



FGDC
Marine and Coastal Spatial Data
Subcommittee

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Chris Andreasen
Advanced Research & Development Division
InnoVision Directorate
NATIONAL IMAGERY AND MAPPING AGENCY



U.S. Navy Relationship

- NIMA ensures availability of worldwide navigation/geo-spatial data for U.S. delivery of troops, supplies and ordinance on target.
 - Maintains a worldwide folio of nautical charts and publications.
 - Maintains Notice-to-Mariners updates for charts and publications.
 - Maintains a 7x24 broadcast communications watch (Warns ships of navigation hazards, acts of piracy or terrorism, political uprisings, etc.)
 - Maintains a folio of products supportive of naval operations which are not available to the public.

Chart Related Int'l Organizations

- International Hydrographic Organization (IHO - nautical chart standards)
- International Maritime Organization (IMO - maritime safety regulation--Safety of Life at Sea [SOLAS] convention)
- International Electrotechnical Commission (IEC- marine equipment test standards)
- International Association of Lighthouse Authorities (standards-visual & electronic aids)
- International Organisation for Standardization (ISO)- GIS Standards

Standards for Electronic Charts

IHO S-52

IHO Specification for Chart Content and Display of ECDIS

- data content, updating, colours & symbols, glossary

IHO S-57, Edition 3

IHO Transfer Standard for Digital Hydrographic Data

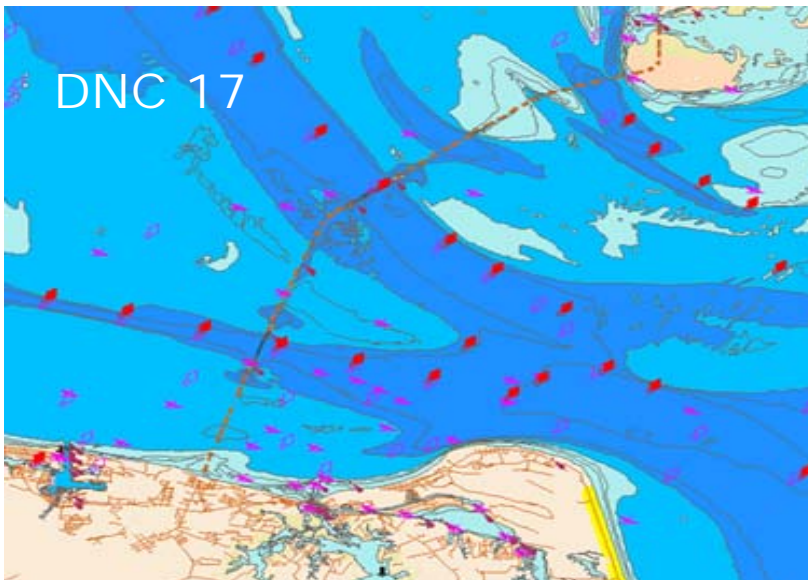
- object catalog, exchange format, ENC Product Spec, ENC

- **NATO DIGEST Standard (ECDIS-N extends the IMO Performance Standard using DIGEST)**
- **RTCM ECS Performance Standard (Implements part of IHO/IMO Standards using commercial software which is proprietary)**
- **ISO ECS Data Standard**

Symbols Development

- IHO Colours & Symbols Working Group
- IEC TC 80 WG 7 (ECDIS) & WG 13 (NAV symbols)
- IHO/IEC Harmonization Group, Marine Information Objects
- International Association of Lighthouse Authorities (IALA) concerning NAV symbols
- NIMA follows this to maintain GeoSym in parallel with international display standards.

Digital Nautical Chart



Unclassified comprehensive database of nautical chart features collected and attributed individually to support marine navigation and GIS.

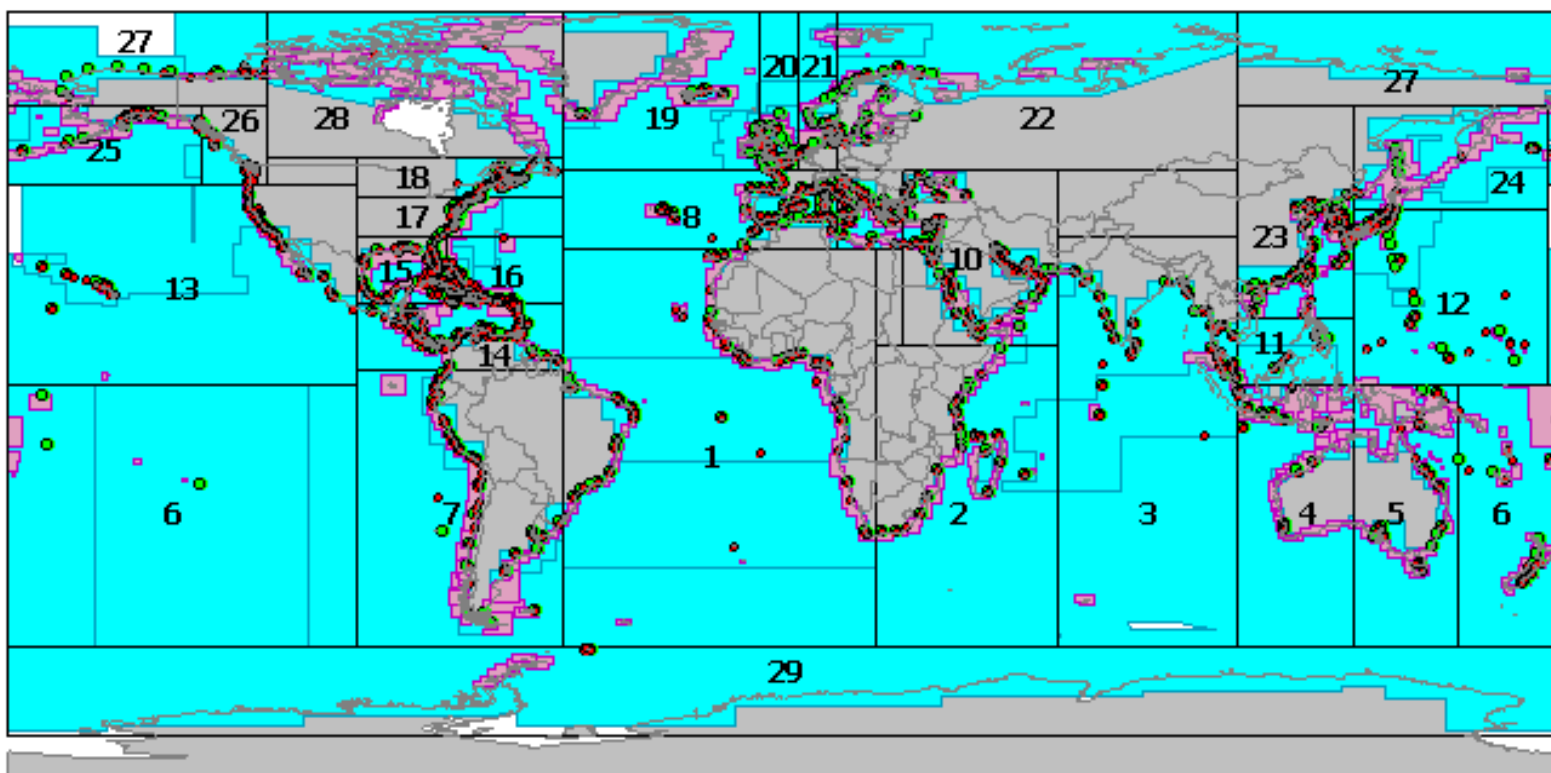
- Vector Product Format (VPF) Content
- Data captured from digitized NIMA & NOAA NOS paper charts:
 - General, Harbor, Approach, Coastal
- Footprint: 29 Geographic Regions
- 12 Thematic Layers
- Supports hard copy chart production
- Media: CD-ROM
- NIMA Gateway:
 - **SIPRNET:** www.nima.smil.mil/products/dnc1
 - **JWICS:** www.nima.ic.gov/products/dnc1
 - **INTERNET:** www.nima.mil/dnctest (User Name/Password)



Digital Nautical Chart (DNC®) Initial Worldwide Database Footprint

Database Coverages

- Harbor
- Approach
- Coastal
- General



DNC data available on CD-ROM.

2002

100%

DNC Content

Initial Navy Database

Charts

<u>CATEGORY</u>	<u>Charts</u>
Harbor	1,680
Approach	1,277
Coastal	1,411
General	<u>450</u>
Total:	4,818

Libraries

<u>CATEGORY</u>	<u>Libraries</u>
Harbor	1,034
Approach	756
Coastal	254
General	<u>78</u>
Total:	2,122

NOTE

DNC Library = 1 or more digitized charts



Digital Updating

- A Technical Resolution of the IHO (International Hydrographic Organization) requires that charts be routinely updated and establishes that this should be on a weekly, bi-weekly or monthly cycle.



