Intelligent Infrastructure: The Missing Link in Smart System Applications
Introduction

Cities today cover 2% of the earth’s surface, but contain 50% of the world’s population. They consume 75% of global energy and give off 80% of greenhouse gas emissions. And cities are rapidly expanding; by 2050, they will be home to 70% of the world’s population.

This explosive growth is placing unimaginable demands on civic leaders who must fulfill their constituencies’ expectations. Energy usage, water and wastewater management, traffic control, mass transportation, and emergency management are just some of the issues that are stretching our cities’ resources to the breaking point.

Forward-thinking leaders in government and business around the world are responding to these problems by embracing the potential of “smart” systems. These solutions apply new information and networking technologies to help achieve economic growth, near-term efficiency, sustainable development, and societal progress. Smart systems integrate information flow across a city’s myriad divisions, departments, buildings, and utilities to improve decision making, optimize resources, and enhance customer services.

But implementing smart solutions can be difficult, particularly when the needed data must be extracted from countless numbers of sensors and devices, plus in-line industrial control or SCADA systems. This highly complex effort can require considerable cost, time, and engineering expertise. It represents a major hurdle to smart solution deployment.

An exciting technology has emerged that promises to overcome these implementation challenges. Called “intelligent infrastructure,” a new family of devices serve as hubs for efficient and cost-effective data collection and aggregation — functions that are critical to achieving the smart system’s great potential.

The Dilemma

Today’s civic, utility, and transportation leaders share common problems. Information management systems and networks are not connected. Control systems are not integrated with business systems. Divisions and departments operate independently. Business and institutional analytics are not in place. Decision making is based on experience not data. Tactical approaches and fixes are employed, instead of strategic planning and decision making. So organizations are focused on reaction and response, rather than anticipation and prevention.

These issues are compounded by a host of external and internal pressures. Reduced tax and sales revenues are driving capital and operating budgets lower. Health care, energy, labor, and benefit expenses are skyrocketing. Aging infrastructure is pushing up maintenance costs. In addition, shifting demographic patterns are escalating community and consumer expectations for service delivery, environmental sustainability, and security.

In this uncertain atmosphere, public and private sector leaders are feeling a heightened sense of political, investment, and operating risk — as their organizations grapple with greater waste, inefficiency, and cost.

The Smart Answer

To solve these overwhelming problems, public and private sector leaders are embracing exciting new technologies that can enhance decision making, optimize assets, and improve resource deployment. Called “smart” systems, they embed the capability to collect, sort, and analyze data quickly and display it on executive dashboards.
These information management solutions draw data from sensors and meters in the entity’s networks and control systems. The data is fed into analytic, modeling, and visualization tools to convert it into actionable knowledge.

Smart systems typically are packaged in vertical market applications with names such as Smart Grid, Smart City, Smart Rail, and Smart Building. By gathering extensive information on assets and processes, they enable governments, utilities, and building owners to monitor and save energy, conserve water, control and protect infrastructure, reduce asset downtime, and accelerate emergency response.

By incorporating smart technologies in their operating and business systems, governments and companies can leverage information to anticipate problems, reduce costs, and coordinate resources in one effective process.

The smart system market is growing rapidly around the world. The major information management companies, such as IBM, Oracle, Cisco, and CapGemini, are aggressively creating solutions and pursuing new business. IBM reported that its smart systems revenues more than doubled from 2010 to 2011.

Almost two-thirds of all utilities plan to increase their smart grid expenditures between 2012 and 2015. In the U.S., this market is expected to continue its double-digit growth to reach approximately $26.7 billion by 2017.1 Worldwide growth in the commercial smart building systems market also is taking off. Spending is expected to reach just over $10 billion in 2015, which translates into a compound annual growth rate of 27% from 2010 to 2015.2

The Challenge

While smart systems are gaining acceptance around the world, their implementation can be highly complex. Collecting and aggregating data from remote meters, sensors and control systems represents a major engineering challenge. Ideally, information such as water or energy consumption from every meter in a utility is available in a consistent format, resolution, and time base. In reality, that isn’t always the case. Instead, smart system providers frequently are confronted with the integration nightmare of connecting countless data sources, systems, and sensors.

For example, information from meters and sensors is most commonly provided by automatic meter reading (AMR) systems and supervisory control and data acquisition (SCADA) systems. Although current technology allows smart systems to collect and aggregate this data, implementation often presents problems.

Common difficulties with AMR systems include lack of resolution, incomplete coverage, and missing information. Resolution in many cases is no finer than one month, which is too long for analytic purposes. Incomplete coverage by the AMR system means that other methods must be used to collect information from meters. This creates an integration issue to process information input from different sources. Out-of-service meters or network connections result in missing information, and substitute values for billing are useless for analytics.

The advanced metering infrastructure (AMI) concept under development for Smart Grid systems is intended to solve these problems. But for now, these solutions must deal with legacy AMR system issues.

In smart energy, transportation, and utility applications, SCADA systems are used for monitoring, control, and automation. Connecting smart solutions to these operations uncovers shortcomings that differ from those found in AMR systems. The variety of inputs is a major difference. SCADA systems are responsible for providing operators with a broad range of process information. For instance, in natural gas and water utilities, this information includes flows, levels, pressures, and temperatures, as well as status of compressors, pumps and valves.
The emphasis is on live information. