Trends and Market Overviews on Grid Modernization:  
Presentation to EMMOS 2016 Conference

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Newton-Evans Research Company
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Today’s Discussion – A Smorgasbord of Topics

• The Electric Power Community - Description
• Grid Modernization – Investments in Smart Grid
• Role of Telecommunications – No single solution
• Control Systems Observations – Summer 2016
• Role of Consultants – Increasingly Important in our Increasingly complex working environment
• Upgrading our Substations
• Advancing DMS -
Company’s Mission and Role in Life: **Bridging the Gap** Between Suppliers and Users of Grid Modernization Technology

- Ongoing studies of Electric Power Grid Modernization and control systems usage patterns and plans among the world’s electric power delivery utilities.
- We serve as the *bridge* between what utilities need and want in control systems and infrastructure and what systems providers-equipment manufacturers need to know in order to develop solutions to meet utility requirements.

![Image of a bridge and people connecting hands]
The Global Electric Power Industry

- More than 10,000 electrical utilities in the world.
  - 30% are in the U.S. alone
  - Only about 50 of the world’s utilities serve 5 million or more customers directly.
  - There are approximately 1.65 BILLION electric metered sites (customers) throughout the world.
  - Several countries have a SINGLE dominant electric power utility or company for G, T or D (Mexico, France, South Africa, Russia, Italy, Mashreq and Maghreb regions of the Middle East)

- There are thousands of large fossil fuel plants producing electricity
  - Along with about 420 nuclear plants
  - And now, with renewables part of the mix, hundreds of wind farms and solar farms join with the long-term hydro electric production sites around the world.
Global Power Industry Statistics

• There are more than 250,000 T&D substations in the world considered “primary”
• There are more than 5,000,000 “secondary” substations around the world.
  – The U.S. alone has an estimated 46 million installed distribution transformers.
Total U.S. Meter Population at YE 2014 = 147.4 Million.
Source: U.S. DoE, EIA as charted by Newton-Evans Research
Revenue from Retail Sales of Electricity to Ultimate Customers: Total by End-Use Sector

- Residential: $177.4 B
- Commercial: $143.9 B
- Industrial: $66.8 B

Total Industry Revenue from Retail Sales of Electricity in 2015: $388.1 B

Source: U.S. DoE, EIA. Charting by Newton-Evans Research
Smart Grid and IT Expenditure
North America Estimates for 2015

Now Including newer additions/ --Expenditures for Grid Analytics and ADMS

$1.9 Billion
Overlap Portion of Operational IT & Smart Grid for Control Systems including ADMS, DA, Substation Automation Protection and Control

$1.8 Billion  “Pure” Smart Grid for DA, AMI, Comms, TX & DX Monitoring/Control Devices, Renewables Interties

$950 Million
Overlap Portion of Admin IT/Smart Grid for MDM, Portions of CIS, Billing, OMS and Grid Analytics

$4.65 Billion
Total Smart Grid

$4.65=1.8+1.9+.950

Source: Newton-Evans
Smart Grid and IT/OT Expenditure
Global Outlook for 2020

- **T&D Ops. IT**: $10.5B
- **Admin IT**: $20.5B
- **Engineering Workstations, CAD, GIS**: $6.5B
- **“Pure” Smart Grid**: $6.5B
- **Total Smart Grid**: $21B

$8.3 Billion
Overlap Portion of Operational IT & Smart Grid for Control Systems
Substation Automation
Protection and Control

$6.5 Billion
“Pure” Smart Grid for DA, AMI, Comms, TX & DX Monitoring/Control
Devices, Renewables
Interties

6.2 Billion
Overlap Portion of Admin IT/Smart Grid for MDM, Portions of CIS, Billing, OMS

$21B = $6.5B + $6.2B + $8.3B

Source: Newton-Evans
Are Users, Vendors Communicating?

Ironically, not in the data communications field

Despite a relatively healthy economy, there's a broadening gap between technological innovation and the diffusion of products among users. This gap has hit home concretely in the data communications arena.

