Exploring Digital I&C Upgrades

Roundtable / Dinner

Nuclear Energy Insider
Power Uprate *Conference*
--June 17, 2011

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Exploring Digital I&C Upgrades Participants

aps

CENG
a joint venture of
Constellation Energy
EDF

Duke Energy

Eskom

FLUOR

ZACHRY

FPL

invensys

AREVA

WorleyParsons
resources & energy

OSIsoft

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Why Are We Here?

- Knowledge exchange
  - Opportunities for improved reliability / output
  - Discuss challenges
- Share insights / perspectives
  - Utilities (demand side)
  - Vendors & suppliers (supply side)
  - Advisors, consultants
- Timely issues with a lot of associated questions
  - Need for I&C upgrades
  - State of the industry; progress
  - Opportunities and challenges

Situation Analysis – State of Industry

- Operating Plants
  - 104 U.S. plants, mostly analog instrumentation & control systems
  - ROW, some 336 plants, though some have upgraded various parts of I&C systems to digital
- New Builds (Digital)
  - 4 Units in the U.S. underway
  - Many additional plants to come, when?
- Regulatory Policy progressing
  - Plants in Sweden, Switzerland, others more advanced
  - NRC has moved slowly due to cyber security concerns

"All new NPPs are being designed with integrated digital I&C as the backbone of protection, controls, alarms, and display and monitoring" --NRC Website

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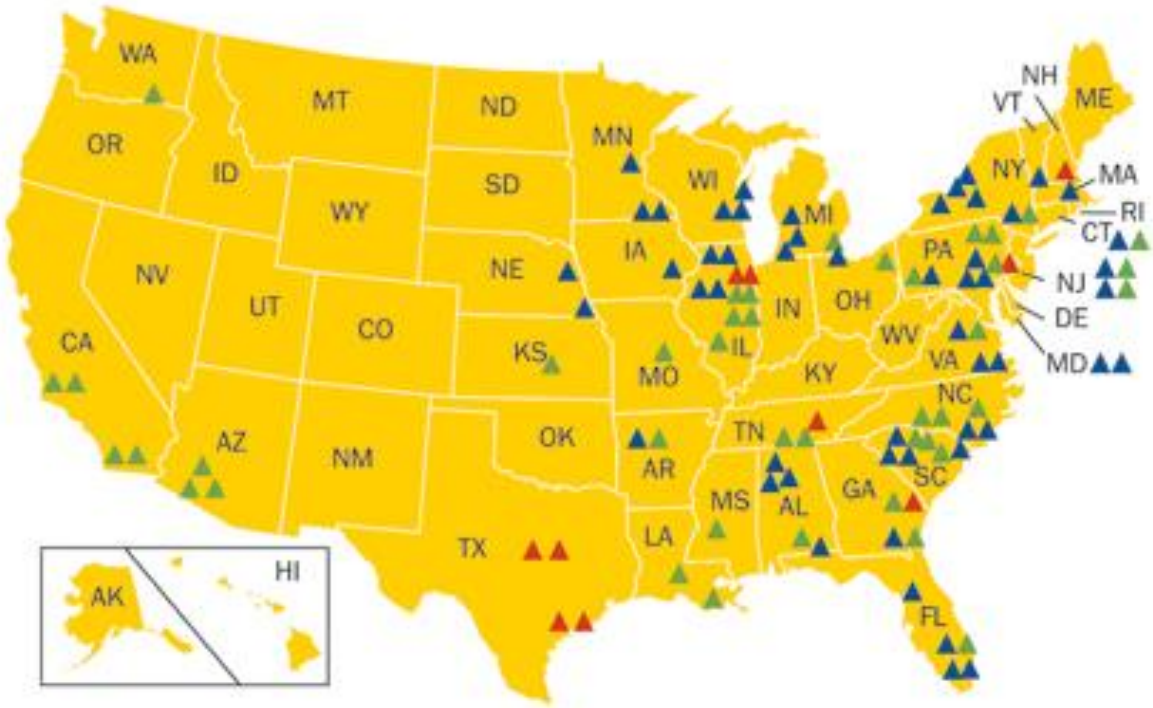
Situation Analysis – State of Industry

