Booz Allen Hamilton Response to Department of Energy Request for Information

Implementing the National Broadband Plan by Studying the Communications Requirements of Electric Utilities to Inform the Federal Smart Grid Policy

Department of Energy

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Introduction

Booz Allen Hamilton (Booz Allen) has had an enduring relationship with the Department of Energy (DOE) for more than two decades. We are pleased to be responding to the DOE's Request for Information (RFI), *Implementing the National Broadband Plan by Studying the Communcations Requirements of Electric Utilities to Inform Federal Smart Grid Policy*, with our perspectives on the use of broadband communications technology to meet emerging Smart Grid requirements. In its RFI, the DOE acknowledges the multiple interdependencies, diverse topics, and challenges in addressing the nine questions posed on Smart Grid and utility industry communications network requirements.

Booz Allen is aware of the central role that well-defined and executed industry communications networks requirements management can play in supporting and sustaining successful industry transformative mandates such as that facing the utility industry in Smart Grid. Since we are certain that the DOE will receive no shortage of quality inputs to its specific inquiry areas from a diverse set of industry stakeholders, we wanted to offer a response which provides an independent perspective structured around critical issues and a framework of supporting observations. We have attempted to evaluate these issues with an eye to the DOE's role with respect to the National Broadband Plan and its role as a catalyst in advancing Smart Grid technology. As such, our response does not directly answer each of the individual RFI questions, but instead offers recommendations which the DOE may wish to consider to ensure success in its Smart Grid communications network requirement work streams including recommendations for risk mitigation.

Critical Issues and Response Summary

The development of well-defined and robust Smart Grid communications network requirements is a key step in enabling the transformation of the U.S. utility industry into the future world of "digital energy." In an increasingly carbon-constrained world, there is a sense of urgency for the DOE to be the key change agent for the Smart Grid. The unprecedented industry migration mandate has never been greater. This mandate presents the DOE with a series of unique challenges as it assesses the current RFI responses and begins to solicit and integrate follow-on inputs as well as shape the development of industry standards. This work will be made doubly challenging by the requirement to work dynamically with and across multiple stakeholder groups, each of whom has distinct vested interests regarding the nine RFI questions posed by DOE. Early development and closure around Smart Grid National Broadband inputs and related utility industry communication network requirements has the potential to have profound impacts on U.S. national security, utility industry migration to a more competitive and sustainable clean energy future, and enablement for emerging Smart Grid revenue streams.

The nine questions posed by the DOE in the RFI require a multidimensional "situation analysis" of (1) how well current communication network solutions are addressing Smart Grid and utility industry needs, and (2) how strong the fit is between current and future solutions and the industry's respective evolving needs. In its nine questions the DOE has asked respondents to address utility industry requirements in the context of the National Broadband Plan and with respect to the strategic imperative to implement Smart Grid. Importantly, the DOE has asked respondents to comment on both the current situation and to provide a "gap analysis," as well as to project emerging and future preferred alternatives approaches and supporting rationale.

Rather than individually address each of the discrete nine questions asked in the RFI, Booz Allen's response is organized around distilled observations related to these topic areas and their respective RFI responses, the implications deriving from those observations for the DOE, and targeted recommendations as to how best to respond to the opportunities and issues raised. Booz Allen's overall goal in responding to the RFI, therefore, is to identify the major critical issues that emerge and to suggest recommendations that the DOE may wish to consider as it addresses the challenges inherent in addressing Smart Grid National Broadband Plan requirements.

Booz Allen recognizes the DOE's role in connection with Smart Grid and utility industry communication requirements is multipronged and appropriately intertwined with the National Broadband Plan and Smart Grid policy mandates. By spurring investment through pilot programs and grant programs funded through the American Recovery and Reinvestment Act, the DOE fills a marketplace gap in the emergent phase of the Smart Grid industry. These initiatives build operational experience,

validate Smart Grid applications, and can stimulate private capital follow-on investments. The creation of baseline communication networks requirements plays an important role in avoiding disparate early-stage deployments which cannot be scaled. Uniform and increasingly open standards contribute to efficient and scalable projects and ultimately new business formation. The DOE's role also encompasses targeted innovation development and stimulation in Smart Grid. In the context of communication networks technologies this role will take on great importance as next-generation software, network architectures options, and more capable middle mile and access infrastructure comes to the forefront. For example, new more spectrally efficient wireless technologies combined with wide area network and local area network hybrid delivery platforms will introduce innovative, lower cost delivery choices for the Smart Grid industry. In addition, the DOE can play an enduring role as a key facilitator in the stimulation of global Smart Grid standards ensuring optimal cross-country harmonization. This role is particularly important given the global benefits of more widespread diffusion of cleantech and Smart Grid technologies across major world regions.

