Multi-Source Maritime Vessel Tracking

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Introduction: NRL Code 8100 is developing the Common Distributed Virtual Database/Information Extraction (CDVD/IE) System for the U.S. Coast Guard (USCG) Maritime Intelligence Fusion Center (MIFC) in Dam Neck, Virginia. The CDVD/IE semiautomatically identifies vessels via multisource data. This provides the USCG with maritime domain awareness of vessels operating in an area of responsibility (AOR) encompassing the Atlantic Ocean, north of the equator, and the Gulf of Mexico/Caribbean Sea. NRL system and software engineers have designed an architecture that implements a multilevel data aggregation and semiautomated tracking system. The CDVD/IE enables the MIFC to monitor potential vessels of interest (VOIs) and automatically generates alerts when behaviors meeting user-defined parameters are detected.

The CDVD/IE Program is sponsored by the U.S. Navy (USN) Office of Naval Research (ONR) and is scheduled for delivery to the MIFC during summer 2006. During fiscal year 2007, NRL and the USCG will exercise the system and assess suitability to support an upgradable path using multiple CDVD/IE installations to form a distributed maritime community grid. The CDVD/IE System uses a suite of commercial and NRL-developed computing technologies and resources to address two main areas:

- Multilevel Security Architecture
- Data Aggregation and Semiautomated Tracking Capability

Multilevel Security Architecture: NRL is developing multilevel security architecture to leverage data available at Sensitive Compartmented Information (SCI), GENSER Secret, and Sensitive But Unclassified (SBU) levels. The design makes this multilevel data available as a SIPRNet web service. The CDVD/IE will enable users to access information from multiple security levels using available DoD and NRL network interconnections, providing a more complete intelligence picture to the USCG.

NRL security engineers established a Memorandum of Agreement with the Defense Information Systems Agency (DISA) to implement a bidirectional SIPRNet to NIPRNet controlled interface device (security guard). NRL CDVD/IE personnel, along with DISA and accrediting agency personnel, have designed an interface approach that permits high-value open-source data to be transferred to the GENSER Secret level. For National Technical Means data sources, NRL communications engineers are implementing an approved one-way controlled interface device and performing associated certification and accreditation.

Data Aggregation and Semi-Automated Tracking: Aggregated data from multiple disparate sources provide far more opportunity to positively identify vessels and construct tracks than nonaggregated, individual source data. Each data source, comprising vessel "metadata" (data about a vessel) and tracks/position data (posits), has the potential to contribute to solving the vessel identification puzzle, Fig. 6.

NRL designers developed a generic data extraction framework that simplifies efforts required to access and make use of differing data sources. This open approach is critical as additional maritime sources become available that will support future requirements to report on smaller vessels, vessels in other AORs, and cargo. CDVD/IE's semi-automatic track stitching and its ability to aggregate data from as many sources and sensors as possible enhances vessel tracking capabilities without increasing the existing analyst base.

The CDVD/IE software architecture implements an "inherent" query, notification, and alert system. The system automatically detects and alerts the operator to activity that falls within user-defined parameters using two key elements known as MyVessels and MyPlaces. These features enable specific vessels and areas to be added to a watchlist (both at the operator level and at the analysis cell level). A vessel listed in MyVessels is automatically updated when new information associated with that particular vessel enters the CDVD/IE environment. For MyPlaces, CDVD/IE invokes a "tripwire" approach. A user can define specific areas of interest within the AOR so that a vessel will trigger an alert if it enters the area. System search capabilities support queries into the CDVD/IE System by geographical location, by metadata attributes, and by alerts. The CDVD/IE System uses existing ELINT (Electronic Intelligence) and AIS (Automatic Identification System) tracking tools and introduces new capabilities to aggregate and stitch track segments from multiple sources. This stitching process encompasses the following functions:

- Metadata stitching
- Track position filtering
- Track candidate determination
- Track comparison (geographical and parametric)
- Spatial database update

As the CDVD/IE acquires new position data (single-source track data), it performs the above functions and conducts quality checks, Fig. 7. The final step in the process results in a database update reflecting the merged track data and metadata. Over time,