VPF Digital Updating (VDU)

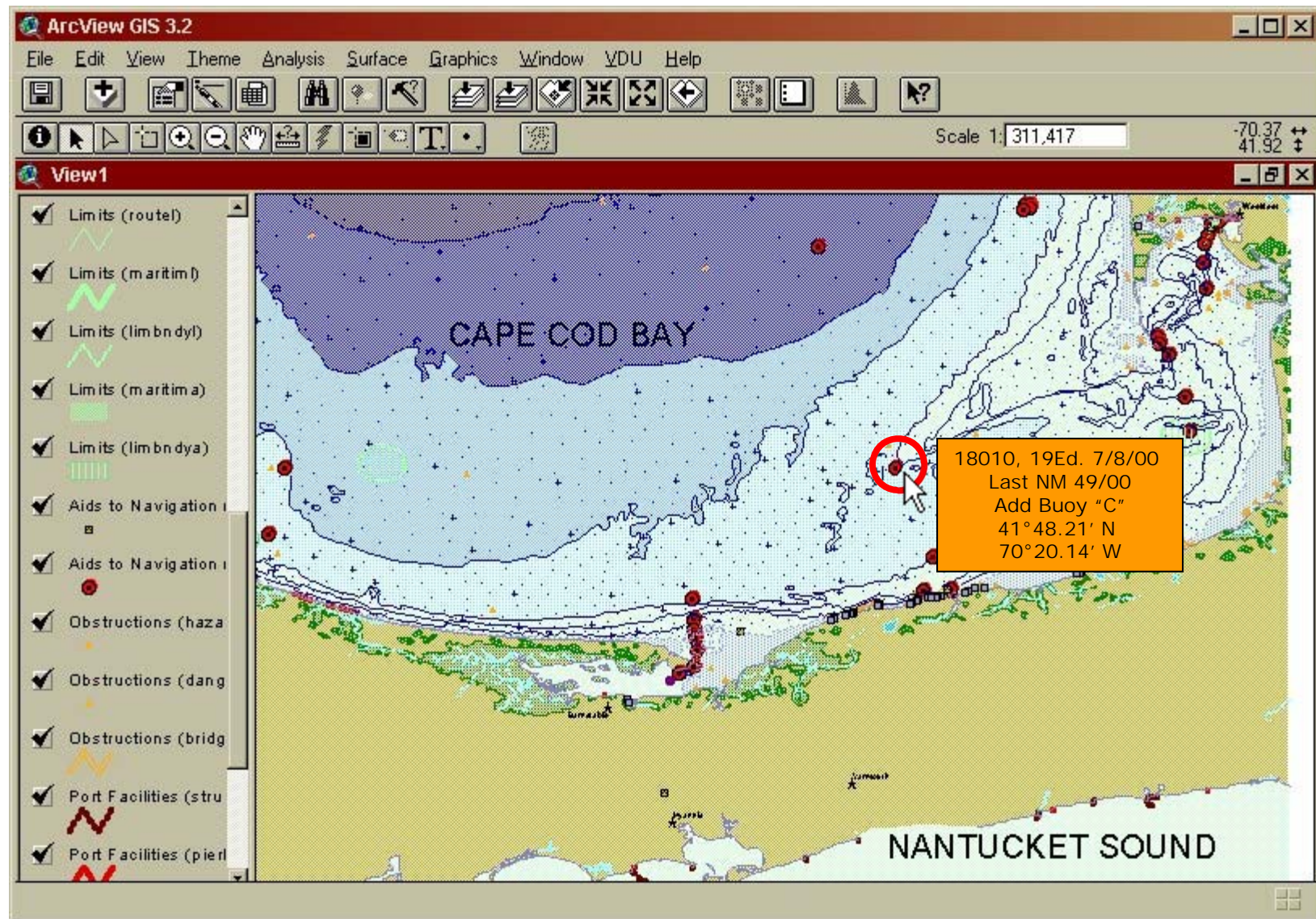
- In late 2000, NIMA contracted SAIC (Science Applications International Corporation) to develop a Concept of Operations (ConOps) for U.S. Navy and Coast Guard using commercially available “patch” software as a new way to achieve the equivalent functionality.
- “Patch” is a software method commonly used in the private sector. For example, when one downloads updates to virus protection software only the needed changes are transmitted, which is done by “patch”.

Identification of Updates to Users

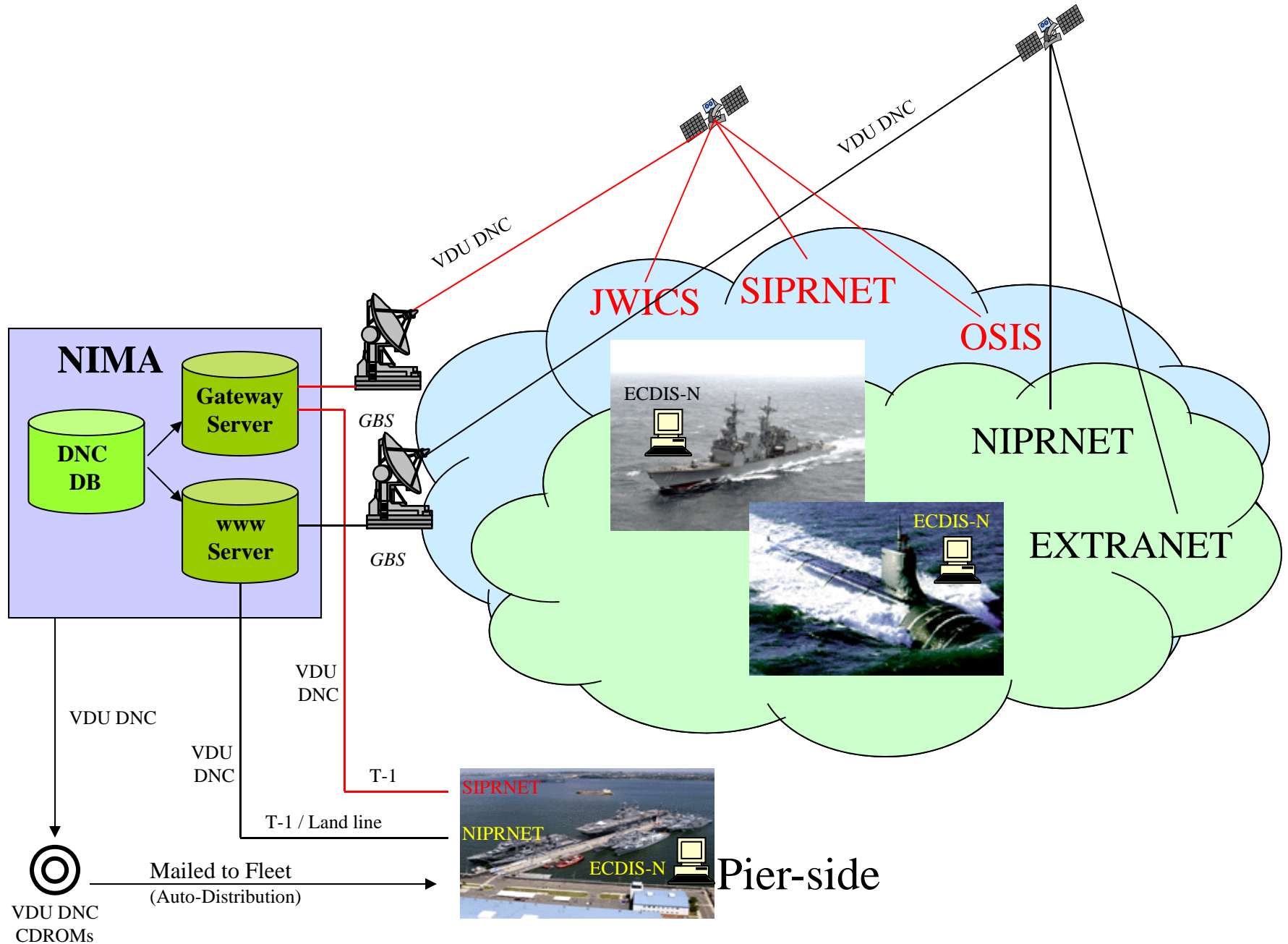
Implementation: A new DNC Update coverage outlines navigationally significant database changes:

- Update coverage exists at the VPF Library level so ships/users may call for individual port updates.
- Cumulative to the base DNC edition on issue.
- DNC production units and the Navigation Safety System provide source data for change layers.
- Area and point feature changes are highlighted such that the mariner will know where significant change has occurred along with a text description of the change, normally the Notice-to-Mariner text.

