Silver Spring® NETWORKS

WHITEPAPER

Smart Grid Standards

The Imperative for the Smart Energy Network

Modern, intelligent, global energy networks are essential to driving greater energy efficiency, increasing integration of renewable energy sources such as wind and solar, and accelerating economic and social progress in the 21st century. Innovative and forward-thinking utilities are making great strides in creating smart energy networks that operate at scale and contribute real-world results to their bottom line, delivering energy efficiency and operational efficiency with an increase in consumer satisfaction.

Smart grid networks yield their full potential benefits when based on open standards. Standards enable interoperability, which in turn ensures that the broadest possible set of products work together. Standard technologies deliver a wide range of benefits to customers, most important of which is vendor independence. Customers benefit from greater choice because of heightened competition, as well as higher-quality solutions, lower pricing, and reduced risk by avoiding vendor lock in. Standards also open a market to new players and speed the pace of innovation.

Silver Spring's Standards Leadership

With a decade of real-world experience in the energy industry to draw on, Silver Spring has helped spearhead several key standards efforts, including:

- Pioneering the use of IPv6 as a networking protocol for the smart grid, from the back office to the endpoint
- Forming OpenAMI, a forum for adapting IP to meet smart grid networking requirements
- Leading the development of IEEE 802.15.4g for RF mesh communications, including compliance of current installations
- Leveraging standard web services to simplify software integration
- Standardizing in-home device communications, including leadership on SEP 2.0 development
- Working to define interoperability testing and certification frameworks to ensure standards compliance and interoperability

Standards have been at the heart of every technical revolution. Industries ranging from transportation, telecommunications, industrial manufacturing – and especially the Internet – have established sets of common standards to the great benefit of consumers and the growth and health of their respective industries.

Since its inception, Silver Spring Networks has been the leading advocate for standards in the energy industry. For more than a decade, we have been developing and deploying standards-based communications and software platforms for Machine-to-Machine (M2M) systems in general and the smart grid in particular, solving pressing problems and delivering real business benefits for our utility customers worldwide. Many vendors subsequently followed our lead and now share a similar perspective on the importance of smart grid standards. But we remain unique in our focus on the energy industry combined with our depth of experience delivering millions of standards-based systems.

Requirements for the Energy Network

Networking technologies have existed for decades across many industries and are now widely deployed in a variety of enterprises. However, the smart grid network is unlike any other in the world. The controlled, easily accessible, indoor environment of traditional enterprise IT networks is dramatically different from that of the outdoor smart grid, which is characterized by:

- **Geographic reach:** Utilities must provision and manage network coverage over tens of thousands of square miles, not simply individual buildings or campuses.
- **Topographical complexity (varied terrain):** Wireless networks must function properly across dense urban, suburban, sparse/rural, and subterranean environments. While mobile or municipal WiFi networks seem analogous to wireless smart grid networks, their fundamental advantage is device mobility. People can move – infrastructure cannot.
- **Difficult physical access:** Smart grid network devices are often in difficult-to-reach locations, so they must provide extremely high reliability.
- **Long lifecycle:** Given the logistical and economic challenges of upgrading vast smart grid networks, utilities expect equipment to last 20 years, or longer. Smart grid technologies and standards must support such longevity.
- **Unpredictable environment:** Smart grid networks offer utilities minimal administrative control over their operating environment. The environment will change, with new buildings for example, and smart grid standards must enable the network to handle unpredictable interference, unexpected obstructions, and other impediments without requiring manual network adjustment.
- **Support for a range of device types:** Unlike computers, many of the devices on the smart grid have limited processing power and memory and cannot be burdened with communications and processing overhead.
- **Machine-to-machine communications:** Most networks today support communications between a human and a computer, but the smart grid uses machine-to-machine communications and supports automated functions such as meter reading or outage response. A smart grid network must support peer-to-peer communications and have the characteristics, such as low latency and redundancy, needed to accommodate grid automation.
- **Massive scale:** A smart grid network must support millions of endpoints, in contrast to the thousands of devices on a typical enterprise network.
- **Unparalleled uptime:** Smart grids are held to a different and higher standard than enterprise networks. They have to – lives depend on them.

"BGE is pleased to partner with Silver Spring Networks in delivering the significant transformational benefits of the smart grid to each of our 1.2 million customers. We look forward to benefiting from Silver Spring's proven technology – technology that is the backbone of smart grid implementations by leading utilities throughout the U.S. and abroad."

KENNETH W. DEFONTES, JR.
PRESIDENT AND CEO

BGE

To meet these unique requirements, the smart grid needs a very different type of network than has been built to date. Replicating existing network models or blindly repurposing standards used for enterprise and mobile networks will not apply and may actually limit a vendor when delivering a smart grid network solution. Rather, a smart grid network requires standardized technologies that have been proven to work in the utility environment. And utilities need a smart grid partner who couples a commitment to open, standards-based products with a deep understanding of their environment and business issues.

