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INTERVIEW:

How We'll Get the Job Done: an Interview with NIST's Dr. George W. Arnold

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Although the inclusion of $4.5 billion dollars of stimulus bill funding for the first time elevated the words "Smart Grid" to the attention of many Americans, in fact the Obama Administration's commitment to upgrading the nation's electrical infrastructure is layered on top of an already-existing government initiative mandated by the Energy Independence and Security Act of 2007 (EISA). Under that bill, the National Institute of Standards and Technology is assigned the crucial role of ensuring that the standards, protocols, models and other tools necessary to make the Smart Grid a reality will in fact developed and deployed.

The centerpiece of that effort is something called the "Interoperability Framework," which is now being actively developed by NIST in cooperation with a wide variety of public and private stakeholders. The person leading that important effort is Dr. George W. Arnold, the nation's first National Coordinator for Smart Grid Interoperability, who was appointed to that role on April 13 of this year. In that role, he is responsible for leading the selection and development of the hundreds of standards that will make the Smart Grid not only possible, but able to fulfill the complex and difficult roles that policy makers have assigned to it.

Happily for that effort, George Arnold's past experience is as closely tailored to the unique demands of his new position as it might be possible to imagine. While a Vice President at Lucent Technologies' Bell Laboratories, he was active in developing the standards needed to transition the nation's telecommunications system into a new technological age, and his organization played a leading role in the development of international standards for Intelligent Networks and IP-based Next Generation Networks. His other standards-related achievements include

serving as Chairman of the Board of the American National Standards Institute (ANSI), President of the IEEE Standards Association in 2007-2008, and currently as Vice President-Policy for the International Organization for Standardization (ISO) where he is responsible for guiding ISO's strategic plan.

NIST has been driving the development of the Interoperability Framework aggressively since the arrival of the Obama Administration, holding an ongoing succession of work shops with all categories of stakeholders. Recently, these collaborative meetings led to the announcement for comment of the first preliminary list of Smart Grid standards, on May 18.

In this interview, George Arnold provides his insights into how this rapidly unfolding effort is proceeding, and what we can expect to see and hear in the future.

I Goals and Process

AU: *A fully deployed Smart Grid will require a very complex network of standards and standards-related tools in order to fulfill its promise. How would you describe these tools?*

GA: Congress, through the Energy Independence and Security Act of 2007, assigned NIST the task of coordinating the development of a framework that includes protocols and standards for information management to achieve interoperability of smart grid devices and systems. The key words are "achieving interoperability." Standards and protocols are necessary but not sufficient. A reference model that identifies interfaces that must be standardized is part of the framework. Industry has also stressed the need for conformance (testing and certification) to be part of the framework. There will be a lot of focus on common information models and data representations to achieve end-to-end interoperability. For example if you drive your plug-in electric vehicle cross-country and recharge, we need information standards that allow for "roaming" on your utility bill. To create an interoperable network, the smart grid has to be based on open standards. They will be technology neutral to allow for flexibility and innovation. Moving from today's electric grid, in which there has been a tradition of proprietary interfaces and product customization for individual utilities, to an interoperable grid based on open standards is a huge change for the industry. The standards also need to account for the regulatory environment. In addition to the federal government, there are 51 jurisdictions (50 states plus DC).

AU: *How much of this will be laid out in the Roadmap that is in preparation, and what is the current status of that document?*

GA: We are going about this in three phases. Phase 1 is intended to baseline an initial set of standards that already exist and can be used now for the smart grid, and develop an initial roadmap which identifies new or revised standards that need to be developed, by which organization, and when. The roadmap is focusing on six priority applications: demand response, wide-area situational awareness, electric storage, and electric transportation (these are the four priority areas identified by

the Federal Energy Regulatory Commission which regulates the bulk interstate power system) and the advanced metering infrastructure and distribution grid.