End-User Query on DNC Changes



VDU DNC Architecture





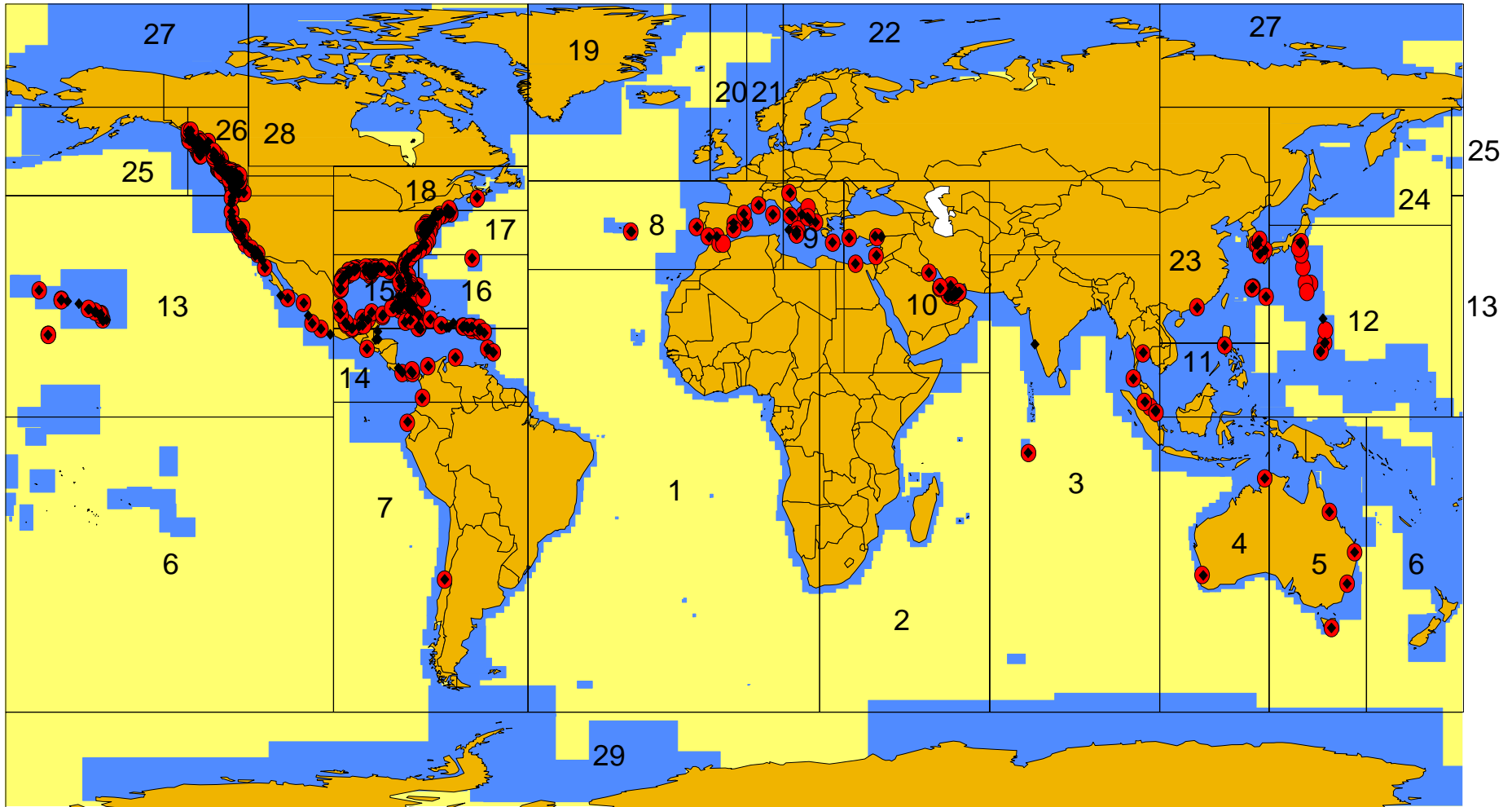
VDU Updating for NIMA Digital Products

- VPF Digital Updating (VDU) is a possible update method for all NIMA vector products. Implementation started with Digital Nautical Chart and will evolve to other products providing the U.S. military with timely and accurate geo-spatial information. NIMA is currently beginning to implement Publications Digital Updating (PDU) for publications.

Navy Deployment of ECDIS-Navy (ECDIS-N)

- 2001 -- All submarines equipped with ECDIS-N.
- 2002 -- Two all digital carrier battle groups (36 ships) to deploy with ECDIS-N certified systems and trained crews (NAVSEA w/NIMA support).
- 2003/04 -- First “all digital” Virginia class attack submarine deploys.
- 2004 -- All Navy ships to deploy with ECDIS-N (Navy had planned 2007).
- Deployment of ECS and other display systems to Special Forces, Navy helicopters, etc.

DNC Continuous maintenance in FY02



• Harbors
434

■ Approaches
404

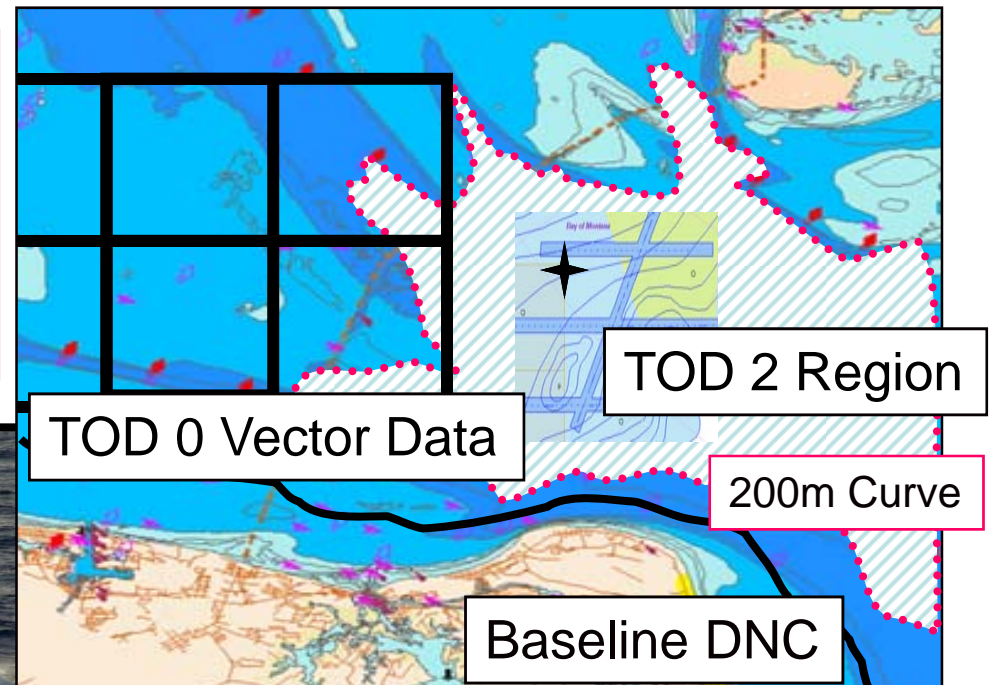
■ Coasts
236

■ Generals
72

Tactical Ocean Data

Tactical Ocean Data (TOD)

The TOD is a geospatial database of bottom contour and other related surface and subsurface chart features collected and attributed individually to support submarine navigation, mission planning, and geographic information systems. Most of the TOD is designed to operate in conjunction with the DNC.



Database development began in 1999

Tactical Ocean Data

Production Schedule

<u>Level</u>	<u>Digital Data Product</u>	<u>EST Completion</u>
•TOD 0 -	OPAREA - 55 charts	Done FY00
•TOD 1 -	BC - 452 charts	FY 02
•TOD 2 -	BNPC - 657 charts	FY 01 (367/657)*
•TOD 3 -	Shal low Water (TBD)	
•TOD 4 -	HI TS - 32 charts	FY 01
•TOD 5 -	Straits - 12 charts	FY 02
•MATT -	CNO Charts - 165 charts	FY 05

* TOD-2 Completion requires full DBDB .5 Coverage

“Multi-fuel” ECDIS Systems

- Systems that display multiple data formats
 - IHO S-57 format vector charts (ENC)
 - Raster format charts (NOAA BSB and UK ARCS)
 - NATO DIGEST Vector Product Format charts (DNC)
 - U.S. Navy (All) and Coast Guard (Deepwater) will function with DNC but be capable of reading S-57 for navigation. Weapons systems integration is with DNC.



Expanding DNC Display Systems

- FUND (Full Utility Navigation Demonstration developed by SPAWAR). This has been freely available, however U.S. Navy since has developed ICE (Integrated Charting Engine).
- Sperry Marine (CRADA with NIMA).
- Raytheon (C-Map developing software).
- Offshore Systems Ltd (U.S., Canada & Denmark).
- Kelvin-Hughes (UK testing).
- Pinpoint Navigation (CRADA with NIMA).



Expanding DNC Display Systems

- Germany (negotiations with 7Cs).
- Netherlands company (uses 7Cs module).
- Poland (negotiations 7Cs).
- Australia (developing w/Hydro Sciences)
- SPAWAR & USCG developing NAVSSI for 169 Navy ships and 30 USCG cutters.
- SPAWAR study had 25 firms respond as displaying electronic charts (not all ECDIS level).

NAVSSI ECDIS-N Platforms - COMDAC INS



All **NIMITZ** class CVs

NAVSSI: Block 3 Build 4

USS JOHN C STENNIS (CVN 74)
USS OSCAR AUSTIN (DDG 79)
USS MAHAN (DDG 72)
USS MILIUS (DDG 69)

169 Combatants



All **ARLEIGH BURKE** class destroyers, **TICONDEROGA** class cruisers, and **WASP** class amphibious assault ships.

NEW ATTACK SUBMARINE (NSSN) will employ ECDIS-N software for its Navigation Data Distribution and Display (ND3) system.



13 **FAMOUS** & 17 **RELIANCE** class cutters.

30 Cutters
(SCCS - June 01)



Other Platforms Supporting ECDIS-N



5 CVs now have VMS & 7 have Raytheon.

Litton VMS & Raytheon Platforms



YORKTOWN & TICO have VMS; Contract in place for 6 more Aegis ships. LCACs and SPEC WAR have VMS & 24 USN ships including RUSHMORE, WASP, have Raytheon.

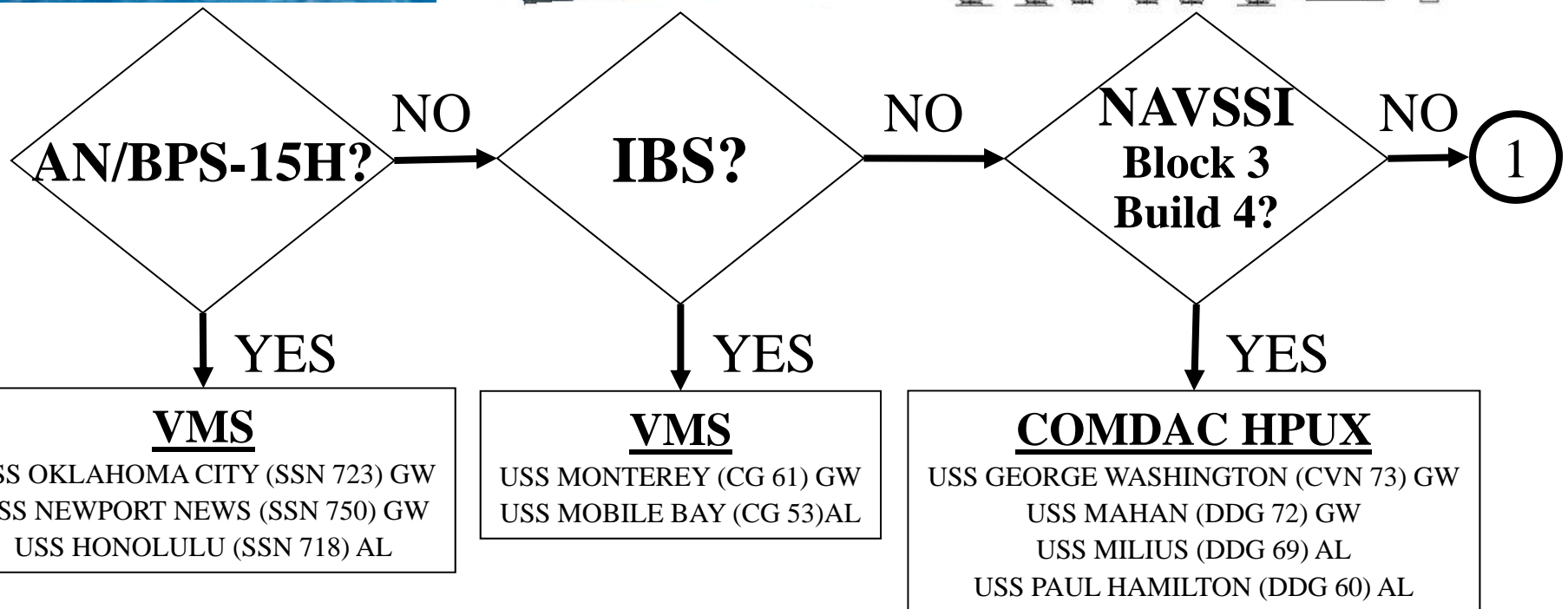
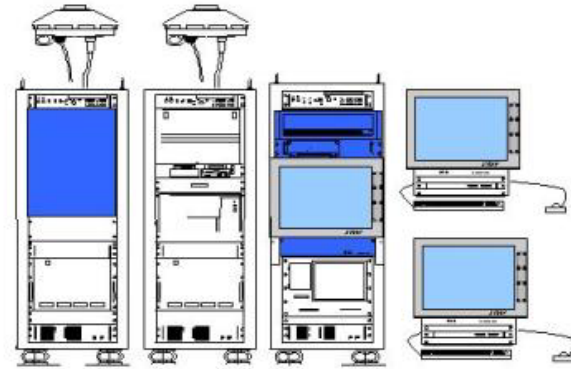
All submarines will have VMS.



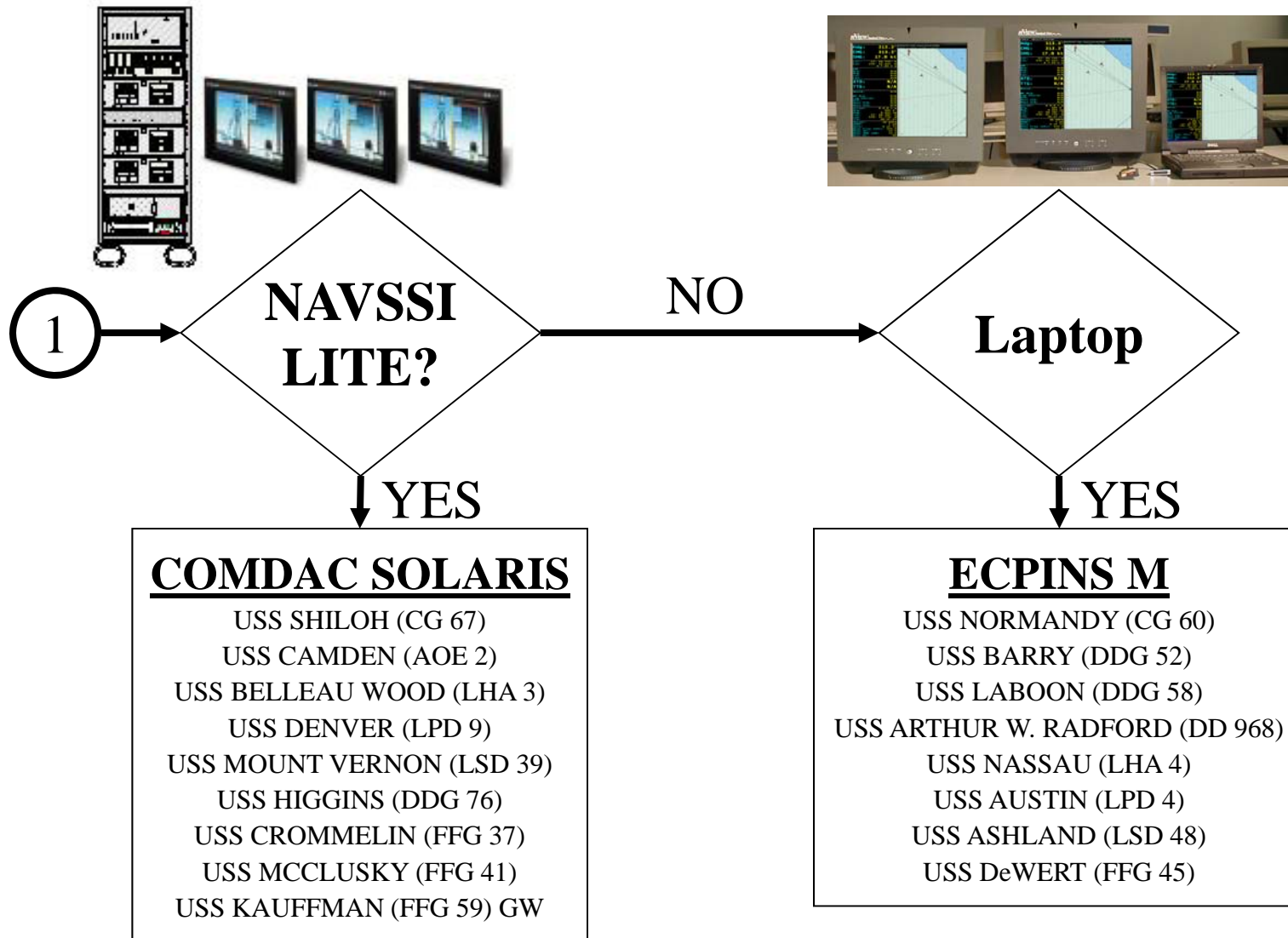
MSC buying Raytheon for 9 big deck ships.



FY02 BATGRU/ARG



FY02 BATGRU/ARG



Availability of DNC

- Due to foreign copyright concerns, DNC is subject to limited distribution, i.e. no public release. U.S. waters can be released (DNC 17 to be released soon).
- DNC is available to cooperating nations, but only through formal agreement. The Hydrographic Annex specifies “all” S-57 data and updates be provided to NIMA in exchange for access to DNC and updates. NO public release is authorized by either party.
- NIMA is evaluating whether it eventually may transition DNC from public availability to permanently impose restriction of DNC as “Defense Nautical Chart”. NOAA should issue U.S. waters public data.

Future Directions for NIMA DNC

- Implementation of visual bearing aspect of ECDIS-N for independence from GPS.
- On-line digital exchange of Aids-to-Navigation data within the USA.
- Expanded approaches for data acquisition.
- Digital publications incorporating digital photos & video clips (all 78 NIMA publications are currently digital).
- Enhanced “interoperability” of the NIMA database [NIMA opposes proposed AML STANAG due to loss of interoperability.]

Maritime Piloting with Digital Nautical Charts (DNC)

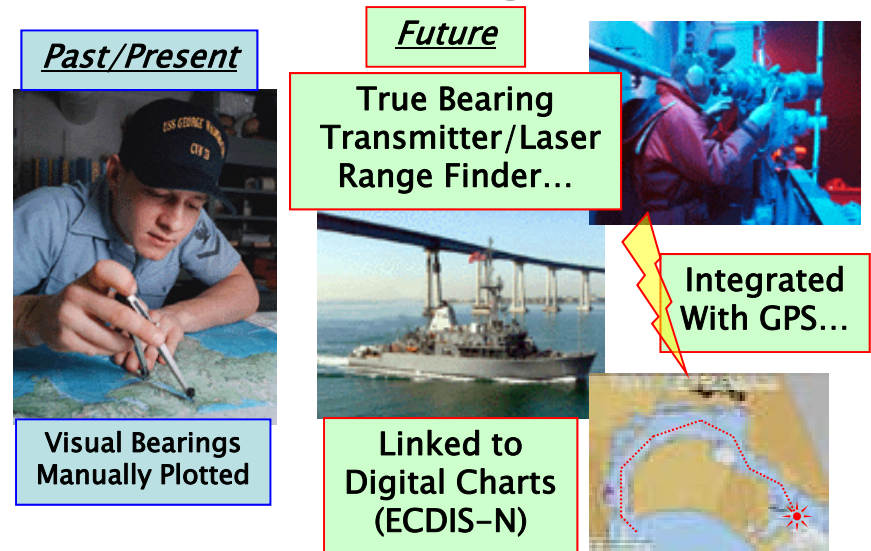
Concept design and prototype development for a Maritime Piloting System with DNC

- **Objective:**
 1. Design a system that integrates line-of-bearing information and laser ranging into Digital Nautical Charts (DNC) on a real-time basis
 2. Assess feasibility of using information captured by this system during piloting operations to update and maintain NIMA's Digital Nautical Charts
- **Background:** The Navy desires a True Bearing Transmitter (TBT)/Laser Range Finder and Digital Imager (LRFDI) device that would integrate more accurate bearing and range information with Digital Nautical Charts.
- **Motivation:** Reduces reliance on electronic GPS-based navigation systems and integrates enhanced visual piloting techniques with digital charts thus improving safety.

