Qualifications

EMS & Control Center Services

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Executive Summary
This document outlines the Quanta Technology, LLC qualifications to assist electric utilities, energy companies and reliability organizations with all aspects of the complete Energy Management Systems and Phasor Management Systems procurement and deployment, with incremental upgrades of these systems, and with Control Center related business process improvements.

Quanta Technology, LLC is a subsidiary of Quanta Services, Inc., an S&P 500 Corporation. Our senior staff consists of seasoned technical experts offering dozens of years of utility, vendor, and consulting experience. They are complemented by talented and highly motivated young engineers. Having worked closely with most major utilities in North America, and with many around the world, these experts are in a position to offer first-hand experience in virtually all areas of the electric utility business. Moreover, the corporate culture at Quanta Technology fosters inter-departmental cooperation, allowing engagement teams to better leverage the company-wide collective expertise. These are some of the foundations on which our clients can expect quality experience and superior project results from day one on assignments aimed at reducing client’s costs, improving their system reliability and managing project risks.

The following represent major areas of Control Center related services. More details about these capabilities are provided in the “Details of QT Control Center Services” section.

Implementation of Synchrophasor Management Systems & Energy Management Systems
We will assist you in the specification, vendor selection and implementation of new Phasor Management Systems and in all stages of upgrades or replacements of Energy Management Systems.

Production Grade Phasor Management Systems
We can work with you to develop a strategy for installation of PMUs in critical substations and select applications and systems that best meet your operational needs. In this new field, Quanta Technology experts are uniquely qualified to help you specify the phasor system functions and the phasor system attributes that are necessary for such a system to meet the high demand of operation in a control center environment.

Energy Management Systems
We can assist with the development of requirements, specifications and implementation of the whole EMS system, or any of its subsystem components, including generation functions, network analysis, operation support functions and advanced functions such as on-line dynamic security assessment.

Control Center Operation Business Functions
In conjunction with your staff, we will review or develop processes and procedures for day-to-day operation, Emergency Procedures, System Restoration Procedures, Operations Support services and Regulatory Compliance services.

Day-to-Day Operation Functions
These include a wide variety of Control Center business functions, such as Balancing Authority functions, Reactive Power Management and Real-time Security Assessment and Control.

Emergency Procedures
We offer services to establish emergency procedures, such as fuel or capacity shortages, renewable energy interruption, transmission constraints, frequency or voltage decay, load shedding, rotating blackouts and control center evacuation. In addition, Quanta Technology can provide System Operator training and drills.
System Restoration Procedures
In the event that emergency procedures fail to mitigate decaying conditions and all or part of the system is lost, system restoration procedures will be needed. Quanta Technology offers a complete review or procedure development, which includes performing all technical analyses necessary to return the system to normal operations quickly and securely. Testing of system restoration procedures, including documentation for NERC Standard compliance, is provided as well. In addition, Quanta Technology can provide System Operator training and restoration drills.

Operation Support Services
Operation support services are the first line of defense against blackout conditions. Quanta Technology offers services in the areas of short-term operation planning analysis, transmission and generation outage coordination, and coordination between planning and operation groups. We can also conduct a post-event analysis, if desired.

NERC Standards Control Center Compliance
Control Center Operations is under the burden to show compliance for nearly 60% of the NERC Standards Requirements. Compliance requires documentation of procedures, proper execution of those procedures and record keeping for compliance audits. Quanta Technology can assist in the review or development of compliance requirements.

Operator Tools & Back Office Systems
In response to the needs created by the recent changes in the electricity industry, Quanta Technology's staff has developed specialized tools to manage the integration of variable resources, distributed generation and for phasor-based voltage stability monitoring.

Why Choose Quanta Technology for Control Center Services
While the mission of EMS remains the same, i.e., helping operators "keep the lights on", reliably and economically, the underlying technologies and regulatory framework continue to change, in some instances quite rapidly. For example:

- Profound changes are occurring with the adoption of phasor technology. Implementation of this technology in control centers is just beginning, but early indications are that the technology has the potential to fundamentally change utilities’ wide-area monitoring, protection and control capabilities. Quanta Technology has been a leader in the development, implementation, and adoption of this technology in general, and in the deployment of production-grade Phasor Management Systems in control centers in particular.