- Typically, U.S. plants using 30-40 year old I&C technology
  - Some plants experienced reduced reliability/productivity
  - Upgrades driven by obsolescence, economics
- Globally, plants in various stages of upgrade
  - Entergy, selective, partial upgrades
  - Some European plants already have all-digital reactor protection systems (France, Germany, Japan, Korea, Sweden, Switzerland, UK)
  - Oconee's project is comprehensive digital upgrade of major safety related systems; first of a kind for U.S.

"The NRC is committed to licensing digital technology in safety system applications"
--NRC Website

104 Operating Reactors

U.S. Commercial Nuclear Power Reactors—Years of Operation



Years of Commercial Operation	Number of Reactors
△ 0-9	0
▲ 10-19	10
▲ 20-29	42
▲ 30-39	52

Source: U.S. Nuclear Regulatory Commission

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New Nuclear Power Plants

Proposed Reactors – How Many Likely 5 Years?

X = Significant Postponement (Linton Assessment)

ABWR ■ AP1000 ✚ EPR ▲ ESBWR ♦ USAPWR ▽ Design/Units - TBA ● ESP

*Review Suspended by Applicant

** COL Application Amended by Applicant to ESP on 03/25/2010

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Key Questions

- What are the pros and cons of upgrading I&C systems to more modern digital technology?
- What is current state in all systems? In safety-related systems?
- Is there an advantage to making conversions in connection with Uprates or Maintenance & Modernization projects?
- How have cyber-security concerns been resolved?
- How long do such programs require? How disruptive?
- What are typical costs?
- What is role of licensee vs. vendors & contractors?
- Others (lessons learned, etc.)

Participant Experience

- Varied experiences
  - APS (Palo Verde)
  - AREVA
  - Constellation
  - Duke (Oconee)
  - Eskom
  - Fluor
  - FPL
  - Invensys
  - OSIsoft
  - Worley-Parsons
  - Zachry

Duke – Oconee Comprehensive Digital I&C Upgrade

- Project team has completed digital upgrades of systems
  - Integrated control system
  - Main turbine control system
  - Control rod drive system
  - Main generator voltage regulator
  - Process control system
  - Emergency power
  - Automatic feedwater isolation system

"Duke Energy has become the industry leader in addressing the associated technical and regulatory issues" of Digital upgrades

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Duke Upgrades Turbine I&C

- Objectives
  - Reduce cost of downtime and unplanned outages
  - Eliminate unnecessary system trips
  - Eliminate single point of failure; provide redundancy
  - Reduce inordinate time for recalibration
- Methods
  - Improve diagnostic software for troubleshooting
  - Upgrade cumbersome analog interfaces
    - Switches, meters
    - Running tests, obtaining readings
  - Execute start-up and valve tests more efficiently
- Hardware/software solutions
  - Invensys, Triconex, Wonderware

Pros and Cons of Upgrade

Pros

- Improve safety and operational performance
- Improve plant reliability
- Eliminate obsolescence of equipment & systems
- Improve productivity
- Improved safety
- Positive ROI

Cons

- Capital investment
- Long term program
- Regulatory validation
- Equipment /design practices significantly different
- Re-training required

"…digital technology has the potential to improve safety and operational performance" –NRC

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Current State

- Use of digital systems not new
  - In 1980s some digital was introduced in subsystems & auxilliary areas
  - In 1990s began to be used in data logging, control and display for non safety related functions
  - Extensively utilized in fossil power and other industries
- Outside U.S.
  - Japan first fully digital I&C system installed in 1996
  - France, UK, Korea, Sweden, Germany, others implemented
- In past, U.S. digital I&C systems were used in
  - Feedwater, recirculation, demineralizer control
  - Main turbine control
- Duke Oconee (Unit 1) first comprehensive safety-related digital I&C system, now operating

When to Upgrade?