Technical Approach

- Leverage design concepts developed by the Navy to date
- Assess the efficacy of existing GOTS and COTS equipment and systems and design a system leading to a commercially available product that will enhance worldwide maritime safety
- Design an integrated TBT/LRFDI device that electronically interface with Digital Nautical Charts to be used in conjunction with GPS provided information during piloting operations
- Assess the feasibility of using information captured during piloting to determine and update positions of fixed navigational aids and landmarks

Automated Piloting with DNC



Tasks

1. Assess applicable GOTS/COTS systems
2. Develop a Concept of Operations (CONOPS)
3. Design a more accurate piloting system that integrates visual bearing data and laser determined ranges with Digital Nautical Charts during piloting operations
4. Develop a prototype maritime piloting system and perform operational testing aboard ship during piloting operations

Motivation for Relative Navigation by Electronic Means

- Provide means for navigation should GPS be lost. Eliminates need to revert to paper chart.
- Provide for relative navigation so navigators are not reliant on NIMA WGS 84 transformations, which may not always be adequate to support large scale navigation.
- Provide for increased redundancy in navigation solution, i.e., adds possibility of laser ranging.
- Provide capability to position uncharted aids. Includes digital camera for confirmation to NIMA.

Electronic Exchange of Accurate Positions for Aids-to-Navigation

- Accurate positions for aids to navigation and channel limits go a long way towards overcoming the problem of old hydrographic data, particularly at ports. USCG, NOAA, ACOE and NIMA are working implementation to improve aids positioning for U.S. waters ECDIS. The NIMA Navigation Safety System currently is tracking 30 million features worldwide.

Littoral Warfare Data

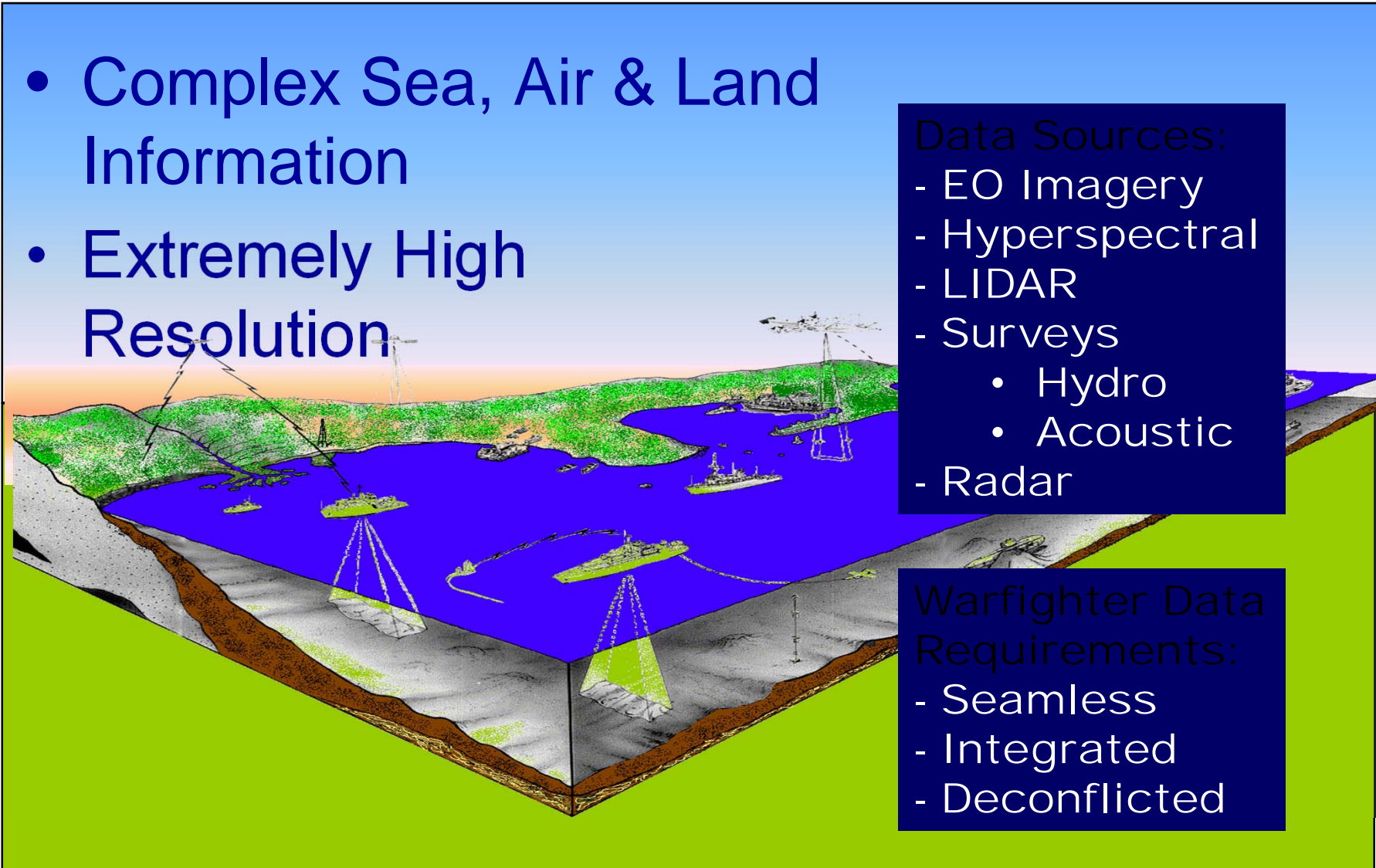
- Complex Sea, Air & Land Information
- Extremely High Resolution

Data Sources:

- EO Imagery
- Hyperspectral
- LIDAR
- Surveys
 - Hydro
 - Acoustic
- Radar

Warfighter Data Requirements:

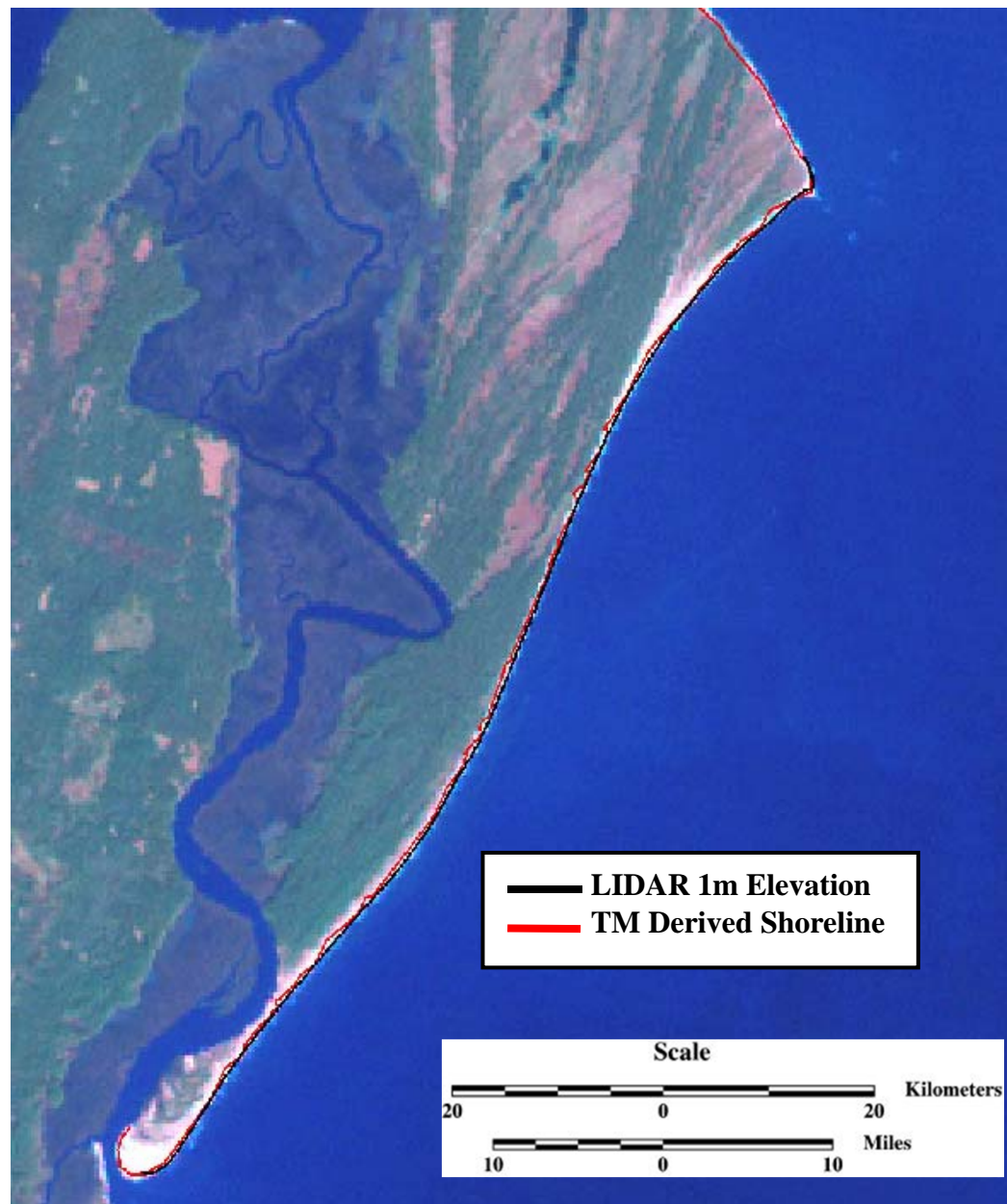
- Seamless
- Integrated
- Deconflicted



Sapelo Island, Georgia

Close-up of Sapelo Island, Georgia

- Sapelo Island is characterized by gentle beach topography with a mean high water line of approximately 1 meter.
- Sapelo Island is a preserve, and as such is largely undeveloped.