The utility industry critical issue areas presented for discussion in this response were selected based on one or more of the following factors: (1) the potential impact as key success drivers to the Smart Grid networks requirements initiative and Smart Grid strategy; (2) the DOE's ability to take near-term decisions and actions in the highlighted issue area; (3) the need for risk mitigation around the issue; (4) the time-criticality of decisions surrounding the issue; (5) Smart Grid economic value creation impact; (6) the impact of the issue on commercial scalability; and (7) the communication network's impact on ensuring operational viability and market adoption in the Smart Grid area.

Evaluation framework and recommendations**.** Booz Allen's discussion of the DOE's critical issues surrounding the study and evaluation of Smart Grid and utility industry communications requirements is organized around key observations informed by: (1) a detailed review of current RFI responses across all stakeholder groups; (2) Booz Allen project work in such industry sectors as Broadband, Energy, and other Critical Industry Infrastructure Vertical Markets; (3) third-party market research; (4) financial and economic value analysis; and (5) domain expertise in the evaluation and management of high-complexity, matrixed Program Management and Requirements Management work streams similar to that involved in Smart Grid communications network requirements management. Based on the key observations concerning communications network requirements for electric utilities, specific recommendation are suggested which could: (a) improve the DOE's of effectiveness in addressing the issue area (e.g., organizational effectiveness through superior use of knowledge management systems and processes), (b) improve efficiency in addressing the targeted issue areas, or (c) enhance both effectiveness and efficiency.

Critical Issue	Key Observations	Recommendations
#1: Managing Smart Grid Communications Requirements, Perspectives, and Stakeholder Priorities Diversity	▪ We observed high diversity in DOE RFI responses based on: inherent complexity of requirements assessment; stakeholder requirements priorities; utility industry segment position, and business model assumptions	▪ Implement a structured and rigorous approach to requirements management ▪ Integrate Communications, Power and Applications Layer requirements vs. Networks Centric Requirements Planning
#2: Smart Grid Communications Requirements Driven by Business Cases	▪ We observed many, but not all, respondents providing little business case context for their proposed needs and recommendations	▪ Link requirements to business cases ▪ Define clear success metrics ▪ Use Smart Grid pilot success cases to inform future requirements prioritization ▪ Avoid "stranded plant" unproven technologies
#3: Managing the Proliferation of Smart Grid Requirements	▪ We observed a proliferation significant variance in Smart Grid definitions and terminology ▪ There is a major difference by stakeholder category in the importance of efficiency-driven Smart Grid prioritization and new business oriented Smart Grid interest	▪ Implement a structured and phased approach: Market Requirements>Functional Requirements>Technical Requirements development ▪ Map prioritized market requirements to core functional requirements ▪ Incorporate utility industry legacy network realities
#4: Ensuring High Organizational Effectiveness	▪ Ensuring a high degree of organizational effectiveness across multiple DOE functional and organizational entities, stakeholder, and	▪ Encourage organizational collaboration ▪ Implement high-impact knowledge management systems and processes ▪ Encourage public-private partnerships which create

	public/private organizations will be a key success requirement for DOE	rapid-response issues resolution capability
#5: Avoiding the Private Network Versus Commercial Network Dichotomy	▪ We noticed a tendency in respondents to focus on legacy commercial network capabilities vs. emergent and next-generation technologies ▪ A more segmented and refined view of the full range of mission critical "private network" needs will likely yield potential alternative solutions	▪ Discourage point solutions and non-extensible network approaches ▪ Encourage open architecture solutions with standardized protocols that promote compatibility and ease of integration ▪ Stimulate exploration of newer hybrid wireless and hybrid fiber/wireless network solutions
#6: Ensuring Timely Private Industry Investment and Commitment to Smart Grid	▪ We observed selective discussion of the major legacy migration issues facing the utility industry	▪ Develop and use key metrics success measurements ▪ Communicate Smart Grid pilot success stories ▪ Develop a structured communications outreach program ▪ Encourage "lessons learned" cross-stakeholder information sharing