- Some tasks that were previously integral to EMS, such as economic dispatch, are now being performed by separate Market Management Systems (MMS), as is the case in ISOs. The overall efficient operation of an ISO requires a tight integration of EMS and MMS functions. The Quanta Technology team has extensive ISO EMS-related experience that can be deployed to effectively assist ISOs as they upgrade their control center computer systems.

- The models for most of the power system components used in an EMS have been standardized in the Common Information Model (CIM). Quanta Technology staff and its associates have participated in the development of the CIM standard and in its practical implementations.
• For most of the EMS history, these systems have been highly customized. While a degree of customization is required in virtually every EMS and Phasor Management System, a significant transition is occurring in the industry at large through the Smart Grid initiatives, including in the EMS area, from highly custom systems to highly configurable systems of components that are more and more interconnected by standards-based interfaces. Quanta Technology has had a first-hand involvement in the Smart Grid standardization efforts, and it also employs seasoned EMS consultants, former EMS developers and control center EMS managers, all with a deep understanding of the underlying technologies and the environment in which they are applied. Our clients can rely on this wealth of knowledge to help them determine whether they need to upgrade an existing EMS or to help them weight in the benefits of tailor-made versus standard product solutions to their needs.

• NERC reliability compliance standards are no longer voluntary; they are mandatory and come with significant penalties for violations. Quanta Technology has on its staff experts who have led development and implementation of the NERC standards, and are in a unique position to assist clients with their compliance needs related to control center functions.

• New business and technology trends related to control center operations are visible. These include tighter integration of outage management systems and processes with EMS; support for dynamic rating of transmission elements; use of dynamic security assessment as a complement to the traditional static security assessment; and integration of renewable generation resources, storage technologies, and distributed generation, with a consequent impact on ACE control and reserve requirements; and integration of Special Protection Scheme logic within the EMS assessment – to name just a few. With leading roles in the implementation of some of these technologies within EMS, or in studies for clients of impacts of some of these technologies, Quanta Technology experts have acquired a deep understanding at a fundamental level, and “dos and don’ts” at a practical level. This understanding can be converted to specifications on how to integrate new technologies in the EMS and PMS, or how to change existing processes to better reflect the changes in the operating character of power grids brought by e.g., a significant penetration of wind energy, photovoltaic sources and shifting loads by electric vehicles.

• Pervasive security considerations are now central to each and every business-critical system. Control center systems are among the most critical systems, not only for the client, but for the health and integrity of the entire national electricity grid. Having worked for some of the largest electric utilities, Quanta Technology's IT security specialists are among the industry's most prominent. They are ready to assist in the assessment of existing and design of new control center security measures.

The arguments regarding the changing landscape of Control Center computer systems are compelling, and the pace of these changes is rapid. We submit that an agile provision of Control Center related services amid this picture requires an integrative approach built on proficiency in many topics. These topics range from understanding of physical infrastructure of electric utilities (generation, loads, transmission, substations and protection, and communications), through proficiency in underlying technologies for Energy Management Systems and Phasor Management Systems, to the understanding of regulatory compliance and cyber security requirements. Quanta Technology has carefully assembled its staff to cover all these fundamental areas with highly experienced veterans of our industry and then complemented it by motivated and highly educated mid-level, younger professionals – many with advanced degrees. Furthermore, Quanta Technology fosters an environment of cooperation internally and attention to clients’ needs externally. We believe these qualities give us a unique ability to fully meet the clients’ expectations on control center related projects.
Details of Quanta Technology Control Center Services

Phasor Management Systems and Energy Management Systems procurement and upgrades are needed to meet the rapidly expanding demands on the system operator and to take advantage of increasing availability of data from PMUs. The following is a list of some of the related services offered by Quanta Technology:

- EMS and PMS needs assessment
- Functional specifications development
- Development of Requests for Proposal (RFP) and Requests for Information (RFI)
- Vendor evaluation, selection and work statement negotiations
- Project management assistance
- Technical support for testing, from Factory Acceptance Tests to Site Acceptance Tests
- System Operator training

**Individual EMS and Phasor Management System Functions**

Quanta Technology offers services to assess, procure or fine tune individual EMS and Phasor Management System functions. Examples include:

- **Real-Time Network Security Monitoring State**
  - Estimation
  - Contingency Analysis
  - Voltage and Transient Stability Analysis
  - On-line Power Flow and Optimal Power Flow
  - Load Shedding

