# Standards Today

A Journal of News, Ideas and Analysis

A publication of CONSORTIUM INFO.ORG GesmerUpdegrove LLP

April – May 2009 Vol. VIII, No. 3


## STANDARDS AND THE SMART GRID




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# EDITOR'S NOTE:

## With Renewed Energy

The first paragraph in my Editor's Note to the last issue read as follows:

> *This issue marks the third and final (for now) entry in a cycle that addresses the role of technical standards in government, and vice versa, occasioned by the election of America's new, technologically savvy president, Barack Obama.*

But even as I wrote that paragraph, a nagging voice in the back of my mind was reminding me that I really wasn't done yet. No serious effort to provide an overview of the Obama Administration's standards-related challenges could be considered complete until I had addressed one more important topic.

That topic, of course, is the new administration's highly ambitious, extremely expensive, and vitally important plan to upgrade the nation's electrical system from its electro-mechanical past into the digital, intelligent future that beckons - and to extend that network intelligence into the homes and businesses of America as well. If successful in achieving this goal, President Obama will go a long way towards delivering on a trifecta of important and challenging administration promises: lowering our dependence on foreign oil and gas, creating new, sustaining and high paying manufacturing jobs in "green" industries, and significantly decreasing America's production of green house gasses. But none of this will be possible to accomplish unless government and industry work together to compile the hundreds of standards that will be necessary to make the Smart Grid work, selecting them where they exist, developing them where they do not, and then implementing them ubiquitously.

So with renewed energy to pursue the important topic of government's new willingness to drive ambitious standards-dependent challenges, I make amends with this issue, and provide an introduction to Smart Grid standards in a manner similar to the previous overviews of Electronic Health Record (December - January) and Open Government Standards (February - March).

My ***Editorial*** introduces the topic by highlighting one of the significant challenges realizing the benefits that the Smart Grid can deliver, one that we all share a responsibility to address. If home owners to not embrace Smart Grid technology, then the billions of dollars of public investment that rely on the installation and use of home-based Smart Grid technology to achieve their intended results may be wasted.

As before, the ***Feature Article*** attempts to provide an understandable overview of what the goals of the government's initiative are all about, and the role that standards must play in achieving these goals. More particularly, I provide an overview of the history of government support for the creation of the Smart Grid and the legislation that has been passed to drive its development. I then review



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the types of standards that will be needed (and whether they currently exist), and the principal standard setting organizations that are actively engaged in the development and support of these standards.

I'm very pleased to follow with an ***Interview*** of Dr. George W. Arnold, recently appointed to act as the first National Coordinator for Smart Grid Interoperability at the National Institute of Standards and Technology (NIST), who provides his first-hand insights into where we are in meeting the Smart Grid challenge, where we need to go, and how we will get there. I have been pleased to know and work with George for some years at ANSI, where he has been very active in a variety of leadership positions, including serving as Chairman of the Board from 2003 – 2005.

The balance of the issue covers other topics that I hope you will find of current interest: my ***Standards Blog*** juxtaposes a meeting location that just about every American business travel has found him or herself in at some time with what lies not so far away, while my ***Consider This*** essay focuses on the current challenges of the print media to survive in an increasingly digital age. This issue closes with a ***Monday Witness*** essay that explores how those that write history can define that term to their own advantage.

As always, I hope you enjoy this issue. But whether you do or don't, it's always good to hear from you. You can reach me at andrew.updegrove@gesmer.com.

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Editor and Publisher
2005 ANSI President's
Award for Journalism

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## EDITORIAL:

# Energy Conservation From Zero to Sixty

Andrew Updegrove

> Throughout the 20th century, the U.S. electric power delivery infrastructure served our nation well,… This once state-of-the-art system brought a level of prosperity to the United States unmatched by any other nation in the world. But a 21st-century U.S. economy cannot be built on a 20th-century electric grid.
>
> *A Vision for the Modern Grid, National Energy Technology Laboratory, for the DOE, March 2007*

For decades utility companies and environmentalists alike have known that the most dramatic and economical advances in energy policy could be achieved through energy conservation than by any other means. By utilizing techniques as simple as buying more efficient appliances and better insulating our homes we can lower our dependence on foreign oil, release fewer greenhouse gases, and savemoney as well, all at the same time. For almost as long, utilities have promoted the concept of "demand side management," and sought to enlist the aid of consumers and businesses to shift electricity usage to low-demand times of the day, with the potential benefit of avoiding the need to build expensive new power plants.

Sadly, conservation efforts that depend on consumer cooperation have been only marginally successful at best, gaining traction primarily during energy price peaks, and as quickly subsiding as gas prices recede. Where gains have been made, this has occurred slowly and through regulatory means, as old appliances fail and are replaced by those that are built to the higher efficiency ratings that are now required by law, and as older buildings are rebuilt or replaced according to new, more energy-aware building codes. But where regulations have not applied, progress has been less satisfying. Few homeowners have opted to install inexpensive energy conservation tools, such as timer-based thermostats and water heaters, that could save them money every month, while slowing the rise of utility rates as well.

*Sadly, conservation efforts that depend on consumer cooperation have been only marginally successful at best, gaining traction primarily during energy price peaks, and as quickly subsiding as gas prices recede.*

Today, through the use of new technologies and standards, and as a product of a new administration in Washington, there is the very real potential to advance energy conservation by an order of magnitude in a surprisingly short period of time. The name that has been given to *űber* design concept that its proponents believe can result in such a quantum leap in policy realization is the "Smart Grid."

One way to grasp what a transition to a Smart Grid can do for energy is by way of analogy: In many ways, the Smart Grid would be to the existing utility network what the Internet and the Web have become to the traditional telecommunications system. Before the Internet, that system was a privately owned, government regulated technology backbone that delivered and accepted a limited range of transmissions (largely voice and fax data) from homes and businesses that could create and accept those signals, and nothing more. In other words, although the network was smart, the nodes (us) were dumb.

*"In the modernized grid, well-informed consumers will modify consumption based on the balancing of their demands and the electric system's capability to meet those demands" - NETL*

Today, of course, the telecommunications backbone comprises the connective tissue between that links an exploding cloud of very smart nodes that feed many data formats (voice, graphic, video) into the system in order to serve virtually all of society's needs, from supporting financial transactions to delivering content of all kinds to supporting global supply chains. Even a humble laptop can play a vital role in creating, managing and utilizing many of the most complex functions that the Internet now supports. The result is that the telecommunications system has become a vastly more valuable network than it ever was before – not one, but several orders of magnitude more valuable and essential to the moment by moment existence and operation of society, commerce, science, education and government.

To close the analogy, as every home WiFi enabled network can become an intelligent node in the global telecommunications network, so can the electrical system of every home or business become an intelligent, interactive node in the national electric grid network. Much as a home or business router can tie a host of two-way services and capabilities into the telephone and cable system, so can a home or business electrical network become an interactive part of the power grid in ways that can dramatically lower costs to the user and demand on utilities, thereby helping achieve all of the environmental, social, and national benefits noted above.

How? By enabling end users to cost-effectively install alternative energy sources, such as wind generators and solar panels that can not only provide immediate power, but that will automatically and intelligently become part of the Smart Grid upon installation. An ever expanding number of the these highly distributed generating units will be able to sell excess power back into the grid at the highest price in real time to distant users, including those that may be willing to pay a premium for "green" power.

A Smart Grid-enabled home system will both decrease central generating requirements as well as lower home owner utility bills by monitoring electrical prices as they fluctuate during the day, and shifting consumption to lower-cost, off-peak times of day while selling back stored energy during high peak, high cost hours, all in real time and on a transactional basis. The owner of a hybrid automobile will also be able to treat that vehicle as a plug and play node in the Smart Grid, able to sell power into the grid at night when the owner is asleep as well as to "fuel up" on electricity at a remote location, all the while resulting in up and down adjustments to the owner's home utility bill.

The technology to do this all of this is available now, or will be in the near furture. The government is counting on users to not only accept that technology in their homes, but to pay attention to it as well. In the words of the Vision document quoted above:

> In the modernized grid, well-informed consumers will modify consumption based on the balancing of their demands and the electric system's capability to meet those demands. Demand for new cost-saving and energy-saving products will benefit both the consumer and the power system.

But will consumers in fact play their part?

The answer to that question will almost surely be both yes and no. No, if consumers, and to a lesser extent businesses, must hire expensive contractors to undertake otherwise unnecessary upgrades, configure and maintain complex new systems, and opt into confusing billing arrangements. But yes if electrical products of all appropriate types are made to "plug and play" with the Smart Grid out of the box, without complex configuration requirements and able to query customers in plain English in easy to understand displays. And yes again if all utility companies use the same formats and conventions to create, transmit, and report Smart Grid information back to consumers in ways that they can readily understand.

That is where standards will play a vital behaviorist as well as technical role, because without standards, nothing can plug and play, no information can be shared, and no network effects can be felt. Nor will prices drop to the point where government subsidies will become unnecessary, or competition arise to provide ever greater efficiencies and more valuable efficiencies.

For this to happen, hundreds of existing and non-existent standards will be needed, and a great deal of determination and cooperation must be demonstrated by thousands of competitors. The good news is that such a challenge has been met before (at least on the technical level), when AT&T brought the nation's telecommunications system forward into the future. And the better news is that the U.S. government, empowered by a national economic crisis, has committed to provide the economic and agency support to make it happen again.

If we wish to seize this golden opportunity to dramatically accelerate our ability to conserve energy, lower energy costs, and meet our global obligations to curtail greenhouse gases, private industry and utilities need to act swiftly. In order to do so, they must dedicate themselves to collaborating swiftly and effectively to develop and then implement the hundreds of standards that will needed to make the Smart Grid a reality.

Everyone will be a winner if they do. The most obvious beneficiaries will be the utilities themselves, as they avoid the costs, complexities and uncertainties of permitting and building new power generation facilities. Vendors will also reap huge profits, as they provision the hardware and software that will make the Smart Grid work.

