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# Assessments To Support Oil Spill Response

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**Abstract**

Assessment methods were developed to support oil spill response strategies and use of the Shoreline Cleanup Assessment Team (SCAT) approach. Large quantities of data often need to be analyzed in a command center. An emergency response system was gradually developed to support oil spill cleanup and response. The system integrated pen-based wearable computers, a global positioning system and differential radio beacon receivers, a wireless local area network, and satellite uplink and downlink systems. Field data were recorded using a pen pad linked to a wearable computer. Digital data capture included
shoreline oiling diagrams created using a geographic information system
SCAT form data entry
determination of exact coordinates of oil patches and other spatial information
image capture with video cameras

The Information gathered were transmitted from the field over a satellite telephone. For larger spills, a wireless local area network was evaluated that linked the SCAT team by satellite to a command center. Field data and imagery were integrated and analyzed to produce GIS maps to support rapid decision making.

**Keywords:** Hurricanes; Shoreline; Oil spills; Raytheon Systems

## Introduction

During an oil spill, field data needs to be collected and rapidly transmitted. This usually involves recording spill conditions on Shoreline Cleanup Assessment Team (SCAT) forms, which are then transported or faxed to a command center and added to a computer database. Delays and errors associated with the transcription, computer entry, and analysis of data from SCAT forms can prevent the information from being used in a timely and efficient manner [1].

In response to this need, the Florida Marine Research Institute (FMRI) within the Florida Department of Environmental Protection (FDEP) collaborated with the following organizations in the testing of hardware and software to facilitate emergency response to oil spills and hurricanes: the NOAA Coastal Services Center, the NOAA Hazardous Materials Response and Assessment Division (HAZMAT), the FDEP Bureau of Emergency Response (BER), Environmental Software Solutions (ES2), Raytheon Systems, the Florida National Guard unit at Saint Petersburg Junior College, and the Florida Department of Community Affairs Hurricane Response Network.

New technologies were evaluated for their capabilities to support rapid data collection, communication, and decision making. Stand-alone equipment can deal with a localized event, whereas equipment tied to a wireless network must be mobilized for larger emergencies. This paper describes components of the systems that were evaluated. The hardware and software needed by a single user and by a larger team were considered.

## Florida Marine Spill Analysis System

In 1991, FMRI developed the Florida Marine Spill Analysis System (FMSAS). It was designed to facilitate the rapid production of maps for decision makers in a command center. It could also be used to create resources-at-risk reports that summarize information concerning the resources affected within designated areas. The FMSAS initially used ArcView GIS version 3.0, developed by Environmental Systems Research Institute (ES2), to overlay and display Environmental Sensitivity Index (ESI) maps of shoreline habitats, as well as biological and human resources-at-risk from oil spills [2-4]. It was used by BER operating on laptop computers in five regions of Florida.

## Shore Clean

Shore Clean version 1.1 was evaluated on desktop computers by FMRI and BER staff [5,6] which facilitated the entry of information concerning shoreline oiling conditions, mimicked SCAT-form methodology, and acted as a decision-support system by providing users with shoreline cleanup options based on the data entered to the system.

## Linking Shore Clean with the FMSAS

Both the FMSAS and Shore Clean were evaluated to support field-data collection. A prototype appraisal was conducted with a pen-based computer in wireless communication by cellular telephone with a command center [7]. The pen-based computer contained a global positioning system receiver and was tested with Shore Clean 1.1 and a portion of FMSAS.

Shore Clean-SCAT was designed to facilitate electronic data entry of information that field personnel normally record on SCAT paper forms [8]. The study revealed the need to link part of the FMSAS with Shore Clean-SCAT, so users in the field could relate Shore Clean data to shoreline segments associated with existing ESI maps. Shoreline segments from the FMSAS were used to zoom into the area of a hypothetical oil spill in Fort DeSoto Park, Pinellas County, Florida. Impacted shorelines were drawn as polygons on-screen over ESI shoreline segments. Data-entry screens in Shore Clean-SCAT were used to record data associated with the ESI segments by means of pull-down menus activated by a pen stylus. This facilitated creating shoreline oiling sketch maps as polygons drawn over shoreline segments onscreen, which later became shape files in ArcView [7].