- Regulatory process
  - What are the licensing requirements?
  - How long did it take?
  - What will be different for Duke in future? For others?
- Is there an advantage to making conversions in connection with Uprates or Maintenance & Modernization projects?
  - How has Duke taken advantage of scheduled outages and other plant down time for this and other capital work?
  - Duke has done key installations during scheduled outages
  - What are the lessons learned?

Cyber-Security Issues

- How have cyber-security concerns been resolved?
  - Cyber-security has been a key concern of NRC
  - How has Duke dealt with this challenge?
  - How have Asian & European plants dealt with it?

"Oconee's software was designed with no external network connections"

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Program Management Issues

- Duke has been planning and implementing it digital I&C upgrade for a decade
  - Why has it taken so long?
  - How long should such programs require in the future?
  - How disruptive is this to ongoing operations?
- What would we expect costs to be?
  - Were vendors expected to invest in this FOAK project?

Program Management Issues

- What is the role of licensee vs. vendors & contractors in digital upgrade of major safety systems?
  - What size staff over the life cycle of this program has Duke devoted to the program?
  - How many and what kinds of contractors and consultants have been used?
  - What is the role of hardware and software vendors?

Lessons Learned

- What lessons can Duke share with other utilities?
- How will Duke do differently on units 2 and 3 as it seeks to implement digital upgrades to these units?
  - Unit 2 upgrade expected in 2012
  - Unit 3 in 2013
  - New panels for 3 reactors: $250 mil
  - Expected to last the life of the plants

Appendix

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Insights for Industry and Government

Who Is Linton Consulting?

- A professional practice providing independent insights and advisory services to industry and government, focused in energy
- Help with business strategy, market development, trend analyses, scenarios and futuristic market/industry visioning
- Strategic View – process that provides high level insights on the future state of industries and markets; developed through ongoing analyses and executive interviews
- Services leading to sound business decisions, plans and actions
- Partnering relationships with UxC, *Nuclear Energy Insider*, and InnovaNet

Who is Linton Consulting?

- Independent practice providing strategic development and market development services in Energy and Manufacturing
  - Over 30 years experience with large engineering and construction firms: CH2M HILL, Lockwood Greene, Fluor
  - Over a decade of consulting experience
  - Extensive industry contacts & ongoing interviews

Strategic View Industry Studies

- 2010 Energy Challenges/ Energy Parks
- 2008 Nuclear Renaissance
- 2007 Oil, Gas, Chemicals
- 2006 Energy
- 2005 Mfg./Industrial
- 2004 Food & Beverage
- 2003 Pharmaceutical
- 2002 Power
- 2001 Infrastructure Life Cycle, Others

Past *Linton* Industry Studies

- Oil & Gas
- Electric Power
- Engineering and Construction
- Water/Wastewater
- Environmental
- Asia/Pacific
- *Market Reports* - Series

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2010 Research Conducted – For SRNS

115 Interviews, Discussions, and Meetings*

- Ameresco
- American Nuclear Society
- Arizona Clean Fuels
- B&W
- BetterPlace
- BP
- Building Construction Trades Dept. (AFL-CIO)
- Canup & Associates
- Carolinas' Nuclear Cluster
- CH2M Hill
- ConocoPhillips
- CSIS
- Duke Energy
- DOE
- DOE- EM
- Dow Chemical
- Eastman Chemical
- Economic Development Partnership
- EIA
- EPRI
- Exelon Corporation
- Fluor
- Gasification Technologies Council
- General Atomics
- General Electric
- GE- Hitachi
- George Mason University
- Honeywell
- Hyperion Power
- Marathon
- Marston Consulting
- MIT
- NEI
- New Carolina
- NNSA
- NRC
- Peabody Coal
- PJM Interconnection
- Progress Energy
- Rentech
- S-4 Energy Solutions
- SCANA
- SC Regional Development
- Senator Graham's Office
- Senator DeMint's Office
- Shaw Group
- Siemens-America
- Southern Company
- SRNL
- SRNS
- SRNS- Honeywell
- SRNS- Northrup Grumman
- SRS-CRO
- TerraPower
- Technology Ventures
- Three Rivers Solid Waste Authority
- University of South Carolina
- UOP - Honeywell
- USEA
- Westinghouse

