

Remote Environmental Monitoring System CRADA

Federal Manufacturing & Technologies

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## REMOTE ENVIRONMENTAL MONITORING SYSTEM CRADA

R. D. Hensley, Principal Investigator

Published March 2000

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CRADA Number 04155700

Project Team

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## **Remote Environmental Monitoring System CRADA**

Project Accomplishments Summary

CRADA Number 98KCP1065

Date: January 26, 2000

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### A. Parties

The project is a relationship between

Honeywell FM&T

AR Designs, Inc

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Chicago, IL 60611

## B. Background

At the time this project was initiated, the technology for remote monitoring primarily used fixed, hard-wired communications connected to environmental sensors. Management and control of operating conditions were mainly controlled from fixed locations. The ability to monitor mobile sensors or to control from a mobile command center was limited at best, especially for commercial applications.

New emerging technologies for low-cost wireless communication, when integrated with embedded software protocols, were identified by AR Designs for potential market application. The ability to wirelessly monitor remote sensors could be effectively used for HVAC, fire protection, and security applications to automate building and facility controls.

AR Designs' expertise is in system architectures including developing software and hardware designs, networking, and communications protocols for wide area networks. FM&T brought to the project technical proficiency in radio frequency (RF) design and testing, hardware fabrication, system integration, and a user application that could serve as a demonstration model. These skills complemented each other to meet the overall needs of the project.

## C. Description

The goal of the project was to develop a wireless communications system, including communications, command, and control software, to remotely monitor the environmental state of a process or facility. Proof of performance would be tested and evaluated with a prototype demonstration in a functioning facility.

AR Designs' participation provided access to software resources and products that enable network communications for real-time embedded systems to access remote workstation services such as Graphical User Interface (GUI), file I/O, Events, Video, Audio, etc. in a standardized manner. This industrial partner further provided knowledge and links with applications and current industry practices. FM&T's responsibility was primarily in hardware development in areas such as advanced sensors, wireless radios, communication interfaces, and monitoring and analysis of sensor data. This role included a capability to design, fabricate, and test prototypes and to provide a demonstration environment to test a proposed remote sensing system.

A summary of technical accomplishments follows:

- Control of and data acquisition from remote sensors was developed and successfully tested. An IC Link's 4300 programmable logic controller was adapted for the application. This 32-bit PC-compatible CPU is similar to a desktop PC but is rated for -40<sup>0</sup>C to +80<sup>0</sup>C and has a form factor the size of a miniature brick. Up to 64 sensors can be monitored. This device can readily communicate over dial-up

telephone, cellular telephone, twisted pair wires, and wireless radio.

The design team implemented a wireless LAN system that ties into the backbone of the company's network using the embedded microprocessor controller technology provided by Industrial Control Links (ICLinks), Inc. This embedded controller allows peer-to-peer communication between controllers using IC Link's own BrickNet Communications Protocol as well as the ability to broadcast to multiple controllers. With the added feature of the Ethernet interface in the controller, Aironet Universal Clients provide wireless communications to an Access Point tied to the plant's network. Any workstation can communicate to a controller and vice versa.

FM&T developed C++ programs for operation of the controller that included interface with the wireless radio and sensors.

- An evaluation of commercial off-the-shelf (COTS) components was conducted with emphasis on fire protection sensors. A selection of sensors suitable for the fire protection application was determined including real-time video monitoring. Knowledge gained helped to understand benefits in using COTS components for DOE applications.
- Transceivers (radio devices for transmitting and receiving RF signals) were evaluated for the application. The devices best suited for this need operate in an unlicensed frequency of 2.4 GHz. Operation is at low power, a feature that prevents interference with other radio equipment and improves mobility when used with battery powered terminal devices. Data rates of 2 Mbps can be transmitted wirelessly and are suitable for voice, data, and video signals.

Added features included an embedded network communication architecture that complies with IEEE 802.3, Ethernet Blue, and IEEE802.11b, making it compatible with other communications protocols. With these features, a wireless LAN (Local Area Network) was established that links to the backbone of the company's network using the embedded microprocessor controller technology previously discussed. Any workstation, either fixed or mobile, can then communicate with the controller and vice versa.

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- A user-friendly graphical interface was developed that provides users with a Windows-based environment for data acquisition, process monitoring, alarming, and networking. Several commercially available software packages were evaluated. Wonderware Corporation's *InTouch 7.0* was selected as the best choice that met the technical requirement. With established industry software, customization and obsolescence were minimized, engineering development time was reduced, and implementations cost was minimized.

Design of customized operator displays for human-machine interface (HMI) for industrial automation, process control and supervisory monitoring was quick and easy. Networking to the WLAN (Wireless Local Area Network) with standard TCP/IP and Ethernet protocols was straightforward using Wonderware's I/O servers.

For the application user, a wireless, remote, real-time, and mobile interface is provided that:

- Reports the status of sensors, alarms, and process monitors;
- Offers ready access to supporting business information; and
- Enables process control capabilities such as video monitoring.
- Integration of these various features and subsystems was successfully accomplished and tested in a demonstration project at the Department of Energy's Kansas City facility. A remote outbuilding was remotely and wirelessly monitored for fire protection with control from the facility network and from mobile controllers. A video describing the content and accomplishment of the demonstration test was produced.
- Several major pieces of communications and networking protocols were developed and enhanced during this project. These were:
  - 
  - IDEA(GIS) – Intranet Development for Environmental Automation (IDEA) via Geographical Information Systems (GIS)

The IDEA(GIS) protocol provides a global application based foundation for interoperable IP-based networks and applications.