But the greatest benefits will be felt by the citizens that do their part and climb aboard, doing well through lower energy costs as they do good by helping the nation achieve greater energy independence and a greener future.

For far too long, energy customers have failed to do their part by taking advantage of the conservation opportunities that governments and utilities have provided in the past. This time around, citizens need to quit idling on the sidelines and make their homes part of the Smart Grid their hard-earned tax dollars will be creating. If they do, America's progress towards a more responsible future will accelerate dramatically.

Gentlemen - and Ladies - clearly it is time to start your engines.



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# Standards and the Smart Grid: The U.S. Experience

Andrew Updegrove

***Abstract:*** *The managers of the aging United States electrical power grid have for some time planned to upgrade it to increase the quality of power on the grid and decrease the risks of power outages. They have also realized the potential for "Smart Grid" technology to be deployed to turn the existing system into an interactive, two-way energy network that recruits home and business owners to create electricity from alternative energy during off-peak hours that can be sold back into the grid when demand is high. Such a system can also conserve energy, lower its costs, and better absorb shocks that might otherwise bring down the system. Growing concerns over national dependence on foreign oil, the increasing costs of permitting and constructing new power generation facilities, and the need to decrease national emissions of greenhouse gasses led Congress to buy into this vision in 2007, when it mandated the creation of a Smart Grid. The current economic crisis provided a new administration in Washington with the opportunity to dramatically increase funding in the 2009 economic stimulus bill in order to speed the transition to a Smart Grid while producing thousands of new "green" manufacturing jobs. The operations of a Smart Grid, however, will be dependent on the rapid selection, and often development, of hundreds of new standards of many types. In this article, I review what a Smart Grid can achieve, the Congressional mandate and funding for the development of the standards needed to enable it, the process being used to select these standards, and the broad range of standard setting organizations that will provide them.*

***Introduction:*** Since the advent of practical electricity distribution in the 1880s, private and public utilities have delivered electrical power to customers using increasingly complex technology. Over time, independently owned utilities became nationally interconnected and regulated networks, controlled and protected by vastly sophisticated computer networks constructed to monitor usage, settle accounts among power producers and purchasers, and redirect power as needed to meet demand and avoid catastrophic failures. According to one commonly repeated truism, the modern power grid is the most complex machine ever built.

In the more precise and knowledgeable words of the National Academy of Engineering, the North American power grid is the "supreme engineering achievement of the 20th century." Unfortunately, this is no longer the 20th century, but the 21st, and a 2003 U.S. government report assessing the state of the nation's electric grid concluded that the last century's supreme achievement is now, "aging, inefficient, and congested, and incapable of meeting the future energy needs of the *Information Economy* without operational changes and substantial capital investment over the next several decades."[1]

Moreover, the demands that are being placed on the grid today are not only quantitatively greater, but qualitatively different than before. To the good, new enabling technologies and the Internet are presenting new opportunities for optimization, load leveling and storage that would have been impractical to consider only a few years ago. At the same time, governments are realizing the degree to which such enabling technology can help realize broader policy goals as well.

*Until quite recently, the sophistication of domestic user-controlled power consumption technology has rarely exceeded that exhibited by a light dimmer switch*

In the 21st century, the government architects of a revamped energy policy now wish to utilize the deployment of Smart Grid technology to help lower our dependence on foreign energy, meet international commitments to decrease our generation of greenhouse gases, and fuel job creation. At the same time, the new infrastructure that government will help create will be expected to become more secure, more interactive, and even "self healing."

Moreover, these expectations will be extending beyond the reach of the commercial boundaries of the traditional grid. Until quite recently, advances in controllable power technology ended where the power line enters the home. Once beyond this commercial/domestic interface, electricity enters a "dumb" domain where the sophistication of user-controlled power conservation technology rarely exceeds that capabilities of a light dimmer switch. Within too many businesses, and often even large enterprises, the reality has been not much different.

Today, a number of developments and forces are breaking down this stark divide, including soaring energy costs and the desire for greater national energy independence. At the same time, the installation of individually owned alternative energy sources is becoming economically viable, and advances in information technology (IT) now permit the ebbs and flows of electricity (in either direction between producer and consumer) to be accurately measured and billed, allowing a customer's account to be adjusted up and down in real time. Most recently, an ambitious and popular new administration has arrived in Washington just as a global economic crisis reached its peak, providing unprecedented public support for massive public funding of new initiatives intended to avoid economic collapse while creating jobs and infrastructure.

This confluence of forces has provided the wherewithal for government to not only fund and support, but indeed mandate, the rapid national deployment of "Smart

[1] "Grid 2003" A National Vision for Electricity's Second 100 Years, United States Department of Energy, Office of Electric Transmission and Distribution (July 20023), p iii., at http://www.climatevision.gov/sectors/electricpower/pdfs/electric_vision.pdf Unless otherwise noted, all on line resources cited were last accessed on June 4, 2009.

Grid" technology that will allow homes and businesses to become not simply on/off consumers of electric power, but sophisticated partners in increasing national energy efficiency, thus decreasing the need to build new centralized power production facilities, with all of their attendant costs, delays, and local and global environmental impacts, as well as decreasing national dependence on foreign (and especially oil and gas) energy sources.

Within this vision of the near future, homes and businesses will become not just more efficient consumers of power, but suppliers as well, contributing excess power back into the grid produced by privately owned wind generators, solar arrays, fuel cells, and even hybrid cars, parked and plugged in for the night in the family garage. Moreover, the systems installed by homeowners will be intelligent and powerful enough to monitor energy costs and allow a customer's home network to automatically shift power usage to off-peak, low cost times of the day, and sell stored power back into the system at the most favorable rates, during high demand peak consumption hours. Meanwhile, the home system's software will interoperate with the utility's system to calculate and complete the underlying financial transactions. The result: lower costs for utilities, due to avoiding the cost of building expensive new power plants, and lower electricity rates for all consumers.

If it is successful in implementing this grand redesign of the American power system, the Obama administration will not only provide the impetus to create what will become the most complex machine ever built without question, but will also make dramatic progress towards achieving multiple national and international policy goals.

There are numerous daunting challenges that lie between the present and the successful completion of such a Smart Grid, but one of the most urgent is the need to assemble (and in many cases develop) the hundreds of standards of all kinds that will be needed to allow such a complex network to not only exist between commercial producers, but to extend its intelligence into hundreds of millions of homes and businesses as well.

In this article, I will provide an overview of the Smart Grid initiative's origins and goals in the United States, and then review the types of standards that will be needed, the history of the U.S. government support for the creation of a Smart Grid, and the principal standard setting organizations (SSOs) that are actively engaged in the development and support of these standards.

## I Origins and Evolution

***The Smart Grid concept:*** Retail electrical distribution had its origins in the United States in the 1880s, and witnessed one of the first great standards wars of the technical age. On the one side was the direct current alternative that was advocated and first commercialized by Thomas A. Edison, and on the other, the alternating current system originated by Nikola Tesla et al. and commercialized by George Westinghouse. Over time, the advantages of AC current prevailed, notwithstanding the heroic, and sometimes even bizarre efforts of Edison to demonize alternating current.[2] Rapid technical advances and the allure of practical electric light (another Edison innovation) led to the spread of electrical power in urban areas. The reach of the electrical grid was extended over time, and as measured by square miles of coverage, dramatically so with the economic support provided by the passage of the Rural Electrification Act of 1936.

Eventually, the various private and public networks became interconnected (and their components more standardized), and distribution and management of electrical power came to be regionally managed in a network of great sophistication. Simultaneously, the costs and permitting challenges of building large new centralized generating facilities began to skyrocket. More recently, with the rise of concerns over global warming, politically palatable fuel sources have become fewer in number, and the costs of those fuels and abatement technology has risen as well – along with demand. Meanwhile, the fabric of the network itself has grown old and more fallible.

For all these reasons, the need to upgrade the aging and over-taxed North American power grid has become increasingly evident. As recently as the turn of the millenium, the near-term ambitions of industry and the U.S. government focused on the initial steps of a very expensive upgrade from a legacy, electro-mechanical system to a digitally based network. For example, a major report issued by the United States Department of Energy (DOE) Office of Electric Transmission and Distribution in July of 2003 titled, *"Griid 2030" A National Vision for Electricity's Second 100 Years*,[3] invited the reader to:

> Imagine the possibilities: electricity and information flowing together in real time, near-zero economic losses from outages and power quality disturbances, a wider array of customized energy choices, suppliers competing in open markets to provide the world's best electric services, and all of this supported by a new energy infrastructure built on superconductivity, distributed intelligence and resources, clean power, and the hydrogen economy.

Once this new, superconducting backbone was in place, progress could begin to be made at the customer level. But under the Grid 2030 vision, it would be almost thirty years before something recognizable as a complete Smart Grid would be in place:

> Grid 2030 is a fully automated power delivery network that monitors and controls every customer and node, ensuring a two-way flow of electricity and information between the power plant and the

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[2] Edison helped electrocute a hapless elephant at Coney Island in 1988 that had been "condemned" for killing three people, although the elephant's real crime appeared to have been its availability to be the subject for a publicity stunt. It's owner, Luna Park, needed publicity, and Edison needed a dramatic way to demonstrate the supposed dangers of alternating current. See, Topsy and the Standards War, at http://www.consortiuminfo.org/standardsblog/article.php?story=20061011081114524.

[3] *"Grid 2030" A National Vision for Electricity's Second 100 Years*. U. S. Department of Energy Office of Electric Transmission and Distribution (July 2003), p. i at http://www.climatevision.gov/sectors/electricpower/pdfs/electric_vision.pdf The report summarizes the findings and results of the National Electric System Vision Meeting, Washington, D.C., held on April 2 – 3, 2003.

appliance, and all points in between. Its distributed intelligence, coupled with broadband communications and automated control systems, enables real-time market transactions and seamless interfaces among people, buildings, industrial plants, generation facilities, and the electric network.

Despite the sobering fact that the first Major Finding of the *Grid 2030* report was that the existing electrical system was "aging, inefficient, and congested, and incapable of meeting the future energy needs of the *Information Economy,"* the goals of government and industry rapidly became more ambitious at the local as well as the federal level. Individual states, such as California, and regions, such as New England, began incorporating the type of long-term goals laid out in the *Grid 2030* report into their near-term goals for electrical system upgrades. Simply decreasing the incidence and cost of power outages and increasing the quality of the power delivered were no longer regarded as being sufficient.

Less than four years after the release of the Grid 2030 report, the DOE's Office of Electric Delivery and Energy Reliability delivered an ambitious new report and call to action that envisaged a far faster transition to the Smart Grid of the future. In that statement, titled *A Vision for the Modern Grid*, the DOE's National Energy Technology Laboratory Modern Grid Initiative called for an interactive grid that would incorporate locally based alternative energy sources, in-home networks, and even plug-in hybrid automobiles into a single, interactive grid that would blend "the traditional centralized model with one that embraces distributed resources, demand response, advanced operational tools and networked distribution systems."[4]

The 2007 vision document called for a transition to this new grid focused on meeting six "key goals:"

> ***The grid must be more reliable.*** A reliable grid provides power dependably, when and where its users need it and of the quality they value. It provides ample warning of growing problems and withstands most disturbances without failing. It takes corrective action before most users are affected.
>
> ***The grid must be more secure.*** A secure grid withstands physical and cyber attacks without suffering massive blackouts or exorbitant recovery costs. It is also less vulnerable to natural disasters and recovers more quickly.
>
> ***The grid must be more economic.*** An economic grid operates under the basic laws of supply and demand, resulting in fair prices and adequate supplies.
>
> ***The grid must be more efficient***. An efficient grid takes advantage of investments that lead to cost control, reduced

[4] National Energy Technology Laboratory, for the United States Department of Energy, Office of Electricity Delivery and Energy Reliability, A Vision for the Modern Grid (March 2007), at http://www.netl.doe.gov/moderngrid/docs/A%20Vision%20for%20the%20Modern%20Grid_Final_v1_0.pdf

transmission and distribution electrical losses, more efficient power production and improved asset utilization. Methods to control the flow of power to reduce transmission congestion and allow access to low cost generating sources including renewables will be available.

***The grid must be more environmentally friendly.*** An environmentally friendly grid reduces environmental impacts through initiatives in generation, transmission, distribution, storage and consumption. Access to sources of renewable energy will be expanded. Where possible, future designs for Modern Grid assets will occupy less land reducing the physical impact on the landscape.

***The grid must be safer.*** A safe grid does no harm to the public or to grid workers and is sensitive to users who depend on it as a medical necessity.

Underlying this high level vision lurked daunting technical challenges, as hinted later in the same document. The envisioned grid would be "self healing," and able to "handle problems too large or too fast-moving for human intervention." It would also be capable of supporting two-way communications with remote devices, and of monitoring and analyzing remote conditions. It would provide the tools to upgrade in-home systems in order to make possible new conservation programs that would "motivate consumers to be an active grid participant" and "include them in grid operations."

The plan also sought to transition a system based and dependent upon traditional "spinning wheel" generating sources that distributed power where and as needed into a more diversified marketplace where businesses and consumers would buy "plug and play" devices that would provide ubiquitous power generation and storage capabilities to the grid, thereby lowering central power generation demands, decreasing power loss over long distance transmission, leveling peak power demands, and lowering national dependence on foreign energy sources.

In order to achieve these complex goals, not only would new technologies need to be created and deployed into homes and businesses, but the more than 3,100 existing commercial power suppliers, most of whom currently employ proprietary IT systems (whether home grown or purchased), would need to upgrade their software and hardware to make them both compliant and interoperable. Compared to the upgrade of the telecommunications

**Some U.S. Smart Grid Milestones**

**July, 2003:** DOE releases *"Grid 2030" A National Vision for Electricity's Second 100 Years.* Report calls for a gradual transition to Smart Grid technology

***August 8, 2005:*** Passage of the *Energy Policy Act of 2005*, which includes new power grid reliability standards and alternative energy incentive funding

***March 2007:*** DOE releases *A Vision for the Modern Grid,* with call for an accelerated transition to a Smart Grid

***December, 2007:*** *Energy Independence and Security Act of 2007* (EISA) signed into law. NIST appointed to coordinate development of Smart Grid Standards

***June 2008:*** DOE workshop brings more than 140 government and industry representatives together to discuss EISA Smart Grid goals system at a time when it was owned by a singe company (AT&T), just the coordination aspects of such a task would be enormous. Moreover, given the fact that the economic life of commercial scale generating facilities is 40 years, utilities would not wish to make expensive mistakes, especially if state regulators might not allow them to pass the costs of such failed experiments through to their customers via rate increases.

While many of these new capabilities had been contemplated in the 2003 document, their wide spread implementation was slated to occur in later phases of a multi decade program. Now, their implementation would be rolled out far sooner and more aggressively. Moreover, with typical American confidence in the power of free markets to work wonders, those envisioning the Smart Grid of the future believed that given the right technology, standards, and regulatory environment, the marketplace would do the rest. Accordingly, the 2007 vision statement includes as one its seven "defining characteristics" the belief that:

> [The] Modern Grid will enable markets to flourish. Open-access markets expose and shed inefficiencies. The Modern Grid will enable more market participation through increased transmission paths, aggregated demand response initiatives and the placement of energy resources including storage within a more reliable distribution system that is closer to the consumer.
>
> Parameters such as energy, capacity, rate of change of capacity, congestion, and resiliency may be most efficiently managed through the supply and demand interactions of markets. By reducing congestion, the modernized grid expands markets; it brings together more buyers and sellers. Consumer response to price increases felt through real time pricing will mitigate demand, driving lower-cost solutions and spurring new technology development. New, clean energy related products will also be offered as market options.

***January 8, 2009:*** President-Elect Obama identifies transition to a Smart Grid as a high priority for hid administration

***March 19, 2009:*** FERC releases *Smart Grid Policy - Proposed Policy Statement and Action Plan* for public comment

***April 13, 2009:*** NIST names Dr. George W. Arnold as first National Coordinator for Smart Grid Interoperability

***April 28-29, 2009:*** Reston, Virginia workshop to select first Interoperability Frameworks standards attracts 400 participants

***May 18, 2009:*** Secs. Chu and Locke announce increased funding for development of Smart Grid Standards and demonstration projects, and announce selection of first 16 proposed standards

***May 19–20, 2009:*** Stakeholder Summit held in Washington, DC

***September 2009:*** Target date for release of Preliminary Roadmap for development of Interoperability Framework

***Bush administration legislation:*** With increasing calls for energy independence and abatement of greenhouse gas emissions, and few easy ways to address either pressing need, Congress was moved to enact legislation that would both mandate as well as support a variety of energy-related initiatives, from new automotive fleet mileage caps to transitioning from incandescent light bulbs to more efficient lighting technologies by 2020. Congress also largely bought into the DOE's latest plan for aggressively moving to Smart Grid technology, and included $100 million in funding per year to support the transition process.

***Energy Independence and Security Act of 2007 (EISA):*** The result of the confluence of these forces was the passage of the aptly named *Energy Independence and Security Act of 2007,* which was signed into law by President George W. Bush on December 19th of that year.[5] Title XIII of that free-ranging package of initiatives[6] is simply titled "Smart Grids," and in the first section of that Title, Congress declared that it is the "policy of the United States to support the modernization of the Nation's electricity transmission and distribution system..[to become] a Smart Grid." The same section declares that the elements that "characterize a Smart Grid" are as follows:

> (1) Increased use of digital information and controls technology to improve reliability, security, and efficiency of the electric grid.
>
> (2) Dynamic optimization of grid operations and resources, with full cyber-security.
>
> (3) Deployment and integration of distributed resources and generation, including renewable resources.
>
> (4) Development and incorporation of demand response, demand-side resources, and energy-efficiency resources.
>
> (5) Deployment of `smart' technologies (real-time, automated, interactive technologies that optimize the physical operation of appliances and consumer devices) for metering, communications concerning grid operations and status, and distribution automation.
>
> (6) Integration of `smart' appliances and consumer devices.
>
> (7) Deployment and integration of advanced electricity storage and peak-shaving technologies, including plug-in electric and hybrid electric vehicles, and thermal-storage air conditioning.
>
> (8) Provision to consumers of timely information and control options.
>
> (9) Development of standards for communication and interoperability of appliances and equipment connected to the electric grid, including the infrastructure serving the grid.
>
> (10) Identification and lowering of unreasonable or unnecessary barriers to adoption of smart grid technologies, practices, and services. *[Sec. 1301]*

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[5] Energy Independence and Security Act of 2007, Title XIII, Sections 1301 - 1306

[6] The Smart Grid sections of the Act apparently mark the transition from core legislation to rider land. Title XIV is titled, "Pool and Spa Safety."

While only the ninth element addresses standards by name, the viability of each of the other elements in fact relies on the existence and implementation of appropriate standards, often of many types.

Among other mandates, Title XIII of EISA requires the formation of a Smart Grid Advisory Committee and a Smart Grid Task Force; requires DOE to carry out a program of research, development and demonstration; provides 20% matching funds for qualifying Smart Grid Investment Costs within that program; and assigns primary responsibility to the Director of the National Institute of Standards and Technology (NIST) to "coordinate the development of a framework that includes protocols and model standards for information management to achieve interoperability of smart grid devices and systems," the scope of which is to be "flexible, uniform and technology neutral."

