

## Technologies for the “Smart Grid”



### A Smarter Grid

Today’s U.S. electric power grid, operating near capacity, needs critical improvements to support current and future demand while accommodating a changing mix of distributed energy resources. In addition, the grid must support national efforts to reduce carbon emissions and use the nation’s energy resources more efficiently through changes in energy use patterns.

Today, power interruptions and disturbances cost U.S. electricity consumers at least \$79 billion per year.

A “smart grid” leverages digital technology to improve reliability, security, transparency, connectivity, interoperability, and efficiency. It enables information collection and communication throughout the system, from generation to transmission and distribution to end users. As the nation’s electric grid becomes increasingly reliant on a digital infrastructure, it faces unprecedented demands on information management, control decisions, and physical and network security.

### SRI Capabilities and Technological Advantages

#### Grid Management

The smart grid will require new tools to integrate physical and human elements in a distributed, self-healing system. With key components exchanging digital information, new demands will be placed on the system in the areas of information processing, situational awareness, decision making, control, and cybersecurity.

SRI has the tools to address many of these concerns through innovative approaches, such as

**“...a new smart grid...will save us money, protect our power sources from blackout or attack, and deliver clean, alternative forms of energy to every corner of our nation.”**

*—Barack Obama*

- *Dynamic hierarchical organization to support scalability as the grid incorporates massive collections of smart grid nodes*
- *Distributed control via emergent behavior algorithms for massive agent systems to support self-healing, demand response, load balancing, and micro-grid islanding for disruption and security management*
- *Situational awareness through data mining and approximate reasoning techniques*
- *Mixed-initiative human-in-the-loop operation through autonomous consumer proxy-agent creation and deployment for market-level interaction with the grid*

#### Demand Side Management (DSM)

The smart grid will have a profound impact on energy markets. By enabling Demand Side Management (DSM), consumer demand can be reduced during peak times and shifted to under-utilized times. This allows utilities to use their producing assets more effectively so they can maximize reliability while minimizing overall costs and emissions. Load leveling can reduce or eliminate the need for expensive plants that operate to produce power only during periods of peak demand.



DSM requires two-way communication between consumers and the grid over a digital network along with consumer proxy agents that can encapsulate user preferences regarding power usage. SRI's expertise in multiagent systems will be especially valuable in facilitating effective DSM solutions.

Improved DSM, coupled with energy storage and the introduction of a new network of transmission lines, can help integrate intermittent resources, such as some renewables, into the grid.

**Grid Cybersecurity**

As the grid becomes a massive computing network, cybersecurity will take on increased significance. Cybersecurity is already of critical

importance in the area of process control such as SCADA (Supervisory Control and Data Acquisition) and EMS (Energy Management System). Advanced Metering Infrastructure (AMI) deployments will elevate cybersecurity concerns significantly. A special concern is that cyber assets in the smart grid could be unprotected against events such as reverse engineering attacks.

SRI is working with the Department of Energy (DOE) on the Detection and Analysis of Threats to the Energy Sector (DATES) Project to develop monitoring and situational awareness solutions for Distributed Control Systems (DCS) and SCADA, with a proposed extension of DATES to include monitoring of smart grid end points (AMI).

The DATES monitoring solution includes novel approaches that take advantage of the special characteristics of DCS and SCADA.