NIMA

NOAA Coastal Services Center
LINKING PEOPLE, INFORMATION, AND TECHNOLOGY





Increasing Navy Data Acquisition

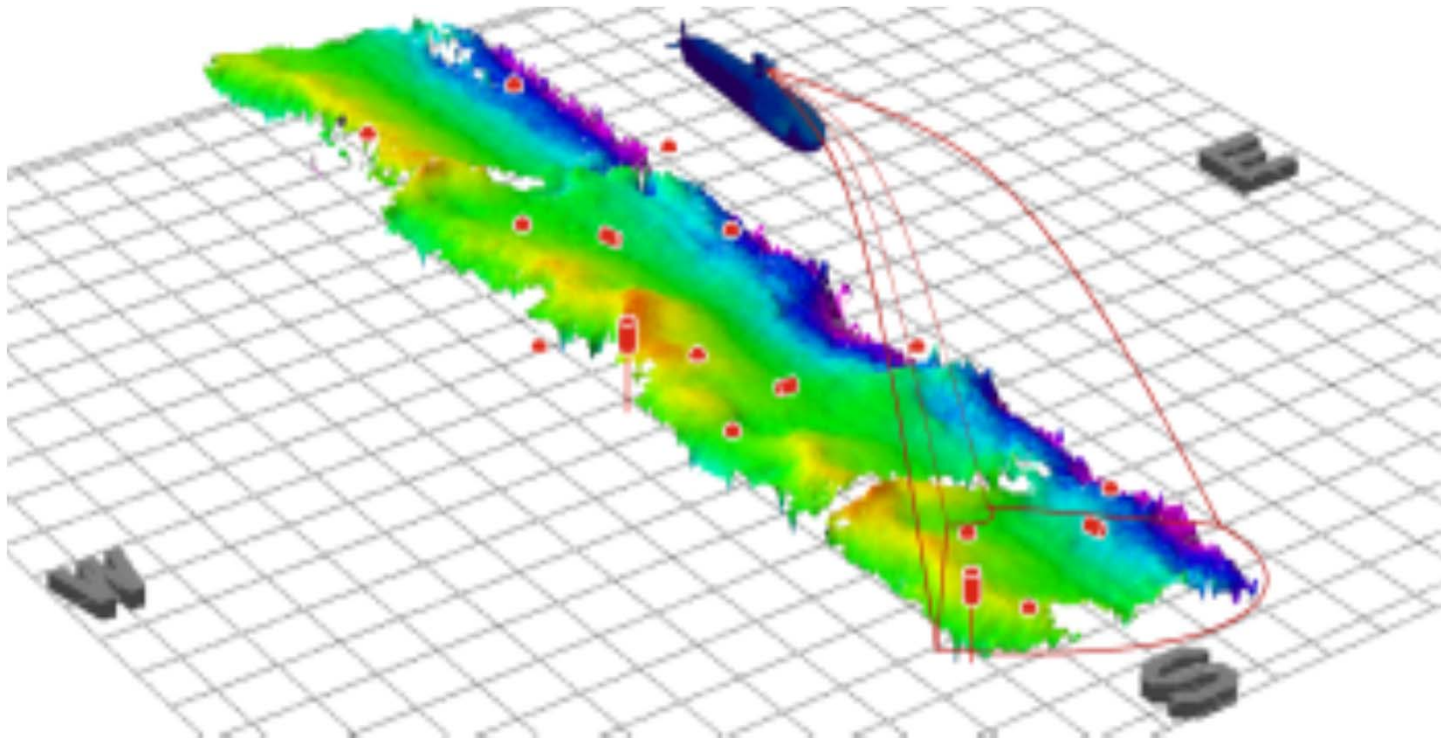
- 8 NAVO survey ships support NIMA with high volume survey data.
- A new NIMA-NAVO MOU provides for NAVO compilation of DNC in-theatre.
- NAVSSI (Navigation Sensor System Interface) equipped ships (~160) to acquire trackline bathymetry.
- Attack submarines begin to deploy with PUMA in 2003.
- Mine sweepers to acquire multibeam SSS.



Increasing Data Acquisition

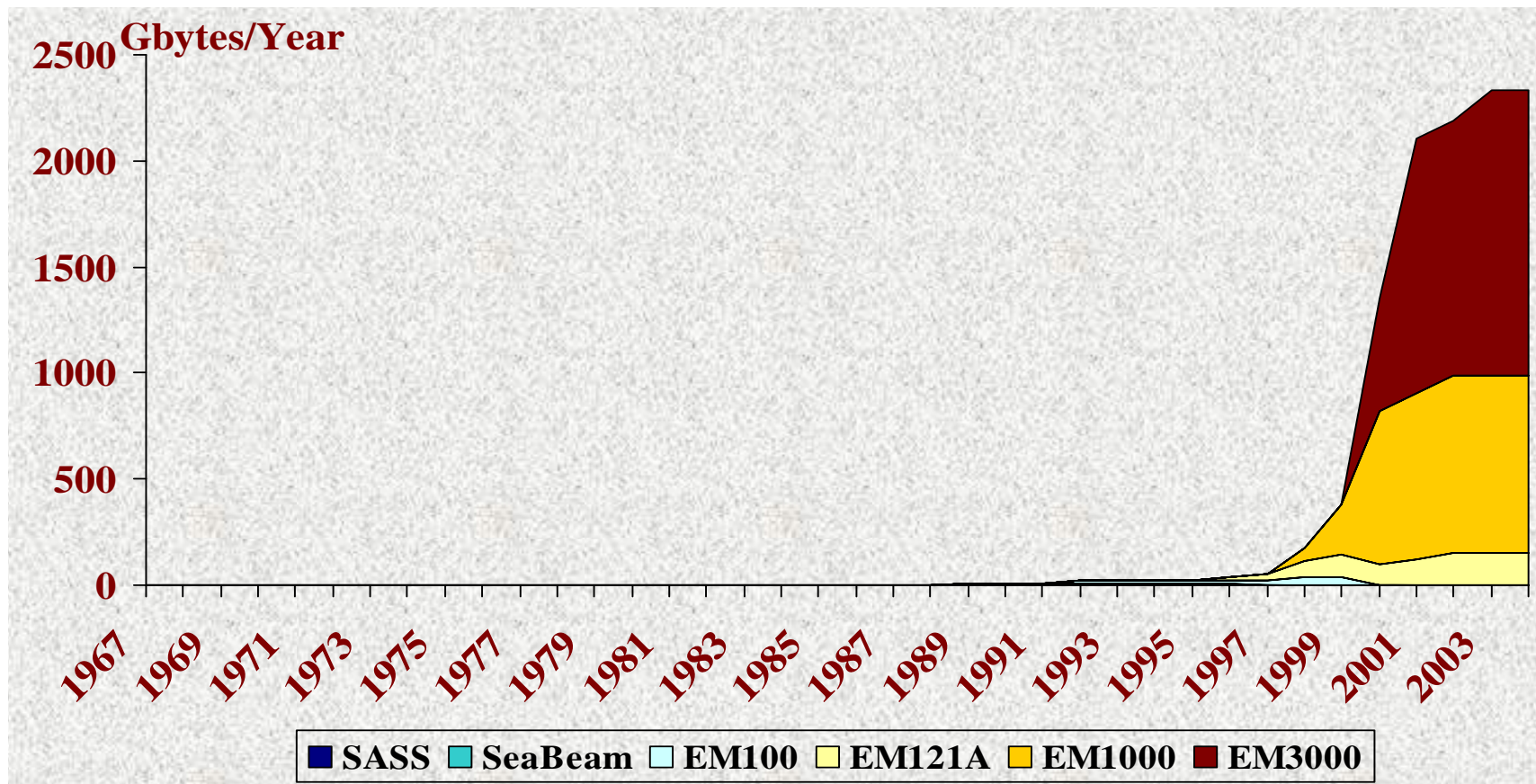
- Army COE & NAVO development of CHARTS and BATS
 - Topographic LIDAR
 - Bathymetric LIDAR
 - Hyper-Spectral Imager
 - Other sensors
- Vertical Datum Harmonization
- Integration of multi-sensor data
 - How best to integrate data from various sensors
 - Automated feature extraction

