site for ordering environmental information. Through MEL, users locate and order environmental information that resides at different United States military and government sites. The Naval Oceanographic Office, Air Force Weather Agency and National Imagery and Mapping Agency are some of these sites.

4.5.1.2 Environmental Scenario Generator (ESG)

The Environmental Scenario Generator is intended to provide an integrated, physically consistent environmental data set meeting M&S customer requirements for an authoritative and realistic representation of atmospheric, oceanic, and/or space natural environment elements for specified regions, time frames, and conditions.

The ESG automates the generation of logically integrated and physically consistent representations of the natural environment by providing the ability to use data and modeling resources available in the MEL; locate desired environmental conditions in historical archives using data mining techniques; execute environmental models on demand; and orchestrate production and delivery of the resulting scenario databases to the customer.

4.5.1.3 Terrain Scenario Generation and Archiving (TSGA)

The TSGA Project is developing and demonstrating both MEL-accessible/SEDRIS™[14]-available worldwide low resolution terrain data archives and integrated databases, and associated terrain database development technology capable of meeting both low- and (progressively) medium-to-high resolution constructive and virtual simulation requirements.

4.6 Challenges

As Navy and all of DoD continues to tackle transition of our systems and products to a digital information environment, the biggest challenges will be to ensure that we approach transition of legacy Navy systems (that require Geospatial Information) such that we do not jeopardize our mission, and at the same time take joint interoperability issues into account. During the Gulf War, we found out the hard way that interoperability can ensure success and timeliness of mission execution or can be a critical detriment.[15] On the other hand, we want to move out prudently, taking the best path for Navy to optimize interoperability, take advantage of readily available commercial technology, and end up with an affordable and sustainable endstate.

NSGI is one avenue attempting to bring all players together to address common formats and standards in order to reduce and/or eliminate stovepipe geospatial and imagery technologies. Within the METOC community, we have been actively working to standardize data and formats via the Joint METOC Conceptual Data Model (JMCDM). The JMCDM has been around longer than the NCDM and CNMOC is currently working with NSGI and NIMA to coordinate and share knowledge and experience. The ultimate goal would be to work out a common data model that incorporates METOC information as well as all other Geospatial Information.

Chapter 5

Future GI&S/GIS Requirements and Capabilities

5.1 A Seamless Virtual Information Environment

The most challenging hurdle will be to bring all of the disparate sets of data together into one common seamless environment. This would allow a virtual merge of land, ocean and air Geospatial Information based upon the functional perspective of the

[14] Synthetic Environment Data Representation and Interchange Specification - SEDRIS™ technologies provide the means to represent environmental data (terrain, ocean, air and space), and promote the unambiguous, loss-less and non-proprietary interchange of environmental data.
[15] Communications incompatibilities between the USAF and USN resulted in Air Tactical Orders (ATOs) having to be hand-carried from shore to ship.

planner. For example, an air strike plan would want obstacles on the ground to be depicted as vertical obstructions versus navigation aids. The development of MSDS has addressed such a seamless merge of data and will be the first seamless digital Geospatial Information dataset developed by NIMA to merge land and ocean environments. A seamless foundation will enable smoother transition for moving map displays in the cockpit as well as simulation capabilities in trainers.

5.2 Better Data and Information Availability

Improvements in technology and collection capabilities will allow for advancements associated with digital Geospatial Information. A few examples follow.

1 – Commercial imagery will continue to develop to better than 0.5-meter resolution in the near future and with competition of industry, there should be an improvement in accuracy and customer satisfaction.

2 – Broad area coverage collection and processing of information will become more common, allowing for a more rapid update of features and analyses such as battle damage assessment, communications networks, change detection, etc. over large geographic areas.

3 – Data compression and storage capabilities will continue to improve, allowing the fleet to deploy with more data per unit volume and receive more information while at sea.

4 – Totally integrated web-enabled Navy and portal/smart portal technology will allow rapid and continuous update capabilities to the warfighter.