*Some organizations had multiple interviews

Savannah River NUCLEAR SOLUTIONS℠
FLUOR DANIEL • NORTHROP GRUMMAN • HONEYWELL

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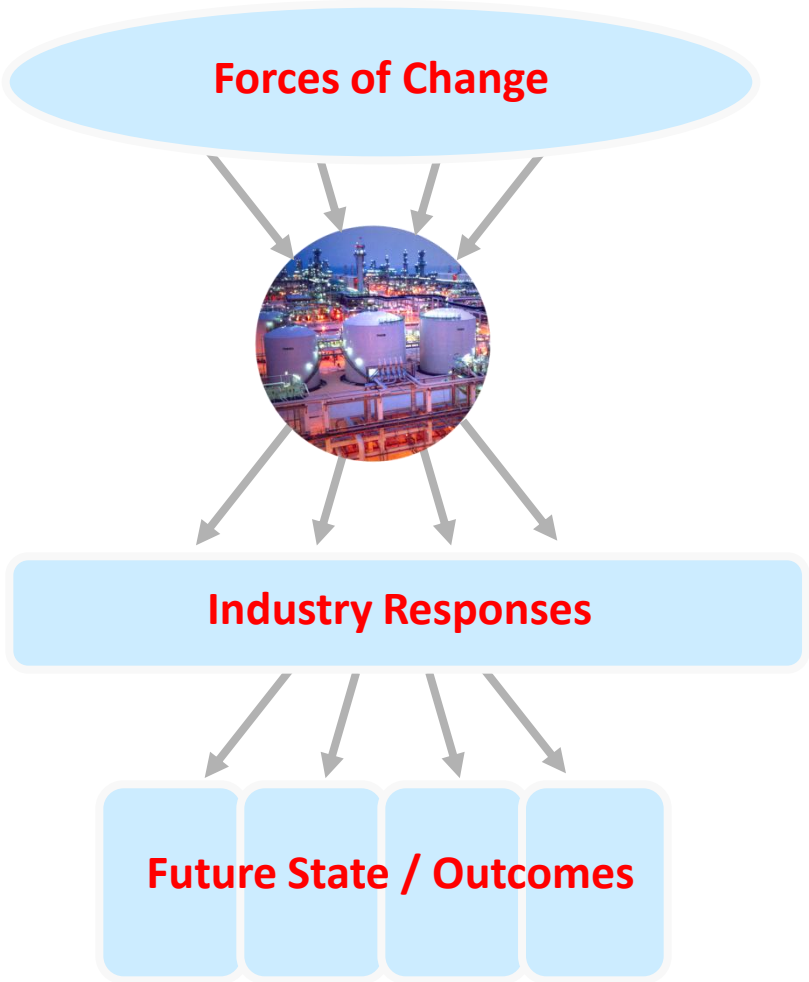
What is *Strategic View*?

- Research model
  - Used 14 years; 5 in energy
  - Forces affecting the future of the energy industry
  - Industry responses
  - Where it is leading – the future state/outcomes
- Process
  - Interviews with executives and thought leaders
  - Research & analysis
  - Executive Roundtable
  - Follow up & plan integration