The wide variation in availability of new data communications products or services and its widespread adoption by large, multi-locational businesses and government organizations seems to be lengthening, except for low-cost devices. This seems to be taking place despite the fact users are telling us they have a need for new technical and price breakthroughs as have occurred since 1982.

The cost of developing data communications systems can and has been a limiting factor. However, if information vital to a prospective user organization has to move rapidly, if there is a true "time value" to at least some applications in the organization's information base, then the cost of moving that information has to pale in comparison with the potential value of placing that vital information at the right location at the right time.

Certainly there are plausible reasons for the delay in making voice and data communications plans "stick," whereby only a relative handful of American organizations appear to have advanced their use of data communications beyond the level of a few modems. And many of the hundreds of large organizations we've surveyed over the last few months have multiple networks for multiple applications, using different line speeds, protocols, device types, and sources of supply, with only minimal centralized controls.

How can this be so? Well, at the risk of oversimplifying an extremely complex environment, here are my reasons, based on conversations with hundreds of user organizations each year:

Two groups in the same company can effectively communicate with each other, if allowed and encouraged to do so.

Considering that there are from four to six important suppliers for each of perhaps 15 major product or service components of even a "starting-gut" level of a multi-point privately operated network, DPMIS departmental budgets for formal staff education should be increased significantly and quickly. There are very few, if any, DPMIS staff members who do not need some working knowledge of data communications principles.

It boils down to the observation that large datacomm users are not yet geared up to take advantage of many of the recent technology and price breakthroughs brought about by increasingly price-competitive suppliers.

On the supplier side, most datacomm providers have failed to realize their market potential because they have relied too much on stressing product comparisons, rather than developing solid, product information that allows their points across.

Most potential user organizations would benefit greatly if datacomm suppliers were to put their best people in marketing support positions, provide tutorials, and produce solid but readable documentation written for people who don't have the letters "M.S.E.E." behind their names.

If suppliers need an incentive to communicate more effectively with their customers, they should keep in mind that information is a critical link and there is a quarter million businesses and government organizations of sufficient size to require such access to external information sources and timely exchange of information with other organizations.

This domestic market potential for data communications obviously has long-term, serious implications billions of dollars. Yet those dollars are not going to be spent until the industry provides sufficient information, explores sufficient alternatives, and supports sufficient standards.

In turn, user organizations have to make the commitment to educate their DPMIS staffs, including the systems and communications planning people. Companies must define clear lines of authority and issue descriptions of the responsibilities of voice and data communications staffs. Users must be committed to understanding and exploring mid-term and long-term integrated voice and data communications alternatives.

If user organizations do not determine their overall data communications requirements and communicate them to their suppliers, the datacomm picture will continue to be confusing.—Chuck Newton is president of Newton-Evans Research Co.
Protocol Usage Patterns – Substation Automation
Mid-2016

North America

- DNP3: 35%
- SEL Fast Message: 78%
- Interleave: 17%
- MODBUS: 9%
- Other: 1%
- IEC 61850: 1%
- UCA2: 0%

International

- IEC 61850: 65%
- Other: 35%
- DNP3: 26%
- MODBUS: 13%
- UCA2: 4%
- SEL Fast Message Interleave: 0%
Relay Protocols Used with SCADA
(mid-2016 Studies)

North America

- DNP3: 88%
- SEL Fast Message Interleave: 23%
- MODBUS: 17%
- Other: 12%
- IEC 61850: 4%
- UCA2: 1%

International

- Other: 46%
- IEC 61850: 38%
- MODBUS: 33%
- DNP3: 25%
- UCA2: 0%
- SEL Fast Message Interleave: 0%
From a competitive viewpoint, what are the key strengths of the supplier of your principal operational control systems?