"Cost, performance, and the ability to build atop a single, standardized platform are critical for WEL Networks' next-generation utility grid. Silver Spring gave us the ability to deliver multiple smart grid applications over a single, open platform and utilize its advanced technology to meet the performance needs of our network, all with a cost profile that helps WEL effectively invest in modernization improvements for the benefit of our customers."

JULIAN ELDER, CEO

The Early Smart Grid Landscape

Electric utilities have been using communications technology to support remote grid operations for at least 15 years. Early deployments were partitioned into two major application areas: Automatic Meter Reading (AMR) and SCADA/distribution automation (DA) systems. Initially, AMR systems used proprietary, low-power wireless systems to support drive-by and walk-up meter data collection. Similarly, SCADA/DA systems typically used proprietary wireless systems to support telemetry and, in rare cases, control functionality.

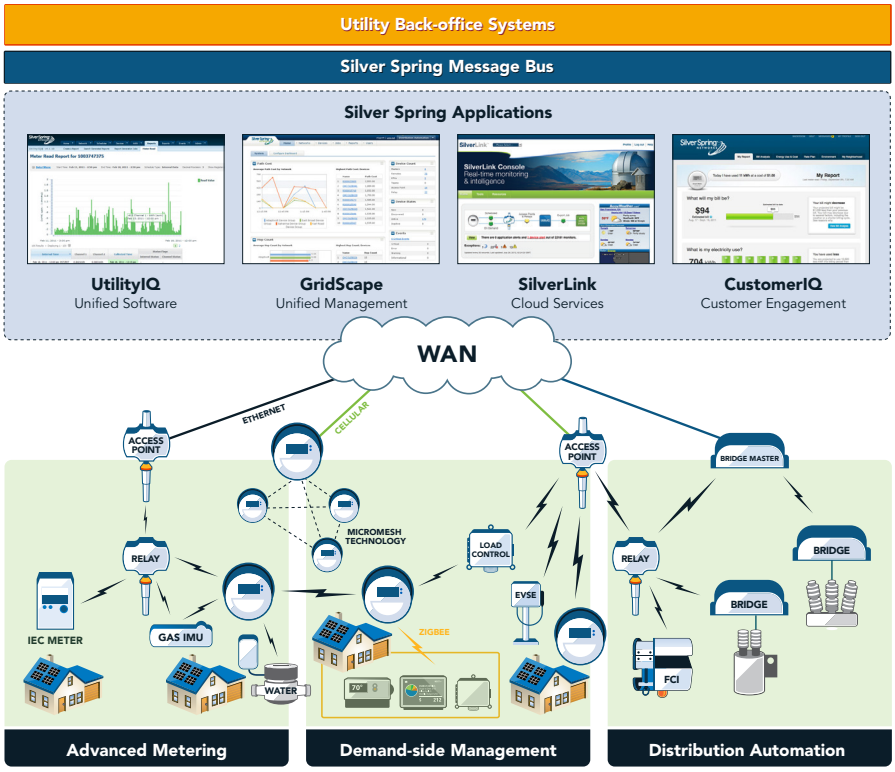
Within a short time, AMR systems evolved to support full remote meter reading using fixed networks that supported telemetry without requiring proximity. These AMR networks used proprietary wireless – point-to-point or mesh – networks or proprietary Power Line Carrier (PLC) technologies. Early, proprietary fixed-network systems supported very low data rates – less than 10 kbps – sufficient only for meter reading and other simple operations. Most large-scale systems deployed before 2005 were of this nature.

Beginning in 2005, utilities found they could capture significantly increased business returns from capital investments in fixed networks. Specifically, utilities broadened their business cases beyond AMR to include applications such as outage/restoration and price signaling, and they began considering deployment of advanced metering infrastructure (AMI). More visionary utilities thought ahead to a full smart grid – that is, a single network platform encompassing multiple applications, including metering, DA, direct load control, voltage management, and others.

Silver Spring's Vision for an Open Platform

Silver Spring entered the energy market in 2002, while some utilities were transitioning from AMR to AMI to full smart grid. Silver Spring found that utilities were eager to move to a smart grid but were limited by the shortcomings of the solutions being offered by incumbent vendors.

Silver Spring Network and Applications



All solutions at that time were proprietary, single-function systems. If a utility wanted to purchase a metering solution, for example, the endpoint, network, and software tied together and came from a single vendor. This vertically integrated model did not support separating out the network or other components, so utilities could not purchase best-of-breed components to optimize the solution for their needs. Without standards, and the ability to mix and match various components, the concept of a partner ecosystem – in which products from multiple vendors can be combined and all work together – did not exist.

"The smart grid platform using the unified network and proven efficiency of Silver Spring Networks will allow us to quickly and efficiently evaluate, develop and implement programs to meet new energy demands."

MARIA TEREZA VILLELA
SMART GRID AND TECHNOLOGY DIRECTOR

AES Eletropaulo

One Network, Many Applications

Silver Spring was founded by networking and computer industry veterans who had seen first hand how open systems accelerate the pace of innovation and benefitted industries such as banking, airlines, and the Internet. By 2002, these industries had already reaped the benefits of moving away from locked-in vertical application-specific systems to a horizontal communications model based on standard, independent technology layers. With this horizontal model, devices or applications at each layer can easily be swapped out, and the network infrastructure is no longer tied to a particular solution. Rather, the network acts as a common infrastructure supporting multiple solutions.

At Silver Spring, our single-minded focus from 2002 on has been to bring the power of open standards to the energy market. To achieve this goal, we built an open network optimized for M2M communications across millions of devices. We chose a platform-based approach so our customers could leverage a common set of technologies, including networking and security, to support multiple smart grid applications, with choice throughout. This approach ensures our Smart Energy Platform is extensible and cost effective, providing utilities with a flexible solution, supporting best-of-breed options, at a very reasonable price per home and business connected. It also means that, as an M2M networking company, we can extend our approach to other applications and industries; for example, connecting street lights, buildings, parking meters, or other city resources as part of the "Internet of Things."

"We are very pleased to have Silver Spring Networks partner with us to bring an open, standards-based smart grid to Brazil. CPFL is adopting a Telecom infrastructure technology which will allow introduction of smart grids in Brazil and, for that, we are counting on Silver Spring to set a global benchmark in how we provide our clients with power and information."

MAURO CARMELLO
MANAGER OF OPERATIONS
AND AUTOMATION

CPFL ENERGIA

Our focus and ongoing 10-year effort have produced tangible results. Silver Spring has created a broad ecosystem of more than 65 partners, providers of meters, distribution automation devices, in-home devices, electric vehicle charging stations, other grid devices, and back-office applications such as Meter Data Management Systems. Their products interoperate with our platform, either plugging into our network or integrating with our software. Silver Spring works extensively with these ecosystem partners to ensure each component works with the others and has been thoroughly tested, so customers are never burdened with integration issues. For example, when you implement feeder switches on the Silver Spring Smart Energy Platform, you can choose from a multitude of switch makers whose devices interoperate with our network and software.

Working with our customers as their partners to implement smart grid solutions has given us a deep knowledge of the utility business and tremendous field experience. More than 12 million homes and businesses worldwide are connected over our Smart Energy Platform, and our unique expertise gives us a real-world understanding of the utility market and its technology needs, information that we continually incorporate into our products and services.

Silver Spring Partner Ecosystem

ADVANCED METERING

TATUNG · EDMI · SECURE · nansen · Itron · Landis+Gyr · elster · GE

DISTRIBUTION AUTOMATION

Schneider Electric · GridSense · HH · Beckwith Electric · COOPER · ABB · DYNAMIC RATINGS · Sentient · HDE · GE · SIEMENS · OSIsoft · G&W · SEL · S&C

DEMAND-SIDE MANAGEMENT

eGOtality · EnTek · Digi · COOPER · comverge · belkin · TENDRIL · ClipperCreek · AzTech · Honeywell · Energate · GE

SOFTWARE

HITACHI · ORACLE · EMC² · eMeter · EcoLogic · OSIsoft

Standardizing the Communications Network End to End

Since its founding, Silver Spring has been a prime promoter of interoperable open standards for energy networks. In particular, Silver Spring has advocated baseline open standards for Layers 1, 2, and 3 of the OSI (Open Systems Interconnect) model, as standards are required at all these layers to ensure open communications and interoperability end to end across a network.

Each layer performs different functions. L1, the physical layer, defines the physical interface (mechanical, electrical, etc.) between devices and the rules by which bits are passed between them. It essentially provides a raw bit stream service. The job of L2, the data-link layer, is to activate, maintain, and deactivate a link between two devices and to provide error detection and control so the next higher layer can assume virtually error-free transmission over that link. L3, the network layer, is responsible for establishing, maintaining, and terminating connections across communications facilities (vs. just a pair of devices). It relieves the higher layers (Layer 4 and above) of the need to know anything about the underlying transmission technologies.

This layered approach to networking has been in use for decades, providing a clean separation of technologies. As a result, IP-based applications, for example, can operate over multiple physical media, including wired, wireless, and cellular, with no change. The beauty of this layered approach to standards is that higher-layer software and applications function properly regardless of the underlying network.

Day One: The Focus on IP

One of Silver Spring's earliest decisions was to build our network using IPv6. Even in 2002, IP was a proven technology, and IPv6 clearly addressed a number of key requirements for a smart grid network:

» It has an effectively limitless ability to scale, easily accommodating multiple millions of end nodes on a single network.
» It boosts resiliency – and therefore uptime – by supporting dual-homing, which lets you connect any node to two different devices; for example, a meter can be dual-homed to two take-out points.
» It features built-in security, whereas previous versions of IP required security be layered on. Specifically, IPsec is a mandatory component for IPv6.

"It's great that we have laid in a technology platform that is going to enable commerce. I look at this like the iPhone. The iPhone without the applications is just a phone, and so we are creating the iPhone here and the applications are going to come."

JOHN DISTASIO
CEO AND GENERAL MANAGER
SMUD™

In 2004, to promote the use of IP in the utility industry, Silver Spring co-founded OpenAMI as a forum in which both utilities and vendors could come together to adapt IP networking for AMI, and smart

grid, deployments. In this forum, we advocated the following benefits of standardizing on IP end to end, that is, from the back office to the end device:

» **Proven networking technology:** IP networks had by then been in place for decades, supporting wildly varied networks of millions of nodes.

» **Proven interoperability:** IP networks cleanly separate device data formats and behavior from the network layer; this approach ensures that, while smart grid application standards evolve, devices can interoperate on the network.

» **Proven integration:** IP-based products and tools were already familiar to utility IT personnel and provided a convenient and rapid trajectory for managing the enormous new networks they had to manage.

» **Proven flexibility:** IPv4 provided familiarity and integration with existing systems, such as DA, that already used it; IPv6 provided natural integration with such infrastructure, while simultaneously adding important new features needed for the smart grid, as just discussed.

"As an early industry catalyst, Silver Spring has been deploying IPv6 smart grid network platforms for more than five years. This pioneering work has helped firmly establish IPv6 as the right networking foundation for massive-scale global M2M networks, of which the smart grid is the first important example delivering real economic benefits today."

VINTON CERF – JUNE 6, 2012
CO-FOUNDER OF THE INTERNET SOCIETY AND VICE PRESIDENT AND CHIEF INTERNET EVANGELIST FOR GOOGLE

As often happens in the early phases of an industry's migration to standards, the OpenAMI effort met with some resistance. Incumbent vendors of proprietary technology, such as meter vendors, were used to a device-centric rather than network-centric approach. That is, they were used to building networks customized for their specific devices and applications, rather than connecting to multi-device, multi-application open networks. Their reluctance to adopt standards also stemmed from the fact that their proprietary networking ensured that customers were locked into a given solution. Over the last decade, these vendors have begun supporting standards, usually by partnering with networking vendors offering IP-based products rather than by attempting to implement these technologies themselves.

Utilities were initially hesitant because IP-based networks had historically been deployed only for certain DA systems, if at all. Some in the industry were concerned that lower-performance metering systems would be unable to support IP networking. Unfamiliarity with IP led a few utilities to conclude that IP meant "across the open Internet," so security concerns were raised.

This skepticism has faded for two reasons. First, it became clear that if IP was appropriate for the high performance and high security required of DA, it would meet requirements in other areas, such as metering and demand response. Second, by 2007, Silver Spring had successfully demonstrated IP devices operating reliably in large-scale production deployments, providing real-world evidence – rather than slideware – of the technology's applicability to the smart grid.

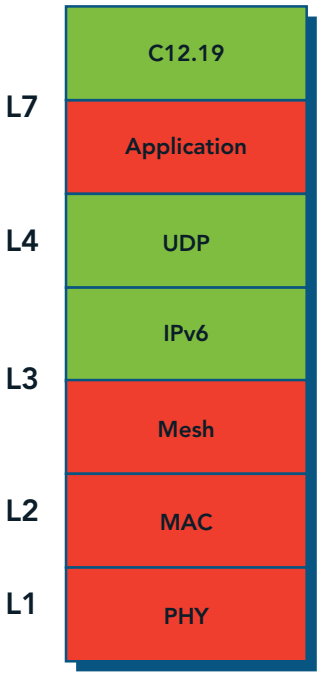
Visionary utilities such as Florida Power & Light Company and Pacific Gas & Electric Company, seeing the value of an open network, were the first to deploy IP-based smart grids. At the time, no appropriate standards for the other layers of the communications stack yet existed. Figure 1 shows the protocol

stack of available standards for the Neighborhood Area Network (NAN). With the role of IPv4/IPv6 clarified and solidified, OpenAMI had served its purpose, and the group transitioned into OpenSG and UtilityAMI.

Standardizing L1 – the Communications Physical Layer

Silver Spring's next key area of focus was to drive standardization at Layer 1, the physical layer (PHY), which specifies the behavior of various communications media. For example, the PHY for Ethernet is governed by the IEEE 802.3 family of standards; WiFi by the IEEE 802.11 family; and WiMAX by the IEEE 802.16 family. As recently as 2008, no standard yet existed for the wireless (RF) mesh technologies that dominate smart grid deployments, nor was any significant effort underway to create such a standard.

Figure 1



The protocol stack for the NAN as it existed in 2005.
Red = proprietary
Green = standard

Standards at the PHY layer are critical to delivering the longevity needed by smart grid networks. Utilities had already deployed, and had an urgent need to continue rapidly deploying, large numbers of networked devices such as meters and access points to meet their business requirements. Since these devices live on the network for decades, it was imperative that standards accommodate this requirement. It is logistically and economically untenable for utilities to do a "forklift upgrade" and replace all their physical devices. Layers 2 and higher of the networking stack can be upgraded over the air to devices in the field, but Layer 1 cannot. The PHY needed to be standardized as cleanly and rapidly as possible.

In September 2008, Silver Spring initiated an IEEE Task Group to create a PHY standard for Smart Utility Networks (SUN), or energy networks. Work began in earnest in 2009 on the creation of what is now the IEEE 802.15.4g standard, which was ratified and published in May 2012.

In collaboration with a large number of silicon vendors, utility equipment providers, international research institutions, and utilities, Silver Spring ensured that IEEE 802.15.4g:

» Accounted for the performance characteristics of smart grid networks, such as moderate bandwidth but very low latency.

» Addressed smart grid geographic reach requirements by defining appropriate power levels, as compared to existing indoor-oriented standards.

» Addressed smart grid outdoor reliability, interference resiliency, and high density operation by including support for Frequency Hopping Spread Spectrum (FHSS) transmission techniques, creating a vast improvement over historical, less reliable wireless technologies.

» Increased data rates formally to 100s of kbps, and even Mbps, broadening the applicability of mesh systems beyond AMR and AMI to support the full sweep of smart grid applications. For example, around 2004, AMI systems on average supported 10 kbps; by 2006, Silver Spring's Smart Energy Platform supported 100 kbps; and as of 2012, we support 300 kbps. The IEEE 802.15.4g specification defines technologies supporting up to 1 Mbps.

» Established a global standard by explicitly including unlicensed and region-specific frequency ranges, or spectrum bands.

» Harmonized existing proprietary technologies, including historical utility vendor mesh technologies – such as Silver Spring's RF mesh – creating an interoperability framework. Incorporating support for existing deployments is a crucial advantage for utilities whose devices have been operating for years before the formal standard was ratified. It also benefits the industry overall, since the standard incorporated mature, proven technology rather than inventing or hypothesizing unproven techniques.

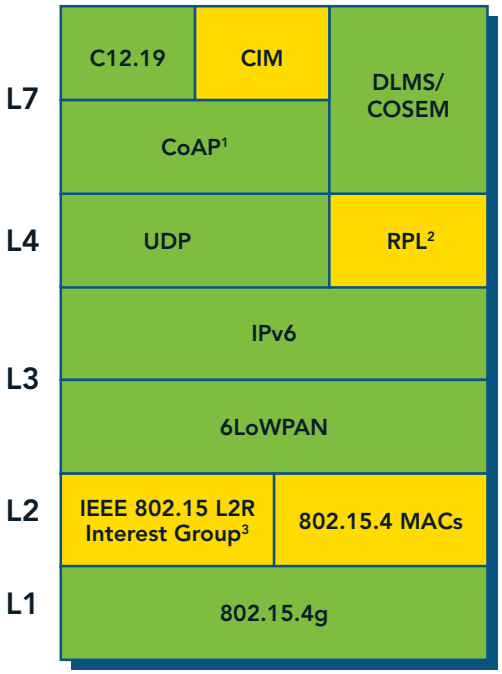
The IEEE 802.15.4g effort has been a resounding success. Because of the backward compatibility built into the standard, deployed Silver Spring hardware can support the standard with no hardware change, protecting the previous investment of utilities and their customers. And all future Silver Spring products will be compatible with IEEE 802.15.4g, ensuring interoperability for both historical and future deployments.

Standardizing L2 – the Communications Link Layer

During the IEEE 802.15.4g effort, it was clear to Silver Spring that PHY layer standardization was not sufficient for full interoperability. Layer 2 – Media Access Control (MAC) or link layer – functionality also needed standardized signaling to fully use the features in 802.15.4g.

A number of activities are underway to standardize the MAC layer, but currently no widely accepted link-layer standard for IEEE 802.15.4g exists (see Figure 2). Some vendors propose IEEE 802.15.4e as an appropriate Layer 2 for IEEE 802.15.4g. This very recently created

Figure 2



[1] Specification options remain insufficiently defined for interoperability testing

[2] New RFC – deployed in HAN, unclear applicability in the NAN

[3] Recently formed interest group to define Layer 2 routing

The protocol stack for the NAN as it exists now.
Yellow = emerging standard
Green = standard

standard – ratified in spring 2012 – has some limitations for M2M communications, particularly in channel management, and has never been deployed at scale for smart grid networks, so it remains unproven in that environment. Currently, worldwide deployments of IEEE 802.15.4e devices number only in the thousands.

ETSI (European Telecommunications Standards Institute) TG28 – Short Range Devices (SRD) – is also evaluating 802.15.4g MAC solutions for large M2M mesh networks as part of M/441, the European Commission Smart Meter Mandate. The TG28 work effort is considering a variety of possible solutions for the MAC.

Layer 2 standards continue to evolve, as will many specifications for M2M communications. IEEE updated the 802.15.4 MAC specifications in 2003, 2006, and 2012 and will likely update them again in the future. Silver Spring will continue to drive innovation and will adopt appropriate standards, as they are proven effective in the utility industry. Fortunately for our customers, any L2 standard on which the industry converges, and Silver Spring therefore implements, can be supported non-disruptively via over-the-air firmware upgrades.

"Silver Spring's adoption of open standards, along with its success in building out a broad ecosystem of interoperable devices, gives us on-going choice and control. We can deploy any number of metering, in-home, and DA devices on our Silver Spring network."

