## EXECUTIVE SUMMARY

**In February 1993, the Defense Advanced Research Projects Agency (DARPA) awarded Grant No. MDA 972-93-1-0008 for $5 million to the High Technology Development Corporation (HTDC), a State of Hawaii agency, to establish a National Defense Center of Excellence for Research in Ocean Sciences (CEROS)**

> **". . . for the purpose of conducting research and development activities of interest to the Department of Defense . . . and . . . to support and stimulate a broad spectrum of research in ocean science in the State of Hawaii."**

**In December 1995, the DARPA grant that funded CEROS was transferred from HTDC to the Natural Energy Laboratory of Hawaii Authority (NELHA), another State of Hawaii agency.**

**The DARPA grant supported a core of 12 prime contractors working on 11 projects plus core administration. More than $4.5 million went to technical development contracts to form the core. Within the core, three projects produced algorithms or software products; three developed prototype systems; two produced models or design studies; two demonstrated proof-of-concept; one contract was canceled before completion. Because of results from the initial DARPA grant, eight projects were selected for the CEROS FY94 Core, which was supported by DARPA grant No. MDA 972-94-1-0010.**

**According to contractor reports, 18 professional positions were created and supported directly because of the CEROS grant. Additionally, most projects used technical consultants or other support personnel during the respective contract period, so the Federal funds had a highly healthy impact on Hawaii's technical community. CTA Corporation of Colorado established an office in Hawaii because of the CEROS award; the successor to that company, Gateway Technologies International (GTII), has continued business in Hawaii focusing mainly on Department of Defense (DoD) projects. DARPA Grant No. MDA 972-93-1-0008 successfully stimulated ocean-oriented, commercially based technology development in Hawaii for DoD purposes. Following is an outline of individual projects provided in the core.**

- **CTA, Inc., Englewood, Colorado -** *Radar/Sensor Signal Processing for Shallow Water Surveillance Technologies* **- Contract No. 36462 - $385,794**

**Completed Phase 1 development of the Hawaii Radar Simulator (HIRADSIM), a radar software simulator for small-target detection in a high sea clutter environment. Phase 1 development brought significant intellectual property and radar simulation technique from CEA Technologies PTY., Ltd. of Australia into Hawaii. The Phase 1 simulator was demonstrated on three types of target-detection tasks: (1) submarine periscope on the sea surface in varying sea**

**states, (2) rubber inflatable boat (RIB) in high-sea or -surf conditions, and (3) complex boat targets in high sea conditions. Final report was received in November 1994. Phase 2 development and demonstration was selected for follow-on funds under the CEROS FY94 core program with GTII as prime contractor.**

- **Detection Limit Technology (DLT), Inc., Waimanalo, Hawaii -** *Development of Fiber-Optic Chemical Sensors (FOCS) for Remote In-Situ Monitoring of pH and Carbon Dioxide in Seawater* **- Contract No. 36279 - $236,700**

**Demonstrated for the first time ability to detect carbon dioxide ($CO_2$) dissolved in seawater using surface-enhanced Raman spectroscopy (SERS). SERS results in million-fold enhancements of the Raman-detection signal. Precision for the SERS instrument, which can measure as little as 3 percent changes in ambient oceanic $CO_2$, exceeds that of standard fluorescence-based instrument. To achieve this breakthrough technology, DLT developed a unique dye coating for the sensor. The dye is not susceptible to photobleaching and is particularly amenable to low-power, diode-based laser sources that would be required to use the instrument on a robust, remote ocean data buoy. The instrument was demonstrated January 1995; final report was received in May 1995. Follow-on project to improve the instrument suite, demonstrate applications, and prepare for commercial manufacture was selected for funding under the CEROS FY94 core program.**

- **Edward K. Noda and Associates, Inc., Honolulu, Hawaii[1] -** *Modeling of Hurricane-Induced Coastal Flooding* **- Contract No. 40496 - $213,929**

**Developed and demonstrated state-of-the-art numerical-modeling techniques to characterize the nearshore wave field associated with hurricanes in the vicinity of the Hawaiian Islands. Hurricane-Induced Coastal Inundation Program (HICUP-1), a hydrodynamic model of coastal inundation, emphasizes wave setup for variable nearshore bathymetry. Test grid for the island of Kauai was demonstrated in August 1997. The scale of the effort will include other defined coastal sites.**

- **Innovations Hawaii, Honolulu, Hawaii -** *Extended Source Apparent Motion (E-SAM)-Lighted Signals for Protection of the Marine Environment* **- Contract No. 38195 - $241,108**

**Designed, developed, and tested a marine lighting system based on the innovative E-SAM principle. A working prototype E-SAM range light was developed and tested in Honolulu Harbor; results showed that the marker was highly conspicuous against densely cluttered background lighting. Final report**

[1] Contract was awarded in April 1996 after HTDC canceled the originally selected contract with Science Applications International Corp. (SAIC).

