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Secure and Reliable Wireless Networks for Critical Infrastructure Facilities

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Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Project Description

- Need:
  - Wireless network systems becoming more widely used in control systems due to lower cost and ease of implementation
  - Critical infrastructures need more security since they provide a means of controlling physical processes
  - Robustness is needed to provide 99.99999% availability demanded by control systems
  - Capability for emergency first responders to gain access to pertinent situational awareness data during emergencies
- Approach:
  - Leverage existing authentication and encryption technologies and techniques to provide pairwise link encryption between mesh devices
  - Research and implement robust multipath routing schemes tailored for control systems
  - Research and implement Quality of Service techniques that prioritize data for particular situations and from particular devices
  - Design and implement keying and triggering system for first responder devices
- Benefits:
  - Having a compromised link will no longer lead to the entire system being compromised
  - Losing an interior mesh node (i.e. DoS) no longer causes interruption of data acquisition
  - First responders no longer have to fumble with security yet communication is still secure
  - QoS keeps first responder devices from having to compete with normal control system devices for situational awareness data
- Competition:
  - Wireless mesh network systems exist at a basic level of security with no consideration for first responder access
  - Industrial standards bodies currently developing standards for industrial wireless mesh networks (want to help drive this)

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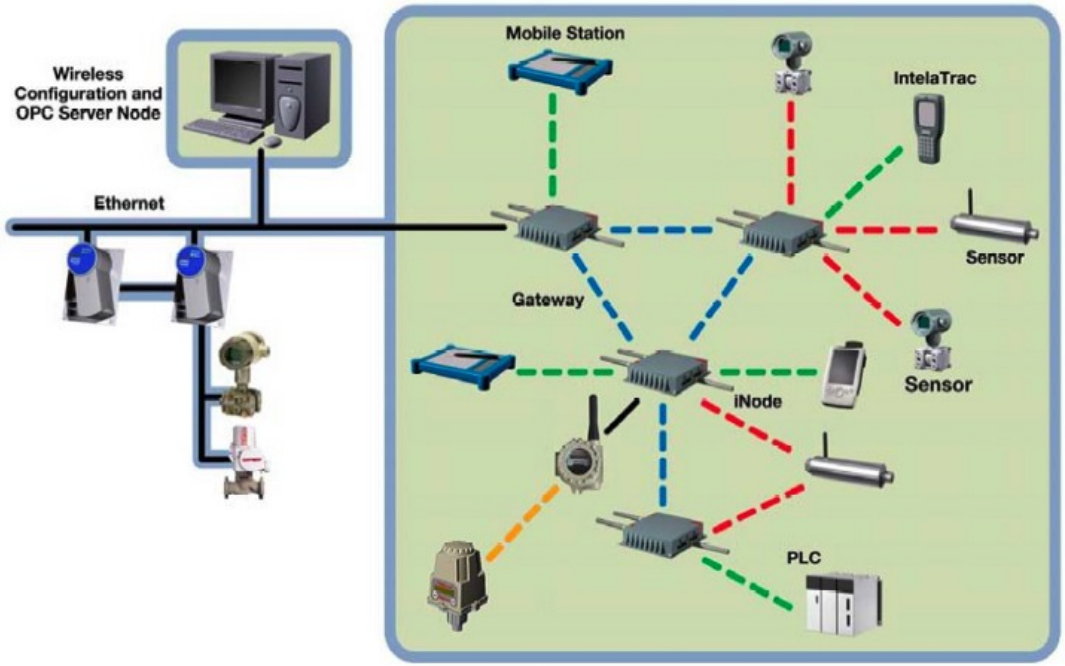
Technical Accomplishments

- Enhanced Security
  - Cryptographic protocol for registration of mesh nodes with certificate authority (CA) and key exchange between pairs of nodes has been outlined
  - State diagram of states, events, and actions to represent the key management system is in development
  - Determination of all cryptographic functionality required (algorithms, random number generation, etc) is currently in process
  - Protocol descriptions for node registration, key exchange, and node removal are in development