Critical Issue #1: The DOE Is Facing a Diverse Set of Communication Requirements, Alternative Perspectives, and Competing Priorities

Diverse Requirements, Perspectives, and Industry Stakeholder Priorities

Recommendations :

- Recognize and address inherent divergence in Smart Grid stakeholder perspectives and network requirement positions.
- Implement a structured and rigorous approach to requirements management.
- Prioritize early critical path requirements area
- Incorporate a high degree of public-private collaboration
- Integrate Communications, Power and Applications Layer requirements vs. Networks Centric Requirements Planning.

There is inherent diversity reflected in the DOE RFI responses to utility industry communications current, emerging, as well as future requirements. This dynamic will require the DOE to implement a structured and rigorous approach to requirements coordination, management, and implementation to ensure success. The issues posed by the DOE's RFI raise a wide-range of communication network technology, legacy network migration, and IT/integrated systems requirements definitions and management issues. The implementation of Smart Grid impacts broadly three main layers: Communication, Power, and Application Layers. Given this inherent complexity and implied need for highly integrated requirements definition and coordination, the issues surrounding requirements management— including definitional consensus and core market requirements closure are complicated. There is a basic need to place communications network requirements into a broader and more comprehensive requirements development framework. This is made more challenging by the current high rate of change occurring in network technologies and evolving standards, a multiplicity of system architecture options, proliferation of hybrid wireless local access delivery options, next-generation service delivery platform alternatives, and a proliferation in intelligent device form factors and capabilities. These developments combined with the introduction of new business models and corresponding economic "value shifts" make it more pressing that the DOE institute a communications requirements approach that is both comprehensive yet highly focused; one that is streamlined and one informed by a pragmatic market focus.

Areas of Broad Consensus	Areas of Divergence
• Strategic importance to U. S. utility industry of accelerated deployment • Need for greater broadband and two-way capabilities • Criticality of well-defined and adoptable standards • Importance of legacy utility networks upgrades • Avoidance of "one size fits all" approach • Critical need for more stringent network performance	• Prioritization on infrastructure-centric needs vs. new Smart Grid opportunities focus • Role of licensed spectrum • Degree of commercial networks' fit with Smart Grid needs • Role of hybrid wireless and unlicensed spectrum • Extent of utility segment commitment to near-term legacy network migration

measurements • Need for highly flexible Smart Grid regulatory regime	• Preferred/dominant network architecture to address Smart Grid requirements

Broad general consensus appears to exist around multiple Smart Grid communication requirements and selective strategic imperatives; however, differences exist in key areas. Although there are a number of critical areas where stakeholder groups diverge—for example, notably regarding the licensed spectrum mandate and the extent of commercial networks' applicability to utility industry needs—most respondents coalesced around the following : (1) high-interest in the adoption of robust two-way and real-time network capabilities. (2) The criticality of achievable standards coherence, coordination, and harmonization. (3) The essential need for enterprise, "mission critical" network capabilities that are under the control of the utility. (4) The increased importance of wireless networks to greater operational efficiency and improved field force communications as well as enablement of new consumer Smart Grid services. (5) Acknowledgement of the limitations of the current, largely one-way legacy TDM (Time Division Multiplex) utility network (6) strong general interest in piloting and commercial deployment of IP and next-generation communications capabilities. (7) Recognition of the communication network challenges in dealing with the increased impact of evolving distributed business models and its impact on the need for greater distributed computing capabilities and higher-speed interactive networks.

Key divergence exists in critical Smart Grid needs and communication requirements priority areas which complicates the execution of the DOE's Smart Grid mission. Perhaps not surprisingly, across the RFI major respondent stakeholder categories: Utility Service Providers, Wireless/Wireline Communication Service Providers, Vendors, Association/Trade Groups, and Smart Grid Specialists/ New Entrants requirement priority areas and recommended solutions differ. Key areas of different stakeholder positions include: (1) the criticality of utility industry access to licensed wireless spectrum (2) the degree to which only owned and controlled "private" utility networks can address utility "mission critical" requirements (3) the extent to which commercial network solutions can address current and future utility industry Smart Grid network "capability gaps" (4) the recommendation of optimal communication network architectures and the most desirable legacy network migration strategy (5) the degree to which Smart Grid application business cases and long-term viability are proven in satisfactorily today (e.g. Automated Meter Infrastructure; Demand Response Management Consumer Solutions) (5) the extent to which public-private partnerships are critical to Smart Grid requirements adoption and long-term success.

