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Integrating Plant Systems into the Plant Process Computer System at the Prairie Island Nuclear Generating Plant

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Overview

- This presentation will cover
  - Prairie Island Nuclear Generating Plant (PINGP) Overview
  - PINGP PPCS System Overview
  - PINGP I&C Network (ICNET) Overview
  - PINGP PPCS & ICNET Integration
  - Project Issues
  - Future of PINGP PPCS and ICNET

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Prairie Island Nuclear Generating Plant

- Prairie Island Nuclear Generating Plant (PINGP)
- Located in Welch, MN; SE of Twin Cities
- On the west bank of the Mississippi River
- Two-unit Westinghouse PWR
- Each unit is rated for 1,650 MWt
- Commercial Ops: Unit 1 - 1973, Unit 2 - 1974
- Owned and Operated by Xcel Energy (Minneapolis, MN)
  - Operated by Nuclear Management Company (Hudson, WI), 2000 – 2008
  - Operating license actually under Northern States Power Co. - Minnesota, an Xcel Energy operating utility
- License Extension - submitted

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PINGP Plant Process Computer System

- Completed in 2006
- Existing PPCS for Unit 1, Unit 2 and Simulator completely replaced (HW, SW, HMI)
- Upgrade of existing DAS equipment
- Local PPCS system name is Emergency Response Computer System (ERCS)

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PINGP Plant Process Computer System

- Unit 1 and Unit 2 Systems
  - Redundant System
- Stimulated Simulator System
  - Redundant System
- Development System
  - Redundant System
- Plant Server Systems
  - Two separate systems
  - Each supporting both Unit 1 and Unit 2
  - Separate Simulator PSS system for E-Plan Drills only

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PINGP Plant Process Computer System

- Display Workstations
  - Unit Control Room (13 – Unit 1, 13 – Unit 2)
  - Simulator Control Room (14, includes limited U2 safeguards bus WS)
  - TSC (4 dedicated – supports both units)
  - EOF (4 dedicated – supports both units)
  - OSC (via Business LAN)
  - Backup EOF (via Business LAN)
  - Business LAN Workstations
- Network
  - Dedicated PPCS Network
  - Interconnected
    - Both Units
    - Simulator
    - Development System
    - Business LAN (firewall)

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PINGP Plant Process Computer System

- Interfaces
  - Caldon/Cameron LEFM
  - Control Room - Outputs
    - Analog three-pen recorders (DAS),
    - LMM lights (DAS),
    - BOP/NSSS anunciators (DAS)
  - OSI PI
  - NRC Emergency Response Data System (ERDS)
  - Megawatt Meter Display units
  - Substation Inputs (protocol converter necessary)
  - River Water Temperature Inputs
  - Radiological Dose Assessment Computer (RDAC)
  - Unit-to-Unit Communication
    - SPDS on each unit requires data points from the other unit

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PINGP I/C Network Overview

- What is the PINGP I/C Network (ICNET)
  - Network for connecting non-Safety Related Plant I&C Systems
  - Physically separate network from the PPCS network
  - Collects data from Plant I&C Control Systems and other data sources
  - Provides standardized secure interface to PPCS for diverse digital systems
  - Utilizes PPCS archive and HMI for data storage and presentation

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PINGP I/C Network Overview

- Benefits of ICNET
  - The new interfaces provide greater ability to assess and diagnose equipment problems
  - Reduction in number of technologies used to collect and present plant equipment data
  - Increased user efficiency by only having to learn and use one HMI tool for trending and analysis
  - Supports equipment excellence and plant life extension

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PINGP I/C Network Overview

- Beginnings of the PINGP ICNET System
  - Idea predates the PINGP PPCS Replacement Project
  - Initially requested by I&C
  - Intended to be an I&C system and NOT an IT system
    - Limited IT involvement in original design
  - Interface with PPCS was not part of original scope
    - Old PPCS was not readily capable of modern day networking

