Data for Defense
New Software Finds It Fast

LAWRENCE Livermore has a long history partnering with the Department of Defense (DoD) to help meet emerging national security needs. Over the past several decades, Livermore researchers have provided DoD agencies with both hardware and software solutions for enhanced missile defense, conventional weapons, armor and antiarmor materials and munitions, remote sensing, secure communications, sensors to detect weapons of mass destruction (WMD), and operational planning tools.

In fact, DoD investments continue to grow and now support multiple strategic science and technology areas at Livermore, further validating that the department is a key work sponsor and partner for the Laboratory. Dave Brown, program director for Defense in Livermore's Office of Strategic Outcomes, says, "My job is to understand the needs, requirements, and budgets of the Department of Defense and then determine within the Laboratory where we can provide technical solutions that leverage our science and technology expertise."

According to Brown, some of the products most valued by DoD have been developed by Livermore software experts to help warfighters and military planners distill, combine, relate, manipulate, and access massive amounts of data in a timely manner. Quickly isolating that information is a growing problem. Because of data overload, analysts typically spend more time collecting data than analyzing it.
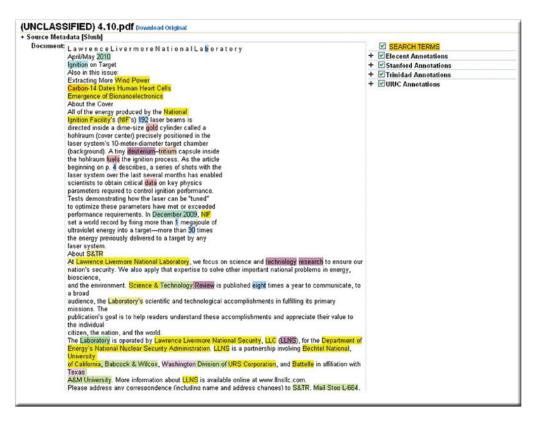
Too Much Data, Not Enough Time

"Warfighters have way too much data to process in a timely manner," says Brown. "Sophisticated algorithms and other software can help them extract what they need to make decisions fast." For example, Livermore computer science and engineering experts developed Persistics, a data-processing pipeline that efficiently extracts pertinent information from enormous amounts of video data collected by unmanned aircraft. (See *S&TR*, April/May 2011, pp. 4–11.)
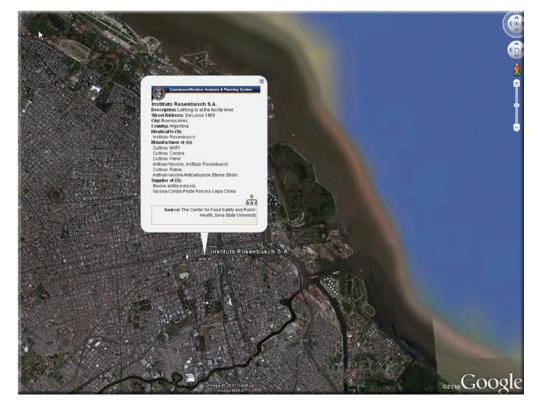
Another valuable resource is the Counterproliferation Analysis and Planning System (CAPS), an information system used by the U.S. Armed Forces to plan missions against facilities that support WMD production. In 1998, then Secretary of Defense William Cohen selected CAPS as the preferred planning tool to combat WMD. CAPS provides in-depth assessments of facilities,

With Trinidad, analysts can efficiently sift through vast amounts of information by zooming in on key terms and highlighting them. As an example, Trinidad analyzed text from a recent issue of *S&TR*. Color highlights indicate successful "hits" for different search terms.

The EleCent Earth application summarizes data in a geospatial display. Users search EleCent data by geographic area and topic of interest, and results are mapped with the Google Earth plug-in. Icons denote "hits" in the selected geographic area, and clicking on an icon produces summary information about that site. In this example, an EleCent search reveals a company in Buenos Aires that produces veterinary pharmacological products.

determines the potential for collateral damage from interdiction attempts, and quantifies the signatures that can reflect ongoing operations at selected sites.