## Wearable Computer

Oil spill response personnel needed a computer to collect field data. The pen-based computer previously tested was rugged and waterproof but lacked PCMCIA slots [7]. Most laptop and pen-based computers weigh 4-5 pounds and can be cumbersome to carry in the field.

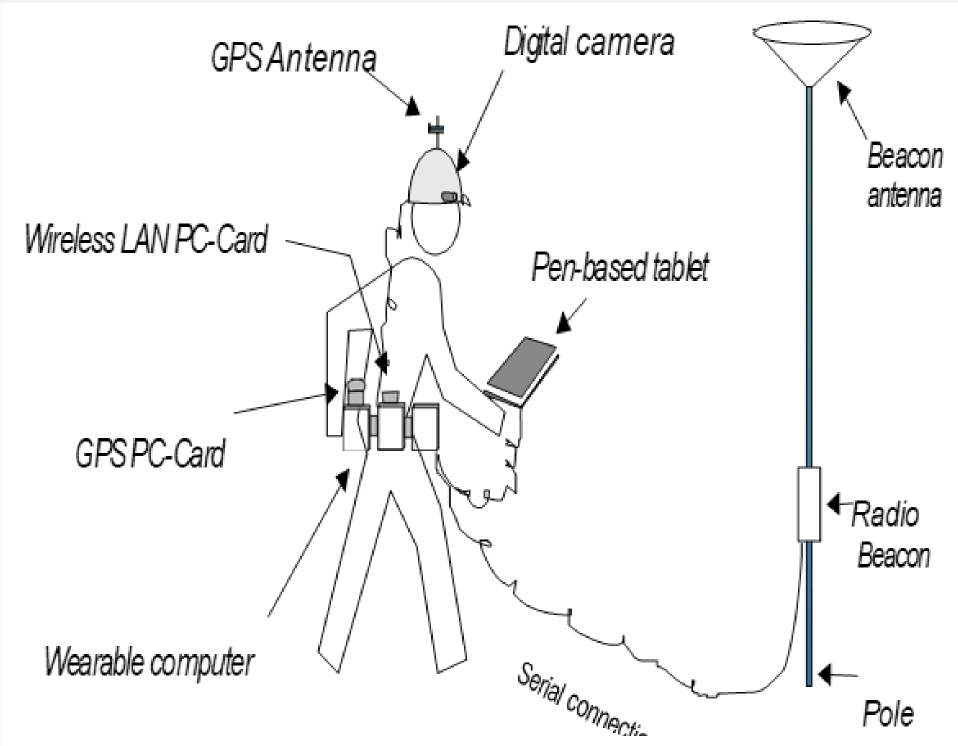


**Figure 1:** Evaluation of the feasibility of using the wearable computer stand-alone to document shoreline conditions with the FMSAS linked to Shore Clean-SCAT (Rubec et al. 1996).


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The ViAII wearable computer overcame these problems. It consisted of three modules, worn in a water-resistant belt pack. The main module consisted of a 1.2-pound computer with a Cyrix GXi 180 MHz processor, 64 megabytes of random-access memory, and a 1.6 gigabyte hard drive. The second module contained two PCMCIA slots for Type II PC cards. The third module held an exchangeable lithium battery (4.5-hour battery life). The wearable computer was tethered to a hand-held, active-matrix, thin-film transistor pen tablet with a weight of 11 ounces. We evaluated the feasibility of using the wearable computer stand-alone (Figure 1) to document shoreline conditions with the FMSAS linked to Shore Clean-SCAT [7]. The wearable computer was tested connected by a cable to a Communications Systems International (CSI) beacon antenna and a CSI MBX-2 radio-beacon receiver, mounted on a pole, to facilitate use of a differential global positioning system (DGPS).

Using DGPS software and an 8-channel Pathfinder DGPS PC card with a wearable computer, it was possible to import DGPS readings into ArcView 3.0. We validated the DGPS readings obtained by comparing them to readings taken with a Trimble AgGPS 122 unit at known way points situated in Fort DeSoto Park. The goal was to test whether the hardware and software could be integrated to provide field workers with a lightweight, stand-alone, battery-operated system for field data collection. The system consisted of a DGPS, digital camera, pen-based tablet, pole, wearable computer, serial connection, DGPS PC-Card, wireless local area network (WLAN) PC-card, and radio beacon antenna.