A structured and rigorous approach driven by market requirements can yield multiple benefits. Early closure on a structured requirements approach by DOE will be key to critical milestone achievement and stakeholder buy in. This is because the development of well-defined and extensible requirements is critical "upstream" technology and network deployment drivers. Smart Grid revenue growth, job creation, economic value creation, market stakeholder signaling, and attraction of necessary private capital investment all are intertwined with the development and communication of pragmatic and robust requirements. Without these elements, the creation of stable and sustainable Smart Grid ecosystems could be delayed, or in some Smart Grid application segments potentially sidetracked indefinitely.

Critical Issue #2: Ensuring the Development of Smart Grid Communications Requirements Backed by Solid Business Cases

In the Smart Grid communications requirements definition and management area the DOE faces unique challenges which will require focused, creative solutions informed by clear business cases. The DOE faces some unique challenges in the Smart Grid communications network requirements area. The utility industry, in general, has been a late adopter of IP-based network solutions and faces a large and operationally difficult set of legacy network migration challenges. Sophisticated Smart Grid interactive, two-way and increasingly distributed computing requirements complicate these challenges. In addition, underlying foundational technologies in networks, IT/networking, software, and devices are undergoing very high rates of change. Communications network commercial standards are shifting to accommodate next-generation application demands such as wireless 4G/LTE (Long-Term Evolution) as well as expanding next-generation Service Delivery Platform options, and a proliferation of new application piloting, as well as the potential for the creation of new revenue and efficiency sources are all adding to industry network standards complexity. Each Smart Grid requirement development work stream must be executed quickly and in a coordinated manner following sound project management principles and conducted against a backdrop of clearly supportable market requirements and cost-benefit assessments.

Business cases will be key to success. Independent analysis of proposed communication network solutions should be conducted. Among the major elements in the business case of most importance are: the consumer, business, and intermediary user adoption trajectory; the size and timing of capital investment; the degree to which Smart Grid network spending obsoletes legacy investment; the cumulative minimization of "stranded plant" capital and operating costs; third-party validated market research; successful predecessor pilot program financial metrics; and clear evidence of operational efficiency sustainability. The Smart Grid communication networks requirements input collection, distillation, prioritization, and ultimate requirements development should be driven by the business case sustainability of Smart Grid initiatives.

Smart Grid Communication Requirements Informed by Rigorous Cost-Benefit Analysis

Recommendations :

- Link requirements to business cases
- Base communication networks requirements on 360-degree business case development
- Define clear success metrics.
- Use Smart Grid pilot success cases to inform future requirements prioritization.
- Avoid focusing on "stranded plant" unproven technologies.
- Ensure ongoing use of market-driven planning framework for requirements.

In addition, to the presence of demonstrable Smart Grid business cases, clear linkage from technical requirements to market needs is a key success driver. Put simply, a staged, but iterative approach that connects Market Requirements, Functional Requirements, and Technical Requirements within a pragmatic market, implementation, and technical framework will be essential. This will hold true for near-term as well as future Smart Grid and utility industry network requirements development, initial adoption, and future extensibility. When high-rate of change technology developments areas are combined with industries undergoing structural change or transformation it is doubly critical that baseline requirements be developed that are linked to proven-in as well as the most likely scenario developments. Without this context and supporting market-driven framework industry stakeholders and investors can be subject to unacceptably high "stranded plant" economics and its negative collateral effects, thus frustrating the DOE's Smart Grid mandate.

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Critical Issue #3: Managing the Proliferation of Smart Grid Requirements

Each of the three primary layers, Communication, Power, and Application, are experiencing fundamental requirements expansion as "digital energy" needs are addressed. Certain themes are common across these Smart Grid and utility industry broadband bandwidth trends and the needs they reflect. Chief among these are: expanded broadband bandwidth in both in the Middle Mile and Last Mile Access segments of the network; marketed increased needs for two-way, interactive capabilities; the requirement for network performance at far higher levels of performance; pervasive network intelligence; flexible and economically viable legacy network migration options; economic real-time network performance monitoring; and integrated, "cross-layer" service delivery platforms. The chart below highlights some of these specific needs and requirements.