- 
- PtP/Mgr – Peer-to-Peer Manager

The Peer-to-Peer Manager (PtP/Mgr) protocol provides embedded systems with access to many of the services and objects of the remote IDEA(GIS) server. The embedded protocol enables point-to-multi-point and peer-to-peer communications networking.

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- Communications Stack – TCP/IP/UDP Protocol & RTOS

The communications stack provides the application with a TCP/IP/UDP protocol utilizing a BSD interface.

- 
- Advanced Architecture of the IDEA(GIS) Framework

The IDEA(GIS) framework is a global application based multimedia gateway/access point (G/AP) that allows intelligent management of video/image, voice, and data information, including browsing, processing and transport of filtered information over embedded target (ET) devices.

- 
- Global Application Based Subnetworks

The IDEA(GIS) framework provides gateway/access point (G/AP) interface consisting of a wireless to Ethernet infrastructure, based on RF Tag technology, personnel status

monitors, and wireless environmental sensors.

The value of this partnership to the goal of this project was to blend the unique talents and resources of private sector business practices with the design and manufacturing capabilities of a government contractor. From the perspective of the private sector partner, AR Designs, FM&T could provide the needed prototyping and hardware development needed for this initiative. Value-added benefit included the DOE and Honeywell name exposure that enhanced alliances with other government and industry partners. From the viewpoint of the government contractor, FM&T, AR Designs provided the unique perspective of industry practices and technology thrusts, especially in the area of building automation and control. Value-added return included experience in commercial off-the-shelf components and knowledge of communications protocols and software for process monitoring and control.

James Rattleff, President of AR Designs, summarized his assessment of the project and performance. "The collaborative efforts with Honeywell (FM&T) have enhanced AR Designs' expertise and capabilities towards the development of high-speed wireless communications. AR Designs looks forward to applying the things learned to advance the current prototype's capability and performance."

#### D. Expected Economic Impact

AR Designs had direct benefit in having a documented deliverable product that can be introduced into the marketplace. This participant has the documented results that can be used to support a business plan needed for financing of the enterprise. Additional benefit was derived in understanding the technology of wireless products and services in preparation for the next technology wave.

Early in 2000, James Rattleff, president of AR Designs, will be applying the results learned in this project to a SBIR proposal that intends to capitalize on communication solutions high performance networks and applications--Wireless LAN Technologies. Further development work is expected to:

- Enhance and miniaturize current prototypes (hardware and software),
- Further develop and integrate embedded sensor/device technology,
- Enhance the building control application in the areas of emergency response and security, and
- Interface applications towards the electrical physical, procedural and protocols for the interconnection between Satellite Exchange (SE) and Access Network (AN) for support of various types of digital and analog access devices.

Remote wireless monitoring of environmental, safety, health, and security conditions can be expected to benefit from this work, especially in areas that may represent a hazard to humans or where the cost of or access to land-line communication is prohibitive.

Consumers and taxpayers are expected to benefit from this work by reductions in the extent of property loss, personal injury, and loss of life.

#### E. Benefits to DOE

Products and processes for RF and radar DP applications benefited as a result of this project. Industry assessment and testing of COTS (commercial-off-the-shelf) components provided a knowledge base that will be useful in DP cost reduction initiatives such as the W76 quarter cost AF&F. Technical competency of the staff was enhanced in areas of C++ programming, RF system development, and test equipment that will benefit future DOE weapon applications. Products and technology developed can be applied to surveillance and facility protection within the DOE DP complex.

The partnership added value that benefits the DOE by providing an entry vehicle to best industry practices and emerging technologies that might not have been possible in the course of normal business.

Since the initiation of this project, other RF wireless projects have emerged at FM&T. This endeavor enables FM&T to gain technical competency that benefited these new projects.

The technology developed for remote wireless monitoring of sensors can be shared with the public as a benefit for real-time, mobile, management and control for buildings and facilities. This would include fire protection, security, and process control.

#### F. Industry Area

Industries benefiting from this project include:

- Fire and Security Protection
- Hazardous Waste Monitoring
- Facility Heating, Ventilation, and Air Condition
- Process Controllers

#### G. Project Status

Project was completed as scheduled with all activities accomplished.

#### H. Point of Contact for Project Information

Ken Bauer

Dale Hensley



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#### I. Company Size and Point of Contact

AR Designs

Point of Contact: James Rattleff, President

312 644 9567 (Voice)

312 644 9566 (FAX)

#### J. Project Examples

A six-minute video has been produced that documents the technology and accomplishments of this project.

#### K. Technology Commercialization

The partners have no immediate plan for commercialization of the technology developed. Further development is planned that will use new low-cost, low-power, miniature components that integrate sensors and wireless radio in a single package.

Should interested business ventures wish to commercialize this technology, Honeywell FM&T can provide technical consultation and assistance in the commercialization endeavor.

## L. Release of Information

I have reviewed the attached Project Accomplishment Summary prepared by Honeywell FM&T and agree that the information about our CRADA may be released for external distribution.

Original signed by 3/11/2000

Name: James Rattleff Date

Organization: AR Designs, Inc.

Title: Director of Technology