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Frances M. Cleveland
President & Principal Consultant

Key Qualifications:

Ms. Cleveland has managed and consulted on information and control system projects for electric power utilities for over 30 years. Her expertise has focused primarily on information technologies, security issues, and communications for power system operations, including SCADA systems, distributed energy resources (DER), substation automation, distribution operations, customer metering infrastructure, and energy market operations. Recent work includes system integration support to the California Energy Commission (CEC), IEC 61850 guidelines and tutorials for substation automation, EPRI's IntelliGrid Architecture using UML, IEC 61850-7-420 standards for DER, IEC 62351 security standards for power system operations, requirements for wireless communications in operational environments, as well as consulting on distribution automation, IEC 61968/61970 Common Information Model (CIM), and OpenAMI.

Professional Background:

- Xanthus Consulting International, President & Principal Consultant – Sept 2005 to present
- Utility Consulting International (UCI), Vice President & Principal Consultant – Sept 1992 to Sept 2005
- ECC (now Kema), Lead Consultant – Jan 1984 to Sept 1992
- Systems Control (now ABB), Senior Consultant – 1975 to Dec 1983

Experience Record:

A brief summary of Ms. Cleveland's major projects include:

1. System Integration and Communications for Utilities

a. **System Integration Assessment**, to provide the California Energy Commission (CEC) with support and recommendations for system integration projects and R&D efforts that will benefit the electric power consumers.

b. **IEEE P1777 – Recommended Practices for Wireless Communications in Power System Operations**, co-chair of working group to issue a questionnaire to potential and actual users of wireless communications, which will be used as a base for developing recommended practices for using wireless communications in power system operations.

c. **Meshed Wireless Sensor System for Substation Monitoring Applications**, (on-going) to demonstrate the feasibility and benefits of meshed wireless communications network for retrieving sensor information in a substation environment.

d. **Assessment of Wireless Capabilities within Substations,** EPRI 1011751, March 2006. The possible use of wireless communications in substations has raised a number of issues and concerns. This report determines that wireless communications is already being used in some applications, and that they could be used safely, reliably, and securely in many more applications, so long as the required data exchanges are not very time-sensitive and proper security measures have been applied. In addition, new standards and new product developments are underway to improve the performance, reliability, and security of these technologies in industrial settings.

e. **IntelliGrid Architecture** to develop a power system industry communications architecture, based on a complete set of power system functional requirements for supporting self-healing power systems, energy marketplace transactions, sharing and synergy among all types of utility operational functions, and integrated customer services. The project results are being contributed as appropriate to relevant

Standards Development Organizations and industry consortia to effectively move the development of key open standards forward to develop a robust industry infrastructure. In the area of customer services, extensive Use Cases were developed on Real-Time Pricing (RTP), Time-of-Use (TOU), market opportunities for customers using distributed energy resources (DER) for both energy and ancillary services, direct and indirect load control, and customer portals as "gateways" to implement these functions. Innovative communications technologies were discussed, ranging from Broadband Powerline Carrier (BPL) within the customer premises, to telephone, wireless solutions, the Internet, and certain proprietary radio systems. See http://IntelliGrid.info

f. **Client-Side Requirements for Data Acquisition and Control Subsystems for Distribution Automation Communications**, to develop the client-side requirements for communication systems for Data Acquisition and Control (DAC) subsystems. In future systems, the functions which need to interact with field end devices are becoming significantly mo re complex and extensive, and are therefore driving the need for new DAC capabilities, particularly data management capabilities.

g. **Tutorial on IEC 61850 for Substation Automation**, which provides 2 to 4 days of presentations covering the concepts, benefits, case studies, and practical experience in implementing IEC 61850. This tutorial has been presented to Power Link in Australia and Metropolitan Electricity Authority (MEA) in Thailand.

h. **Guidelines for Implementing Substation Automation using IEC 61850,** which provide guidelines for implementing IEC61850 for substation automation. These guidelines were developed for EPRI clients.

i. **Communications Technology Assessment**, which is a web-based product covering all aspects of utility business areas, telecommunications media, communications protocols, security, and R&D requirements for utilities.

j. **Network and System Management** for utilities, which analyzes network management requirements for distribution automation, describes existing network management capabilities, and recommends network management approaches for distribution utilities.

k. **City Public Service, San Antonio (CPS):** Developed requirements and functional specifications, assisted in Tender Evaluation, and participated in project implementation for CPS's Distribution Automation Pilot Project (DAPP) using UCA Version 2.

l. Development of UCA object models for the **Water Industry** and the **Gas Industry**

m. Development of the original **Utility Communications Architecture (UCA),** in particular the UCA version 2 CASM and GOMSFE for Substation Automation and Distribution Automation.