## Hardware Components Associated with the Wearable Computer

There was a general need for portable, high-bandwidth radio modems that interfaced with portable computers that could be powered off each computer's battery in a variety of emergency response situations [9]. Raytheon had developed a WLAN that worked with high-speed, spread-spectrum radio modem PC cards.

An audio headset (with speaker and microphone) and a Kodak DVC 300 digital video camera mounted on a hard hat were tested for input of voice and video through a Universal Serial Bus on each wearable computer (Figure 1).

## Data Collection over Wireless Network

A PC card facilitated real-time communication over the WLAN by providing wireless connectivity with portable computers equipped with Type II PCMCIA slots. The card had an external antenna that allowed 2.4-2.5 GHz, frequency hopping, radio communications. Data transfer up to 2.2 megabytes per second facilitated real-time transmission of vector-based and raster-based GIS files, video, and voice data communications. A Raytheon Access Point, with a Raylink PC card, connected the WLAN to a wired ethernet network.

## WLAN Evaluation

During May 1997, FDEP collaborated with Raytheon Systems to test a prototype of the Raytheon WLAN using a pen-based computer, with a passive-matrix liquid crystal display and PCMCIA slots, which communicated with a laptop computer acting as a Windows NT server. Raytheon Systems developed high-gain, omnidirectional and unidirectional antennas that linked to the WLAN. The antennas extended the range of the WLAN from the server along the beach at Ft DeSoto Park. Antennas pointed up and down the beach were used to create a WLAN along six miles of shoreline.

A Connectix Quick Cam 2 video-conferencing camera mounted on a hard hat was used to communicate real-time video between the two computers. The system used CU-See Me software over the network. Coordinate positioning was also tested using a Trimble GPS PC card associated with a pen-based computer and a GPS antenna mounted on the user's hard hat.

We evaluated the Raytheon WLAN, by linking several wearable computers in two-way communication with a Panasonic CF-25 notebook computer, acting as a server, over a Microsoft Windows NT network (Figure 2).

We tested the use of DGPS over the WLAN, by transmitting U.S. Coast Guard differential corrections, obtained by the CSI antenna and a radio beacon receiver, from the notebook computer to two wearable computers equipped with Trimble DGPS PC cards. We are also evaluated the transmission of ArcView GIS shape files, other dBase files, voice, and video data from the wearables to the notebook computer. This allowed field workers to gather data using wearable computers linked over the WLAN along an impacted shoreline.

## Satellite Communications

Stand-alone communication from isolated locations requires a mobile unit that is linked to the telephone system either by cellular telephone or via satellite (Figure 3). Computer data had already been transmitted by cellular telephone [7]. However, because some areas of Florida were outside the cellular telephone network; we also tested voice and computer data communications using an 8-lb satellite telephone (ST251) from American Mobile Satellite Corporation; which allowed two-way satellite communications.

### Over Wireless LAN

Statewide, the Department of Community Affairs (DCA-HRN) maintained 130 stationary VSAT facilities, that could uplink and downlink voice and computer data using asynchronous communications. A TCP/IP link was implemented. for evaluations that occurred in July 1998. DCA-HRN provided two mobile VSAT trailers, equipped with gasoline-powered generators, which



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facilitated two-way communications. The first trailer uplinked voice and computer data from the WLAN on the beach to a satellite (Figure 3). The second trailer downlinked data to the command center and other VSAT locations statewide. The latter trailer could also download NOAA National Weather Service satellite imagery to the command center.