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PINGP I/C Network Overview

- Beginnings of the PINGP ICNET System (cont.)
  - Replacement PPCS opened the door to interfacing with existing and new I&C systems
    - Operations desired to interface with out-plant alarm stations
      - Typically minimal Control Room alarm windows for out-plant system local alarms
      - Upon local alarm, quick dispatch of out-plant Operator to determine cause
      - Many out-plant systems didn't have archiving capabilities
    - Opportunity to demonstrate capabilities of new system
    - After analysis, chose Aux Bldg PLC, Water Treatment, NSSS/BOP Annunciator, and select Paperless Recorders
    - Desired more, but cost and timing of future equipment replacements were considerations
    - Interfaces initially separate from ICNET

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PINGP I/C Network Overview

- Beginnings of the PINGP ICNET System (cont.)
  - Condenser Tube Cleaning System Upgrade Project
    - ICNET concept morphed to include interface to PPCS
    - Previously chosen out-plant system interfaces added to ICNET plan (separate funding)
    - Transition to IT ownership of system
    - Funded initial ICNET design and implementation

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PINGP I/C Network Overview

- ICNET Systems
  - Current ICNET Systems
    - Aux Bldg PLC
    - Water Treatment
    - NSSS/BOP Annunciator
    - Paperless Recorders
    - Condenser Tube Cleaning System
  - Future ICNET Systems
    - Air Compressors (later 2009)
    - Safety Related Paperless Recorders (2009)
    - Paperless Recorder Project (future)
    - Other plant I&C systems as they are upgraded and replaced

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PINGP I/C Network Overview

- Aux Bldg PLC
  - Common station equipment
  - Liquid Radwaste Control System
  - Goals / Needs
    - Integrate additional data into the PPCS
    - Provide visibility into Liquid Radwaste Control System valve, level and alarm details in the Main Control Room
  - Modicon 584L PLC
  - Modbus Serial Interface
  - Direct Interface to PPCS
    - Remote Equinox Serial Hub appears as local Serial Comm ports on the PPCS Server

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PINGP I/C Network Overview

- Water Treatment
  - Common station equipment
  - Provides purified and treated makeup water to primary and secondary systems
  - Goals / Needs
    - Integrate additional data into the PPCS
    - Remotely identify cause of local alarms
    - Continually monitor chemistry condition of makeup water
  - Honeywell PlantScape 500 Digital Control System
    - Interfaces to Allen Bradley SLC 500 PLCs
  - OPC Interface to ICNET Server

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PINGP I/C Network Overview

- NSSS/BOP Annunciator
  - Hathaway/Beta SER Systems (3 per unit)
    - NSSS: redundant Hathaway SERs, BOP: Beta SER
  - Goals / Needs
    - Integrate additional data into the PPCS
    - Visibility of annunciator alarms to ERO (EOF, TSC, etc.)
    - Tools for redundancy check, windows lit and COS
  - Serial Interface
  - Direct Interface to ICNET Server
    - Remote Equinox Serial Hub appears as local Serial Comm ports on the ICNet Server
  - Proprietary Hathaway/Beta communication protocol

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PINGP I/C Network Overview

- Paperless Recorders
  - Non-Safety Related recorders (6 per unit)
  - Goals / Needs
    - Integrate additional data into the PPCS
    - Recorder data repository for I&C
    - Remote recorder configuration
  - Honeywell Minitrend V5 Trend Recorders
  - OPC Interface to ICNET Server
    - Honeywell TrendServer Pro OPC server on ICNET Server with proprietary communication to Honeywell recorders

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PINGP I/C Network Overview

- Condenser Tube Cleaning System
  - Goals / Needs
    - Integrate additional data into the PPCS
    - Remotely indentify cause of local alarms to help determine level of operator response
  - Allen Bradley SLC 500 PLCs
  - OPC Interface to ICNET Server
    - Rockwell Automation RSLinx Gateway OPC server on ICNET Server