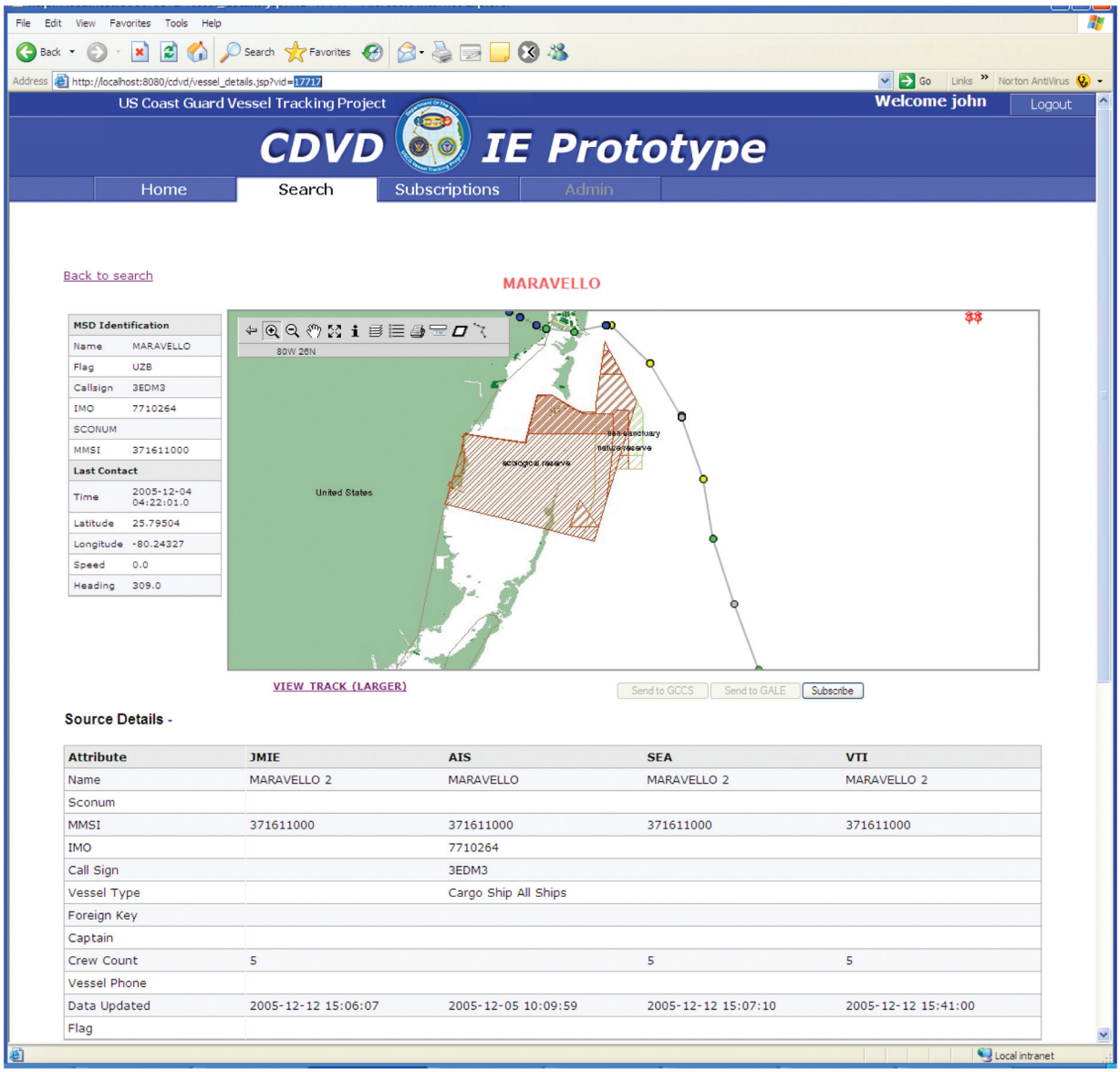

FIGURE 6
Single vessel track and associated multisource data.

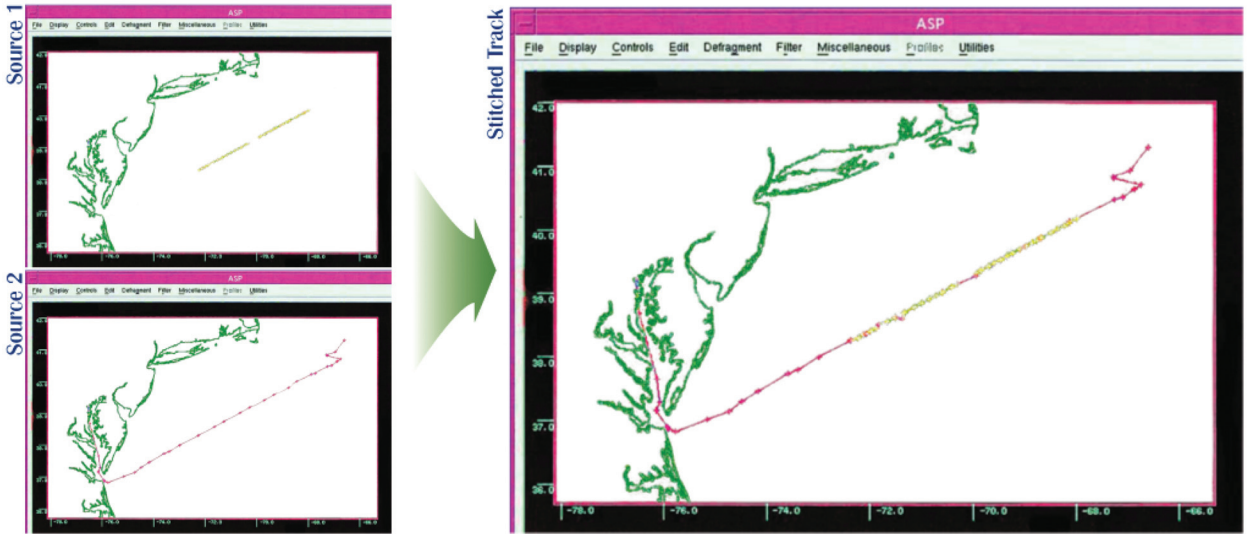

FIGURE 7
Track stitching with two data sources.

updates to the database begin to build a robust repository of known vessel data, reducing the load on the analyst to "start from scratch."

Summary: The CDVD/IE system will provide a leading maritime domain awareness capability for the USCG with future applicability to the USN and Intelligence Community. This system paves the way for rapid aggregation of disparate sources across security domains, with architecture adaptable to modern web services technologies and commercial standards.

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