5.3 Future Navy Requirements

The METOC community has historically paved the way with respect to technology afloat and the Navy is now paving the way towards a fully digital geospatial environment. Navy systems of the future will be integrated in a system of systems such as the Horizontal Integration (HI) Program whereby all systems share data and information interchangeably throughout the ship. This will require interoperable digital Geospatial Information support with automatic update capability in order to meet the challenge of various weapons and mission planning systems. In addition, if we are going to continue effective exploitation of METOC data using through-the-sensor technology, our systems must develop with capabilities to ingest and process data collected and more rapidly feed the 4D Cube and COP/CROP.

Commercial developing and emerging technologies will be key to achieving state-of-the-art capabilities and the speed of information exchange required to stay ahead of our adversaries and ensure knowledge and information superiority. The METOC community, by design and necessity, has always been ahead of others in technological capabilities, but integrating old and new systems to ensure interoperability is the most challenging requirement of the near and far future. Doctrinal changes in force structure and varied mission support requirements will continue to drive the Navy towards a common joint interoperable web-based network capable of seamless sharing between U.S. and allied forces. Effective requirements planning and integration both within the Navy and with other Services will help eliminate potential show stoppers during future conflict.

Glossary

Abbreviations and Acronyms

4D	Four-dimensional
AERO	Aeronautical
AOR	Area of Responsibility
API	Application Program Interface
CIB®	Controlled Image Base
CINC	Commander-in-Chief
CJCSI	Chairman, Joint Chiefs of Staff Instruction
CNMOC	Commander, Naval Meteorology and Oceanography Center
CNO	Chief of Naval Operations
CONOPS	Concept of Operations
COP	Common Operating Picture
CROP	Common Relevant Operating Picture
DIICOE	Defense Information Interoperability Common Operating Environment
DISA	Defense Information Systems Agency
DMS	Defense Mapping School
DMSO	Defense Modeling and Simulation Office
DNC®	Digital Nautical Chart
DoD	Department of Defense
DPPDB	Digital Point Positioning Data Base
DTED®	Digital Terrain Elevation Data
DTOP	Digital Topographic
EIMS	Environmental Information management System
ESG	Environmental Scenario Generator
FD	Foundation Data
FFD	Foundation Feature Data
FNMOC	Fleet Numerical Meteorology and Oceanography Center
GCCS	Global Command and Control System
GCCS-M	Global Command and Control System – Maritime
GIB	Geospatial Intelligence Board
GIC	Geospatial Intelligence Council
GII	Geospatial Information Infrastructure
GI&S	Geospatial Information and Services
GI^3IPT	Geospatial Information Infrastructure Implementation Integrated Planning Team
GIS	Geographic Information Systems
GTP	Geospatial Transition Plan
HI	Horizontal Integration
IC	Intelligence Community
INE	Integrated Natural Environment
JMCDM	Joint METOC Conceptual Data Model
JV2010	Joint Vision 2010

JV2020	Joint Vision 2020
LMRIS	Living Marine Resource Information System
METCAST	Meteorological Broadcast
MC&G	Mapping, Charting and Geodesy
MEL	Master Environmental Library
METOC	Meteorology and Oceanography
MSDS	Mission Specific Data Set
MSEA	Modeling and Simulation Executive Agent
NAVOCEANO	Naval Oceanographic Office
NCDM	NSGI Conceptual Data Model
NEO	Non-combatant Evacuation Operation
NIMA	National Imagery and Mapping Agency
NIMC	National Imagery and Mapping College
NITES	Naval Integrated Tactical Environmental System
NOWCAST	Now Forecast
NRL	Naval Research Laboratory
NSGI	National System for Geospatial Intelligence
OPLAN	Operations Plan
OPSEC	Operational Security
ORD	Operational Requirements Document
PTA	Precise Time Interval and Astrometry
R&D	Research and Development
S&T	Science and Technology
SEDRIS™	Synthetic Environment Data Representation Interchange Specification
SPAWAR	Space and Naval Warfare Systems Command
TEDS	Tactical Environmental Data Server
TEP	Tactical Environmental Processor
TOD	Tactical Ocean Data
TPED	Tasking, Processing, Exploitation and Dissemination
TSGA	Terrain Scenario Generation and Archiving
UCDM	USIGS Conceptual Data Model
UCEG	USIGS Community Evaluation Group
USG	United States Government
USIGS™	United States Imagery and Geospatial Services
VMAP	Vector Map

Definitions of Key Terms

4D Cube – three-dimensional view of the battlespace over the fourth dimension of time; N096 concept using a web-enabled environment to exploit and fuse static and dynamic METOC information with other intelligence sources and provide that value-added knowledge directly to the warfighter

Common Operational Picture – the COP is a graphical overview or display of friendly, hostile, and neutral units, assets, overlays, and/or tracks pertinent to operations; a key tool for commanders in planning and conducting joint operations. The COP may include relevant information from the tactical to the strategic level of command. The original source document is CJCSI 3151.01, dated 10 June 1997; another definition source is found in JCS Joint Pub 3-35, Joint Deployment and Redeployment Operations, dated 7 September 1999.