A key issue in the distribution grid is standards for the integration of distributed renewable energy resources. The roadmap will also cover cybersecurity and data networking. NIST is getting input for the roadmap through a series of public workshops. The first two were held in April and May, the work will continue through webinars in June and a third public workshop will be held in July. NIST plans to publish the roadmap in September. In Phase 2, starting in September, we will be setting up a more permanent private sector –public sector body called the Smart Grid Interoperability Standards Panel which will evolve the roadmap on an ongoing basis and recommend new or revised standards to NIST. Phase 3 will put in place a conformance testing/certification framework to support the smart grid.

AU: *What are the core areas of standardization where progress will be most urgently needed, and how much of the work will involve developing new standards, as compared to assessing and integrating existing standards into the roadmap?*

GA: There are existing standards that provide a starting point. During our first workshop in April we identified 16 existing standards on which there was strong industry consensus and can be used now. That's probably 5% of what will ultimately be needed. We will be adding to the list of NIST-identified standards for the interoperability framework on an ongoing basis. A lot of new standards will need to be developed. We estimate it is in the hundreds. By way of reference, I have looked at what was required to specify the standards for the next generation network in telecom. Over 600 standards documents have been generated thus far after 5 years. Most of them describe a mix and match of existing standards rather than entirely new standards. The smart grid is more complex than NGN. The standards themselves are being developed by about 15 different SDOs.

AU: *Do you expect that all of the important standards work will be specified in the Roadmap, or do you anticipate that unexpected standards initiatives will be launched by industry that will add significant value around the edges of the Roadmap as well?*

GA: The Roadmap will always be a living document. It will change over time as industry identifies new applications, architectural improvements, and integrates new technologies.

AU: *What are the areas of standardization where we have the most to work with (e.g., existing standards, existing standards organizations that are appropriate to the task, etc.)?*

GA: There is a rich set of existing standards for the underlying data networking requirements of the smart grid. The main needs here are in selecting appropriate profiles to ensure interoperability across vendors and cybersecurity. There are a lot of existing standards for cybersecurity. The main need is to determine how they should be applied in the smart grid. There are some standards available for data

formats, for example for smart meters, and information models for automation within the grid itself. There are existing standards for connection of distributed energy sources to the grid. Some of the most important organizations that are working in this space include IEEE, NEMA, IEC, IETF, NERC, in addition to NIST (for cybersecurity). There are about 15 organizations in total. In addition to traditional SDOs, consortia such as ZigBee are in the mix. ANSI also has a key role in ensuring there is a good process for standards development and facilitating access to IEC and ISO.

AU: *No surprise on the next question: what are the areas where we have the least, and what is the strategy for addressing these areas?*

GA: An example is creating a standard language for representing and communicating dynamic pricing across the grid. This is a very fundamental standard that needs to be developed. I would add to this standards for demand response signals, and more broadly for distributed renewable energy integration—common information models for interactions so that we can get to a market driven (price-based) electricity economy that will foster new ways of doing things, new business models, new ways to enable energy efficiency and integration of distributed generation and storage. How to deal with roaming of electric vehicles across the grid is another example. At our workshops we have been using the use-case methodology to determine what the requirements are. At the July workshop we expect to identify which standards development organizations should take on these and other tasks.

AU: *If you see any major voids in standards work, how can the Obama Administration go about incentivizing private industry to fill these gaps?*

GA: Secretary of Commerce Locke and Secretary of Energy Chu convened a leadership meeting with 70 industry CEOs and senior executives at the White House on May 18 to gain their commitment to this effort. It was an unprecedented meeting. I cannot think of any other program in which standards have received that level of attention. It was also a remarkable meeting. There was a shared sense of urgency and understanding that the standards needed to be developed on an expedited basis for the smart grid to happen.

Deployment is actually running ahead of the standards, and the $11 billion of Recovery Act funding for the smart grid will make deployment go even faster. There is a concern that we cannot allow these investments to become stranded because the standards are not yet there to ensure interoperability. So the standards work has to move much faster than it usually does.

I say it was a remarkable meeting because the industry CEOs who were there were much more knowledgeable than I expected about why standards take so long and how they can be done faster. A lot of good suggestions were made, and the standards organization and industry CEOs who were there made a commitment to apply resources and innovative processes to move the work along quickly. They viewed the pressure coming from government as helpful.