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PINGP I/C Network Overview

- Air Compressor (2009)
  - Common station equipment
    - 3 Instrument Air compressors (Spring 2009)
    - 2 Station Air compressors (Fall 2009)
  - Goals / Needs
    - Integrate additional data into the PPCS
  - Modbus/TCP Interface
  - MARC Omnii-Comm
    - Serial Interface to Sullair Supervisor electronic controller
    - Converts Sullair Supervisor protocol to Modbus/TCP
    - Ethernet Modbus/TCP Interface to ICNET Server

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PINGP I/C Network Overview

- Safety Related Paperless Recorders (2009)
  - Safety Related recorders (4 per unit)
  - Goals / Needs
    - Recorder data repository for I&C
    - Print quality records
  - Yokogawa DX-1000N series DaqStation recorders
    - Qualified isolation device (internal SR-NSR boundary)
    - Ethernet outputs are non-Safety Related
  - Ethernet FTP Interface to ICNET Server
    - Daily recorder files automatically transferred to the ICNET Server via FTP on a 24 hour interval
  - Daily recorder files automatically printed monthly

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PINGP I/C Network Overview

- Paperless Recorder Project (Future)
  - Non-Safety Related and Safety Related Yokogawa paper chart recorders (24 per unit)
    - Obsolete, repair parts not available, high failure rate
  - Non-Safety Related Honeywell recorders (8 per unit)
    - Newer models, consider replacing for standardization
  - Goals / Needs
    - Reliable equipment operation
  - Yokogawa DX-1000N series DaqStation recorders
  - Consider:
    - Modbus/TCP Interface to ICNET Server (continuous data)
    - Integrate additional data into the PPCS
    - Transfer data files to Business LAN via secure FTP
    - Electronic quality records

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PINGP PPCS & ICNET Integration

- ICNET Components
  - Computer Equipment
    - ICNET Server
      - R*TIME Software
      - Honeywell TrendServer Pro OPC Server software
      - Rockwell Automation RSLinx Gateway OPC Server software
      - Hathaway/Beta Interface software (R*TIME)
    - ICNET Printer
    - Equinox Serial Hub
      - Remote Serial Interface

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PINGP PPCS & ICNET Integration

- ICNET Components
  - Networking Equipment
    - Firewall
      - Cyber Security
    - Cisco switches
      - Several models
      - End Node Switches
      - Computer / Printer Connections
      - Firewall Connection
      - Fiber Concentrators
    - N-Tron switches
      - Unmanaged end Node Switches

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PINGP PPCS & ICNET Integration

- PPCS Interface – data flow
  - Aux Bldg PLC
    - Modicon PLC to Equinox Serial Hub (serial connection)
    - Equinox Serial Hub to Remote Equinox Serial Comm Ports (PPCS server)
    - Remote Equinox Serial Comm Ports (PPCS server) to R*TIME Modbus Interface (PPCS server)
    - R*TIME Modbus Interface (PPCS server) to R*TIME CVT (PPCS server)

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PINGP PPCS & ICNET Integration

- ICNET Interfaces – data flow
  - Water Treatment
    - Allen Bradley PLC to Honeywell OPC Server (Water Treatment server)
    - Honeywell OPC Server (Water Treatment server) to R*TIME OPC Client (ICNET server)
    - R*TIME OPC Client (ICNET server) to R*TIME CVT (ICNET server)
    - R*TIME CVT (ICNET server) to R*TIME Unit-Link Client application (ICNET server)
    - R*TIME Unit-Link Client application (ICNET server) to R*TIME Unit-Link Server application (PPCS server)
    - R*TIME Unit-Link Server application (PPCS server) to R*TIME CVT (PPCS server)

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PINGP PPCS & ICNET Integration