Common Relevant Operational Picture – a presentation of timely, fused, accurate, assured, and relevant information that can be tailored to meet requirements of the joint force; it is common to every organization and individual involved in a joint operation (whereas there can be several COPs, there is only one applicable CROP). It is sufficiently robust and adaptable to accommodate exchange of information with non-DoD organizations (including governmental, international, and private) and coalition forces. The CROP is a key element of information superiority and battlespace awareness. Source of this term is the Chairman, Joint Chiefs of Staff, Joint Vision 2020.

Foundation Data – an assemblage of near worldwide geospatial data coverage, independent of missions, that is relatively stable, accurate, and tied to a common geometry. Foundation Data consists of controlled and orthorectified imagery, elevation data, bathymetry, vector features (including air and nautical navigation safety), and other data such as gravity and magnetics.

Foundation Feature Data – a series of thematic layer coverages, features and attributes that range in density from what would normally be found on a 1:100K Topographic Line Map in areas of military interest (e.g., urban areas) to that found on a 1:250K Joint Operations Graphic in open terrain. Examples of FFD include: Data Quality, Boundaries, Hydrographic Features, Population, Transportation and Vegetation

Functional Manager – an assigned responsibility in DoD and the IC for providing periodic high-level guidance to a functional community with respect to programs, initiatives, and activities. This allows community program managers to more accurately prepare IPOM and POM submissions.

Geospatial Framework – a consistent view of Geospatial Information and supporting services that provides a coherent frame of reference to support formation of an integrated view of the mission space.

Geospatial Information – any information about the earth that has an associated contextual, spatial, and temporal reference; more specifically, it is a collection of precise spatially co-referenced information about the earth, with temporal tags, arranged in a coherent structure and format.

Geospatial Information Infrastructure – the collection of people, doctrine, policies, architectures, standards, and technologies necessary to create, maintain, and utilize Geospatial Information and services in the context of a geospatial framework.

Geospatial Intelligence – a term coined by NIMA, refers to information about any object that can be located on the earth (basically merges geospatial information with intelligence about that geo-located area).

Imagery Intelligence – intelligence derived from exploitation of collection by visual photography, infrared sensors, lasers, electro-optics, and radar sensors such as synthetic aperture radar wherein images of objects are reproduced optically or electronically on film, electronic display devices, or other media.

Joint METOC Conceptual Data Model – CNMOC initiative to develop a common data model applicable to all METOC information; this effort will set the METOC data standard and ensure compatibility and interoperability in a digital environment.

Mission Specific Data Sets – intensified foundation data encompassing greater detail (density and/or resolution) or additional features and/or attributes to meet specific mission requirements. May also include the "tailoring" or analysis of available Geospatial Information to support the information needs of a decision maker.

NSGI – formally USIGS™, consists of an extensive network of organizations, people, leadership, training, doctrine, standards, procedures, hardware and software that provides our nation with fused imagery, imagery intelligence, and Geospatial Information needed to achieve information superiority.

NSGI Components – the policies, doctrine, training, people, architectures, systems, information, products, and services that together constitute NSGI.

Orthorectification – removal of all distortions in imagery, to include lateral displacement due to terrain relief, usually through stereo photogrammetric processes, to create a photographic image with map-like accuracy and scale; simply put, a view from directly above, removing all distortion.

Portal – a web site that offers a great amount of content and services related to a specific or range of subject areas. When considered within USIGS, this includes the subject areas of Geospatial Information, imagery, and imagery intelligence.

Raster – a data form in which geographic features are represented as grid cells in a matrix, with each cell recording some sort of information averaged over the cell's area; in other words, a scanned image or map (dumb data that cannot be further manipulated).