- **Real-Time Generation Control Functions**
  - Security-constrained Economic Dispatch
  - Automatic Generation Control
  - Optimal Reserve Allocation, Monitoring and Deployment

- **Real-Time Reactive Power Management**
  - Voltage/VAR Scheduling and Voltage Control
  - VAR Zone Determination
  - VAR Reserve Monitoring

- **Short-Term Operation Planning**
  - Study network and generation analysis functions
  - Economic-based outage planning and approval
  - Interface with unit commitment and outage scheduling
  - Demand and energy forecasting
  - Wind power potential forecasting

- **EMS Modeling**
  - CIM-based source data bases
  - Network equivalencing
  - Source model and applications tune-up
• SCADA and Related Functions
  – Dynamic Branch Rating
  – Communications protocols (e.g., ICCP, DNP)
• Phasor-based Functions
  – Low Frequency Oscillation Detectors
  – Voltage Stability Monitoring
  – Voltage magnitude and phasor angle monitoring
• Wide-Area Situational Awareness (WASA) Visualization
  – Alarming and alarm filtering
  – Quick outage detection
  – Dashboards

Control Center Business Functions are the day-to-day process functions of the control center. These can include a wide variety of responsibilities, which are categorized into the following three major activities:

• Balancing Authority Functions
  – Load forecasting
  – Security constrained economic dispatch
  – Deployment of regulation (frequency and interchange control, CPS-based AGC)
  – Optimal reserve allocation, monitoring and control
  – Tagging/ramping/scheduling
• Reactive Management
  – Dynamic voltage schedules
  – Capacitor & reactor control settings TCUL/LTC transformer settings
  – Distribution generating sources
  – Reactive reserves or VAR zones/margins
• Real-time Security Assessment and Control
  – Thermal contingency analysis
  – Voltage and transient stability analysis
  – Corridor/interface limit determination
  – Dynamic Transmission Line Rating

Emergency Procedures are developed to address abnormal system conditions or events in an effort to prevent the loss of the power system.

• Fuel or capacity shortage
• Renewable energy interruption
• Transmission constraints
• Frequency or voltage decay Load shedding
• Rotating blackouts Control Center evacuation
System Restoration Procedures are required to expeditiously return the system to normal, in a stable and secure manner. These procedures must be verified and documented through testing or analysis. In addition, System Operators must be trained and tested in the implementation of these procedures.

- Cranking Path Switching Sequence
- Cranking Path Modeling
  - Generator exciter and governor controls
  - Induction motors
  - Transmission lines and cables
  - Transformers – Fixed Tap/TCUL/LTC
- Simulating Cranking Path Energization
  - Steady state
  - Voltage stability
  - Transient stability
  - Dynamic stability
  - Fault current
  - Switching transients
  - Protective relaying
- Restoring Off-site Power to Nuclear Plants

Operation Support Services are the first line of defense against conditions resulting in a blackout. In addition, post-event analysis is often conducted by Operation Engineers.

- Short-term Performance Analysis
  - Thermal performance
  - Voltage control
  - Voltage instability
- Dynamic/transient instability
- Circuit breaker duty analysis
- Transmission and Generation
- Outage Coordination
- Planning/operations coordination
- Post-event analysis

NERC Standards Control Center Compliance is a major burden on the control center. Approximately 60% of the requirements in the NERC Standards are the responsibility of the control center. Quanta Technology offers:

- Review of procedures
- Review of documentation
- Review of physical/hardware/software/communication configurations
- Review of reporting procedures
- Cyber security requirements and NERC CIP compliance evaluation
Complementary Services

As the examples of services featured below illustrate, Quanta Technology offers a full spectrum of utility services in addition to the Control Center services.

Transmission Services
- Support for planning and permitting of new transmission lines
- Reliability-based planning and engineering
- New connections and interconnection studies
- Substation siting and ROW routing and planning
  - System optimization
- NERC/ERO/RRO standards compliance
- Application of new technologies, such as Distributed Generation and Automation
- Wind farm/renewable energy interconnection & deliverability

Protection and Automation Services
- Development of long-term, cost-effective strategies and roadmaps for protection and control upgrades that embrace integrated use of IEDs and standard protocols, such as IEC 61850
- Improved monitoring and response to wide-area disturbances via advanced phase measurement technology
- Application of smart relays
- Enterprise use of IED data
- Protection, automation and control for massive deployment of wind generation
- NERC/ERO/RRO regulatory reliability compliance/standards