2. Security Issues

a. As **Convenor of IEC TC57 WG15**, have led the development of security standards for utility operations protocols, including ICCP, IEC 61850, and DNP. In addition, the development of Network and System Management data objects for power system operations, to help ensure security and reliability of end-to-end systems. These security standards, most of which have just been approved by the international committees, consist of IEC 62351: Data and Communication Security – Part 1: Introduction, Part 2: Glossary, Part 3: Profiles Including TCP/IP, Part 4: Profiles Including MMS, Part 5: Security for IEC 60870-5 and Derivatives (i.e. DNP3), Part 6: Security for IEC 61850 Profiles, and Part 7: Security Through Network and System Management. New security efforts will include security requirements for wireless communications as well as additional profiles of protocols used in the power system industry.

b. As **Chair of IEEE PES PSCC Security Assessment WG**, am heading the development for the IEEE of Recommended Practices, educational material, and other information related to the assessment of information security risks in power system operations.

c. **Assessment of Substation Physical Security Measures within Substations,** EPRI 1011752, March 2006. The need for physical security of substations is becoming more urgent as power systems are operated closer to their limits, as information systems become increasingly important to power system operations, and as sophisticated substation equipment becomes more vulnerable to physical threats due not only to deliberate attacks but also to inadvertent mistakes, failures, and natural catastrophes. This requirement for physical security affects all substation assets to one degree or another. The key is the tradeoff between the costs (monetary and some reduced efficiency) of implementing security measures and the probabilistic benefits associated with avoided costs (monetary, social, political, and legal).

d. **Security Risk Assessment and Mitigation Procedure for TVA Operational Information Assets**, March 2005. Cyber security has undoubtedly become a major issue for almost all electric utilities. This is partly due to the competitive environment, where crucial information (gathered legally or illegally) can translate into millions of dollars, but mainly due to the increased vulnerability brought about by the integration of networking technologies within the systems and equipment used on the power system. It is particularly true for the United States that a loss of electrical power for any extended time and over a large area can have serious consequences for the economy, for the safety of people, and for the legal and financial status of the utilities affected. PowerWAN will be a vital part of TVA's future. Physical infrastructure alone is not enough to meet the challenge. To be successful, sound security policy, risk assessment practices, and mitigation procedures must be developed. These requirements were analyzed and discussed in the report.

e. **Scoping Study on Security Processes and Impacts**, July 2003, EPRI 057144. The primary objective of this Scoping Study was the assessment of the financial and societal costs of implementing security measures. Financial costs include the costs for developing security policies and implementing security countermeasure technologies. Societal costs include the impact of security policies and technologies on the efficiency of personnel and systems.

f. **Security Enhancements for Utility Information Architectures**, August, 2002, EPRI EP-P10074. Cyber security has become a major issue in utilities due partly to the increased vulnerability of utilities as they network their computer systems and power system equipment; and partly due to the competitive environment where crucial information (gathered legally or illegally) can translate into millions of dollars. A number of technology solutions have been proposed for improving the security of the communications protocols used in power system operations, mostly based on encryption which does have an impact on performance. These solutions go a long way to increasing the information security. However, they are not the complete story – for end-to-end security beyond the protocols, additional types of security are needed. The objectives of this project was to assess the impact on performance of the security measures being proposed for the common protocols used for digital control of power system equipment, and to determine what additional security measures outside the domain of protocols may be needed for complete end-to-end security.

g. **Security Primer** on communication network security requirements for utility T&D operations. The primary focus of this work was to describe the potential areas of vulnerability of utility SCADA systems, substation automation, and other power system operational automation.

