# Detection and Analysis of Threats to the Energy Sector (DATES)


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# Securing Process Control Systems

- **Digital controls are essential to modern infrastructure systems**
- **Migration from proprietary systems to commodity platforms, TCP/IP and other common standards, connection to corporate IT**
  - Significant gains in productivity, inter-operability
  - Increasing exposure to cyber attack?
- **Best practice architectures call for perimeter defenses**
  - Increasingly diffuse electronic perimeter
- **Intrusion Detection provides a necessary complementary defense**

# DATES Vision

- Future control systems with PCS aware defense perimeter
- IDS systems fully tuned for control system protocols and highest threat attacks
- Realtime event correlation system for threat identification and response
- Developed in partnership with leading SIEM and PCS providers
- Demonstrated on realistic PCS implementations

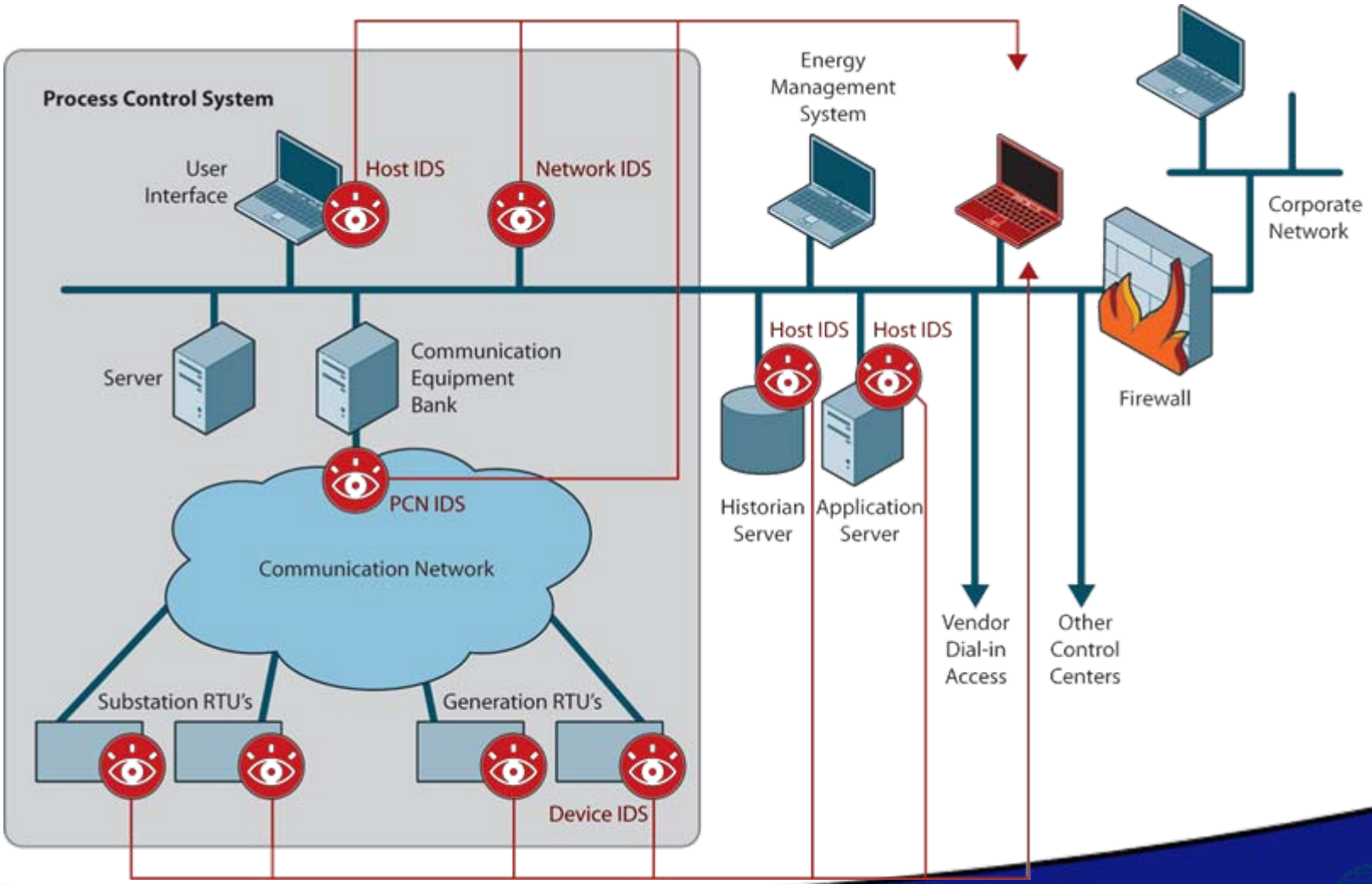
# Intrusion Monitoring as Part of Defense in Depth