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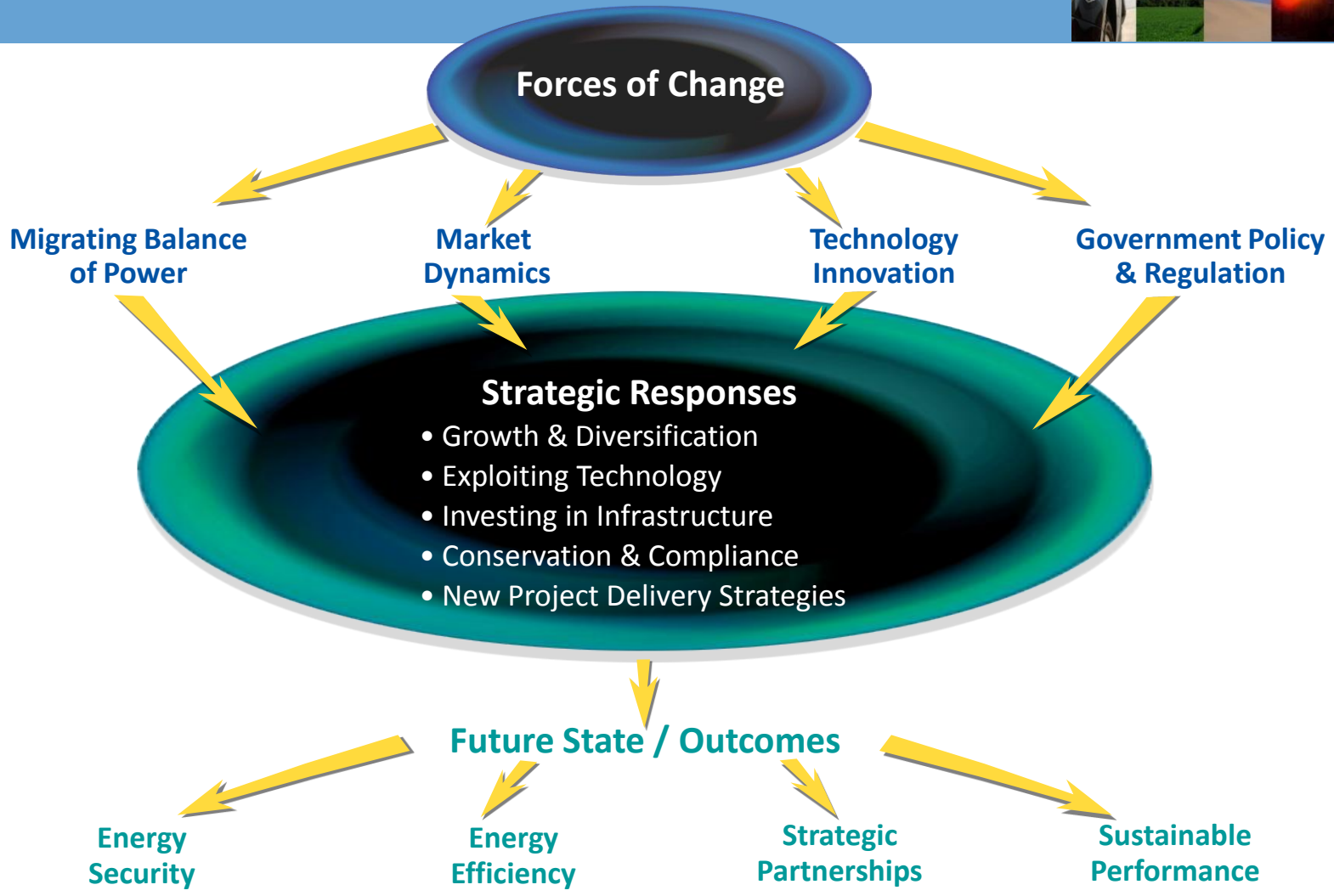
Strategic View – Energy (Example)



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Executive Roundtables

- Common purpose
  - Convene executives and thought leaders for knowledge exchange
  - Expand understanding
  - Share perspectives
  - Confirm/challenge paradigms
  - Advise leadership
  - Uncover ideas and opportunities for your organization
  - Explore Future – trends and challenges
  - Establish practical, realistic path forward

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