Accessed through the major classified military networks, CAPS has supported several missions, including the Kosovo conflict, Operation Enduring Freedom, and Operation Iraqi Freedom, as well as relief efforts following catastrophic events such as earthquakes. The CAPS staff at Livermore also provides a daily technical reachback capability in response to requests from warfighters and planners.

Over the past few years, software developers have focused on making the vast amount of information residing in the CAPS data warehouse more manageable. CAPS stores more than 810 million documents, and billions of relationships link the data they contain. By designing an intuitive, easy-to-use computer interface for the system, the development team reduced data retrieval from hours to nearly real-time output, thereby freeing time for DoD personnel to perform in-depth analyses. In 2010, the team received a Global Security Silver Award for its success.

Two key components speed data extraction and enhance understanding. The first, Trinidad, provides a powerful data "triage" capability for quickly identifying pertinent high-value information while discarding the rest. Trinidad helps users more efficiently sift through mountains of unstructured data including open-source articles, scientific publications, Web-based news, and government reports—all of which contain information associated with a particular mission.

Trinidad leverages Hadoop, open-source software designed for reliable, scalable, and distributed computing, as well as the latest techniques for natural language processing. Advanced algorithms developed by Livermore researchers identify and zoom in on key terms or knowledge from subject-matter experts. A Web interface helps analysts with data triage by prioritizing documents and identifying items of interest. Search criteria can be a simple term or list of terms or complex phrases defined by Boolean relationships using the words *and*, *or*, and *not*. The resulting report highlights important terms so analysts can scan the relevant documents quickly. Trinidad can run on a laptop or a much more powerful Linux computer cluster.

The second component, Element Centric (EleCent), allows users to store, update, retrieve, and analyze data categorized as critical or related to a CAPS mission. EleCent combines an enormous database with Web-based tools for viewing results in various formats, from tabular lists to geospatial maps. EleCent uses Grails, an open-source application framework for rapidly developing Web-based tools. The data to be analyzed are derived from many sources, including commercial data sets and results from Livermore's defense-related research.

The EleCent Editor application allows authorized users to enter, edit, verify, and export data. The Editor serves as a tracking

mechanism for every piece of data (element) in the system. Before information is entered into EleCent, a subject-matter expert at Livermore reviews it for accuracy. It then becomes available for external customers and is automatically included in the data triage performed by Trinidad. Users may then explore the relevant Trinidad documents identified by the Editor for a particular search element. In addition, filtering options allow users to easily find, select, and bin data and export those results to other tools for further analysis.

Providing a Geospatial View

Another tool designed by the Livermore team is EleCent Earth. This application uses the Google Earth plug-in to display results in a geospatial format as well as in a tabular list. With EleCent Earth, users can search by geographic area plus topic of interest. Results are plotted on a map at the level of detail selected by a user (either world, regional, or country view). Icons mark the "hits," or search results returned, for the specified area. Clicking on an icon produces a summary of the site, including its name, type, location, Web address, and other information.

In 2011, the CAPS team showcased the flexibility of the EleCent software architecture in a proof-of-concept demonstration for a potential sponsor. The sponsor's database was structured in such a way that made it difficult for other organizations to import and host. Livermore developers imported the data set into EleCent and processed it with the EleCent Editor. The data were immediately viewable by users, who could then sort, export, and exploit the information.

Trinidad and EleCent have received highly favorable reviews from DoD analysts worldwide. Together, the two components make CAPS an even more powerful tool for U.S. warfighters. "CAPS provides stellar, accurate knowledge in a format that can be readily analyzed so a warfighter can make sound decisions quickly," says Brown.

He notes that the Laboratory puts a lot of science behind every DoD product. "To the casual observer, CAPS may look like a simple Web browser, but we have many years of development effort behind it," says Brown. "Whether we're developing software, hardware, or a combination of both, our goal is to take technically complex problems and produce operationally relevant solutions for the warfighter."

—Arnie Heller