3. Distributed Energy Resources (DER)

a. **DER Object Model Draft Standards (IEC 61850-7-420)**, which includes communication object models for DER system management, DER devices, and interval metering (based on ANSI C12.19) for use in TOU, RTP, and other schemes. The DER device types covered are reciprocating (diesel) engines, fuel cells, photovoltaic systems, and combined heat and power (CHP). IEC 61850 is the international communications protocol standard for substation automation and distribution automation. It is being expanded to include DER communications, hydro plant communications, inter-substation communications, and substation-to-control center communications.

b. **DER/ADA Project: Utility Communications Architecture© (UCA) – Object Models for Distributed Energy Resources (UCA-DER)**, to develop the object models of DER information that can be exchanged between DER devices and any systems which monitor, control, maintain, audit, and generally operate the DER devices. These object models will be based on IEC61850 components and concepts, with extensions as necessary.

c. **Distributed Energy Resources (DER) communications and control requirements**, which assessed the requirements of the stakeholders and the potential roles of distributed resources for distribution utilities in the new, deregulated environment. Included assessment of customers bidding DER into the electricity market for both energy and ancillary services.

d. **Distributed Energy Resources and Advanced Distribution Automation (DER/ADA)** for determining the information needs of advanced distribution automation for DER devices, such as diesel generators, microturbines, fuel cells, and other resources.

e. **Open Communications Architecture for DER**, to develop standard object models for integrating DER into utility distribution networks.

4. Distribution Automation

a. **Value of Distribution Automation**, to provide the California Energy Commission (CEC) with descriptions of DA functions, possible scenarios for implementing these functions, the potential utility, customer, and societal benefits from these functions, and the technical challenges to implement them.

b. **Guidelines for Implementing Distribution Automation (DA) using IEC 61850,** which provide guidelines for developing requirements for, and implementing, IEC 61850 for advanced DA. The IEC 61850 requirements for DA will be based on the existing IEC 61850 object models and design criteria, but will be extended as necessary to meet advanced distribution automation requirements, including interactions with DER, real-time pricing, market demand-response, and other functions of the future.

c. **City Public Service (CPS) of San Antonio, Texas**, the second largest municipal in the United States, undertook a system-wide Distribution Automation project using state-of-the-art telecommunications networking and integration technology, starting in 1995. This project was the first implementations of the Utility Communications Architecture (UCA®) which eventually led to the international standard, IEC 61850. The first phase of this project was the Distribution Automation Pilot Project (DAPP). The DAPP comprised the design, specification, and implementation of automated switches, voltage regulators, capacitor bank switches, reclosers, LTC controllers, and substation RTUs, which were either interfaced to a loop of fiber optic telecommunication cables strung along two distribution feeders or directly linked to CPS's fiber optic backbone telecommunications network in the two pilot substations. In conjunction with the development of a new EMS/SCADA system for CPS, Distribution Management System (DMS) applications were specified to manage the field devices, not only for the DAPP pilot project, but for the system-wide implementation of automated switches and other field devices. These automated switches are being installed up to a possible total of 1000 switches.

d. **Los Angeles Department of Water and Power, Distribution Management System Study**. This study analyzed the management structure of distribution operations, and recommended changes in the organization to reflect the increased importance of customer satisfaction in the strategic objectives of the Department. Part of this process included interviewing a number of large industrial customers to learn directly what their needs and desires were related to power quality, including momentary outages, voltage sags and swells, harmonics, power surges, and long-term outages. The Department's CAIDI and SAIFI statistics were also assessed. These needs were then translated into specific requirements for computerized systems and functions for each type of requirement, potential alternative solutions were examined, and for each alternative, the advantages, disadvantages, costs, and paybacks were analyzed.

5. Automated Meter Reading and Load Control

a. **OpenAMI** participation to develop design principles for Automated Metering Infrastructure (AMI) and Demand Response (DR), primarily in response to the CEC's call for demand response technologies. Metering interfaces are the main focus, addressing the capabilities and possible enhancements, interpretations, and/or protocol mappings of the ANSI C12 series of metering standards.

b. **Omaha Public Power District (OPPD)** to performed an Automatic Meter Reading and Load Control (AMR/LC) benefit-cost analysis, comparing the costs between current meter reading methods and a variety of automatic meter reading and load control methods. These AMR technologies included proprietary radio-based, power line carrier, telephone, the Internet, and other public telecommunications media. The vendors and their products assessed included Itron (manual, remote, and fixed AMR), CellNet (Schlumberger), DCSI TWACS, Hunt Technologies Turtle, Nexus, Hexagram, Nertec, American Innovations, and others. Three customer environments (industrial/commercial, urban residential, and rural residential) were modeled. Different levels of customer tariff incentives were also assessed.