KEN GRANT
MANAGING DIRECTOR, SMART GRID

OG&E®

Standardizing the Communicating Devices and Applications

In parallel with efforts to standardize communications, Silver Spring has also focused on standards for devices and applications using the network platform. These include:

» **Home area networking (HAN):** Smart Energy Profile 2.0 (SEP 2.0) is an IP RESTful profile of the IEC 61968 Common Information Model (CIM). It enables residential and small business customers to utilize devices they already own, such as computers, tablets, and smart phones, to gain access to their energy usage and price information. It enables a new generation of thermostats, displays, and other devices to communicate by existing methods. Silver Spring has been a leading advocate for and contributor to SEP 2.0.

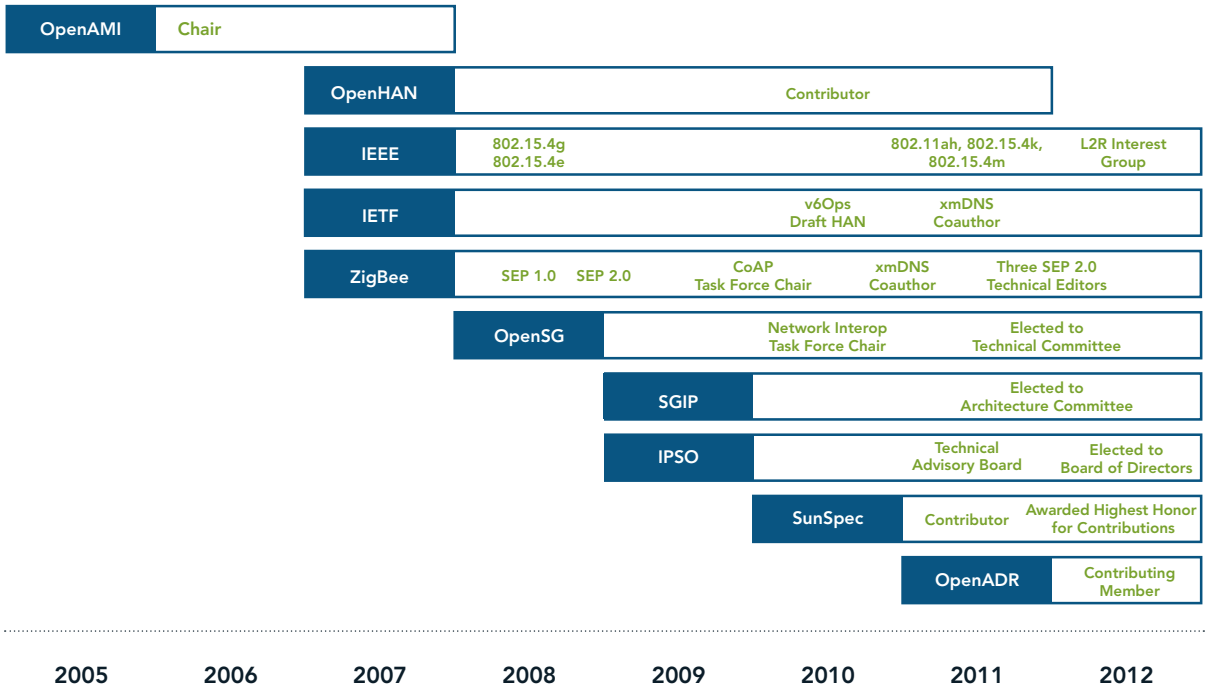
» **Demand response (DR):** Open Automated Demand Response 2.0 (OpenADR 2.0) is an emerging set of demand response protocols for commercial and industrial customers. It is based on standard web services. Silver Spring is a member of the OpenADR alliance and has made technical contributions.

» **Consumer data:** GreenButton is a simplified profile of the Open Automatic Data Exchange (OpenADE) protocol, intended to accelerate the availability of usage and price data to third-party applications for consumers. Silver Spring has implemented Green Button support in its CustomerIQ consumer engagement platform.

» **Renewables integration:** Silver Spring is a participant in SunSpec, an industry group focused on standardizing access to distributed generation data and defining power quality control functions, especially focused on photovoltaic system components. Standards-based data access and control functions are a necessary step towards smart grid-enabling these devices.

» **Back-office interfaces:** CIM provides definition for a variety of the data elements exchanged between back-office systems, such as metering data, price, demand response events, outage and other system data. As CIM interfaces mature, Silver Spring will transition its systems' XML/web services interfaces to take advantage of these standard data definitions.

The following timeline provides an overview of Silver Spring's leading role in developing standards for the smart grid.



Standards Are Not Complete – The Need for Ongoing Work

We have so far described the vast array of standards available – some proven at scale for years – in smart grid networks and specifically as embodied within the Silver Spring Smart Energy Platform. These standards provide customers confidence that their investment in existing and ongoing rollouts is protected and that, with a platform such as Silver Spring's, future networking and software standards can be incorporated without requiring hardware changes.