**was received in January 1995. Follow-on funding for further prototype development was included in the CEROS FY94 core program.**

- **IBM Loral Federal Systems, Manassas, Virginia -** *Acoustic Analysis Toolkit* **- Contract No. 36382 - $480,000**

**Applied advanced signal-processing techniques to commercial off-the-shelf (COTS) hardware and techniques for ocean surveillance and monitoring. Acoustic Analysis Toolkit and COTS computer hardware was successfully adapted to signal-processing tasks for analyzing humpback whale vocalizations and bottlenose dolphin echolocation signals. Technology transfer and interaction with the University of Hawaii (UH) Kewalo Basin Marine Mammal Laboratory (KBMML) was intended to add to the expertise. The project was assigned to Loral Federal Systems as part of the IBM corporate reorganization. Final report was received in April 1995. Related dolphin studies at KBMML are being funded by the Office of Naval Research (ONR).**

- **Knapp Engineering, Inc., Aiea, Hawaii -** *Low-Cost Prebuckled Cylindrical Pressure Hulls* **- Contract No. 36282 - $414,450**
- **Oceanit Laboratories, Inc., Honolulu, Hawaii -** *Low-Cost Prebuckled Cylindrical Pressure Hulls* **- Contract No. 36280 - $342,800**

**Designed, fabricated, and analyzed prototype innovative pressure hulls based on a counter-intuitive** *prebuckled cylinder* **theory. The design promises economical pressure hulls without the precision production processes required by traditional ring-stiffened pressure hulls. Prototypes seemed to support the basic design stipulations. Design studies final report received in March 1995; prototype tests final report was received in September 1995. A follow-on effort by Knapp Engineering to investigate prototype manufacturing techniques was included in the CEROS FY94 core program.**

- **Makai Ocean Engineering, Inc., Kailua, Hawaii -** *Development of a Cost-Effective Global Positioning System (GPS)-Based Sensor for Measurement of Heave, Pitch, Roll, and Heading in Oceanographic Platforms* **- Contract No. 36277 - $230,250**

**Adapted state-of-the-art global positioning system (GPS) technology to a compact, sea-worthy package for gathering data critical to a variety of near- and off-shore applications; e.g., weather prediction and tactical planning. Prototype unit was developed, tested, and demonstrated at sea. Technical obstacles associated with short-baseline interferometric measurements were overcome and accuracy of the prototype system exceeded design objectives. Final report was received in February 1995. Follow-on effort to demonstrate commercial viability of prototype system was included in the CEROS FY 94 core program.**

- **ORINCON Corp., Kailua, Hawaii - Underwater Echolocation for Object Recognition - Contract No. 36356 - $769,732**

**Echolocation performance data were collected from bottlenose dolphins at UH facilities. Signal-processing algorithms and computer-based neural networks were developed to model dolphin capabilities in hardware. Resulting prototype signal-processing system successfully emulated dolphins' ability to detect and classify buried targets. Final report was received in October 1994. Follow-on development was included in the CEROS FY94 core program.**

- **Science Applications International Corp. (SAIC), San Diego, California -** *Effects of Underwater Noise on Marine Mammals Offshore Hawaii* **- Contract No. 38146—$246,324**

**Intended to develop and install an advanced acoustic sensor array off the island of Kauai and to monitor marine mammal distribution and behavior north of the island. HTDC canceled the contract in December 1994 before the monitoring system was completed or installed. However, the cable was transferred to ONR for a project to monitor endangered whales in the Atlantic Ocean. The balance of the funding was applied to contract support for E.K. Noda & Associates for hurricane modeling. Final report was received in April 1995.**

- **Sea Engineering, Inc., Waimanalo, Hawaii -** *Development of a Broad-band FM Sub-bottom Profiler for Seafloor Imaging and Sediment Classification* **- Contract No. 36278 - $292,000**

**Developed and tested a state-of-the-art broadband, sub-bottom acoustic profiling system for shallow-water surveys. The system provides rapid and accurate bottom classification and characterization and is uniquely capable of distinguishing consolidated and unconsolidated coral sands during field tests off Waikiki Beach. Final report was received in January 1995.**

- **Science and Technology International (STI), Honolulu, Hawaii (formerly SETS Technology, Inc., Mililani, Hawaii) -** *Hyperspectral Remote Sensing for Maritime Applications* **- Contract No. 36281 - $691,800**

**Adapted proprietary signal-processing scheme into a prototype airborne hyperspectral imaging system for near-shore surveillance and mapping; adapted advanced sensor system into marine applications. Final report was received in September 1994. Additional funds were provided through CEROS to demonstrate the prototype sensor for DoD; successful test results were received in March 1995. CEROS FY94 core program included funds to support follow-on development and application of the sensor system.**