In order to meet the oxymoronic objective of "flexible uniformity," NIST is directed under EISA:

> …to consider the use of voluntary uniform standards for certain classes of mass-produced electric appliances and equipment for homes and businesses that enable customers, at their election and consistent with applicable State and Federal laws, and are manufactured with the ability to respond to electric grid emergencies and demand response signals by curtailing all, or a portion of, the electrical power consumed by the appliances or equipment in response to an emergency or demand response signal, including through—
>
> (A) load reduction to reduce total electrical demand;
>
> (B) adjustment of load to provide grid ancillary services; and
>
> (C) in the event of a reliability crisis that threatens an outage, short-term load shedding to help preserve the stability of the grid;…
> *[Sec. 1305(b)(3)]*

The legislation charges NIST with commencing development of the Framework within 60 days of the enactment of the legislation in collaboration with other named governmental units, and to:

> …provide and publish an initial report on progress toward recommended or consensus standards and protocols within 1 year after enactment, further reports at such times as developments warrant in the judgment of the Institute, and a final report when the Institute determines that the work is completed or that a Federal role is no longer necessary. *[Sec. 1305(c)*

Congress appropriated $5,000,000 per year to NIST for the fiscal years 2008 through 2012 for this purpose, and also authorized the institution of rulemaking proceedings to:

> …adopt such standards and protocols as may be necessary to insure smart-grid functionality and interoperability in interstate transmission of electric power, and regional and wholesale electricity markets. *[Sec. 1305d)]*

***Obama administration legislation:*** While the endorsement in EISA for the creation of a Smart Grid as contemplated by the 2007 Vision document was strong, the funding provided was weak in comparison to the scope of the task. The likelihood of deploying a fully functioning Smart Grid even by 2030 might therefore have been in doubt, but for the election of President Obama in 2008 in the midst of a severe and spreading economic crisis. The technically-oriented new president had already expressed his commitment to pursue a variety of energy-related initiatives, including implementing the Smart Grid. On January 8, several weeks before his inauguration, President Elect Obama announced the main points of the recovery and investment plan that he would propose in response to the economic crisis, and identified the transition to a Smart Grid as a "high priority" element of his administration's move towards energy independence. His ability to secure Congressional funding support to realize upon this initiative was augmented by the urgent need to address the seemingly imminent collapse of the global financial system.

The new president's plan to address the economic situation included an ambitious government spending and jobs creation bill intended to upgrade the nation's crumbling infrastructure as well as promote new jobs-creating "green" industries. When President Obama signed the American Recovery and Advancement Act of 2009 (ARAA) into law in February, it included a $4.5 billion appropriation to support the transition to a national Smart Grid. The vision laid out in the 2007 document and already underway as a result of EISA could now proceed with robust funding support, as well as the credibility of a new and firmly committed administration behind it.

The high degree of importance associated by the Obama Administration with the Smart Grid initiative was underlined by a landmark meeting the new president hosted in the White House on May 18, 2009. In that meeting, Mr. Obama brought together over 70 CEOs and other industry leaders to enlist their support and commitment to creating and implementing the standards needed to ensure the successful implementation of the Smart Grid on the ambitious timeline called for by the President.

***NIST Initiatives:*** NIST was already moving forward on the Interoperability Framework mandated by EISA, publicly supported Secretary of Commerce Gary Locke and DOE Secretary Steven Chu. On April 13, Dr. George W. Arnold, a seasoned standards veteran and the former Chairman of the American National Standards Institute (ANSI) was named the first National Coordinator for Smart Grid Interoperability. A series of multi-day workshops and high level meetings were held in April and May of 209 to draft an interim Interoperability Framework Roadmap intended to facilitate the completion of the Interoperability Framework in three phases. Meanwhile, demonstration projects would continue apace to be approved and funded.

On May 18, 2009, Secretary's Chu and Locke announced the public release for comment of the first 16 standards proposed for inclusion in the Interoperability Framework, based on the input gathered during a workshop held in Reston, Virginia on April 28-29 that drew 400 participants They also announced that NIST would now have $10 million to support its work in the current fiscal year to accelerate completion of the Interoperability Framework, and that the matching funds allocated under EISA to support Smart Grid development and demonstration projects would be dramatically increased as well: from $20 to $200 million for the Investment Grant Program, and from $40 to $100 million for demonstration projects.[7]

The 16 standards offered for adoption in this first phase (see the Appendix to this article) were selected from the many Smart Grid-appropriate standards already in use. They had been developed by a broad range of consensus processes, including four standards globally adopted by the International Electrotechnical Commission (IEC); three by the Institute of Electrical and Electronics Engineers (IEEE), an ANSI accredited SSO with a global membership; one American National Standard, approved by ANSI; four standards developed by a total of five consortia (two consortia collaborated on one standard) with global memberships; one standard by NIST, and one standard by a government supported laboratory.

NIST's plans for the balance of the year include releasing a draft of the Preliminary Interoperability Roadmap in September, and the formation of a Smart Grid Panel of industry experts that will act as an advisory group to help define the standards that do not now exist, and identify the most appropriate, existing SSOs to enlist to rapidly fill the gap through an open, consensus process.

In connection with creating the charter and work plan for that panel, NIST has reviewed the government's experience working with another ongoing public/private effort to achieve an ambitious standards-dependent goal: the development and deployment of a national Electronic Health Record system. As with the Smart Grid initiative, the move towards EHR's was endorsed by the previous administration and supported by Congress, which mandated a move to EHRs and provided limited funding for that purpose. As with the Smart Grid, the Obama Administration not only endorsed the EHR initiative, but included dramatically greater funding to support it in the 2009 economic stimulus bill, giving greater credibility to achieving a significant national implementation of EHRs by 2014.

Like the Smart Grid initiative, the success of EHRs will be heavily dependent upon the universal implementation of a large number of standards (many of which do not yet exist) created by a wide range of SSOs. In order to address this need, an Electronic Records Standards Panel, administered by ANSI, was formed in mid-

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[7]Joint Press Release, United States Depts. of Commerce and Energy, Locke, Chu Announce Significant Steps in Smart Grid Development," May 18, 2009, at http://www.commerce.gov/NewsRoom/PressReleases_FactSheets/PROD01_007985 The Department of Energy later issued a Notice of Intent and a draft Funding Opportunity Announcement (FOA) its Smart Grid Investment Grant Program stating that grants will be provide in amounts of $500,000 to $20 million for smart grid technology deployments, and that grants of $100,000 to $5 million will be provided for the deployment of grid monitoring devices. Matching grants may cover up to 50% of a project's cost. A further $615 million may become available to support demonstrations of regional smart grids, utility-scale energy storage systems, and grid monitoring devices.

decade. That panel comprises a wide variety of experts from the multiple categories of stakeholders interested in the development, deployment and use of EHRs. The EHR panel not only developed profiles of the standards that would be needed to enable EHRs, but actively supported working groups to develop new standards where needed.

NIST expects its Smart Grid Interoperability Standards Panel to be formed in September at the commencement of the second phase of its development of the Interoperability Framework. NIST will instruct the new panel to follow the EHR panels' lead in helping to determine which standards should be included in the final Interoperability Framework, but not to assist in their development. That task will be allocated to existing SSOs.[8]

***The Interoperability Framework Roadmap:*** The development of the Interoperability Framework will be completed under a Roadmap that is now in the process of preparation. The work to be done and deliverables to be completed under the Roadmap are being divided into three phases. The first phase will end with the finalization of the initial list of baseline standards drawn from those already in existence that directly (i.e., that relate to energy) or indirectly (e.g., that relate to IT network security) address Smart Grid needs, and the approval of the preliminary draft of the Roadmap itself. In point of fact, there will never be a final draft, in the sense that the Roadmap by necessity will be a "living" document that will evolve over time as field needs and technology each continue to evolve after the Interoperability Framework itself enters maintenance mode.

While standards will play a central role in enabling the Smart Grid, it is recognized that more will be needed to create the practical reality of a "plug and play" system. As a result, (and as contemplated by EISA), additional policies, models and other tools will be needed to describe architectures, implementation best practices and more. Documents of this type will continue to be added during the second phase of the process described in the Roadmap.

It is also recognized that standards often cannot (and in fact should not) be written in such detail as to ensure that interoperability is automatic. In order to ensure compatibility in the field, especially for products that consumers will buy, conformity tests and a conformity testing infrastructure will be therefore be developed during the third Roadmap phase, so that product samples can be tested to determine whether they demonstrate interoperable performance. Products that are tested to be compliant can then be appropriately branded to guide customers in their purchasing decisions.

***The Interoperability Framework:*** The current scope of the framework represents the continuing evolution of the Smart Grid concept from the origins described above. It addresses the six areas deemed to be most important to government and industry in creating a Smart Grid (the first four are of particular interest to the Federal Energy Regulatory Commission, which oversees the interstate bulk sale and transmission of electrical power):

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[8] See the interview of Dr. George W. Arnold that appears in this issue for further details on NIST's plans for facilitating the development of the additional standards needed to complete the Interoperability Profile.

- ✓ ***Demand Response***, which (among other things) will seek to level the loads placed upon the electrical grid by allowing users and producers to react to price fluctuations and shape their behavior accordingly.

- ✓ ***Wide-area situational awareness***, which will seek to avoid power outages and brownouts.

- ✓ ***Electric storage***, which once again will level demands by allowing power to be stored when available in excess and then bled back into the grid when demand exceeds supply. With the hoped-for proliferation of user-owned alternative energy devices, such as solar arrays, wind generators and hybrid card, the intelligent and reliable management of highly distributed storage will become especially important.

- ✓ ***Electric transportation***, which will become increasingly complex, as the number of power generating nodes becomes vastly more numerous, and the power produced by these nodes becomes more variable.

- ✓ ***Advanced metering infrastructure***, which will provide the essential link between the home network and the Smart Grid. This area subsumes a large number of standards, from wireless and powerline data links within the home and between the home and the network, data formats, enabling financial transactions, and much more.

- ✓ ***Distribution grid***, representing the further evolution of what is already an amazingly complex system to accommodate the vast clouds of increasingly complex data that will now flow across the country as (for example) a homeowner in Fresno, California opts to buy "green power" that is credited against the electricity fed into the grid by wind generator atop the lobster coop building on the waterfront of Vinalhaven, Maine.