In terms of networking standards, ongoing work is beginning to converge around the question of IP mesh routing protocols. Although IPv4/IPv6 smart grid mesh networks have been in place for more than five years, routing on these networks is not formally standardized.

Silver Spring is an active participant in several ongoing standards activities focused on mesh routing, including the Routing Protocol for Low Power and Lossy Networks (RPL) in the Routing over Lossy Links (ROLL) working group in the IETF. Silver Spring has made contributions and suggestions to the ROLL working group, and Silver Spring has an implementation of RPL for SEP 2.0 for the HAN, which meets the specification's design goal of supporting a mesh of 30 devices in a home or business. The IEEE 802.15 Interest Group for Layer 2 Routing (L2R) is also focused on this issue. This group is examining Layer 2 solutions to building scalable mesh networks. When industry consensus converges around an appropriate standard solution – Layer 2, Layer 3, or both – Silver Spring will incorporate it into our platform via a firmware upgrade.

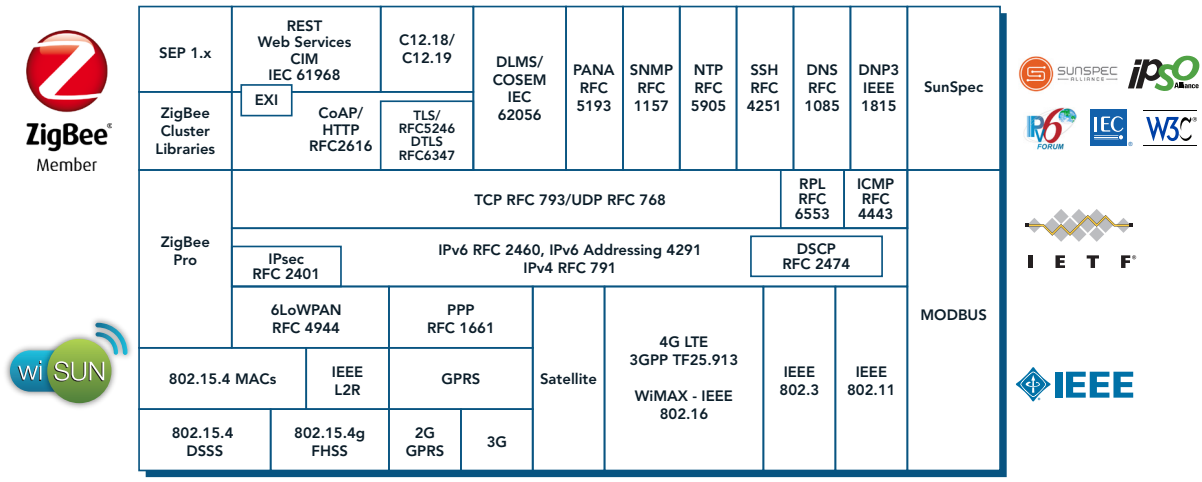
Above IPv6/IPv4, for Layer 4, Silver Spring supports both the Transmission Control Protocol (TCP) and the User Datagram Protocol (UDP).

The Constrained Application Protocol (CoAP) is being developed in the Constrained RESTful Environments (CORE) working group in the IETF. While the standard is not yet complete, initial implementations show that CoAP appears to be appropriate for the Neighborhood Area Network (NAN). Silver Spring has been active in the CORE working group and has contributed to the CoAP specifications. Data to be carried in CoAP would include C12.19 table data as well as elements from CIM.

Many regions of the world use Distribution Line Message Specification/Companion Specification for Energy Metering (DLMS/COSEM). A method of using UDP to transport DLMS/COSEM is defined in IEC 62056-47.

Figure 3 shows the cumulative effect of these standards efforts, a rich protocol stack of smart grid standards that Silver Spring supports in its solutions.

Figure 3



The protocols Silver Spring supports for smart grid networks.

Reaping the Benefits of Standards

Having standards for the smart grid is crucial for interoperability and customer choice. However, how much flexibility customers have depends on the way in which a solution is architected. From the start, Silver Spring opted to build its Smart Energy Platform on network standards and an open software architecture so that customers could enjoy tremendous diversity in device and application mix. Silver Spring's open platform approach yields numerous benefits for customers.

» **One platform to serve all applications** – With a platform, you build things once, such as the network and security architecture, and then leverage them for each application. For example, you use the same network for AMI and DR rather than building separate networks. Likewise, you apply the security architecture, built into each node and network layer, consistently to all applications. Silver Spring's open software architecture also enables reuse – a DR program, for example, not only leverages the network and inherits security coverage, it also leverages integration from Silver Spring software into your Customer Information System (CIS) via the open message buses. This ability to apply a common set of network, security, and integration services across our Smart Energy Platform enables you to roll out new smart grid applications quickly and at low cost.

Standards and Interoperability

Standards exist to ensure customers can freely choose among multiple products. But standards do not guarantee interoperability. To achieve that result, standards must be:

» **Relevant:** Given the smart grid's unique challenges, appropriating standards from other domains is no guarantee of effective performance in the utility environment. To simply claim a solution supports a published standard is meaningless; having proven that standard's relevance and efficacy in production, at scale, over long periods of time, is what matters.