AU: *Do you think that preference should be given to accredited standards organizations over consortia in developing the standards that are needed, or should a neutral "whoever can give us the best technical result the fastest" policy be adopted?*

GA: The key is that we need technically sound, open standards, done quickly. The utility industry also wants a robust, representative process for their development and maintenance. Both accredited organizations and consortia with open, transparent processes will play a role.

AU: *Given the scope and complexity of the task at hand, do you see ways in which industry and/or government agencies will need to work together differently than they have in the past in order to meet the Obama administrations ambitious goals on schedule?*

GA: What is happening today in smart grid is very much like the automation of maintenance and operations in the nationwide telecommunications network that took place in the late 1970s and early 1980s, only with today's computing and data networking technology. A key difference is that in the telephone network, at that time, it was all owned by one company so coming up with a plan and setting standards was easier – it was done by Bell Labs. Today's electric grid is owned and operated by 3100 electric utilities. It was never designed with an overall plan, and there has not been a need for standards-based interoperability until now.

The standards work that has evolved is being done by 15 different organizations. Someone has to coordinate it. That is the job Congress asked NIST to do. Fortunately, NIST has a long tradition of working side by side with industry in the voluntary consensus process, and industry seems to be comfortable with NIST taking on this role.

AU: *Which standards organizations do you see playing the most important roles in enabling the Smart Grid?*

GA: IEEE, IEC, NEMA, NAESB, NERC, ISA, ASHRAE, ISO, NIST (cyber), SAE, OASIS, IETF, NFPA, UL, ZigBee Alliance, OpenSG Users Group, Open Geospatial Consortium, … There will be more. ANSI plays a very important role in defining requirements for a robust standards development process, and at least among the accredited organizations, helping to avoid overlaps in scope, and international engagement.

II The Challenges Ahead

AU: *Some commentators have said that we can move ahead with demonstrations and actual deployments today, while others have expressed concern that more standards need to be developed before incentive funds can efficiently be spent in the field. Are there areas where you believe more standards must be developed before anything else can be done, and if so, what are those areas?*

GA: We need to move ahead with the demonstration projects and deployments. They will help validate the standards that are chosen. The standards have to catch up and we are going to be driving the process hard. Where necessary the standards will have to allow for gateways or adapters to accommodate "pre-standard" deployments. Fortunately a lot of the standards are software-based, and even hardware can be updated with secure downloadable flash memory.

AU: *Private industry will be primarily responsible for developing the standards needed under the guidance of NIST, but Federal Energy Regulatory Commission (FERC) may ultimately mandate compliance with some of these standards. Is there precedence for this approach, and if so, what past initiatives come to mind?*

GA: FERC has the regulatory authority to mandate standards. They have this authority for the bulk and interstate power system, and for the reliability and security of the grid. The state public utility commissions have similar regulatory authority at the distribution and retail level. The enforcement authority they have is primarily through approval of utility rates – for example they can determine whether a utility can recover its investment in the grid in its rates. We are trying to do something with the grid that has not been done before. The interoperability in the telecommunications network is done almost entirely through voluntary standards, and it seems to work. However the electric grid is much more fragmented (3100 utilities) and has more a tradition of using proprietary systems. Some combination of voluntary and mandatory standards will likely be needed.

AU: *What lessons can we learn from those past efforts?*

GA: I think we are breaking new ground.

AU: *Standards have traditionally been set in niche-specific "silo" organizations, with only loose liaison relationships being created between organizations to lessen redundant efforts and increase synergy. Will this approach work for creating the full network of Smart Grid standards, or will a different approach be needed in some cases?*

GA: I think it will work. There is not that much overlap between the organizations in what they are doing for the smart grid, and where there is, such as IEEE and IEC, there are cooperative development arrangements in place.