***Challenges:*** While the *Grid 2003* report focused in the near term on traditional "big engineering" goals, such as proving the feasibility of creating, and then deploying a national superconducting energy transmission backbone, the Interoperability Framework includes a strong focus on seemingly less ambitious, but in fact as, or more, challenging deployments. For example, in order to allow the "markets to flourish" and for consumers to "participate in the grid" (including by having the ability to buy from "green" power sources, if they so desire, at higher per KW rates), home appliances and HVAC systems, hybrid cars, utilities and businesses will all need to be able to interoperably exchange data that would identify the source and price of power as it fluctuates moment by moment, and also support the real-time purchase and billing (or deferral of purchase) of that power until the parameters entered by the end user have been met.

Similarly, a grid that for a century was increasingly based upon a tightly interconnected array of large, centralized, robust, well maintained generation facilities will now need to incorporate tens of thousands, and perhaps eventually millions, of power sources and power storage nodes, almost all of which will deliver variable (e.g., wind, solar and stored) rather than constant and controllable power. Moreover, to a greater or lesser extent, these microgenerating sources will lie beyond the influence of those that must ensure the adequacy at every moment of the grid itself.

There will be many IT challenges involved in implementing, managing and maintaining such a vast and sophisticated system even after the architectures, standards, and protocols that will enable it have been agreed upon. These challenges will include dealing with the innate complexity of the system, processing and storing the vast amounts of data that will be produced, and ensuring the security of the entire system against cyber attack. The security aspects are of particular concern, because not only will financial data need to be protected against criminals, but individual homes that sell power back into the system will need to be protected against cyber attack by terrorists or national enemies. Otherwise, the entire grid could be brought down if a sufficiently able and determined hacker or foreign power were to succeed in shutting down the alternative energy generators atop millions of American homes.

## II Areas of Standardization

Given the complexity and scope of a Smart Grid, it is hardly surprising that a very broad range of standards will be involved in enabling one. In some cases, the standards are already developed and widely deployed, while in others they are only now being specified.

***Starting points:*** The likelihood of standards actually existing for a particular Smart Grid purpose is a product of three primary dynamics: the state of the art in the technology in question, the length of time that commercial opportunities have existed to drive the development of standards to enable profitable sales of new products and services, and the degree to which general purpose standards can be repurposed to meet Smart Grid goals.

An apt description of these three factors can be found in the area of advanced metering infrastructure. In order for the individual homes to be interactively connected to the Smart Grid, a number of elements are needed, including the following:

- ✓ A wired and/or wireless link between the home and the grid that conforms to recognized standard(s)
- ✓ Data schema and formats for the information that needs to be exchanged between the home network and the Smart Grid network in order to complete transactions, report on system conditions, and so on
- ✓ Common interface standards shared by “smart” appliances, thermostats and alternative generating and storage devices so that they “plug and play” with the Smart Grid when they are connected
- ✓ A home network capable of controlling and collecting data from appropriate electrical devices by wired or wireless means

***Linkage:*** Using the first element as an example, we find that a great deal of work has already been done in this area, with the result that there are already a variety of standards, technologies and vendors available to choose from in order to integrate the home into the Smart Grid. This is in part because the "last mile" transmission of data has been a major issue for a variety of service vendors for some time, and especially for those that are in competition to sell broadband services (e.g., Internet and video access). Because the telecom companies that owned the traditional "twisted pair" copper connection between the consumer and the telephone networks inexplicably declined for many years to offer a high bandwidth solution, there was a great incentive for others to come up with solutions, such as bundling Internet access with cable television packages, delivery of data via satellite dish, and even across the power line owned by the utility company, which also connected the consumer to a national grid.

Other types of vendors also had a need to be able to exchange information with the consumer, and one of the industries that had a particularly strong desire for such a channel of communication happened to be electrical utility companies themselves, which desired to avoid the costs of sending meter readers, on a monthly basis and on foot, to read the physical meters attached to individual homes. As a result, multiple vendors developed wireless hardware and software to permit the remote reading of meters on a "drive by" or other basis, thus creating a linkage between the customer and her electric supplier that was, if desired, independent of the telecommunications network.

Further, because the wireless industry has grown rapidly, the number of standards created to transmit wireless information has burgeoned. Today, there are a wide variety of wireless standards that have been optimized for multiple purposes, each with its own sets of requirements and constraints relating to factors such as distance of transmission, amount and type of data to be communicated, and power limitations. These standards are also created and maintained by a variety of well-established SSOs that each focus on a particular standard, or family of standards, such as the IEEE (WiFi), the BlueTooth SIG, and the NFC Forum (Nearfield Communications). New organizations continue to be formed, such as the Wavenis Open Standards Alliance, which develops wireless standards specifically to communicate with devices such as smart electric meters. And in many cases, the wireless standards developing SSOs (or their promotional affiliates, as in the case the WiFi Alliance) that exist already have well developed certification programs in place. As a result, they and the adopters of their standards should be able to readily adapt to the conformance testing requirement that will later be required under phase III of the Interoperability Framework Roadmap.

Accordingly, there are already multiple vendors with experience in cost effectively creating, installing and maintaining meters that can monitor and pass along information to an external network, as well as a rich ecosystem of SSOs capable of delivering the standards that they need. At the same time, the IT industry is developing important supporting technologies, such as the ability to update software via powerline, wired or wireless connection. The intelligence of electric meters will therefore be easier to upgrade after the first meters are installed.

***Other elements:*** A similar picture can be found to a greater or lesser extent in the case of each of the other elements noted above. For example, under the data category, a variety of XML-based data format standards have been developed by the Organization for the Advancement of Structured Information Standards (OASIS) for a number of purposes, including by intelligent meters, and to engage in transactions. OASIS has already chartered additional working groups to create new standards that will be tailored precisely to the needs of in-home Smart Grid systems.

In the area of controllers, much work has already been done for the commercial market, and LEEDS standards and certification for energy efficient building construction and management have gained great traction in the last several years. And in the area of home networks, there are several active organizations developing standards and profiles for both wireless networks (including mesh networks, that link together the tags of multiple devices and sensors to pass along data) and powerline networks, able to transmit information using the in-wall electrical system of the home itself.

As a result, NIST was able to select its first set of Interoperability Framework standards and related materials from an ample supply of standards developed by a wide variety of SSOs, taking into account the suitability of their processes and maintenance capabilities, as well the suitability of the standards themselves. Going forward, the choices will narrow in some areas of need as the needs to be addressed become more cutting edge, but it seems that NIST currently expects that capable and appropriate SSOs are already in existence that will be willing to develop the totally new standards that will be needed to complete the Smart Grid.

## III Players

Due to the number of industries involved in power generation, management, distribution and use, and the number of areas of standardization that will be invoked in constructing a Smart Grid, there are many public and private organizations with a valid interest in helping select and create the standards and related tools that will be added to the Interoperability Framework. Due to the amount of federal money available in the short term, and the size of the market for Smart Grid related products and services in the long term, the number of companies interested in having an impact on the final composition of the Interoperability Framework is far greater.

The following is an overview of some of the principal public bodies and private industry groups that are participating in the development of the Interoperability Framework, and the standards that will populate it.

***Government:*** Many government agencies will be impacted by, and will wish to comment on, the Smart Grid. For example, the Department of Homeland Security will be concerned over whether the Smart Grid will be properly secured against cyber attack, and EISA mentions Homeland Security by name as an agency whose input the Secretary of Commerce is to seek in preparing the reports to Congress required by Section 1302 of Title XIII. Additionally, within a single agency (e.g., the Department of Commerce), some units (e.g., NIST) will have direct responsibility for Smart Grid matters. Moreover, many government agencies and sub units are active members of the SSOs that have developed and will develop standards that will be included in the Interoperability Framework. Accordingly, the following is only a high level sampling of the government bodies that have been directly and actively involved in developing and deploying the Interoperability Framework.

***Department of Energy:*** Under EISA, the DOE has overall responsibility for the Smart Grid. Individual parts of DOE are also mentioned by name, and given specific duties. They are:

- ✓ ***The Office of Electricity Delivery and Energy Reliability (OEDER):*** OEDER is co-charged (with the Smart Grid Task Force) with reporting to Congress on a regular basis regarding "the status of Smart Grid deployments and any regulatory or government barriers to continued deployment." *[Sec. 1302]*

- ✓ ***Smart Grid Advisory Committee:*** This committee of eight or more individuals is to represent both the full range of Smart Grid technical expertise as well as all public and private stakeholders in advising the government on Smart Grid matters, including, "the evolution of widely-accepted technical and practical standards and protocols to allow interoperability and inter-communication smart grid-capable devices…" *[Sec. 1303(a)*

- ✓ ***Smart Grid Task Force:*** This group is to be made up exclusively of federal employees of "the various divisions" of OEDER that have Smart Grid transition responsibilities. Its mission is to ensure "awareness, coordination and integration" of Smart Grid matters, including "development of widely-accepted smart grid standards and protocols;…" *[Sec. 1303(b)]*

- ✓ **National Institute of Standards and Technology:** The Director of NIST is given, "primary responsibility to coordinate the development of a framework that includes protocols and model standards for information management to achieve interoperability of smart grid devices and systems" with the input of FERC, OEDER, the Smart Grid Task Force, the Smart Grid Advisory Committee, and "other relevant Federal and State agencies" and private industry *[Sec. 1305(a), (a)(1) and (a)(2)]*

***Federal Energy Regulatory Commission (FERC):*** When Smart Grid standards are selected, FERC can incorporate compliance requirements based on those standards into regulations, as appropriate to Smart Grid needs, and consistent with its statutory authority.

***Other Federal groups:*** A variety of government units have played visible public roles in the development of Smart Grid initiatives and reports, including the National Energy Technology Laboratory (which authored the 2007 Vision report), and the Lawrence Berkeley National Laboratory, which developed one of the standards included in the first list of standards recommended for inclusion in the Interoperability Framework.

***Intergovernmental groups:*** The Federal agencies are also assisting the States and industry in working towards EISA goals. For example, FERC and the

National Association of Regulatory Commissions (NAURUC) have jointly sponsored the Smart Grid Collaborative as a forum within which federal and state regulators can discuss Smart Grid related matters of mutual interest.