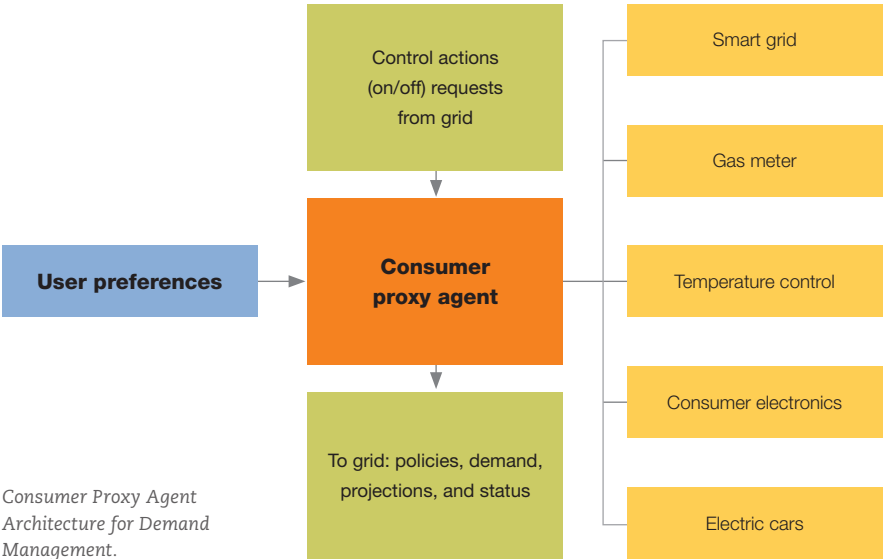
Security of the grid is required to ensure transaction integrity at all scales. The efficient functioning of demand response and other aspects of the energy markets enabled by smart grid critically depend on a distributed computational framework where trust in the correct behavior of autonomous participants is essential.

**Grid Connectivity and Monitoring**

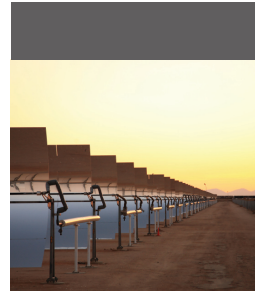
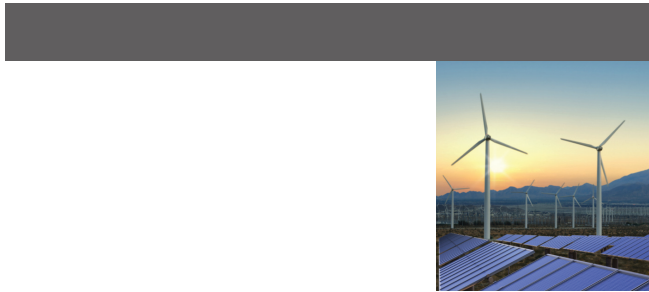
Grid security depends largely on the robustness and reliability of the underlying network. Requirements of the future grid include

- Low-cost, redundant connectivity to support a massive, distributed system of nodes and users
- Data and bandwidth management for large-scale systems using distributed processing and sensor network analytics
- Physical and network security
- Communications interoperability for contingency response

SRI has developed embedded, standards-compliant 802.11s mesh technology that offers redundant, flexible, local networking, with



Consumer Proxy Agent Architecture for Demand Management.



a reduced cost of installation. 802.11s mesh networking enables the deployment of home area networks (HANs) and sensor area networks (SANs), which are key to facilitating investment in smart grid appliances and to encouraging user behavior to comply with the evolving dynamics of the new grid.

SRI's Aware™ System technology offers local and remote physical monitoring on separate, dedicated networks. Aware provides situational awareness using video and tracking technologies for emergency response to assist in restoration of grid components. It enables scaled video network systems supporting multiple clients with lowest power and footprint size per camera and it affords interoperable communications during contingency. The Aware application also includes embedded system training for disaster response personnel.

Aware is an affordable, portable security system that can leverage the existing infrastructure as well as provide an independent system for local and distributed monitoring. Aware software can run on standard PCs to provide video viewing, asset tracking, and various communication capabilities, offering in-depth features while minimizing investment in hardware and