PUMA/TEDS INTEGRATION



HYDROGRAPHIC CENTER OF EXCELLENCE

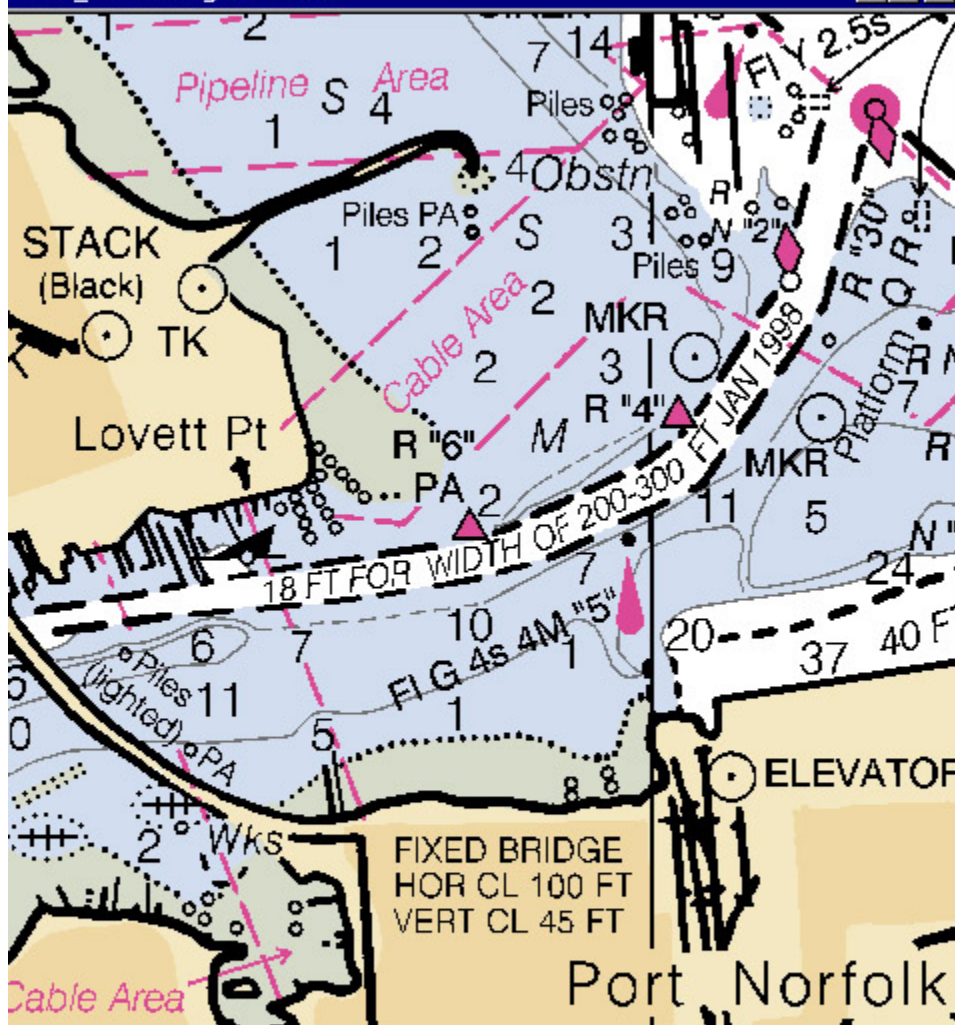
Processing System improvements



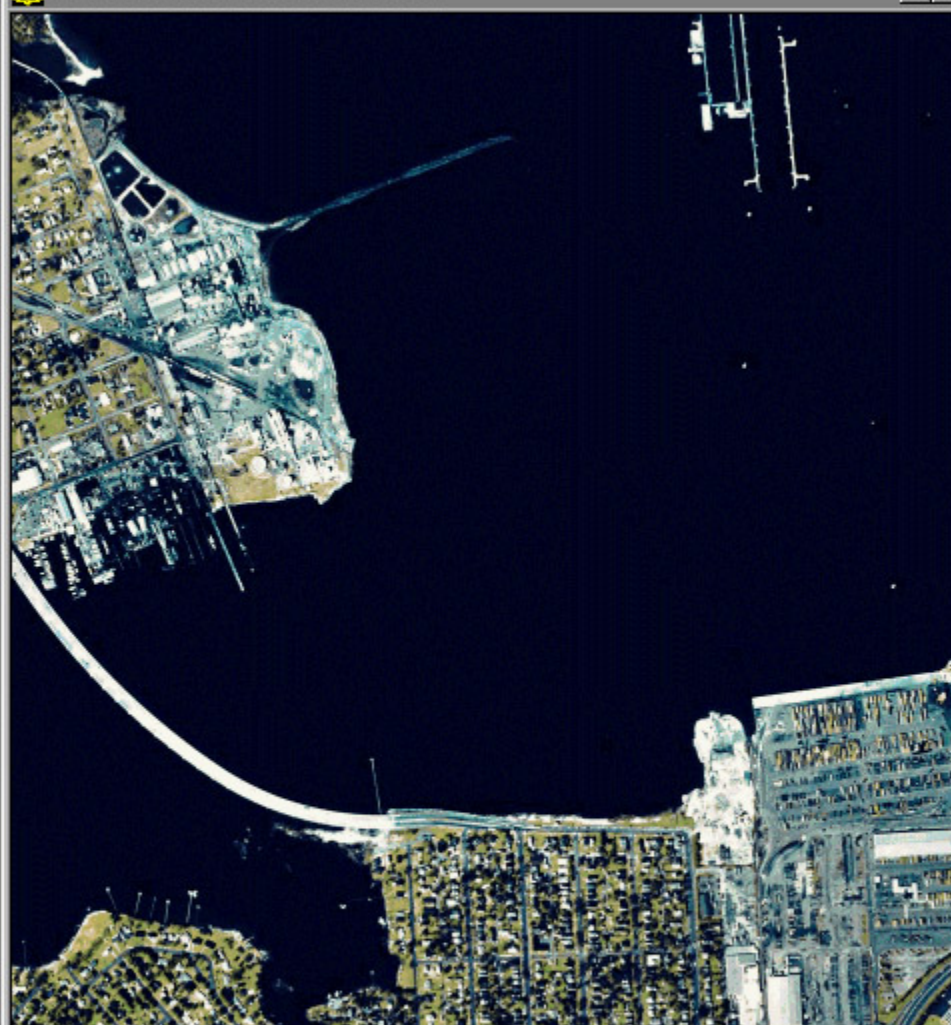
View Charts GoTo Tools Routes Vessel MOB WWW Window Help



12222_1 Soundings in : FEET



NOT FOR NAVIGATION NavPhoto



Sync to Vessel Relative ☒ Link Charts North Up ☐ No NTMs Found ☐ 1.97 KM

Sync to Vessel Relative ☒ Link Charts North Up ☐ No NTMs Found ☐ 1.97

B: Course: 000 Mag Range: 0000.0 Mi. Lat: xxxxxxxxxxxx Lon: xxxxxxxxxxxx Elapsed Time: 00:00:00 Time To: 00:00:00

ty

1:40000 1.00X

Lat: 36° 51' 08" N
Lon: 076° 19' 52" W

LOCK

Var 10.9° W

Datum OK
Offshore Navigator

Image Integration Issues

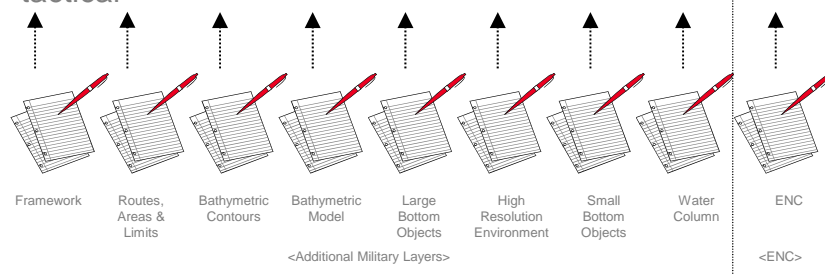
- Revised shoreline on a nautical chart product made available to the public has UNCLOS boundary/limit implications. Where resources (oil & gas) are involved, there is high potential of protests to U.S.
- Hydrographic Offices have expressed concern over having to verify a NIMA derived shoreline.
- SRTM (Shuttle Radar Topography Mission) imagery has potential for causing revision of island positions at end of 2003.
- Possible answer is to put NIMA high resolution shoreline on WVS+ rather than public nautical charts.

NIMA Format Actions

- Since NIMA has significant DNC coverage and Navy is in the process of systems deployment, DNC & TOD will be deployed “as is”.
- NIMA is working to “clean up” differences in DIGEST implementations across NIMA data.
- NIMA has begun looking into the issues of translation/compatibility with ENC in S-57. Since little S-57 data is available, there has not been much incentive for implementation of translation. It is recognized that this situation will change over time. NIMA is working with the NATO & IHO subcommittee of IHO-TSMAD.



Maritime Command & Control	Submarine Navigation	MCM/Amphibious Environmental Info	Water Column Information
Maritime Foundation and Facilities Routes, Areas and Limits Large Bottom Objects Bathymetric Contours - tactical Bathymetric Model - tactical	ENC Bathymetric Model - Submarine Navigation	High Resolution Environment Small Bottom Objects Bathy Contours - MCM/Amphibious Bathymetric Model - MCM/Amphibious	Water Column



AML Interoperability Issues

- Lack of S-57 data for use with AML.
- Lack of control of the SENC when the S-57 exchange standard is used (software variation).
- Problems due to differing interpretations of Product Standards when uniformity is needed for digital systems (move to shore-side SENC).
- Due to data content, format and display differences, an AML for DNC will not work with S-57 nor will an S-57 AML work with DNC. DNC requires GeoSym.
- Use of S-57 with different SENC formats will require multiple AML software modules and be costly across NATO, including the U.S. Navy & Coast Guard.