Smart Grid communication network requirements should be strongly informed by market needs and adoption trends as well as be managed with a pragmatic eye to legacy network and migration realities. Smart Grid technical requirements that are well-defined, clearly presented and communicated, and provide for future application capabilities are baseline characteristics of successful communication networks requirements. However, technical requirements development must be conducted in a broader context that is grounded by market requirements which map to well-crafted functional requirements. As previously referenced, the requirement development work streams should reflect the core needs of the respective "layers"—e.g. Communications, Power, and Application. This staged approach to requirements development is also especially necessary when new technology proliferation and network architectural options are being injected continuously into the market place from a variety of sources simultaneously. Such sources include: the increased presence of new entrants offering innovative solutions; regulatory regime liberalization; market ratification of next-generation wireless standards through deployment commitments (such as LTE vs. WiMAX in mass market developed nation mobility adoption); and incumbent vendor horizontal integration or partnerships to endorse preferred network alternatives. It will be incumbent on the DOE requirements management and coordination activity to track and assess the impact that these developments will have on evolving market needs in a dynamic market such as that represented by Smart Grid.

The current state of the utility industry communications portfolio predominantly reflects legacy historical choices and incremental new technology investment. Although not universally the case, the general status of current utility industry networks can be summarized as: (1) predominantly one-way and historically narrowband-centric; (2) heavily reliant on proprietary network solutions; (3) limited adoption of newer IP-centric network technologies in the middle mile and local access networks; (4) selective experimentation with more forward-leaning hybrid fiber and wireless network architectures and solutions; (5) tentative exploitation of the full potential of licensed spectrum 4G wireless and Wide Area Network(WAN)/Local area Network(LAN)/Personal Area Network (PAN) integrated capabilities; (6) highly selective acquisition of newer and emergent network technologies frequently driven by Smart Grid pilot funding or "proof of concept" objectives; and (7) intelligent network deployments such as Phasor Measurement Units (PMUs) in Transmission and Distribution and Smart Meter Infrastructure (Intelligent Electrical Devices) deployments that creates improved—but geographically incomplete views infrastructure delivery status or full end-user customer base visibility. This last area can create greater network heterogeneity which can increase operational inefficiency and potentially could lead to undesirable network and geographic "balkanization" and capital inefficiency.

Managing Requirements Proliferation

Recommendations:

- Implement a structured and phased approach: Market Requirements>Functional Requirements>Technical Requirements development
- Map prioritized market requirements to core functional requirements
- Incorporate the realities of the utility industry legacy network migration challenges into core requirements planning
- Leverage "best-of breed" vendor and independent third-part domain expertise

Layer	Current Trends	Broadband Requirements/Needs
Communications	• Significant projected expansion in utility network traffic volume • Increased demand for middle mile and last mile access bandwidth • Prevalence of hybrid network architectures • Mandate for greater near-real-time and real-time network management visibility • Emergence of innovative hybrid WAN/LAN mixed wireless solutions • Increasing interest in global harmonization of standards • Smart Meter accelerating deployment and utility industry broader adoption and customer acceptance	• Scenario-driven detailed capacity planning • Network architecture selection and staged middle mile and last mile staged network investment linked to business cases • Assessment of relative benefits of fiber and wireless integrated solutions • Close monitoring of cellular/ wireless wide area network (WAN) and integrated LAN and other solutions for Smart Grid needs • Robust participation in international standards bodies especially in wireless and next-generation application areas • Increased local access alternatives, management of unlicensed spectrum interference, licensed spectrum
Power	• Accelerating deployment of transmission and distribution smart monitoring devices (e.g. PMUs) • Increase in distributed generation geographic dispersion and microgeneration sites • New entrant business models and industry structures (e.g. aggregators) • Increased emphasis on Critical Industry Infrastructure (CII) protection	• Linkage with middle mile capacity planning and real-time information delivery platform capability • Innovative edge network, node aggregation, and middle mile capacity to support regional traffic delivery and application support • Early broadband requirements capture for new business model participants and projected scaling requirements
Application	• Proliferation of field force mobility applications • Increased consumer Intelligent Home Display (IHD) deployments • Greater use of video and rich media broadband applications for critical	• High security mobility solutions and sufficient bandwidth • Integrated and end-to-end service delivery platforms (SDPs); broadband coverage and capacity • Secure video platforms and stringent