***Private Sector:*** There are a multitude of organizations of all types, and ad hoc alliances of organizations, that are providing input and deliverables to the Smart Grid project. They fall into the following main categories:

***Non-governmental organizations:*** The government at times relies on non-profit laboratories and other organizations with expertise in energy related matters that provide advice and services to the government. For example, NIST earlier contracted with the Electric Power Research Institute, Inc. (EPRI) to assist it in writing an interim report on Smart Grid architecture and a standards roadmap. EPRI also supports a variety of other Smart Grid related projects and initiatives, including the EPRI Intelligrid Consortium and the Open AMI Task Force.

***Standard Setting Organizations:*** The full range of SSOs are active in the creation of standards relevant to Smart Grids, and their role is a recognized and essential element of the Smart Grid transition envisioned by Congress in EISA. Several SSOs (IEEE and NEMA) are mentioned by name in Title XIII, Section 1305(a)(2) of EISA). About 15 of these SSOs will play an important role in supplying the standards that will populate the Interoperability Framework.[9] These organizations include:

- ✓ ***De jure SSOs:*** Standard setting organizations that have open and inclusive eligibility policies, and conform to certain process norms such as decision by consensus and the availability of a right to appeal decisions are often referred as "*de jure*" bodies. Both global standards organizations that accept membership at the national level and nationally accredited organizations of this type will supply standards for the Smart Grid. They include:

  - ***American National Standards Institute (ANSI):*** While ANSI is a non-profit membership organization and not a branch of government, it is internationally recognized as the *de facto* representative of the United States in standards matters, and as the official representative of the U.S. in international standards organizations such as ISO. The United States government also frequently looks to ANSI for standards related guidance and assistance (e.g., ANSI administers the Electronic Health Record Standards Panel funded by Congress). ANSI also accredits the process and rules of U.S. standards organizations, including many of those that have or will develop standards that will be selected for inclusion in the Interoperability Framework, and adopts standards developed by other SSOs as "American National Standards," one of which is included in the first 16 standards preliminarily accepted by NIST for the Smart Grid.

  - ***American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE):*** ASHRAE is an ANSI accredited standard setting organization with a long history (it was founded in 1894) and a large membership of individuals (51,000) that in more recent years has become

[9] Arnold interview, *ibid*.

international in membership and incorporated sustainability into its mission.

- o ***Institute of Electrical and Electronics Engineers (IEEE):*** While IEEE is headquartered in the United States and accredited by ANSI, it has a global membership of hundreds of thousands of individuals (corporations can join as well). It hosts hundreds of working groups, include several that develop wireless standards. Its standards are among the first to be preliminarily selected for the Interoperability Profile, and it is mentioned by name in EISA.

- o ***International Electrotechnical Commission (IEC):*** One of the oldest standards organizations in existence, with roots that extend back to the earliest days of the power industry. Representation in the IEC is at the national level. Its standards are among the first to be preliminarily selected for the Interoperability Profile. Its standards cover a variety of Smart Grid relevant areas, such as IEC61850, substation automation architecture standard, and IEC 61970/61968, the Common Information Model (CIM), which provides common semantics to be used in converting data into information.

- o ***National Electrical Manufacturers Association (NEMA):*** NEMA is an ANSI accredited organization founded in 1926. Unlike ASHRAE and IEEE, membership is at the corporate level. Its members primarily manufacture products used in the generation, transmission and distribution, control, and end-use of electricity.

✓ ***Consortia:*** Many hundreds of standards development organizations have been formed over the last two decades in the IT, and to a lesser extent, the communications technology (CT) industries, typically with names such as "consortia," "alliances," "forums," "associations," or "SIGS" (for "Special Interest Group"); typically they are grouped together under the single categorical name of "consortia." Most of these organizations have not sought *de jure* status via accreditation on a national basis, although many have become well respected on an international basis. Some consortia focus on a single standard, while others have become institutionalized, and host dozens, or more, simultaneous working groups at a time, usually within a single domain of recognized competence. The membership in such organizations is sometimes national, but more typically international. The standards they adopt are sometimes adopted by global standards organizations such as the IEC and the International Organization for Standardization (ISO). Those certain or likely to have their standards included in the Interoperability Framework include the following:

- o ***HomePlug Powerline Alliance (HLA):*** HLA is a consortium with membership at corporate level. As its name suggests, the HLA develops standards that allow information to be transmitted via the in-wall wiring of a home or other building by any compliant device plugged into a wall outlet. Other standards organizations are developing standards for the transmission of data, and even enable Internet connectivity, via external power lines as well. Together with the ZigBee Alliance (see below), it has created a profile that was adopted by NIST as one of the first recommended Interoperability Framework standards.

- ***Organization for the Advancement of Structured Information Standards (OASIS):*** OASIS is an international consortium with individual, corporate, government and academic members. It develops standards with a focus on Internet commerce, but has a very wide scope within that category. It is particularly well known for developing non-energy specific standards based on XML that will nonetheless be useful for Smart Grid purposes. It also hosts working groups that are targeted at Smart Grid implementations, such as its Energy Interoperability technical committee.

- ***Zigbee Alliance:*** ZigBee is a corporate membership consortium developing and promoting a low-power, wireless standard for home network monitoring and control. It is intended for a variety of products. Together with the HomePlug Powerline Alliance, it created a profile that was adopted by NIST as one of the first recommended Interoperability Framework standards.

***Other Non-Profits:*** A variety of other groups representing every conceivable category of stakeholders in the energy ecosystem in every possible way (e.g., trade associations, lobbying groups, and so on) is taking an active interest in the Smart Grid, and in some cases in its standards as well. There are also a large number of initiatives that have been launched to address specific elements of the Smart Grid, due to the amount of funding that has been made available by DOE and under EISA. A few of the large number of the groups that have been formed expressly to address Smart Grid issues, or that have an interest in this area at the federal level (there are many other groups that are regionally or state focused), are as follows:

- ✓ ***The Advanced Grid Applications Consortium (GridApp):*** An organization formed in 2004 with support from the DOE Office of Electricity in conjunction with funding from member utilities. GridApp provides a fast-track process for engineering development, demonstration and validation of selected high-impact technologies for the electric utility industry.

- ✓ ***Edison Electric Institute (EEI):*** The trade association for shareholder-owned utility companies.

- ✓ ***GridWise:*** Funded by DOE/OEDER, GridWise activities include the GridWise Alliance and the GridWise Architecture Council.

- ✓ ***GridWise Alliance:*** A consortium of public and private members supporting Smart Grid goals. The Alliance entered into a Memorandum of Understanding with the DOE in 2004, and submits comments to FERC and other government offices on behalf of its members on a regular basis.

- ✓ ***GridWise Architecture Council (GWAC):*** The GWAC is a coalition whose members include representatives of utility and IT companies, universities and research organizations. It is mentioned by name in EISA Title XIII, Sec. 1305(a)(2) as an example of the organizations whose input the Director of NIST should solicit. It recently released a report stating that the deployment of deployment of the Smart Grid could create as many as 280,000 jobs over the next four years.

- ✓ ***North American Energy Standards Board (NAESB):*** NAESB is a trade association with a very large corporate membership. It serves gas as well as electric utility companies.

***Ad Hoc groups:*** Various stakeholders in the marketplace have also joined to develop, or been commissioned by one industry participant to assist in the development, of input for Smart Grid development. For example, IBM and the Carnegie Mellon Software Engineering Institute have created their own roadmap for the transition to the Smart Grid, called The Smart Grid Maturity Model.

## IV Conclusions

The specification, development and adoption of standards to make the grand vision of a national Smart Grid a reality represents an unparalleled private-public challenge. While there are technical antecedents for such an effort (most obviously, the upgrading of the telecommunications infrastructure), no such initiative in the past has involved so diverse a mix of industries, with such divergent realities and approaches to their respective businesses.

Even the contemporaneous and equally ambitious effort to deploy electronic health records (EHRs) nationally pales in comparison, due to the fact that transition to a Smart Grid will require a larger number of standards to be agreed upon, and the technical areas in which those standards will operate are more diverse.

But at the same time, the simultaneous launch of several complex and ambitious standards-dependent efforts by the Obama administration – in the Smart Grid, in health care and reimbursement, in open government, and in cybersecurity – provides a unique opportunity for the public and private sectors to leapfrog ahead in the collaborative discipline of complex standards development and deployment.

Until now, government has usually played a largely passive role in the development of standards, allowing private industry to lead the way. But private efforts are better suited to solving narrow and specific problems, leading to many standards, poorly coordinated. Where complex problems must be urgently solved that must invoke hundreds of disparate standards to be identified, harmonized and, most importantly, broadly adopted, the private industry based process that develops consensus-based standards on an opt-in basis is less well suited to the task.

Through these simultaneous efforts, both the government, through involvement by multiple agencies, and the private sector, through the hands-on experience of multiple industries, will benefit from a unique opportunity to experiment, through trial and error, to learn how government and industry can best work together to solve the technology-based challenges of today and tomorrow. Given the breadth of approaches being taken, which range from the enormous financial incentives (and then penalties) that will be used to bring EHRs on to the desktops of private physicians, to the commercial opportunities presented by implementation of the Smart Grid, followed by eventual regulations, there will be many lessons to be learned.

Not all of these efforts are likely to be successful, at least initially. But when the dust settles, the benefits should be multidimensional in scope. It is to be hoped that not only will the very significant investment of public and private funds yield up a Smart Grid that actually meets the many industry and policy goals that have been set out for it, but that the private and public sectors will have learned a new way to work together to solve complex, standards based challenges.

If this latter goal is achieved, the lessons learned in the rapid rollout of the Smart Grid and the other ambitious standards-dependent initiatives of the Obama administration can, and presumably will, be applied in the future to the numerous and equally complex challenges that will certainly lie ahead. If so, the development of this new public-private standards development partnership may prove to be more beneficial and long lasting than even the transition to a national Smart Grid.