Technical Accomplishments

- Multi-functional Plant Communication Network
  - Protocol description for first responder credentialing is in development
  - The accounting feature of RADIUS will be used to enforce the length of time a first responder can access the network



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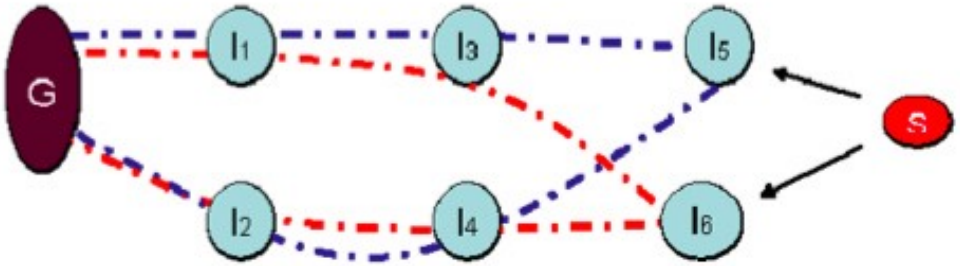
Technical Accomplishments

- User Interaction and HMIs
  - Interacted with industry first responders to get a feel for the best approach to providing them with data in the event of an emergency.
  - Our initial approach assumed hand-held PDAs could be used by first responders to provide them with situational awareness data.
  - Our preliminary conversations suggest that, due to typical hazmat suits, in the short term a mobile command and control center should be given access to the wireless network, and in the long term head's-up displays (HUDs) should be considered.
  - CONOPS under consideration
    - Plant emergencies
    - Railcar derailment with HAZMAT cargo

Technical Accomplishments

- Robust and Reliable Communications
  - Leveraging emerging 802.11s standard to provide multiple node-disjoint paths between network nodes, which recommends AODV and OLSR
  - Considering enhancing AODV to support multi-path routing



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Milestones and Deliverables

- **Enhanced Security (end of Nov 08)**
  - Automatic node authentication
  - Unique cryptographic material per link
- **Multi-functional Plant Communication Network (end of Dec 08)**
  - Easy and fast deployment of time-limited credentials to emergency responders
- **User Interaction and HMIs (end of Dec 08)**
  - Access to data from the site
  - Condensed using predefined filters
  - Simple and easy to understand
- **Enhanced Robustness (end of March 09)**
  - Dual redundant non-overlapping routes
- **Quality of Service (end of March 09)**
  - Optimized message priority depending on current situation
- **Testing and Demonstration (Stage 1: mid Feb 09, Stage 2: mid May 09)**
  - OneWireless and generic (Linksys) mesh networks
  - Integration with Wonderware SCADA system
- **Final Report (end of June 09)**
  - Technical Performance Report
  - Commercialization Plan
  - Standardization Plan

Demonstrations

- **Stage 1: Mid Feb 09**
  - Enhanced Security
    - Show node registration via signing of public key by trusted third party
    - Contrast with current deployment
    - Show node revocation
  - Multi-functional Plant Communication Network
    - First responder credential is time dependent, but extensible
    - Credential deployment (under discussion)
  - User Interaction and HMIs
    - Mobile command unit has access to plant network and can securely obtain info on hazardous areas
- **Stage 2: Mid May 09**
  - Enhanced Robustness
    - Live mesh and killing nodes
    - Visualize with network route
  - Quality of Service
    - Show priority given to sensor data during normal operations
    - Switch to 802.11 data during emergency
    - Use UDP and VoIP to demonstrate