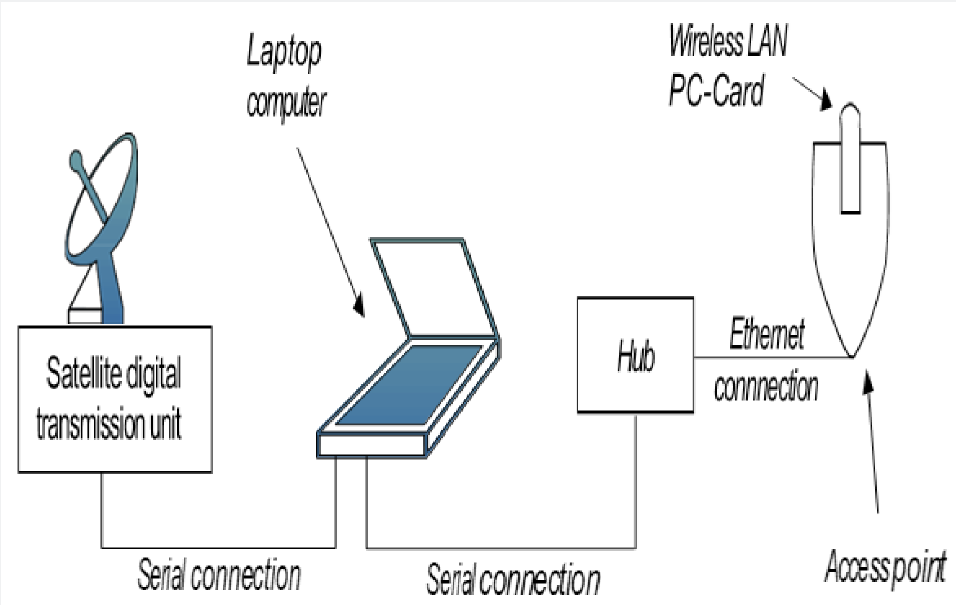


**Figure 2:** Hardware components of the relay station. The Access Point associated with a directional antenna feeds data through a 10 Base-T hub to a laptop computer linked to the satellite transmission unit.

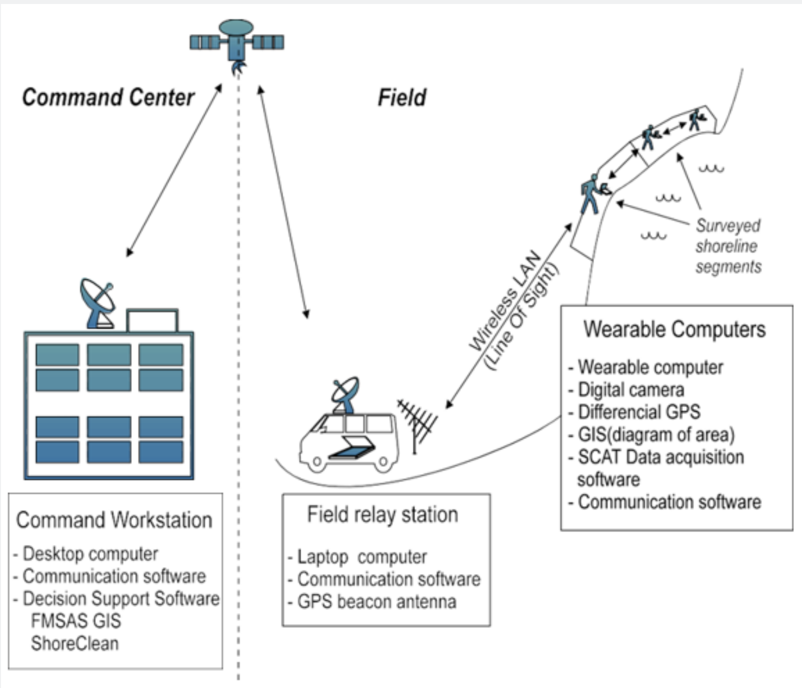


**Figure 3:** Diagram showing the system hardware and software components of the wireless system. Lines with arrows show communication channels of voice and computer data between the field and the command center. It consisted of a laptop computer, wireless LAN, PC-Card, satellite transmission unit, hub, serial connection access point and ethernet connection.