- ICNET Interfaces – data flow
  - Annunciator
    - Hathway/Beta SER to Equinox Serial Hub (serial connection)
    - Equinox Serial Hub to Remote Equinox Serial Comm Ports (ICNET server)
    - Remote Equinox Serial Comm Ports (ICNET server) to R*TIME Hathway/Beta Interface (ICNET server)
    - R*TIME Hathway/Beta Interface (ICNET server) to R*TIME CVT (ICNET server)
    - R*TIME CVT (ICNET server) to R*TIME Unit-Link Client application (ICNET server)
    - R*TIME Unit-Link Client application (ICNET server) to R*TIME Unit-Link Server application (PPCS server)
    - R*TIME Unit-Link Server application (PPCS server) to R*TIME CVT (PPCS server)

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PINGP PPCS & ICNET Integration

- ICNET Interfaces – data flow
  - Paperless Recorders
    - Honeywell Trend Recorder to Honeywell Trend Recorder OPC Server (ICNET server)
    - Honeywell Trend Recorder OPC Server (ICNET server) to R*TIME OPC Client (ICNET server)
    - R*TIME OPC Client (ICNET server) to R*TIME CVT (ICNET server)
    - R*TIME CVT (ICNET server) to R*TIME Unit-Link Client application (ICNET server)
    - R*TIME Unit-Link Client application (ICNET server) to R*TIME Unit-Link Server application (PPCS server)
    - R*TIME Unit-Link Server application (PPCS server) to R*TIME CVT (PPCS server)

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PINGP PPCS & ICNET Integration

- ICNET Interfaces – data flow
  - Condenser Tube Cleaning System
    - Allen Bradley PLC to Rockwell Automation RSLinx (ICNET server)
    - Rockwell Automation RSLinx OPC Server (ICNET server) to R*TIME OPC Client (ICNET server)
    - R*TIME OPC Client (ICNET server) to R*TIME CVT (ICNET server)
    - R*TIME CVT (ICNET server) to R*TIME Unit-Link Client application (ICNET server)
    - R*TIME Unit-Link Client application (ICNET server) to R*TIME Unit-Link Server application (PPCS server)
    - R*TIME Unit-Link Server application (PPCS server) to R*TIME CVT (PPCS server)

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PINGP PPCS and ICNET Integration

- Project Issues
  - Initial funding from PPCS Replacement Project budget under-runs and Condenser Tube Cleaning Project
    - Limited Planning
    - Limited Implementation Schedule
    - Limited/Competing Resources
    - Limited consideration of Cyber Security issues
  - Engineering Support for Design Change
    - No/Limited Resources for Design Change Work
    - Delayed Implementation Schedule

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PINGP PPCS and ICNET Integration

- Project Issues
  - Cyber Security, Cyber Security, Cyber Security
    - Limited consideration of Cyber Security Issues initially since Industry / NRC Guidelines evolving
    - Delayed Implementation Schedule caused complete design review with a number of design changes for Cyber Security
  - Condenser Tube Cleaning Upgrade Project
    - After new Condenser Tube Cleaning System installation, ICNET scope removed from project
    - PPCS Replacement Project was tasked to cover implementation costs

PINGP PPCS and ICNET Integration

- Project Issues
  - ICNET Project was Stopped
    - Funding from PPCS Replacement Project withdrawn
    - Add-on scope requested to be stand alone, be justified on its own merits (business case) and get own funding
  - Subsequent Funding
    - Hard sell to management as we competed against aging/obsolete plant equipment
    - Funding eventually approved to complete project

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PINGP PPCS and ICNET Integration

- Design Issues
  - LEFM
    - ICNET or PPCS
  - Aux Bldg PLC
    - RTP or Computer Modbus Interface
    - ICNET or PPCS
  - Air Compressors
    - ICNET or PPCS

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PINGP PPCS and ICNET Integration

- Design Issues
  - Combined PPCS / ICNET Maintainability
    - Common Equipment
      - Utilized the PPCS implementation standard Cisco switch models where possible
      - Equinox Serial Hub is the PPCS implementation standard
      - N-Tron switch model utilized is the PPCS implementation standard
    - Existing Cabling
      - Distributed PPCS Data Acquisition network means fiber already in place to most locations