- Technology Platform Stability: 80%
- Total Cost of Ownership: 70%
- Support Staff: 50%
- Partner Relationships: 30%
- Upgrade Schedule: 30%
- On time Installations: 20%
- R&D Investments: 10%
- Sales and Marketing Team: 10%
- Management Skills: 0%
- Other: 0%
For each of the following statements regarding the role of T&D consulting engineers, indicate "agree," "uncertain," or "disagree."

<table>
<thead>
<tr>
<th>Statement</th>
<th>Agree</th>
<th>Uncertain</th>
<th>Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consultants are becoming more important than ever.</td>
<td>50%</td>
<td>50%</td>
<td>0%</td>
</tr>
<tr>
<td>Consultant role is limited to helping with RFPs and Proposal assessments.</td>
<td>50%</td>
<td>0%</td>
<td>50%</td>
</tr>
<tr>
<td>Consultants are active every step of the procurement process through to installation.</td>
<td>50%</td>
<td>70%</td>
<td>30%</td>
</tr>
<tr>
<td>Consultants are required to bring utility OT and IT groups together.</td>
<td>50%</td>
<td>10%</td>
<td>40%</td>
</tr>
</tbody>
</table>
To what extent do you find T&D Engineering consultants to be fair and impartial in the U.S. market? (Pick only one.)

- The majority are fair and impartial, 80%
- They each have their favorites, 20%
- They are all fair and impartial, 0%
In your opinion, how is the role of T&D engineering consultants likely to change over the 2016-2020 years?

- **Be more of Brick and Mortar type organizations providing turn key solutions and maintaining systems for the utility companies.**
- **Depending on the complexity, schedule, and in house expertise of projects, consultants will have to reside at utilities for extended periods of time.**
- **I feel that they will become more specialized focusing on one area of T&D engineering.**
- **It appears that smaller T&D consulting companies are being absorbed by larger firms. Larger firms do not always provide the same level of personalized support. As a result, their role may diminish.**
- **More grassroots involvement in day-to-day operations due to aging work force and lack of replacement workers.**
- **There will be increasing reliance on these types of companies**
- **They will have to adapt to the changing markets and more technical (computer) fields.**
- **This group needs to be more in-tune to the needs of their clients and not the goals of the consulting company which is how fast can this job be turned and move to the next one. This means that they should not look at the type of contract they have, i.e. project or cost plus but to the job they will provide to the client in meeting expectations.**
- **With increasing budget pressure, consultants will continue to provide the expertise and manpower that utilities may lack internally. In the future I think consultants will need to be provide even more value for each dollar. Accountability will continue to increase for consultant spending as it is for internal utility spending.**
- **With the paradigm shift in the electric industry, IOUs are cutting back on staff and having Engineer, Procure, Construct programs to minimize cost for the sole purpose to satisfy their investors. I for see an increase of consultant to do this work. I also believe that the Municipals will follow the IOUs.**
Will the Operations/Engineering organization at your utility be working more closely with the IT department during 2016?

- yes, 70%
- no, 20%
- uncertain, 10%
What are your major topics for working with your control system suppliers over the next 24-26 months?

- Cybersecurity: 100%
- NERC CIP compliance: 100%
- OT/IT integration: 20%
- Operations staffing levels: 20%
- Data analytics: 10%
- Other: 10%
Sizing the U.S. Substation Market

• N-E’s Latest Physical Counts – U.S. Electric Power Substations

• Utility Owned and Operated Substations
  – Transmission Class (HV and EHV) = 13,670
  – Distribution Class (MV 38.5kV and Lower) = 51,960

• Industrially Owned and Operated Substations
  – Transmission Class = Perhaps 1,500 units
  – Distribution Class = Perhaps 12,000 units
Substation Automation Market Facts and Factors in North America

Do you have funds budgeted for new and retrofit substation automation and integration programs at your utility between 2014 and 2016? (North America respondents)

- **Yes**
  - 2014: 77%
  - 2015: 70%
  - 2016: 65%

- **No**
  - 2014: 23%
  - 2015: 30%
  - 2016: 35%
Status of Automation in Transmission Substations