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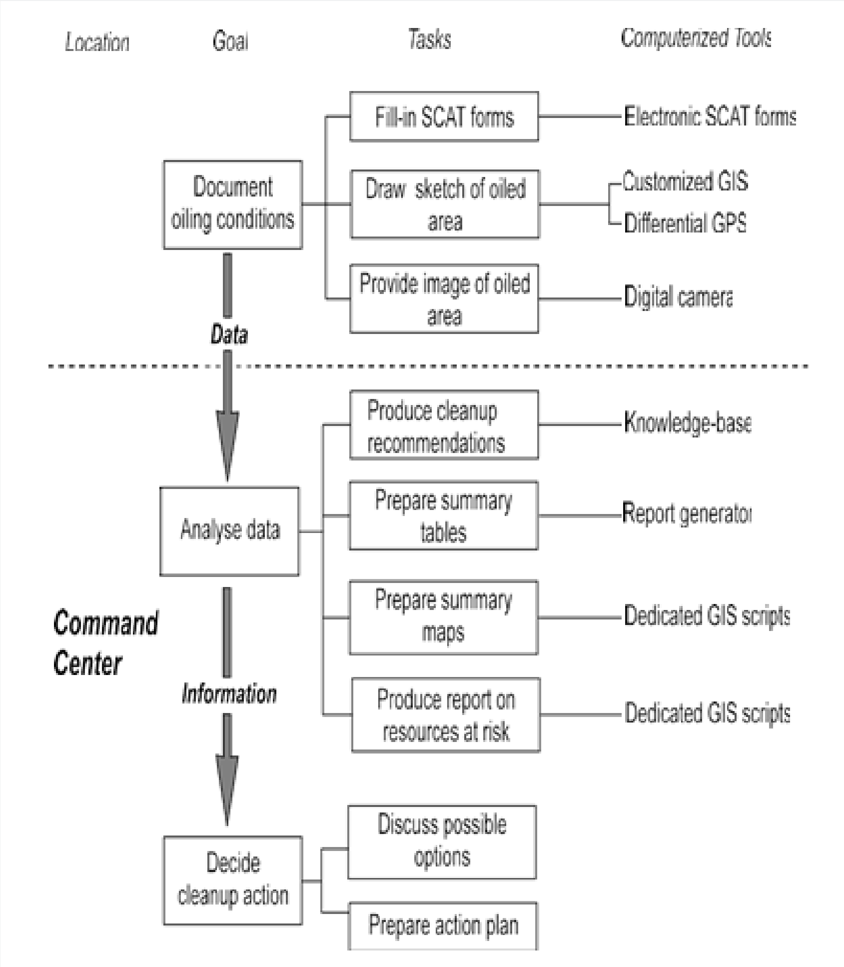


**Figure 4:** Summary of the main goals, tasks, and support tools involved in computerized decision-support. The arrows show the main flow of data and information.

Transmission of real-time video between the field and the command center, or with other locations nationwide, required a high-bandwidth satellite link. St. Petersburg Junior College (SPJC) had an Emergency Response and Management Program funded through the Department of Defense that maintained a sophisticated high bandwidth satellite communications unit in a truck. We planned to collaborate with the Florida National Guard to use the SPJC facility to uplink video data from the WLAN. The DCA-HRN would provide access to KU-band satellite communications. The video signals would then be downlinked to a 1.2-meter analog satellite dish situated at FMRI.

## Data Integration in Command Center

The evaluations involved setting up a command center at FMRI that could receive information by satellite. A receiver on the roof downloaded real-time video, voice, Shore Clean-SCAT, and GIS data files transmitted from the field.

## Maps For Decision Makers

Shore Clean version 2.0 allowed linkage to GIS packages such as ArcView and MapInfo [5,6]. ES2 linked Shore Clean 2.0 with a portion of FMRI's FMSAS for the Tampa Bay area operating in ArcView 3.0. This allowed maps to be created in the command center using field data that displayed the status of shoreline cleanup operations in relation to ESI shoreline segments and resources-at-risk. The evaluation involved testing a prototype of Shore Clean version 2.1 linked to the FMSAS to support the creation of resources-at-risk reports and to help determine shoreline cleanup options.

The SCAT survey teams documented oiling conditions in the field. Raw data were transferred from the field to the command center, where it was analyzed and transformed into an array of


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representations (maps, summary reports, and lists of cleanup recommendations), targeted to support decision making in the command center (Figure 4). The SCAT information manager was responsible for 1) data maintenance and, 2) the timely provision of information to decision makers responsible for planning and making strategic decisions. Decision making in the command center was facilitated by visualizing the data on maps [5]. The FMSAS was used to merge various segments to create composite maps in ArcView. The extent and degree of oiled habitat, the status of cleanup operations, and the deployment of personnel and equipment were depicted on composite maps.

## Conclusion

Command center staff could efficiently monitor the situation and rapidly deploy personnel and equipment. The hardware and software systems developed were found to work individually and as part of a larger system to support oil spill assessment and response. The evaluations were conducted with funding from the NOAA High Performance Computing and Communications Program.

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