	infrastructure monitoring • Accelerating interest in secure extranet and inter-regional real-time communications • Higher-capability Smart Grid intelligent device monitoring, management reporting, and data visualization needs	Service Level Agreements (SLAs) • Coordinated regional networks and interoperability • Higher data refresh rates; increased LAN and intranet traffic volume

Utility industry legacy network migration challenges complicate communications network requirements development. The nature of the utility industry communications requirements development is further complicated by the advanced capabilities implied by participation in Smart Grid opportunities—both efficiency and operational improvement oriented (e.g., for infrastructure-centric utility participants) as well as those which are centered on new revenue capture and diversification (e.g., Electric Service Providers, Distributed Generation Aggregators). The functionality resident in the current utility network infrastructure portfolio in general is ill-suited to the real-time, higher bandwidth, hybrid network landscape of the future. Legacy network migration, executed in a structured and staged fashion, linked to business objectives and market adoption readiness, will be crucial elements of the success of the Smart Grid future in the U.S. This migration is key because Smart Grid networks will need to support: greater levels of interactivity; far more stringent network performance Service Level Agreements (SLAs); a greater percentage of high bandwidth traffic and broadband application types (voice/VOIP, data, two-way video, rich media, GIS data etc.); orders of magnitude increases in aggregate traffic volume; traffic prioritization management and oversight; near real-time and real-time management reporting; and increased presence of unlicensed, hybrid wireless, and licensed spectrum networks, systems and devices. Without a structured legacy network defined roadmap and staged migration plan able to support the above requirements, progress in the deployment of Smart Grid networks will be suboptimal.

Critical Issue #4: Ensuring High Organizational Effectiveness in Smart Grid Program Management

The DOE historically has operated as a decentralized organization with project elements and related workstreams spread between its labs and diverse departments. In the assessment and implementation of the utility industry requirements and Smart Grid National Broadband Plan mandate the DOE will need to work collaboratively with the FCC. In addition, it will need to coordinate with and organize the contributions of a highly diverse set of stakeholders and requirements commentors—both public and private. This will require an innovative and flexible organization approach that puts a premium on prioritization of activities, project milestone management, and enhanced organizational effectiveness programs. How the DOE elects to tackle these issues will very much lie at the intersection of Smart Grid technology and broadband capabilities.

Ensuring High Organizational Effectiveness

Recommendations:

- Focus requirements workstreams on priority critical path milestones
- Encourage and incent organizational collaboration
- Implement high-impact knowledge management systems and processes
- Leverage public-private partnerships extensively
- Create rapid-response issues resolution capability
- Communicate progress continuously to key stakeholder

Development, ongoing assessment, and management, of the utility industry and Smart Grid comunications network requirements presents DOE with unique and multiple challenges. Because communications network requirements work streams embody a large and diverse set of topics and involve disparate entities—both public and private—the DOE and its primary collaborators such as the FCC—will face unique challenges under heavy time pressure for deliverables to multiple constituencies as well as core utility stakeholder groups. To effectively address these challenges and ensure successful outcomes the DOE should: (1) focus requirements workstreams around major critical path milestone deliverables; (2) ensure appropriate "centralization" of requirements aggregation, reconciliation, and issues management; (3) ensure the creation of a high-collaboration environment across governmental agencies and private contributor stakeholder groups; (4) create a high-frequency communications and management reporting strategy and processes to support dynamic knowledge sharing; (5) implement clear lines of accountability for "integrative program management"; and (6) provide for requirements issues identification and schedule risk reporting with rapid escalation to ensure project workstream delays are mitigated to the full extent.