- **Control Systems use perimeter defenses**
  - Firewalls, switches
  - Network segmentation
  - DMZ between control and business networks
- **Why monitor?**
  - Ensure perimeter defenses are still effective (Configuration Drift)
  - Ensure perimeter defenses are not bypassed (Out of band connections, dual ported devices—What's on YOUR Field LAN?)
  - Ensure perimeter defenses are not compromised (Attack on the firewall itself)
  - Be aware of unsuccessful attempts to penetrate

# Detection Strategies

- **Signature: Look for known misuse**
- **Model Based**
  - Note regularities in PCS traffic
  - From configuration to rules
  - Machine learning of comm patterns, master/slave, temporal dynamics
  - Encode a model of expected behavior
  - Alert on exceptions
- **Specification**
  - Based on formal analysis of a protocol, or a particular implementation of a protocol
- **Deep process awareness**

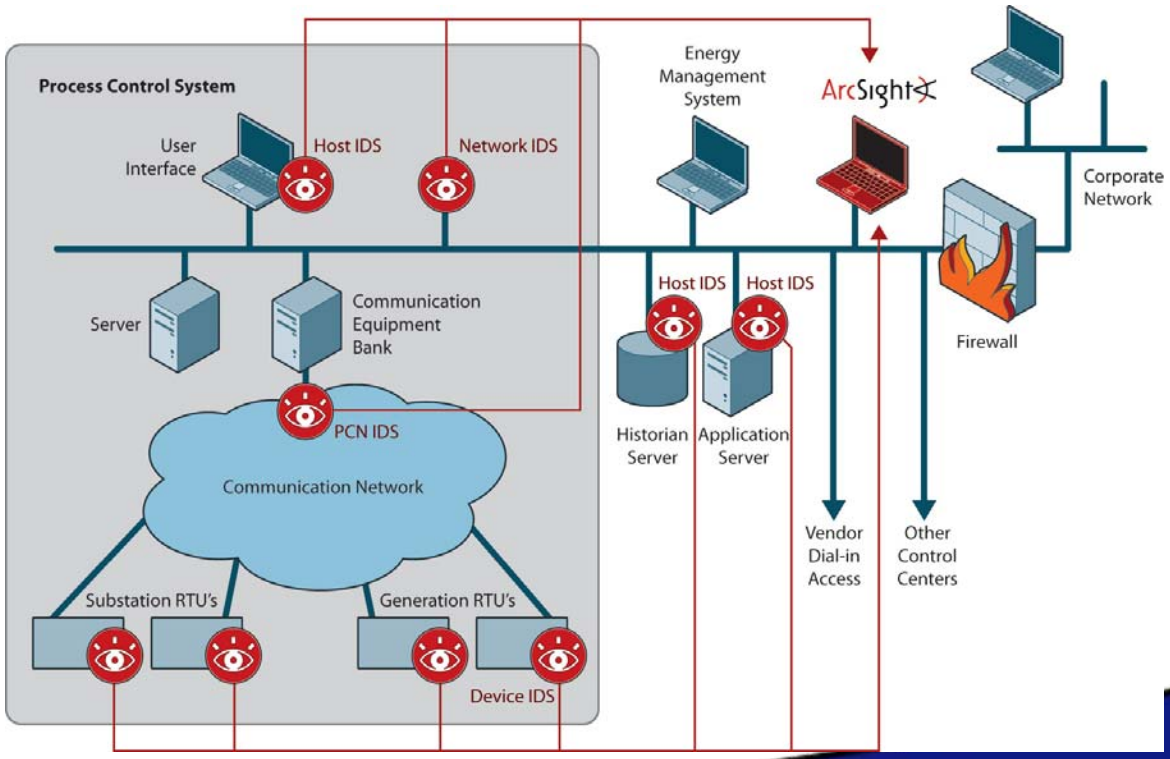
# High Level Monitoring Architecture



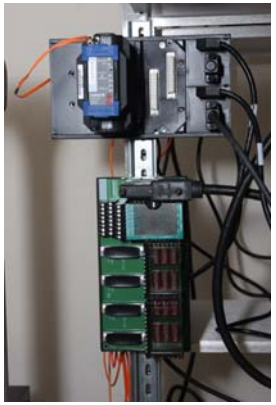
# Visualization of Comm Patterns (OPC)

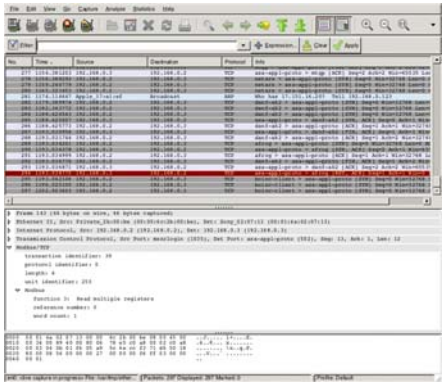
# Detection and Event Management

- **Control System aware IDS at the Device, Control LAN, and Host**
- **Event Correlation integrates new detection data sources into ArcSight**
- **Result:**
  - Correlate attack steps
  - Follow an attack across LAN segments