Level of automation for Transmission Substations (North America respondents)

- Now in operation
- To be retrofit by YE 2016
- New to be built by YE 2016

The graph shows the number of substations in different levels of automation:
- With no automation
- Some automation
- Full automation

- Now in operation: The majority of substations fall under full automation, with significant numbers in some automation as well.
- To be retrofit by YE 2016: A smaller number, primarily in some automation.
- New to be built by YE 2016: An even smaller number, primarily in some automation.
Status of Automation in Distribution Substations

Level of automation for Distribution Substations
(North America respondents)

- **Now in operation**
- **To be retrofit by YE 2016**
- **New to be built by YE 2016**

<table>
<thead>
<tr>
<th>Level of Automation</th>
<th># of Substations</th>
</tr>
</thead>
<tbody>
<tr>
<td>with no automation</td>
<td>1500</td>
</tr>
<tr>
<td>some automation</td>
<td>3500</td>
</tr>
<tr>
<td>full automation</td>
<td>1000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level of Automation</th>
<th># of Substations</th>
</tr>
</thead>
<tbody>
<tr>
<td>now in operation</td>
<td>2000</td>
</tr>
<tr>
<td>to be retrofit by YE 2016</td>
<td>500</td>
</tr>
<tr>
<td>new to be built by YE 2016</td>
<td>300</td>
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Where Do ADMS and D-SCADA Fit in the Scheme of Grid Control and Monitoring Systems?

Diagram showing the integration of ADMS and D-SCADA within the grid control and monitoring systems framework.

Key components include:
- AGC/DCS
- GMS
- Market Management System
- Demand Response
- DERMS
- EMS
- ISO/RTO Systems
- D-SCADA
- ADMS
- SSA
- DA
- OMS
- GIS
- IED Coordination
- HEMS
- Customer Info System
- Field Force Automation
- MDMS
Key Findings from Recent Newton-Evans DMS Studies

Based on the mid-late 2014 and 2015 studies and multiple earlier studies, increasing numbers of large utilities have indicated the following:

• Integrated systems are becoming more desirable

• Entrenched suppliers of large control systems (EMS primarily) have an "in" but often cannot provide the required component systems for an integrated approach to DMS-OMS-GIS.

• Many mid-size utilities consider their DSCADA systems (primarily the ACS, OSI, Telvent and Survalent communities) as suitable platforms for DMS/DA.

• A high proportion of all respondents do not yet see a need for a separate DMS. This is especially true among the mid-tier utilities.
Use of DMS as of Mid-2014, 2015
(Participants in Newton-Evans’ Study)

• Just over 40% of all respondents indicated use of a DMS as of June 2014. Up to about 44% by YE 2015.
  – IOUs were more likely to indicate having a DMS installation than were respondents from other utility types.
  – Nonetheless, all of the surveyed utilities do have a DSCADA capability and are likely to be applying SCADA control over basic DA functions such as capacitor bank control and recloser control.
DMS Functionality in Current Deployments

- SCADA
- Unbalanced Distribution Powerflow
- Unbalanced Distribution State Estimator
- VVO/VVC
- FLISR
- Switching Analysis, Planning and Execution
- DMS Training Simulator
- DERMS
- Network Topology Processor
- Load Relief/Management
- Event Replay
- Smart Meter/AMI Integration
- Other
Level of IT/OT Systems Integration with DMS

- Outage Management System (OMS)
- Interactive Voice Response (IVR)
- Geographical Information System (GIS)
- Mobile Workforce Management (MWFM)
- Automated Vehicle Location (AVL)
- Advanced Metering Infrastructure (AMI)
- Meter Data Management (MDM)
- Other (please specify)
ADMS as Centerpiece System

- Automatic Circuit Reclosers
- Voltage Regulators
- Capacitor Banks
- Faulted Circuit Indicators
- Poletop RTUs
- Line/Post Monitors