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## APPENDIX

**Initial Smart Grid Interoperability Standards Framework, Release 1.0**

| Standard | Application | SSO | SSO Type |
|---|---|---|---|
| AMI-SEC System Security Requirements | Advanced metering infrastructure (AMI) and Smart Grid end-to-end security | OpenSG Users Group | Consortium |
| ANSI C12.19/MC1219 | Revenue metering information model | American National Standards Institute (ANSI) | De Jure |
| BACnet ANSI ASHRAE 135-2008/ISO 16484-5 | Building automation | American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) | De Jure |
| DNP3 | Substation and feeder device automation | DNP Users Group | Consortium |
| IEC 60870-6 / TASE.2 | Inter-control center communications | International Telecommunications Commission (IEC) | De Jure |
| IEC 61850 | Substation automation and protection | IEC | De Jure |
| IEC 61968/61970 | Application level energy management system interfaces | IEC | De Jure |
| IEC 62351 Parts 1-8 | Information security for power system control operations | IEC | De Jure |
| IEEE C37.118 | Phasor measurement unit (PMU) communications | Institute of Electrical and Electronics Engineers (IEEE) | De Jure/ANSI Accredited |
| IEEE 1547 | Physical and electrical interconnections between utility and distributed generation (DG) | IEEE | De Jure/ANSI Accredited |
| IEEE 1686-2007 | Security for intelligent electronic devices (IEDs) | IEEE | De Jure/ANSI Accredited |
| NERC CIP 002-009 | Cyber security standards for the bulk power system | North American Electric Reliability Corporation (NERC) | De Jure/ANSI Accredited |
| NIST Special Publication (SP) 800-53, NIST SP 800-82 | Cyber security standards and guidelines for federal information systems, including those for the bulk power system | National Institute of Standards and Technology (NIST) | Government Agency Institute |
| Open Automated Demand Response (Open ADR) | Price responsive and direct load control | DOE/Berkeley Laboratory/Demand Response Research Center (DRRC) | Government Agency Funded Laboratory |
| OpenHAN | Home Area Network device communication, measurement, and control | UCA International Users Group | Consortium |
| ZigBee/HomePlug Smart Energy Profile | Home Area Network (HAN) Device Communications and Information Model | ZigBee Alliance<br>Homeplug Powerline Alliance | Consortium<br>Consortium |

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

**Andrew Updegrove**

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?*



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***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.

## STANDARDS BLOG:

# From the Ridiculous to the Sublime

Andrew Updegrove


Long-time readers will know that whenever I can, I disappear into the desert for as long as I can. Often, the opportunity arises as a result of a business trip, and so it is that I write this in northwestern Arizona a few days after spending a day at a standards client meeting in a conference room buried deep within the bowels of the raucous, random, blaring, unworldly nonsense that is otherwise known as the Mandalay Bay Casino and Resort, Las Vegas, Nevada.

Some of the nonsense worked to my favor, or at least amusement, as my $143.95 room reservation was unexpectedly traded up into a penthouse suite on the 62nd floor of the hotel – a suite that was bigger than the entire first floor of my admittedly small house, with 18 foot ceilings (the room, not my house), a wall of glass behind two sets of motorized drapes, a bar, living room, two bathrooms (one palatial), four flat screen TV sets (more than I have owned of any type in my entire life), and no coffee maker.

But the rest of the complex was just acres and acres (and *acres* and *acres*) of slot machines, jumbled together restaurants, vast conference rooms and halls, and the worst signage on the face of the planet, both inside and out. Applying logic, the only rational explanation is that the hotel security guards must spice up their tedious days staring at surveillance screens by randomly switching the arrows on signs to destinations such as "registration."

What a hoot it must be tracking hapless guests as they spiral endlessly about the enormous gaming hall from camera to camera, heavy suitcases in tow, wandering desperately amid the flashing lights and thunderous din looking for the sanctuary of the check-in lobby. One imagines the guards sitting there, laughing and betting on how many times they can trick this tired Kansan or that to circle the casino floor before finally stumbling, exhausted and desperate, through the only narrow (and naturally unmarked) exit that allows escape into the lobby.

Needless to say, the desert was looking pretty good by the time I escaped from the hotel myself in a four wheel drive car, heading south, and then east, on dirt roads that turned into jeep tracks as they wound into rugged, dry mountains graced with a blush of late spring flowers and the first cactus blossoms of the season.

The weather was fine, and my relief palpable by the time I set up camp, and watched the colors of the sunset flare up in the western sky, and transform grandly, then subtly, and at last imperceptibly into a faint yellow aura silhouetting the high crags of the surrounding mountains, as Rigel and Betelgeuse, and then a host of other stars, silently emerged from the gathering dark of a crystalline, moonless night. Happily, Vegas was too far over the horizon for even it's prodigious candle power to intrude in the distance an wash out the thousands of stars that were glowing into view.

For which I was quite grateful. I am a light sleeper, and one of my quiet pleasures in the fresh, clear air of a high desert night is watch the constellations wheel overhead when I wake up, and gauge the time by the location of those that I can recognize. Majestically, the earth's rotation makes them seem to slowly rise and transit the vault of the impeccably dark, desert sky as the earth hurtles soundlessly underneath.

After such a night and no matter how fitfully I may have slept, I wake up not so much refreshed as restored. And the sound and fury of Las Vegas seems impossibly, but thankfully, far away

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CONSIDER THIS:

# #57 Googling to Newspaper Solvency

Andrew Updegrove

I am an avid, lifelong, reader of newspapers in general, and of the *New York Times* in particular. Moreover, I'm a staunch believer in the essential role of an press in a modern democracy. But I'm also the owner of a Web site that serves over a million page views a month, some of which display short extracts of news articles, with links back to the full text. On occasion those links lead back to stories appearing at the Web site of the *Times*.

So why am I trying to kill my beloved *Times* and its worthy brethren?

Well, in fact I'm not. The real causes of newspaper distress are the diversion of ad dollars from print to on-line placements, and a plunge in the rates being paid for those same ads. The latter results in part from the ever-increasing supply of ad-ready Web pages, and the development by Google of technology that allows inexpensive ads to be targeted at the pages most likely to generate sales. That's not the way some newspaper owners and journalists see it, though. They would like to charge Google, and even small "aggregators" like me, for the privilege of driving traffic back to their own ad-bearing Web sites.

If you think that sounds backwards, you're right. It also explains why Google's revenues are still rising while the *Times* continues to report substantial losses. What Google realized years ago, but newspapers continue to miss, is the value of enlisting vast numbers of independent site owners (ISOs) as distributors. By creating targeting technology that enables even low-volume products to be cost-effectively advertised via these distributors, Google was able to harness the full power of "long tail" economics to its business model. Ads like these generate only pennies of revenue for Google and drag down ad rates overall, but Google's super-efficient technology platform allows it to more than compensate through volume.

The only way for newspapers to survive on ad revenue, then, is to learn how to sell on-line ads faster than their print-based advertising and subscription revenues evaporate. Surprisingly enough, they can – but only if they begin to emulate Google, rather than bash it.

Here's how: newspaper publishers need to start looking at aggregators as partners rather than enemies. Publishers also need to see news snippets not as content, but as advertisements for the newspapers themselves. By motivating ISOs to drive traffic back to the newspapers that underwrite the production of high quality content, publishers, like Google, can capture the long tail financial rewards to which they are entitled.

For the *Times,* such a program would work like this:

1. Launch a News Partner Program to encourage new ISOs to add automated news extract feeds to their sites, and incentivize existing aggregators to display only news from the Times. Make it as easy for an ISO to participate as it is to join the Google AdSense program.

2. Limit an ISO's extract rights to six per day, and control the amount of content that will display at the ISO site, so that there is enough of the story to grab a reader's interest, but not to satisfy her curiosity.

3. When an ISO reader generates ad revenue at the *Times* site, share 10% with the ISO.

4. Offer a default option that automatically matches news extracts with the content that is displaying on the same ISO page.

5. Empower ISOs by letting them customize what displays at their sites. Allow them to choose from topics as broad as "politics" or as narrow as "digital photography." Update the Times News Reader to allow ISOs to select individual stories simply by clicking on them.

6. Compete with Google by becoming an ad reseller, leveraging the relationship with ISO partners to generate further income.

7. Give commissions to site owners for new print subscriptions that result from promotional ads run at ISO sites.

Would this work? Yes, because it would be more appealing to ISOs and readers than the already wildly successful Google ad model, which produces only pennies a month for most ISOs, and displays ads, rather than interesting content, to visitors.

While simply allowing bloggers and others to syndicate small extracts of news stories would not be likely to generate enough ad revenue to save the *Times* and its peers from economic perdition, it could be an important first step in transitioning the world of print media into a digital future where it can more successful leverage its unique strengths and resources. By forging loyal networks of nimble ISOs, the *Times,* like Google, would gain the partners it needs in order to adapt to the challenges of on-line business as they continue to evolve.

It's a win-win proposition. And I can't be the only loyal *Times*-reading ISO who is standing by, just waiting for the invitation.



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**MONDAY WITNESS:**

# Prejudice, Prehistory and the Puzzle of Pictographs

Andrew Updegrove

*The following piece was written in northeastern Arizona during a recent hiking and camping trip*

The southwestern landscape hosts a variety of signature geologic forms, some of which have become iconic as the backdrops for countless western movies. If you should find yourself channel surfing late tonight, a single frame of a mesa, butte, spire or hoodoo will instantly lock you on to the genre, even before the dusty characters ride into view.

The desert rock garden is a less well known type, but it will be familiar to anyone who has spent any time knocking about the southwest, and around Arizona in particular. Unlike the angular, striated spires and hoodoos that erode out of sedimentary formations, rock gardens are more often volcanic in origin than not, usually granitic, and rounded in form, characteristically resembling enormous blowups of the sand dribbles that a child makes at the beach by allowing a slurry of water and sand to slip through her fingers.