c. **Puerto Rico Electric Power Authority,** to perform AMR and Load Control benefit cost analysis, covering radio-based systems and power line carrier systems. Quantitative data was collected from PREPA and analyzed related to meter reading, load surveying, theft, possibilities of deferring construction with load control, and other electrical and financial information. After performing a detailed analysis, it was concluded that the power line carrier TWACS system would have the shortest payback period. Most of the benefits were related to losses due to theft, inaccurately estimated meter readings, and on-demand meter readings. Because Puerto Rico is so mountainous and because many of the meters are not easily accessible by short-range radio systems, the radio-based systems were not as feasible as the power line carrier system.

d. **City Public Service of San Antonio, AMR and Load Control** to undertake a system-wide Distribution Automation and Customer Site communications project using state-of-the-art telecommunications networking using fiber optic cables and radio-based systems, while integrating the AMR/Load Control with Distribution Automation using the UCA 2 technology (now known as IEC 61850). AMR/LC capabilities were analyzed, including: automatic meter reading for electric, gas, and water meters, load control, tamper detection, automatic detection and reporting of power outages and restorations of service, call-back of customers after restoration of power, remote service connect and disconnect, end-use load surveys of electric, gas, and water usage, providing billing information to customers on-line or over the Internet, real-time pricing, retail wheeling, and leasing/sharing of AMR infrastructure for use with other companies.

6. Deregulation

a. **Participation in IEC TC57 WG16 on Market Operations**: development of international standards for market operations between utilities, based on the concepts of the United Nations CE/FACT business-to-business model, ebXML.

b. **Coordination of Western RTOs/ISOs**: Assisted the three western RTOs/ISOs in determining requirements for coordinating market and power system operations if the FERC standard market design were to require a common interface to all western RTOs.

c. **DStar (WestConnect) RTO**: Developed Unified Modeling Language (UML) Use Cases for the proposed DStar market rules. Also developed specifications for a SCADA/EMS and a Market Operations System to operate the RTO and implement the market rules.

d. **EGAT (Thailand)**: Assisted in determining EMS and market operation requirements as EGAT was separated into a market operations company and a transmission operations company.

e. **California ISO**: Assisted in the startup of the CAISO EMS system when it was developed to manage the California transmission operations.

f. **Transaction Management System (TMS):** Developing alternative architectures for the continent-wide TMS system for managing transactions for transmission services and ancillary services, and analyzing power system security.

g. **Open Access Same-Time Information System (OASIS):** Contributor and Editor of the Open Access Same-Time Information System (OASIS) Standards and Communication Protocol for the EPRI-sponsored "How" Working Group, which developed the Internet-based design for implementing FERC's Order 889 for Transmission Open Access.

7. Integration of Systems

a. **Participation in harmonization of international standards through IEC TC57 WG19**, with the focus of integrating IEC 61850 with the Common Information Model (IEC 61970).

b. **Participation in Distribution Information Exchange Model (DIEM)** for the exchange of information between distribution operational systems, as member of the IEC TC57 WG14.

c. **Participation in the extension of the Common Information Model (CIM)** to distribution and market operations.

d. **Omaha Public Power District (OPPD):** Developed an Automation Plan covering SCADA, EMS, Distribution Automation, Substation Automation, Automatic Meter Reading, Integration Standards, and Communication Protocols.

8. Telecommunications Master Plans

a. **Utility Telecommunication System Costs**, EPRI 2001

b. **Omaha Public Power District (OPPD) Mobile Computing Study**, July 2001

Professional Activities:

- **Convenor** of IEC TC57 WG15 (Information Security)
- **Editor** of IEC TC57 WG17 (Distributed Resources)
- **Chairperson** of the IEEE Power Systems Communications Committee (PSCC) of the Power Engineering Society (PES), **Vice Chair** of IEEE SCC36, and **Chair** of IEEE PSCC Working Group on Security Assessment
- United States **Technical Advisor** to the IEC TC 57 for WG 03 (RTU telecontrol), WG07 (ICCP), WG14 (Distribution Integration), WG15 (Information Security), WG16 (Market Operations), WG17 (Distributed Resources), and WG19 (Harmonization of TC57 standards)

Education:

- MBA, San Jose State University (1987)
- M.S. in Electrical Engineering and Computer Science, University of California at Berkeley (1975)
- B.A. in Applied Physics and Electrical Engineering, Harvard University (1969)
- Languages: English, Spanish (partial)