Success in the DOE's facilitation and management of the National Broadband Plan Smart Grid activities will entail far more than requirements development and will also include: how effectively it distributes the roles for the testing and evaluation of pilot programs; how it measures the operational and financial return on its portfolio of investments; which success metrics it implements for pilot programs and requirements activities; how extensively the DOE specialized lab expertise can be leveraged against FCC domain expertise; how rapidly the DOE can capture "best of breed" input from its diverse stakeholder groups; and what communication processes can be implemented for the DOE to achieve its Smart Grid mission through effective knowledge management and information sharing.

Specifically within the requirements management area project success will be predicated on program management overall organizational effectiveness. Because the collection, initial assessment, ongoing evaluation, and ultimate creation of Smart Grid communication networks requirements involves a wide array of disparate individuals, organizations, and stakeholder positions, effective requirements management requires both fluid matrix management and a highly structured program management approach. Given its Smart Grid mandate and critical role in communications network requirements facilitation, a highly structured approach to integrated program management grounded in the key drivers of organizational effectiveness can contribute significantly to program success. Chief among these organizational effectiveness drivers are: (1) clear cross-functional and cross activity program management and coordination ownership; (2) the appropriate balance of centralized leadership/ownership and distributed or field organization ownership; (3) appropriately aggressive solicitation of private/industry stakeholder inputs and leveraging of communication network domain expertise; (4) critical path and milestone-driven progress tracking; and (5) investment in additional in-house personnel and outsourced resources as appropriate to support high-impact program deliverables.

Critical Issue #5: Avoiding the Private Network Versus Commercial Network Dichotomy

Modern communications network technologies and deployment options are undergoing transformative change and are at multiple inflection points offering enterprise network buyers and users an increasingly diverse set of choices (and corresponding need to mitigate risk). Some, but not all, DOE RFI participants responded in an either/or fashion to the DOE's inquiry regarding the extent to which commercial networks are now —and in the future— will be able to meet the utility industry's needs. That is, that commercial networks (and by implication commercial providers) are partial or incomplete alternatives for Smart Grid needs. Certainly COTS (Commercially Off-The Shelf) true plug-and-play "plain vanilla" commercial networks options will be a scarce, if not a null set for many Smart Grid. However, the perspective offered by Booz Allen is that the Smart Grid network alternatives are best viewed as a continuum of network solutions which will range from very high, to high, to moderately high fit, though limited/no fit. Each solution selected should be based on technology feasibility, operational viability, and economic sustainability. Inevitably, the evaluation dimensions will require complex performance, geographic availability and cost trade-offs, as well as other key criteria.

In effect, the network options for utilities in connection with Smart Grid should be viewed as a set of specific portfolio technology and cost/benefit business options whose ranking will shift over time. One requirement area that in particular no matter what network option is selected utilities will need to continue to exercise increasing vigilance around is s cybersecurity. Cybersecurity is increasingly critical not only in the mandated critical infrastructure domains of the utility industry— transmisssion, distribution, and core enterprise applications— but increasingly in a wide varietry of network connection domains, sub-networks, and dispersed intelligent devices. In addition, with the increased deployment of distributed computing, extranets, and inter-regional network communications these requirements will only accelerate. Thus utilities will approach migration to "non private" network solutions "like the man who taps the iron bridge twice." Thus certain "mission-critical" utility industry enterprise networks may involve no or limited trade-offs from the current, in-house or proprietary approach and this strategy may not only be appropriate but essential in the context of Critical Industry Infrastructure (CII) objectives and will require careful evaluation regarding the trade-offs involved in adopting non-traditional approaches. However, whichever options are selected to be subjected to rigorous market, functional, and technical as well as economic fit analysis.

Avoiding point solutions and incorporating service delivery platforms that are extensible will be key success factors. Communication industry experience and Information Communications and Technology (ICT) emerging technology requirements best practices suggests that enterprise point solutions if not developed and launched with a clear road map that links technology (supply) with validated market adoption (demand) that an undesirable "stranded plant" dynamic can be put in place. The primary impacts of a stranded plant scenario are: sub-par financial returns, underutilized infrastructure assets, deteriorating market share, and operational inefficiency. Worse still are: reputational impairment with consumers; potential unrecoverable credibility for the Smart Grid application or use case with investors; inability for utilities to "prove-in" rate recovery requests; and vendor partnership reduced or eliminated support. In addition to the drag that non-scalable point solutions place on utility economics and competitiveness, pre-mature selection of service delivery platforms—the software and systems "engines" that power application management and delivery; operational support systems; and business support systems— must be selected with equal care to the underlying physical and logical network infrastructure choices. This is doubly critical in next-generation architectures where IP-based platforms support products and services with variable Service Level Agreement (SLA)-driven performance requirements. The extensibility of the service delivery platform to support future services will be an increasingly critical element of successful communications network requirements and successful launch management for Smart Grid services.