AU: *The Obama Administration has launched several other ambitious standards-dependent policy initiatives, most notably the commitment to rapidly deploy Electronic Health Records (EHRs) on a national basis. What are the standards-related challenges you see as being common – and not common – to enabling both EHRs and the Smart Grid?*

GA: In designing our approach to the smart grid coordination effort, we studied what Health and Human Services did with the Healthcare IT Standards Panel. We have adapted what we thought were the best features, and are taking a different approach in aspects that were less successful.

AU: *The public-private processes that are developing in real time to create EHRs and the Smart Grid will certainly provide valuable lessons for the future of standards development. As a result, I'm interested in which aspects of the Healthcare IT Standards Panel's approach transfer well, and which Smart Grid needs require new approaches?*

GA: Having a standing public/private sector panel administered by a neutral private-sector organization which recommends standards needed to achieve interoperability is a good model. We do not plan to use the panel to develop the interoperability specifications. For the smart grid, that work will be done by the standards development organizations. There are hundreds of specifications needed, and we are fortunate to have fifteen or so organizations who are well-equipped to get the job done.

AU: *Standards groups are known for launching redundant efforts, especially where one vendor, or group of vendors, can gain a market advantage through having its technology win. Do you expect this to be a big issue with Smart Grid standards, and what, if anything, do you think the government should (or can) do to try and limit such activity?*

GA: I have to say that so far I have not seen this to be a big problem. There are a few cases of competitive standards but in the areas I have seen there is market demand for multiple solutions and our standards framework needs to accommodate it. What has pleasantly surprised me is that everyone sees this as a once-in-a-lifetime opportunity to redesign one of the most important infrastructures of the nation, and that if we do this right the pie gets bigger for everyone. There is a level of cooperation that I have not seen before.

AU: *Your personal involvement in the Smart Grid involves addressing security concerns. Where do you see the greatest challenges in this area?*

GA: A lot of the legacy systems deployed today were developed before the security standards and methodologies we have today existed. "Security by obscurity" is a term I have heard used to describe some of the legacy proprietary systems. The smart grid uses the robust standards and tools we have today to design in security at both a technical and operational level. For some time there will be a coexistence of legacy and new systems, and this will present challenges.

III The Smart Grid and the Future of Standards Development

AU: *As earlier noted, the history of standards development has been niche-focused, with individual organizations, staffed by interested participants, serving their own needs. As standards-dependent networks become increasingly important, complex and global, this approach is becoming increasingly inadequate. What does the Smart Grid challenge tell us about how the standards development infrastructure needs to evolve, and how should we go about encouraging it do so?*

GA: It is helpful actually for standards organizations to have well-defined areas of expertise. This works as long as there is a clearly defined coordination role accepted by government, industry, and the standards development community. Having a clearly defined urgent national goal that everyone understands and supports is also very helpful. Where we need to get better is in being more nimble in starting needed standards projects quickly, and dedicating industry and SDO resources more intensively to get standards done quickly, without so much dead time between meetings.

AU: *In the United States, industry espouses a "bottom up," industry-led approach to standard setting, while many countries abroad follow a "top down," government-led approach. Do you think that one process is better suited than the other to address complex challenges like enabling a Smart Grid, and do you think that the United States could learn any lessons from abroad in pursuing its Smart Grid goals?*

GA: I think the smart grid is a perfect example of the reason the US is a world leader in so many fields. The American way abhors "one size fits all" solutions and prizes innovation and flexibility. In the smart grid we are capitalizing on our strength - a dynamic and flexible decentralized system – as well as our innovation in solving problems and spirit of public/private partnership – to find the right balance of "top down" and "bottom up" to achieve the coordination needed for the smart grid.

AU: What haven't I asked that I should have to complete this picture?

GA: It seems like a very big challenge. Is this job doable? Absolutely. There are at least three major infrastructure transformations that have been successfully accomplished before: automation of operations for the telecommunications network in the 1970s/80s, development of the internet in the 1980s and 90s, and next generation telecom networks in this decade. We have plenty of lessons learned that we can apply to successfully realize the smart grid. We have no choice. We cannot achieve the nation's goal of energy independence and reduction in greenhouse gas emissions unless we do this.