Public Relation Activities

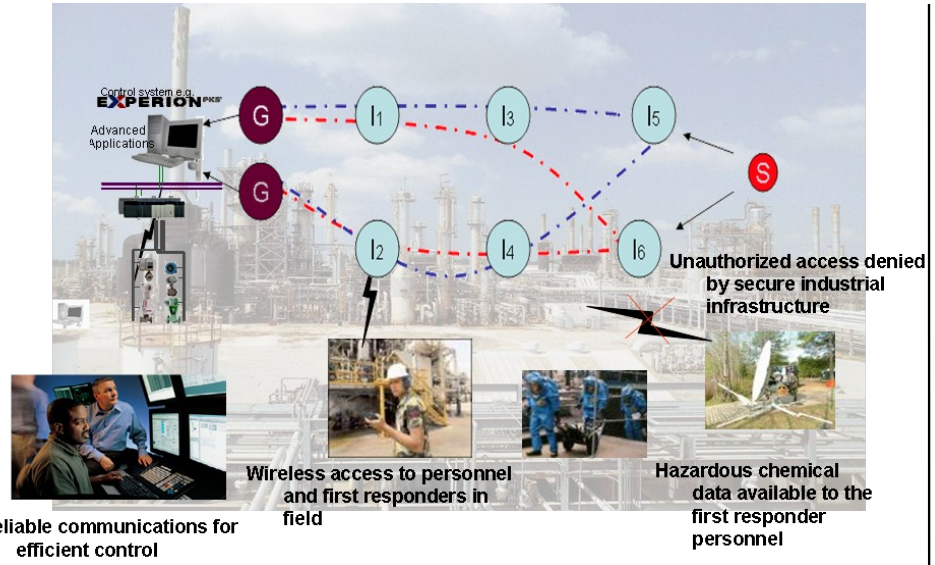
- **Recent:** None
- **Planned:** CATCH conference March 3-4 09
  - At least abstract and poster
  - Demonstration likely but not certain

Planned Transition

- **Commercialization**
  - Honeywell OneWireless is a success story with the U.S. DoE
    - www.honeywell.com/ps/wireless
  - Enhancements developed as part of this project will be proposed for the next generation of OneWireless products
- **Standards**
  - Applicable technologies will be offered to standardization bodies
    - IEEE 802.11, IEEE 802.15.4, ISA 100.11a

BAA Number: Cyber Security BAA07-09 **Offeror Name:** Sandia National Laboratories

Title: Secure and Reliable Wireless Networks for Critical Infrastructure Facilities



Operational Capability:

- Network to be robust to any single point of failure.
- Secure node registration and secure isolated pair-wise communication.
- Extensive safety and productivity improvements, as well as seamless bridging
- and inclusion of first responder devices.
- Quality of Service (QoS) provided for different data as well as for different situations.
- Useful, easy to read data displays available to mobile workers as well as situational awareness (SA) data available to first responders.
- Additional cost of ownership of a OneWireless system for our proposed reliability and security enhancements are expected to be negligible.
- Technical approaches outlined will provide rapid, secure, relevant SA data to first responders as they respond to emergency situations.
- OneWireless was developed as part of an 8 million dollar cost share with DoE and is a commercially available product for critical infrastructure systems.
- OneWireless is designed to be ISA100 compliant and can be integrated with other SCADA systems.

Technical Approach:

The Sandia-Honeywell team will deploy and test a hybrid mesh network for secure and reliable communications in industrial control systems with the following features:

- *Robust and reliable communication of field device data to the control system*
- *Enhanced security using single or multiple keys*
- *Multifunctional plant communication network that provides extensive safety and productivity improvements*
- *Quality of Service mechanisms for different types of data*
- *User interaction and human-machine interfaces available to mobile field workers and emergency first responders*

Milestones, Deliverables, and Contact Info:

Milestones:

- Use case scenario definition and requirement gathering
- Implementation and functional testing based on voice of customer inputs
- System integration, deployment, and testing utilizing Sandia's existing Honeywell Experion PKS system
- Enhanced system demonstration

Period of Performance: *12 Months (total)*

Deliverables: Network demonstration and final report describing reliability and cyber security enhancements, as well as a commercialization path and standardization path, related to hybrid wireless industrial process control system networks for critial infrastructure.

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