Placement of DA Device Controls

Field

Substation

Control Center

Newton-Evans research company
ADMS as Centerpiece System

Placement of DA Device Controls

Field-Based
S&C Intelliteam II, L+G Grid Stream; SCADA center product suite, Cooper/Yukon Feeder Automation, G&W/Survalent Lazer Automation

Control Center-Based
ADMS or DSCADA Systems Providers

Substation-Based
GE-Alstom-ASAT, Cooper Cybectec, GE Digital Energy, Novatech, SEL, Subnet Solutions
Placement of DA/DMS Controls

- Findings from 2015 DA Study
  - Three approaches in use today
  - Trending toward Control Center in future
FIGURE 3.92 Typical overhead distribution equipment included in a distribution SCADA system.
The Potential Role of Technology Transfer for Managing the Emerging Smart Grid . . .

A Look Towards Commercial Aviation's Cornerstone Operations Control System to Provide Regional and Nationwide Operations Management for Electric Power

By Charles Newton

The FAA Telecommunications Infrastructure System for TSO is perhaps the most important example of a system that can help manage the complexity and vastness of the electric grid. The system is designed to support a wide range of communication and information needs, including real-time monitoring and control of various aspects of the grid.

Recently I had the opportunity to tour the FAA Telecommunications Infrastructure Control Center at the NASA Ames Research Center. The facility is quite expansive and offers a broad range of capabilities for managing the grid. The center is equipped with state-of-the-art technology and provides a comprehensive view of the grid's operations.

The Systems Engineering Design, Development, and Integration system (SEDI) is a key component of the FAA Telecommunications Infrastructure System. It includes a comprehensive set of tools and processes for designing, developing, and integrating the system's various components. The SEDI system is designed to support the FAA's mission of providing safe, secure, and efficient air traffic management.

In more than 130 countries around the world, the FAA Telecommunications Infrastructure System is in use, providing critical communications and information services to the aviation industry and other stakeholders. The system is designed to be scalable and adaptable, allowing for easy integration with existing infrastructure and the ability to evolve as new technologies become available.

In conclusion, the FAA Telecommunications Infrastructure System is a powerful tool for managing the emerging smart grid. Its capabilities and potential for integration with other systems make it an ideal solution for managing the complex and dynamic nature of the grid.

Newton-Evans research company
Food for Thought – Upcoming EMS/SCADA/DMS Study Topics

- A major Eastern U.S. utility submitted these:

  Is the support group for your EMS/DMS/SCADA part of your corporate IT department or managed by the line of business?

  What are the Operating System preferences for your EMS/DMS platform?
  - Microsoft Windows
  - Linux (what provider?)
  - Mixed (both Linux and Windows)
  - Other

  What are some of the latest technologies that you have incorporated into your new or existing EMS/DMS platforms?
  - Solid State drives
  - 4K Monitors
  - Large format monitors
  - Virtual Machines (VM)
  - Other

  Server Virtualization in control center OT
Summer 2016 Study Topics

• Upgrading of Feeder RTUs
  – 13% plan to do so by 2018
• Automating motorized pad/pole mounted switches
  – 23% plan to do so by 2018
• We will do some of each of the above
  – 30% plan to do some of each
• One third have no plans to do so
Continuing Use of Earlier Generations of Relays

• Do you still have any Westinghouse(ABB) CO Relays in Use?
  – “Yes, we do” = 73% of respondents
  – “No use” = 20% of respondents
  – “Uncertain” = 7% of respondents
    • Sample reported 2,677 units installed

• Do you still use any GE IAC EM Relays?
  – “Yes, we do” = 43% of respondents
  – “No use” = 40%
  – “Uncertain” = 17%
    • Sample reported 4,782 units installed
2016 GRID MODERNIZATION SUMMIT

Join SGIP on
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Washington DC.
Trends and Market Overviews on Grid Modernization:
Presentation to EMMOS 2016 Conference

Thanks for Sitting In On The Presentation!