Distribution Services
- Aging infrastructure management
- Reliability improvements
- Spatial load forecasting
- Power quality
- Storm Hardening
- Distribution automation & demand side management
- Regulatory support
- Benchmarking

Substation Operation Services & Engineering Standards
- Assess engineering and operation processes for effectiveness
- Conduct audits of standards utilization for safety, cost, reliability, operating, inspection and maintenance
- Update engineering planning, design, specification and construction standards
- Update operation and maintenance practices
- Conduct specialized safety studies, such as *Grounding and Stray Voltage, Arc flash, Pole loading, Capacitor Optimization*
Enterprise Solutions

- Align and integrate engineering, automation, customer solutions, and IT with business strategy & processes (e.g., Renewable Energy/Distributed Resources; Smart Grid/Smart Meter; Home Area Network/Electric Vehicle)
- Foster and manage change across utility hierarchy, e.g., sharing pricing risks with customers; proactive communications – external and internal; fostering energy efficiencies
- Deliver enterprise, transformational benefits beyond incremental benefits from individual technology investments

Regulatory Services

- Compliance with the NERC Reliability Standards; Corporate ERO compliance program structure and design; process design; documentation development; corporate program audit; gap analysis & compliance roadmap; engineering and field labor assistance
- Critical infrastructure protection (CIP) starting with critical infrastructure identification
- Audit preparedness – practice audit; due diligence review of self-audits; remediation assistance
- Additional regulatory support services – event analysis and investigation; settlement development and risk mitigation; expert witness and testimony

Training

Examples of delivered courses:
- Distribution Reliability
- T&D Asset Management
- Business Essentials for Power Engineers
- Aging Infrastructure
- Spatial Load Forecast
- Power Delivery Planning (multiple levels)
- Distribution Engineering Fundamentals
- Power Systems for Non-Engineers

- Distribution Protection and Coordination
- Application of Synchronized Measurement (SM) Technology
- Stray Voltage/Neutral Grounding
- Power System Protection (multiple levels)
- Transmission Infrastructure Development
- Transmission Planning
- Regulatory Compliance
Sample Control Center Projects

Recent examples of Quanta Technology Control Center Technology projects are highlighted below.


Quanta Technology was selected as program manager for the implementation of New York Independent System Operator’s three-year, $75.7 million Smart Grid deployment project. NYISO was awarded a $37.8 million grant from the Smart Grid Investment Grant (SGIG) Program of the U.S. Department of Energy under the American Reinvestment and Recovery Act (ARRA). This project will enhance the reliability and efficiency of the New York state power grid with the deployment of a phasor measurement unit (PMU) network and capacitor banks, which will be used to expand wide-area situational awareness and coordination of voltage across the state transmission grid. This investment provides the foundation for further development of Smart Grid infrastructure in New York. Quanta Technology’s responsibilities include setup of a project management office, technical and procurement services, SGIG grant administration, project scheduling and coordination with transmission owners for system implementation, and testing and commissioning. NYISO and all eight New York transmission owners will work together to implement the system.

Transmission Owners: Central Hudson Gas & Electric Corporation, Consolidated Edison of New York, Orange and Rockland, the Long Island Power Authority, National Grid, New York State Electric & Gas, Rochester Gas and Electric, and the New York Power Authority

Total Project Budget: $75.7 million

2. PJM Synchrophasor Technology Deployment Project (2010-2012)

Quanta Technology is providing support for project management and technical expertise, including participation in the Executive Steering Committee and support to the project team in the areas of Technical Lead, PMU/PDC System, Applications and Data Analysis, System Integration, System Testing, Cost/Benefit Analysis, and Project Coordination. Specific responsibilities include risk management, project cost and benefit analysis, ensuring that overall system design meets system requirements (including interoperability and security), PMU consultation to TOs regarding PMUs and PDCs as needed, and overall system test plan and testing. Virginia Tech will also participate in system testing.