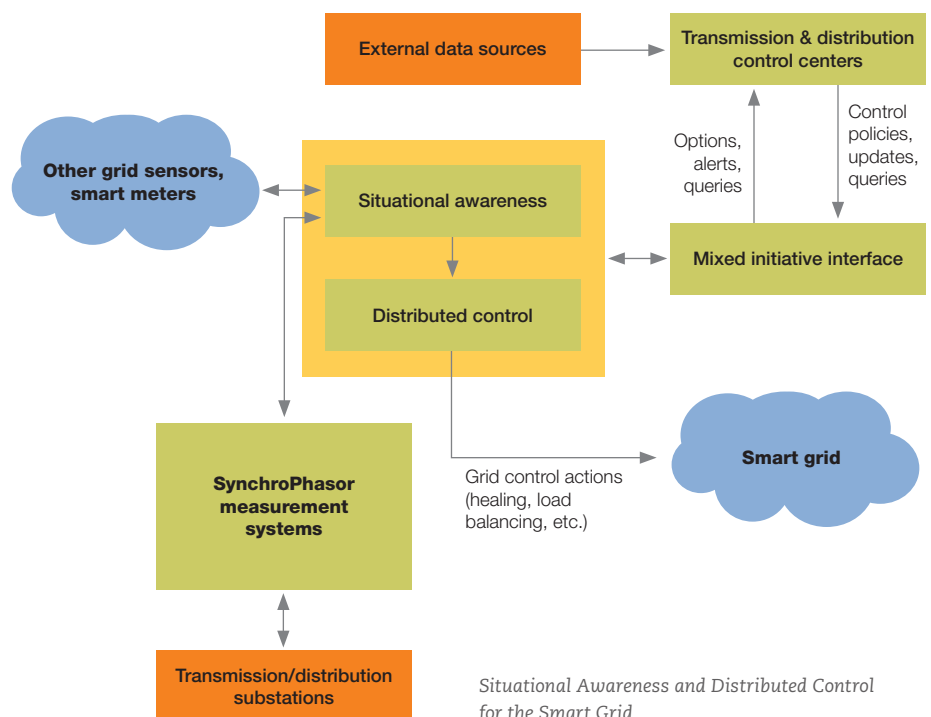
software. In addition, the Aware platform represents a set of capabilities on which SRI has the ability to build advanced solutions to meet specific smart grid requirements.

### Holistic Approach to Smart Grid Technology

SRI focuses on integrated development and testing of solutions rather than isolated developments, with the advantage of leveraging advances in simulations that model existing portions of the grid, adding visibility and intelligence to the technology platform.

SRI's approach can use such simulations for predictive purposes in the course of self-healing or load management. An example of such simulations is the GridLab-D system.

SRI's technology is based on a Web services framework overlaid on a digital communications infrastructure, which is compatible with ongoing progress in smart grid interoperability and standardization. Compliance with industry standards makes it possible to build a more secure, scalable, future-proof architecture.





## SRI Project and Application Examples

Challenges arise as new technology and environmental factors play an increasingly important role in the electric grid. Renewable energy sources and distributed generation must be incorporated in smart grid planning. SRI is developing solutions that will secure autonomous interfaces to the grid. Such interfaces are required to integrate distributed generation and use of renewables.

SRI's approach is based on technologies developed in the multiagent systems field under funding from the Defense Advanced Research Projects Agency (DARPA). These technologies include the DARPA Autonomous Negotiating Teams (ANTS) Program (massive mobile sensor networks), the Coordinators Program (mixed initiative systems for distributed scheduling), and the Next Generation (XG) Program (policy language for representing and reasoning with user preferences).

As part of the DARPA ANTS Program, SRI developed the Distributed Dispatch Manager (DDM), a massive agent system for a mobile sensor network problem domain. That system involved over 20,000 sensor agents and targets

over a large geographic region. To date, it remains the largest such demonstrated (in simulation) multiagent system.

With regard to network security, SRI is working with public safety agencies and military clients that are currently implementing SRI's solutions. The Aware application for communication, data sharing, and video viewing in mobile or fixed environments provides independent digital communication for system demonstrations, proof-of-concept deployments, and real-time monitoring. Aware can easily be tailored for specific needs of the smart grid group.

An established reputation and ability to cooperate with industry and other research organizations make SRI an ideal partner to develop and implement smart grid solutions.

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## About SRI International

Silicon Valley-based SRI International is one of the world's leading independent research and technology development organizations. SRI, which was founded by Stanford University as Stanford Research Institute in 1946 and became independent in 1970, has been meeting the strategic needs of clients and partners for more than 60 years. The nonprofit institute performs sponsored research and development for government agencies, businesses, and foundations. SRI also licenses its technologies, forms strategic alliances, and creates spin-off companies. In 2008, SRI's consolidated revenues, including its wholly owned for-profit subsidiary, Sarnoff Corporation, were approximately \$490 million.

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