AML Interoperability Issues

- For the U.S. to adopt AML, significant resources would be required for restructure of the NIMA database, Navy systems would have to be recertified and U.S. deployment of electronic navigation would be delayed--all for very little U.S. gain in the near-term.
- It does not appear that IHO will entertain change to S-57 any time soon and S-57 is topological level 1, skin of the earth data, whereas DNC is topological level 3. NIMA will progress towards air, land, sea & 4-D cube, i.e., time variable data, interoperability.
- Both formats need to transition to topological level 5.

AML Interoperability Issues

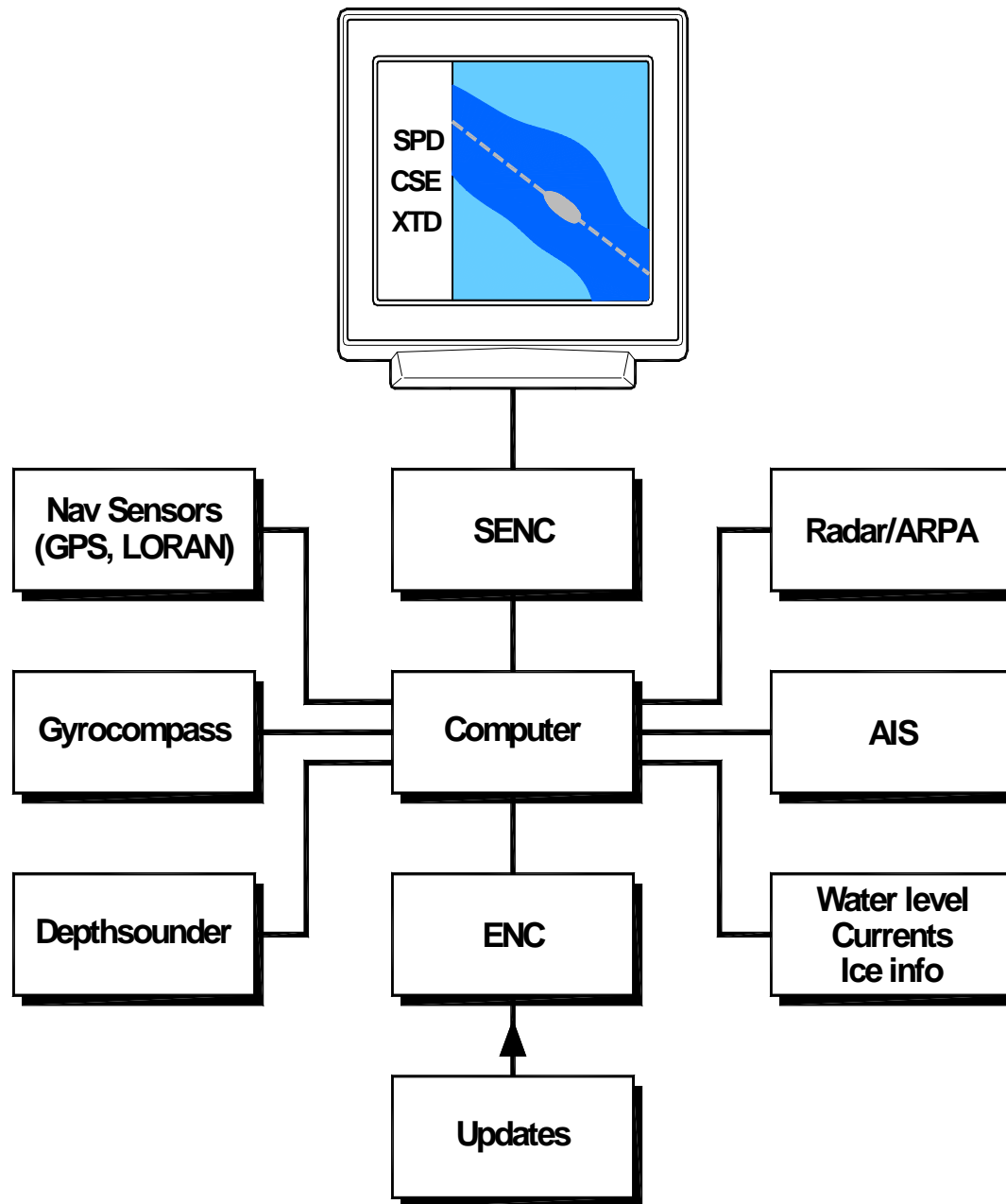
- NIMA is open to progression to a common international format for the ENC/DNC data. This appears to be a long-term effort.
- The NIMA workforce and contractors will be busy bringing worldwide DNC up-to-date through the end of 2004 and, with Navy systems being deployed, format change will not be implemented until sometime later. At the current rate of progress of S-57 data collection, it does not appear that IHO will be willing to change any sooner than the U.S. military.

AML Interoperability Issues

- It appears that it will take decades for worldwide ENC coverage to be attained, particularly in view of the IHO WEND principle. From a military standpoint, one must question how long, if ever, “denied area” S-57 data will become available for integration with AML.

ECDIS COMPONENTS

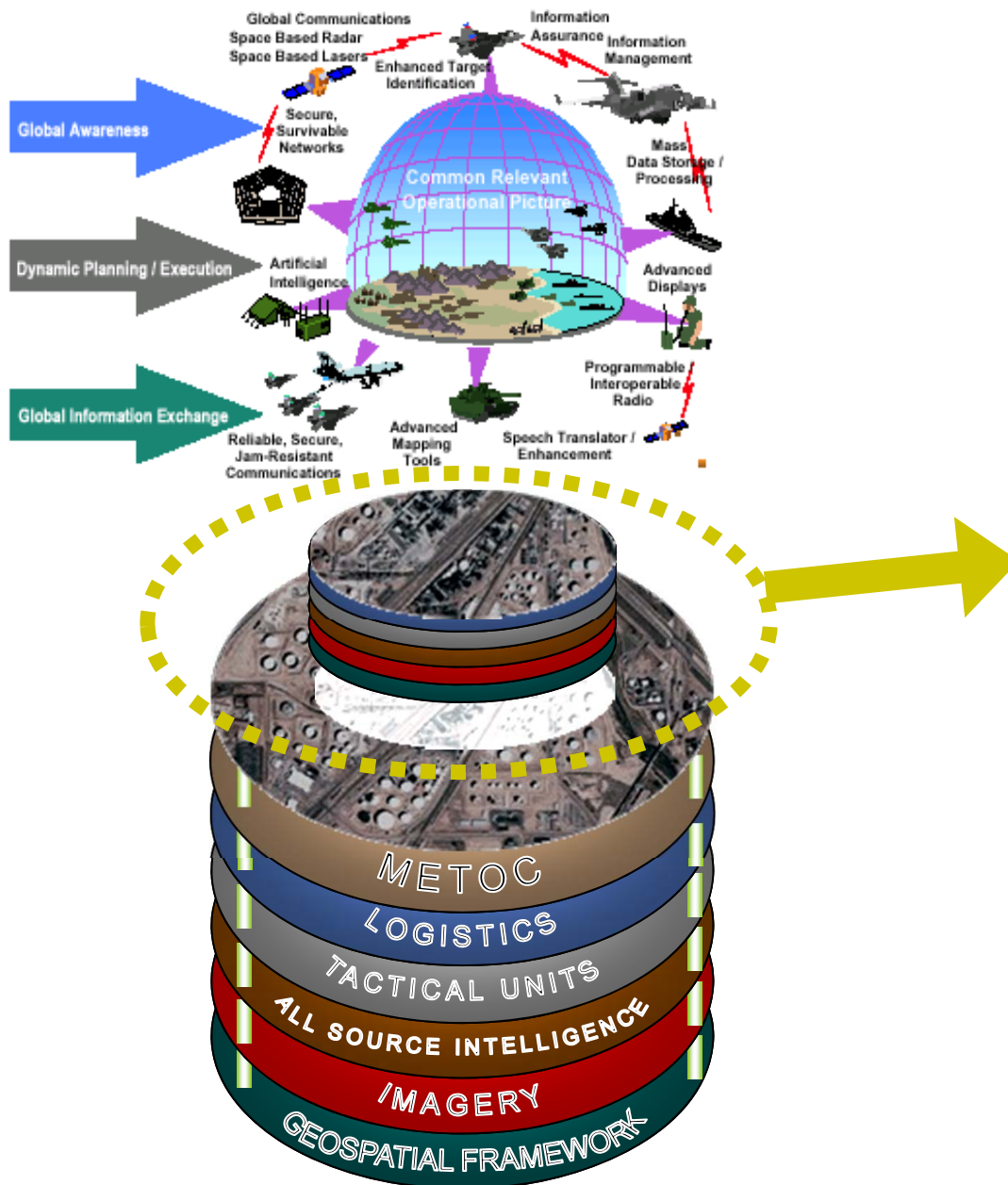
Color Display



Cooperation with U.S. Navy

- Integration of time variable data with DNC.
 - Navy and NIMA have representation on the IHO Marine Information Objects (MIO) working group.
 - Navy and NIMA have representation on the IHO/IEC MIO Harmonization working group.
 - U.S. has representation on all electronic chart display working groups.

4D Cube and the “CROP”



The CROP is the presentation that supports the decision-makers

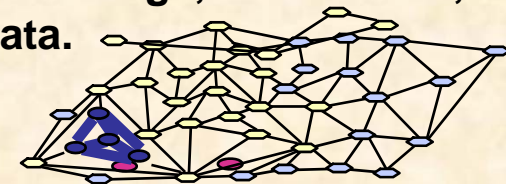


The 4D Cube is the enabler:

- Separates the wheat from the chaff
- Provides the common frame of reference



The network links the nodes that share/use/provide knowledge, information, and data.



Developing the 4-D Cube