Requirements – validated, constrained customer shortfalls; in the geospatial context, requirements may be for capabilities, product types, or area coverage. CJCSI 3901.01 and Joint Pub 2-03 provide guidance on how to request, prioritize, and manage risk for Geospatial Information requirements.

Smart Portals – Powerful, interactive network communications channels driven by profiles, that obtain content and services from sources, and automatically make it accessible to customers via smart push or pull of information.

USIGS™ – United States Imagery and Geospatial Information Service; the extensive network of organizations, people, leadership, training, doctrine, standards, procedures, hardware and software that provides our nation with fused imagery, imagery intelligence, and Geospatial Information needed to achieve information superiority.

Value-Adding – work performed subsequent to the finished production or generation of Geospatial Information to increase its value. This may include, but is not limited to, data verification, correction, update, densification, supplementation with additional categories of Geospatial Information, reformatting, fusing, re-sampling, or linking to related content in other databases. Value-added Geospatial Information may not meet the accuracy and quality standards associated with foundation or mission-specific data.

Vector – a data form in which spatial features are represented by primitive geometric entities such as points, lines, and polygons; considered “smart data” in that it can be manipulated to tailor products to the needs of users.

Internet Sites of Interest

CNMOC	www.cnmoc.navy.mil
CSIL (S)	http://diaimagery.dia.smil.mil/CSIL
CSIL (SCI)	http://diaimagery.dia.ic.gov/CSIL
FNMOC	www.fnmoc.navy.mil
Navigator of the Navy	www.navigator.navy.mil
NAVOCEANO	www.navo.navy.mil
NIMA Defense Mapping School (U)	http://nima.mil/NIMC/
NIMA Defense Mapping School (SCI)	http://college.nima.ic.gov
NIMA (S)	www.nima.smil.mil
NIMA (U)	www.nima.mil
NLMOC Norfolk, VA	www.nlmoc.navy.mil
NPMOC Pearl Harbor, HI	www.npmoc.navy.mil
NPMOC San Diego, CA	www.npmoc-sd.navy.mil
Oceanographer of the Navy (N096)	http://ucso2.hq.navy.mil
SPAWAR	www.spawar.navy.mil
USNO	www.usno.navy.mil

Points of Contact

CNO-N096 GI&S Branch Head	202-762-1005 (DSN762)
Navigator of the Navy Assistance	202-762-0265 (DSN762)
NIMA Commercial Imagery Program	301-227-3520 (DSN287)
NIMA CSIL Information	202-231-2004 (DSN428)
NIMA Defense Mapping School, Ft. Belvoir	
NIMA Navy Customer Team	703-264-3002 (DSN570)
Registrar	703-805-3213 (DSN655)
Deputy Commandant	703-805-3212 (DSN655)
Imagery/Geospatial Branch	703-805-3703 (DSN655)
Naval Ice Center	301-457-5306 (DSN290-0183)
NAVO Warfighting Support Center (WSC)	228-688-5152 (DSN828)
NEMOC, Rota Customer Support	011-34956822410 (DSN314-727)
NLMOC Customer Support	757-444-7750 (DSN564)
NPMOC, Pearl Harbor Customer Support	808-471-0004 (DSN471)
NPMOC, San Diego Customer Support	619-545-6032 (DSN735)
NPMOC Yokosuka Customer Support	011-81-311-743-5595 (DSN315-243)

References

CJCSI 3151.01, Global Command and Control System Common Operational Picture Reporting Requirements, June 1997

CJCSI 3901.01, Requirements for Geospatial Information and Services, July 1999

DISA, Defense Information Infrastructure Common Operating Environment (DII COE) Baseline Specifications, Version 3.1, April 1997

Joint Pub 2-03, "Joint Tactics, Techniques and Procedures for Geospatial Information and Services Support to Joint Operations."

Joint Vision 2010

Joint Vision 2020

National Imagery and Mapping Agency Portfolio, 1998

National Imagery and Mapping Agency Standard Hardcopy Imagery and Mapping Products, 1997

Strategy for Research and Development: A Roadmap to a Vision of Operational Oceanography, CNO(N096), September 2000

United States Imagery and Geospatial Information Service Geospatial Transition Plan, August 2001