» **Ratified by a formal, recognized body:** Standards Development Organizations (SDOs) such as the IEEE, TIA, and IEC have rigorous, public processes to ensure fairness and precision in defining standards.

» **Widely supported:** A standard must be sufficiently widely adopted to have a large ecosystem of companies that implement it in products. While a single company or group of companies may promote something as a standard, if no other vendors implement it, then interoperability is not possible.

» **Tested and certified:** Standards specifications are often complicated, with many implementation options. A formal, recognized body must deliver an interoperability testing and certification framework for compliance, as the WiFi Alliance does for WiFi products and the WiSUN Alliance does for IEEE 802.15.4g products. Interoperability results must also demonstrate support from a sufficient diversity of vendors – not, for example, multiple communications solutions that all use the same underlying chipset, which does not demonstrate cross-vendor interoperability.

» **Product choice** – By taking a layered approach in implementing networking and other services on our platform, Silver Spring is able to give customers a choice of products at different layers. Customers can choose from a variety of meters, DA devices, in-home devices, and other grid equipment, some with Silver Spring communications embedded and all proven to interoperate with the Silver Spring network. Similarly, customers have application choice – multiple Meter Data Management Systems (MDMS), CIS, Outage Management Systems (OMS), and other back-office applications are deployed in production interoperating with Silver Spring software. Customer choice heightens competition and yields lower pricing, higher-quality solutions, and reduced risk by avoiding vendor lock in.

"Everybody partners to a degree, but … if I had to choose the company that is out in front, I'd name Silver Spring Networks."

JESSE BERST

SMART GRID™ NEWS.COM

» **A flourishing partner ecosystem** – By being standards-based throughout the platform, Silver Spring has developed a large ecosystem of partners, many of whom offer multiple devices that interoperate with our Smart Energy Platform. Partner products include in-home devices such as HAN devices and electric vehicle charging stations, DA devices, meters, and load control switches, as well as back-office software, including MDMS solutions from leading providers such as Oracle, Itron, eMeter, and OSIsoft.

» **Greater innovation** – With a standards-based, layered approach to product development, Silver Spring and its ecosystem partners can innovate at a given layer and quickly deliver new features and functionality to customers, independent of each other. For example, Silver Spring has introduced networking improvements without needing changes either in partner devices connected to the network or in the applications riding on top of it. "Best of breed" products keep getting better.

» **No integration hassles** – Silver Spring's strong commitment to interoperability testing and certification with our partners ensures that customers do not have to commit time and resources toward integration. You can combine components from multiple Silver Spring ecosystem partners and know they will all work together.

Getting the Most from a Standards-based Platform

The growth in the smart grid market has attracted many new players and prompted many incumbents to shift their approach. Established networking vendors and mobile carriers are moving to offer smart grid solutions. However, the environment they are entering is quite different from their familiar ones, and it will likely require several years of iteration before their smart grid offerings can fully address utility requirements. They are selling what they have, not necessarily what you need or want. Some established meter vendors, unable to innovate quickly enough in the networking space, are buying and bolting on third-party network gear or outsourcing networking to some of these same new entrants. Make sure that network is designed for your needs, not their product-line gaps.

Getting answers to the following questions will help you discern the newcomers from the proven leader in smart grid standards:

1. How long has this solution provider offered a standards-based smart grid network?
2. At what scale has this provider connected standards-based devices, operating in full production mode?
3. How many customers can this solution provider offer as references running the standards-based system?
4. How are this provider's customers leveraging the standards-based network to support multiple applications?
5. How much of this solution provider's product focus is on the energy industry?
6. What leadership can this provider demonstrate in driving standards for the energy industry?
7. How many meters from different suppliers has this solution provider integrated onto its standards-based network?
8. How many back-office systems has this provider interoperated with in proven deployments?
9. How many solutions areas does this solution provider support, with interoperating products from other providers?
10. What certification and interoperability testing bodies has this provider helped create?

At Silver Spring, we are proud of our answers to all these questions and our decade of real-world experience and track record of field-proven smart grid deployments. As new industry standards and technologies evolve, we will support them through firmware upgrades, so customers are never at risk of stranded assets.

Our Customers

We welcome the opportunity to share with you our perspective on which standards are relevant to the smart grid and how open, standards-based solutions can help you meet your business objectives today.

About Silver Spring Networks

Silver Spring Networks is a leading networking platform and solutions provider for smart energy networks. With its pioneering IPv6 platform, Silver Spring has networked over 12 million homes and businesses throughout the world with the goal of achieving greater energy efficiency for the planet. Silver Spring's innovative products enable utilities to gain efficiencies, integrate renewable energy sources and empower customers to monitor and manage energy consumption. Silver Spring Networks is used by major utilities around the globe including Baltimore Gas & Electric, CitiPower & Powercor, Commonwealth Edison, Florida Power & Light, Jemena Electricity Networks Limited, Pacific Gas & Electric and Pepco Holdings, Inc. among others. For more information please visit **www.silverspringnet.com**.

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