The project consists of the following:

- Phasor Measurement Units (PMUs) to be installed in 91 substations in 10 states (Illinois, Indiana, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Virginia, West Virginia) and 17 Phasor Data Concentrators (PDCs), covering about 73% of the PJM total load pass-through
- Communications between PMUs, PDCs, and PJM’s Super PDC (SPDC)
- Testing to verify PMU and PDC interoperability and compliance with IEEE and IEC standards (e.g., C37.118), and dynamic performance
- Integrated data management and visualization software, based on Real-Time Dynamics Monitoring System (RTDMS) and Phasor Grid Dynamics Analyzer (PGDA) of the Electric Power Group (EPG)
- Data analysis using synchrophasor data in transmission system planning and operation
- Cyber security assessment and improvement planning in requirement and design and in final system testing
This project will provide the foundational infrastructure upon which additional PMUs and PDCs and future advanced applications, such as congestion management, can be deployed. Not only will this project improve system reliability, operational efficiency, and transmission asset utilization, it will also accelerate modernization of the transmission grid consistent with Smart Grid attributes of the Energy Independence and Security Act of 2007:

- Increasing use of digital information to improve Grid reliability and efficiency
- Enabling future applications for dynamic optimization and control of Grid operations and resources
- Facilitating integration and dynamic management of renewable resources
- Establishing cyber security improvement plans
- Fostering interoperability for synchrophasor data and sharing with other industry organizations in support of the North American Synchrophasor Initiative (NASPI)

Total Project Cost: $27.8 million


Project description: Quanta Technology is currently assisting PG&E in deployment of a large-scale Synchrophasor measurement system to enhance EMS and Grid visualization, which will be implemented in three years. The project entails the deployment of a PG&E-wide, open, flexible, interoperable, secure, and expandable phasor monitoring network, to enhance PG&E’s existing monitoring systems. The project team helped to formulate strategic project partnerships including a leading EMS vendor. The team prepared a comprehensive Project Execution Plan, outlining ongoing tasks, project schedule and cost tracking, compliance-related tasks, issues/risks benefits, as well as document management and revision tracking processes. Completed tasks include the development of an applications roadmap and system architecture for a network-based synchrophasor system. A study of optimal PMU/Phasor Data Concentrator (PDC) locations (both on AC and DC systems), was also completed based on the prioritized applications, system studies, infrastructure, and cyber security requirements/measures. Other critical documents prepared include, system functional and performance, system architecture, as well as a deployment roadmap.

In addition, preliminary system/application studies were completed, the project cost/benefit metrics refined; and the overall system architecture was designed.

Total Project Cost: $4M

Project completion (three-year DOE SGIG project) 2009-2013

4. Southern California Edison – Wide-Area Situation Awareness System Deployment Project

Starting in early 2009 with the Edison overall smart transmission grid vision, Quanta Technology was to provide services as follows:

Phase 1: Project Scoping

- Build SCE stakeholder consensus for the long-term vision of PMU applications across the enterprise
- Provide advisory services to the Edison team for the conceptual design of PMU communications and network architecture, with consideration of the NASPI/3 framework and Edison IT guidelines
- Develop a detailed project scope of work, estimated budget, project timeline, and execution plan.
Phase 2: System Design and Major Components Specification Development

- Assist Edison with the detailed design of the communications network to support PMU and related applications needs
- Prepare technical specifications for procurement of PMU/DFR devices, central data concentrators, data archiving and management systems, and operational PMU applications

Phase 3: Procurement Support

- Pre-bid preparation support, such as compiling a potential vendor list, finalizing RFP, and holding pre-bid meetings
- Perform evaluation of vendors' bids, participate with SCE team for selection of vendors

Phase 4: Implementation Support

- Review, finalize, and approve vendors' designs
- Provide implementation support including project management, quality assurance, conformance testing, field acceptance tests, and system integration and commissioning
- Provide advisory services to Edison for back-end integration testing
Key Personnel

Bryan Rushing, Senior Director, Transmission

Bryan Rushing, Senior Director, Transmission & Regulatory, is an energy professional with more than thirteen years of progressive technical, operational, problem solving and commercial experience in the power supply industry. He is skilled in identifying business development opportunities, technical and economic valuation, strategy formulation and plan implementation. Bryan’s areas of expertise are Areas of Expertise are Origination & Business Development, Power Supply Planning, Transmission Service Procurement and Analysis, Energy and Ancillary Service Markets, and Regulatory and Policy.

Bozidar (Boza) Avramovic, Ph.D., Executive Advisor

Dr. Avramovic, Executive Advisor, has extensive experience in all technologies and business processes related to Energy Management Systems (EMS). He has also worked in research and development for NSF, EPRI, DOE and electric utilities. Boza’s areas of expertise are EMS technologies (generation control, static and dynamic network security analysis, dynamic line ratings, EMS integration, etc.), all phases of EMS deployment (scoping and requirements analysis, functional specification and RFPs, vendor selection and work statement negotiations, implementation assistance, etc.), centralized phasor management systems (as with EMS, both technology and processes, including integration with EMS).