# Test System Diagram (SRI/Invensys)








Control LAN

Field LAN

# Partnership Between R&D and Industry

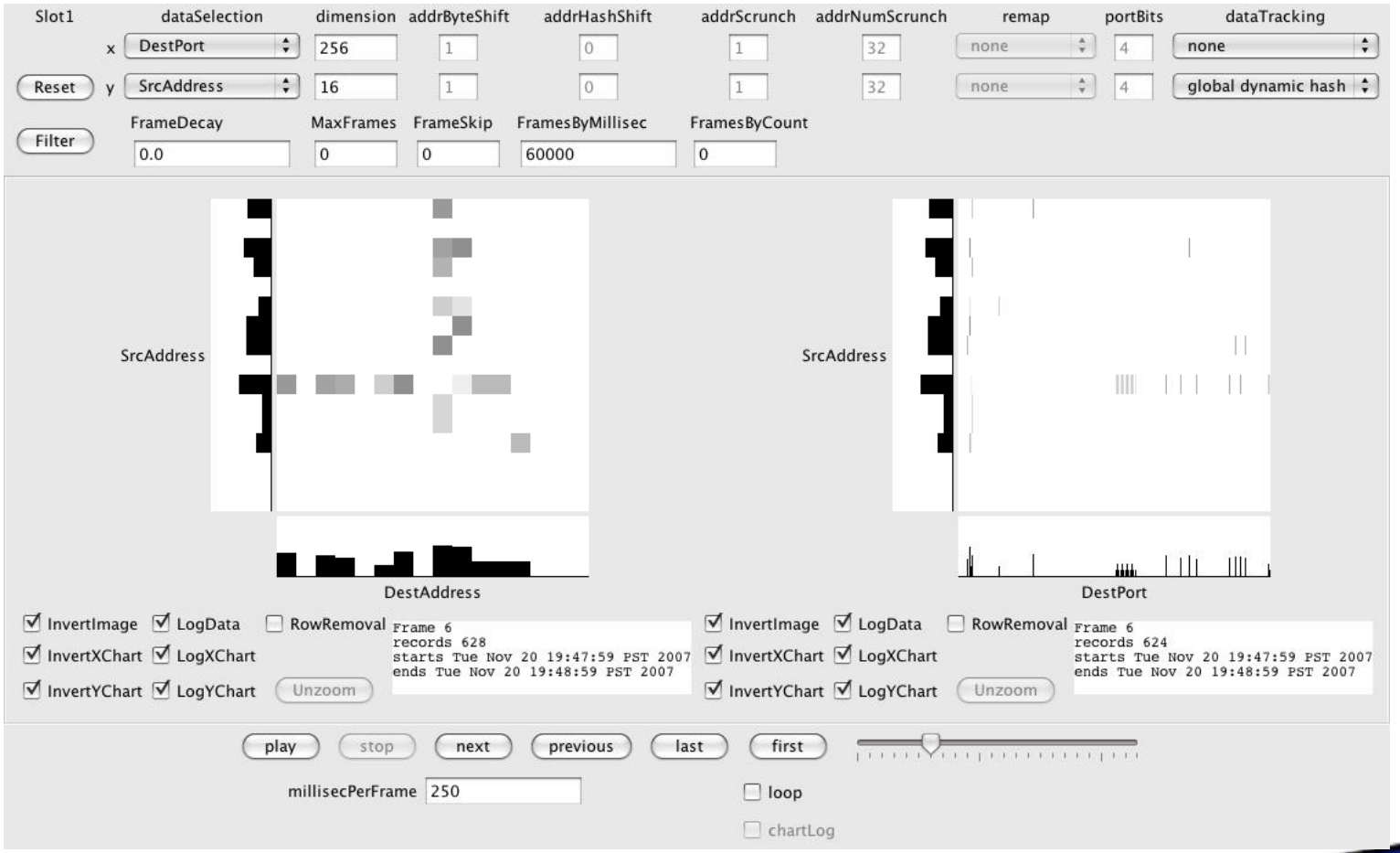
- **SRI (Overall Lead): Intrusion Detection, Protocol Analysis, Event Aggregation**
- **Sandia National Laboratories: Architectural Vulnerability Analysis, Attack Scenarios, Red Team**
- **ArcSight: Security Incident Event Management, Situational Awareness Dashboards**
- **Invensys: Demonstration System, real-world protocol implementations**