While you might not recognize them as easily, rock gardens have as authentic a place in western history as do the Painted Desert landscapes so beloved by Hollywood directors: when Butch Cassidy and the Sundance Kid led their Hole in the Wall gang through the hole in the wall, the passageway they took led into a rock garden. You can find it in Joshua Tree National Park. It's a beautiful labyrinth, and well worth a visit.

Today my Jeep track took me by just such a rock garden quite a long way from anywhere, and a few hundred acres in size. It was mid-morning, the sun was shining, and ravens circled the eroding granite plutons that rose from the desert floor to form globular eminences riven with fissures, and pocked with erosional cavities. It seemed like a good time and place to use a hunt for rock art as an excuse to take a walk.

Rock art can be found throughout the southwest, and less commonly in other parts of the United States as well. Unlike the breathtakingly lifelike cave paintings of aurochs and horses in the Cro-Magnon caves of France and Spain, the rock art of the southwest is figurative rather than literal. Devoid of the cultural context in which these paintings (pictographs) and pecked out images (petroglyphs) were created, the rock art of the southwest teases more than it tells, leading those that would attempt to interpret it to refer to enigmatic figures as "wizards," "monsters" and the like. Here in the clear bright light of the desert, surrounded by panoramic views of the world in which the long-gone artists lived, these shapes are compelling, because they so clearly tell stories that we cannot understand.

Therein lies the great and largely hopeless challenge of archaeology – an inherently limited and imperfect effort, part craft and part science, that attempts the impossible task of resurrecting the reality of extinct societies from the random artifacts related to their lives that have managed to survive. In this context, rock art is especially fascinating and frustrating.

Fascinating, because we can so much more clearly glimpse the creative and spiritual consciousness of those that lived long ago from a painting than we can from a bone awl. But also frustrating, because our vision is so inadequate to interpret what we see. We simply can't, at this long remove and without the world view that informed the artist, truly know what to make of what has been left behind.

Without the back-story to petroglyphs and pictographs, archaeologists are left to work with more empirical material: stones and bones, seeds and pollen, pottery shards both painted and plain, and datable charcoal. But looking only to such remnants makes it too easy to consign those that left such limited clues behind to a state of primitive social and mental development. Until the last century, this practice made it easy to deny recognizing archaic peoples as the complex, creative, ingenious human beings they in fact were, notwithstanding the fact that they were anatomically identical – and therefore of equal intellectual potential – to ourselves. Sadly, the same attitude was applied throughout the so-called Age of Discovery (surely an interesting turn of phrase to those often sophisticated and ancient cultures that were "discovered") to all of those living in less developed parts of the world. Worse, it was used by colonialists as an excuse to exploit those that they conveniently concluded were members of inferior races.

Have we truly advanced beyond this prejudice today? To answer that question, it is useful to examine not only what we do, but also what we say. When we do, we find that there are clues to be found in the words we use that reflect ongoing prejudices of which we may be less than aware. Consider, for example, the curious and condescending term, "prehistory."

As used by archaeologists and academics, prehistory encapsulates the entire period of human existence that predates the invention of writing. Taken literally, “prehistory” implies that “history” simply did not exist before it could be recorded, notwithstanding the fact that our “historical” era constitutes the very thinnest veneer on the surface of human temporal existence.

What a judgmental word to use, given that *homo sapiens* has been expanding its dominance of the earth for at least 100,000 years (plus or minus a few score millennia, depending on who you talk to), and besting wooly mammoths and mastodons with stone and wooden weapons much of the time along the way. No mean feat, especially when compared to the heavy weaponry a modern hunter would never dream of entering the African savannah without today. And our more distant tool and fire making ancestors first made their way out of Africa hundreds of thousands of years before that.

The written record of a society's accomplishments and culture, after all, help earn it a measure of legitimacy and equality in the competitive world we live in. In the absence of such an acknowledged record, it is easier for those bent on exploitation to relegate a culture to second class status, or dismiss its people as outright savages whose right to exist can be effectively ignored. the lot of illiterate aboriginal peoples at the hands of western civilization (another curious word, in this context) has therefore not been a happy one, despite the fact that most of the Europeans and Americans that first crossed the Atlantic could themselves neither read nor write.

The problem is this: without a written record, how are a society's accomplishments to be recorded and preserved in a way that makes them accessible, understandable and worthy of current respect? Sadly, we have no idea what great advances may have been made in the more distant past, because not all great civilizations leave ruins of great temples. And yet, archaeologists are finding tantalizing examples of what has come before. Only now, for example, has the existence of vanished cities in the Amazon been confirmed, because the civilizations that built them had no usable building stone with which to build.

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But those cities are long gone. In a horrific pattern that repeated itself throughout the Americas, European-borne diseases rapidly destroyed the social structure of virtually every sophisticated society that existed at the time of Columbus. Sometimes, the collapse occurred even before Europeans arrived on the scene, as diseases like smallpox and measles worked their way inland via native trade contacts.

By the time widespread European settlement began, the descendents many of these complex societies had reverted to a hunter-gatherer existence, as was the case with the ostensibly vanished (but in fact still nearby) inhabitants of the fabled "lost cities" of the Amazon basin. Long before the Spanish moved upriver, these great centers of indigenous society had decayed and fallen, and the jungle had reclaimed the roads that connected and the plantations that surrounded them. And yet now we learn that 1500 years ago the same societies that built these cities developed a way to fertilize their fields by working charcoal, pottery shards and fish bones into the soil, creating a rich mixture capable of maintaining fertility for many years. Scientists now refer to the results as *terra preta*

In the aggregate, the *terra preta* fields discovered to date comprise an area as large as France – and the potential of this ancient technique is now being explored not only for its potential to revitalize Third World agricultural, but as an environmentally sound and inexpensive method to sequester carbon dioxide in order to alleviate global warming. In contrast, modern agricultural science is incapable of sustaining agriculture in the Amazon for more than a few years after virgin jungle is cleared. Whose technology, then, is more advanced? Our modern, energy intensive, polluting, petrochemical-based agricultural methods of transient efficacy, or the more creative and sustainable techniques developed by these long forgotten, supposedly primitive, prehistorians?

Or consider the achievement of the aboriginal people of Australia, who arrived in the antipodes more than 40,000 years ago. The date is remarkable, because at that time Australia was more than 200 miles from the nearest land (which was itself an archipelago of often widely separated islands). In order to reach their destination, the first Australians needed to develop and build seaworthy boats of significant size, and develop impressive navigational skills as well. Moreover, their voyages of discovery demanded a degree of daring and determination equal to that of Columbus, as they sailed over the horizon and into the unknown to reach their new home. Many years later, the Polynesians colonized the entire Pacific, crossing incomparably more vast and unknown distances of open ocean.

Who knows what other great but forgotten accomplishments humanity attained before western society invented "history?"

While we will doubtless never discover a fraction of these deeds, I expect that we will learn enough over time for thoughtful people to conclude that the accomplishments of the artists of Lascaux and the mariners of Australia were not aberrations, but representative of the attainments of many of the waves of advancement that washed up, albeit only for a time, upon the shores of human development, only to recede into the unremembered depths of what moderns regard as prehistory.

One of the waves we are aware of washed up on the shores of the American southwest, only to be pulled back by an as-yet poorly understood confluence of forces that at minimum included a devastating drought. But before the abandonment of the Four Corners area of the Southwest, those that lived in the early centuries of the last millennium built impressive, communal stone buildings as many as five stories in height, laid out roads connecting their outlying communities with their cultural centers, and established trade networks that extended into Mezzo America. The traces of their existence can be found everywhere in the southwest, in scatters of stone flakes left behind by tool makers, in pottery shards marking places of habitation, in granaries perched high on cliff walls, in the remnants of complex irrigation systems – and in the enigmatic rock art of countless artists that will ever remain to us unknown.

The lot of Native North Americans, of course, was no happier than that of their Amazonian kindred. As elsewhere in the western hemisphere, indigenous peoples were almost invariably regarded as being less than the equals of their conquerors, and even less than human. This, notwithstanding the fact that the great cities and earthworks of the Adena and Hopewell cultures in the Mississippi river valley were the equal in size to the largest contemporary cities and defenses in Europe. But like the Amazonians, the societies that built great cities like Cahokia – which includes what may be the largest pyramid in the world - soon collapsed after first contact. Those that rediscovered the remains of these complex and successful societies insisted that they must have been built by "lost civilizations," even the Lost Tribes of Israel, rather than the ancestors of living Native Americans. When I was in school, the existence of these highly developed civilizations was never even mentioned.

*How different might things have been if these cultures had developed writing? Would they have earned greater respect?*

How different might things have been if these cultures had developed writing, or if the Codices of the Maya had been translated and widely read, rather than burned by Spanish priests as heretical writings? Would they have earned greater respect and better treatment for indigenous peoples?

Perhaps not after all. But what richness of understanding about our common history as human beings was lost when these largely unrecorded societies collapsed under the onslaught of western guns, germs and steel. Instead, we are left only with the durable detritus that archaeologists pore over, and the rock art that hikers stumble upon as they range across the vast and empty expanses of the southwest.

I wasn't surprised that my time spent roaming through this particular rock garden today yielded little. As it happened, most of the granite was disintegrating rather than firm in the protected places where rock art might often be found. But at last, I found a single panel on a wall of competent granite, hidden under an overhang and shielded from the weather. The panel had but two elements, one in grey-green pigment and the other in white, the latter making opportunistic use of a cluster of quartz crystals to capture and reflect more light. The first, low down, was a many rayed sun, while the second floated higher and to its right - a small, solitary, serene moon.



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That was all that this artist had to share on whatever long ago day she was moved to take up her brush and pot of paint.  Perhaps she may have been one of those last Anasazi, the ones who abandoned this region to migrate to locations still largely unknown.  If so, these images at least serve to recall her existence, and that of all those other ones who had made these harshly beautiful lands their home.  Perhaps the message of the departing artist was simply to proclaim, “Once we lived here.  Know this, now that we are gone.”



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