Ed Pfeiffer

Ed Pfeiffer, P.E., Executive Advisor, has over 30 years of progressive experience in hands–on power system analysis in both transmission and generation expansion. He has both regional and national industry committee participation experience through NERC. Ed’s areas of expertise are Transmission System Planning and Generation Interconnection Planning.

David Takach

David Takach, Executive Advisor, has 43 years of experience in power systems, from equipment design to analysis. Mr. Takach’s background includes extensive involvement in developing IEEE standards and, as a utility employee, directing Electrical Utility funded research and development both with EPRI and with various universities in the Missouri/Illinois area. He is currently responsible performing various power system analytical studies for the electric utility industry, including power system stability and electromagnetic transient analysis. Dave’s areas of expertise are Power System Analysis in Transient Stability, Electromagnetic Transients and Small-Signal Stability.
Tom Gentile

Tom Gentile, P.E., VP Transmission Eastern Region, is responsible for developing and managing the Northeast Regional Office of Quanta Technology. Mr. Gentile has over 34 years of experience and proven leadership with transmission and distribution system planning, analysis, engineering, program/project management, and interfacing with RTOs/ISOs and regulatory agencies. Mr. Gentile has participated in various planning and operating committees at NERC, NPCC, NYISO and ISO-NE. Tom's areas of expertise are Transmission & Distribution Planning, Economic System Planning, Integrated Resource Planning, and Asset Management.

Leonard Januzik

Leonard Januzik, Senior Director and Midwest Regional Manager, has over 35 years of experience in power system planning and operations as well as consulting support services. He has years of hands–on power system analysis experience in both transmission and generation expansion and has both regional and national industry committee participation experience through NERC. Len's areas of expertise are Generation modeling and operation including variable sources and economic analysis, Transmission planning analysis and expansion options, and Reliability and Risk Assessment.

David Elizondo

David Elizondo, Principal Advisor, has a broad range of experience in electric power transmission and distribution which includes at least 10 years of extensive experience in power system analysis and simulations. Dr. Elizondo has recent experience with the integration of renewable energy resources into the electric power system, the application of robotic technologies for energized work in electric facilities and the integration of synchrophasor technology for wide area monitoring in energy control centers. David’s areas of expertise are long-range transmission plans for large renewable generation integration, robotic technologies for energized maintenance and construction of electric facilities, and application and visualization of synchrophasor technology for wide-area monitoring in energy control centers.

Farbod Jahanbakhsh

Farbod Jahanbakhsh, Senior Advisor, provides technical expertise on Power System study, Planning, Design and Engineering Analyst. Farbod is involved in various types of power system simulation, transmission studies, distribution generation studies, EMF analysis, substation design, industrial service, renewable energy impact studies, and more. His areas of expertise are steady state and transient stability studies, using power system analysis software tools and creating engineering applications, modern analysis methods and criteria in field power system planning and operation, simulation by PSCAD and EMTP for fast transient and power quality analysis, engineering including grounding, EMF and Arc-Flash hazard, and renewable solar PV and wind penetration studies.
Robert Haas

Robert Haas, Advisor, Transmission, has over 20 years of experience in power system planning and operations as well as consulting support services. He has experience in transmission planning and operations, available transfer capability studies, and information technology support. Robert’s areas of expertise are Transmission planning analysis, Available Transfer Capability studies, Generation interconnection studies, Power system stability studies, Breaker fault duty studies, and Energy Management System support.

Vivek Balasubramaniam

Vivek Balasubramaniam, Senior Engineer, Transmission, has worked as Project Coordinator for NYISO on their Smart Grid project and has been involved in framing schedules, managing the Project Management Office, and monitoring activities apart from working on their PMU Placement Study. Vivek also worked on a Transmission overlay project and also on a white paper identifying the merits of 765 kV lines and on a project modelling feeders on CYMDIST. While in Graduate School, Mr. Balasubramaniam specialized in Power Systems and had worked on projects related to Voltage Stability and Reactive Power Compensation apart from experience on projects related to Power System Protection and Power Electronics. His areas of expertise are Power System Operation & Control, Project Management and Power System Protection.