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PINGP PPCS and ICNET Integration

- Design Issues
  - Combined PPCS / ICNET Maintainability
    - Common Software
      - R*TIME is the PPCS implementation standard
      - Use OPC where available but NOT between ICNET and the PPCS (minimize firewall port exposure)
      - R*TIME Unit-Link is the PPCS implementation standard (replication of Unit data to the PINGP Development System)

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PINGP PPCS and ICNET Integration

- Design Issues
  - Combined PPCS / ICNET Maintainability
    - Reuse PPCS Infrastructure
      - Plant / Corporate LAN access to PPCS data, applications and displays put into place for PPCS replacement
      - Getting ICNET data into the PPCS means it is available to Plant / Corporate LAN users

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Future PINGP PPCS and ICNET Integration

- Future Systems
  - Interfacing to each new digital device will be assessed using a cost-to-benefit analysis as part of the design change

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- Questions?

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PINGP PPCS Project

- The following slides provide additional information on the PINGP PPCS Replacement Project

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PINGP PPCS Project Timeline

- Initial Specification Development - 2002
- Replacement Options Study – Fall 2002
- Final Specification Development – Spring 2003
- RFQ & Bid Evaluation – Summer 2003
- Project Approval Oct. 10th 2003, Contract Award in November
  - Final approval held pending additional dry cask storage
- Rush to order a majority of HW by end of 2003
- “Early Release” Turnover to Ops – February 4th, 2005
- U1, U2 & Sim FAT’s – Summer 2005
- Simulator Installation & SAT – July/August 2005
- Unit 1 Final Installation & SAT – December 5th - 15th, 2005
- Unit 2 Final Installation & SAT – January 11th - 18th, 2006
- Availability Test – March 4th - May 3rd, 2006

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PINGP PPCS Project Scope

- Computer Room
  - All H/W & S/W replaced
  - Server Equipment:
    - New HP Servers in a Primary (w/Hot Backup) Configuration
    - Development System identical to units (H/W & S/W)
    - Plant Business LAN served by separate PSS servers
  - Network Equipment:
    - Redundant Cisco Switches
    - Redundant Firewalls to Plant Business LAN
    - HP NAS and Tape storage units
    - GPS Time Receiver
    - Existing RMU Fibers reused (re-terminated)
    - Existing Spare Fiber used for Control Room
    - Some Fiber to be installed for TSC and EOF
  - Redundant power to all components

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PINGP PPCS Project Scope (cont.)

- Data Acquisition
  - Forty (40) RMUs upgraded (21 – Unit 1; 19 Unit 2):
    - Interface Replaced with RTP2000
      - Compatible with 74xx series cards
    - Other chassis and components upgraded as needed
  - Scope did NOT include:
    - Analog and digital cards
    - Chassis-external power supplies
- Control Room
- TSC, EOF, OSC and Backup EOF
- Simulator

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PINGP PPCS “Early Release” System

- Backup parallel system for TRM LCO relief
- Turned over to Ops ~1 year prior to final release
- Same Scientech R*TIME display and subsystem environment as final release
- Field data received “raw” from Data Concentrators
- Key TRM LCO applications & database converted
- Workstation put in control room
  - … and select personal Business LAN locations
- Delayed final installation a few months
- Implementation proved to be invaluable
  - Resulted in less TRM LCO entries and earlier operator familiarization with the new system

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PINGP PPCS Implementation

- PPCS cutover from old to new system performed while units online!
- 25 site-specific applications were developed
  - Most based on old functionality, some new functionality added
- Over 125 displays per unit on old system, over 350 on new
  - Retained similar look/layout
  - Graphics kept simplistic to keep focus on system data/status
- Periodic logs/reports retained
  - Reduced number sent to printer
- Documents – 117 total
  - SRS/SDD – 25, combined (highly recommend)
  - FAT & SAT – 37 each
  - Other - 18
- Scientech PMAX balance of plant performance monitoring software package installed on separate server

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