# DATES Summary

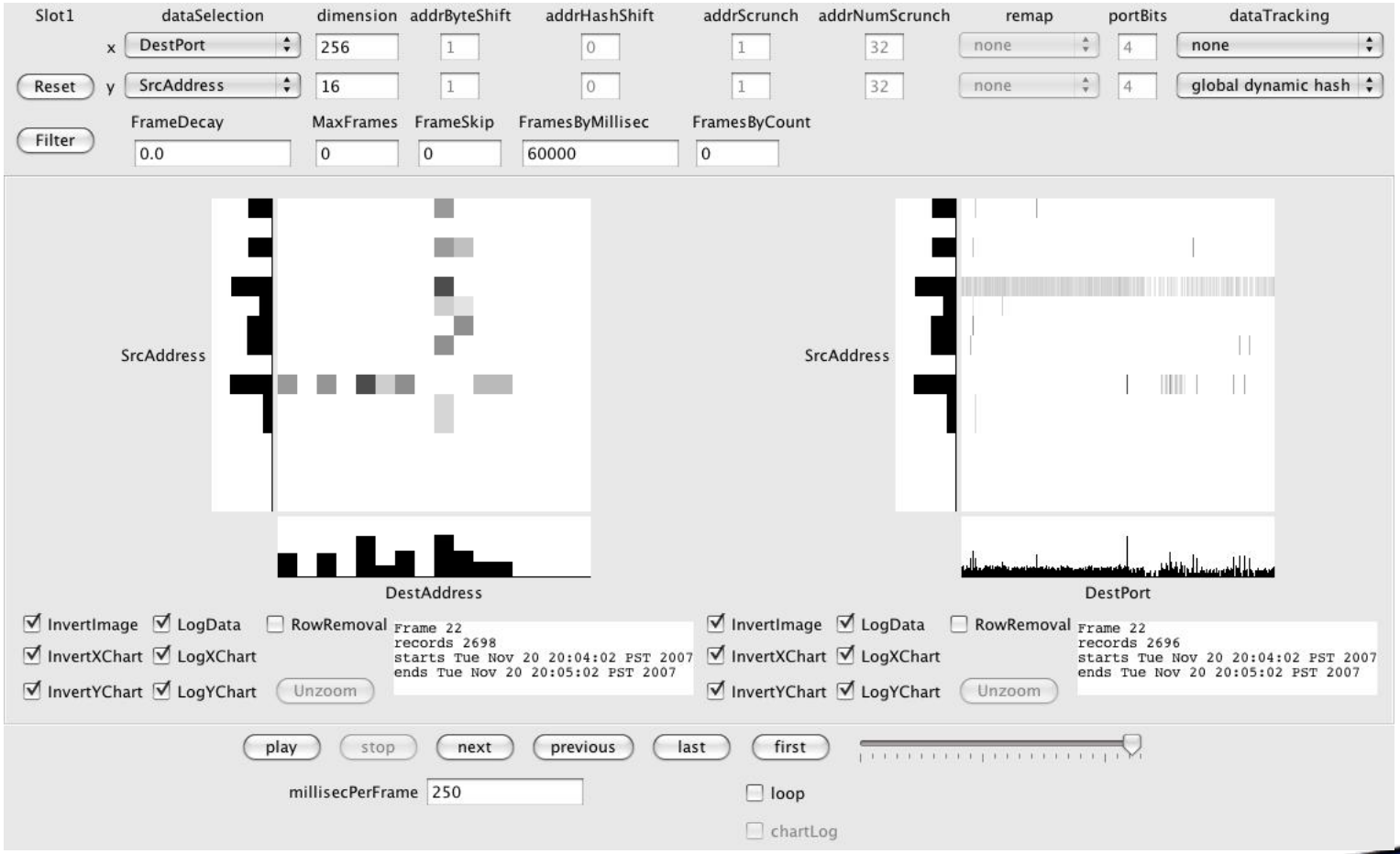
- IDS is a necessary complement to perimeter in PCS
- DATES is developing novel approaches beyond signature detection
- Industry partnerships ensure real world relevance

# Backup

# OPC Trace (Normal)



# OPC Trace (Port Scan)



# Protocol Model: Individual fields

- **MODBUS function codes are one byte**
  - 256 possible values, but
  - MSB is used by servers to indicate exception
  - 0 is not valid, so valid range in 1-127
- **Range is partitioned into public, user-defined, and reserved**
  - With no further knowledge, can construct a “weak specification”
- **Many actual devices support a much more limited set of codes**
  - Permits definition of a stronger, more tailored specification

# Protocol Model: Dependent Fields

- **Encode acceptable values of a field given the value of another field**
  - Example dependent fields include length, subfunction codes, and arguments
  - For example, “read coils” function implies the length field is 6
  - For other function codes, length varies but a range can be specified
- **Specifications for multiple ADUs: future work**

# Detecting Unusual Communication Patterns

- **Specification of network access policies**
  - Comms between CZ and DMZ are restricted to corporate historian client and DMZ historian server
  - Comms between DMZ and PCZ are restricted to PCZ SCADA historian and DMZ historian server
  - SCADA server may communicate with the flow computer and the PLC using MODBUS
  - SCADA server may communicate to SCADA historian
  - SCADA HMI may communicate with SCADA server and engineering station
- **Detection of exceptions is via SNORT rules**
- **More complex networks (more devices) can be accommodated via IP address assignment with appropriate subnet masks**