Avoiding the Private Network Vs. Commercial Network Dichotomy

Recommendations:

- Focus network choices on technical feasibility/fit, and operational viability, and economic sustainability.
- Discourage point solutions and non-extensible network approaches
- Ensure long-term regional/super-regional and national scalability
- Encourage open architecture solutions with standardized protocols that promote compatibility and ease of integration
- Encourage exploration of newer hybrid wireless and hybrid fiber/wireless network solutions
- Avoid proprietary solutions except where absolutely essential

Critical Issue #6: Ensuring Timely Private Industry Investment and Commitment to Smart Grid

Government funding of Smart Grid through stimulus programs and innovation grants and loans can provide Smart Grid application jumpstarting, but sustained private capital investment is critical for long-term success**.** The combination of venture capital/private equity, corporate M&A and investment as well as ARRA grant dollars combined with a wide range of Investor Owned Utility (IOU) and other Electricity Service Provider pilot investments have advanced Smart Grid application deployments in the near-term. However, the deployment of Smart Grid applications and supporting communications infrastructure varies considerably by region and by stage of deployment. The ARRA portfolio is appropriately diverse covering a wide range of Smart Grid projects including interoperable open Smart Grid demonstrations; grid monitoring and renewable integration; and energy Internet microgrid projects; and dynamic line rating. However, the economic benefits to Smart Grid pilot investments are not yet fully proven or completely comprehended and accepted by investors. The presence of proprietary Smart Metering and Advanced Meter Infrastructure (AMI) platforms and networks combined with the emergent-to-early majority status of the applications has lead to vendor share fragmentation and technology diversity. The appetite for risk and the appetite for forward-leaning consumer engagement around new Smart Grid services are variable across utility industry sub-segments (e.g. Large Investor Owned Utilities Vs. Cooperatives or Municipal Utilities). In addition, the regulatory environment has contributed to investor concern given diverse regulatory regimes including 51 Public Utility Commissions and FERC. New Electricity Service Provider (ESP) value-creation potential and the sustainability of new consumer services revenue streams are in many cases unclear (e.g. Interactive Energy Management In-home Displays.)

Ensuring Private Industry Investment and Commitment

Recommendations:

- Develop and use key metrics success measurements for Smart Grid applications and pilot deployments
- Communicate Smart Grid pilot success stories
- Develop a structured communications outreach program grounded in economic analysis and fact-based use cases
- Encourage "lessons learned" cross-stakeholder information sharing
- Track private capital commitment to Smart Grid investment segments and create capital requirement "gap closure" index

Government's facilitative role in the Smart Grid area is appropriate and critical; however, long-term success is predicated on private capital commitment at unprecedented levels. Government's facilitative role is appropriate and essential across a wide number of areas related to Smart Grid network requirements and implementation. Areas in which facilitation by the DOE is essential include: technology standardization, spectrum allocation and optimal use assessment; critical industry infrastructure protection; innovation management through cultivation of pre-emergent technologies; and targeted stimulus investment in early-stage Smart Grid infrastructure and services. Advancement in these areas will serve to jumpstart adoption of high-potential capabilities. Therefore, the DOE in its utility communications requirements activities should: (1) ensure that a well designed communications outreach program organized around network-enabled Smart Grid opportunity areas with proven business cases is available to potential investors on a high-frequency basis; (2) provide for pilot program "success stories" and lessons learned information sharing across key stakeholders including investors; and(3) develop a series of key success metrics for Smart Grid programs which are consistent, measurable, and easily communicated to relevant parties including major investor constituencies.

Conclusion

DOE can best succeed in its mission to ensure robust communication network requirements development by focusing on a evaluation process driven by validated market requirements and robust business cases. Smart Grid requirements should be conducted within in the broader context of integrated Communication, Power, and Application layer assessments which address utility industry legacy network migration realities while taking full advantage of emerging broadband-centric capabilities.

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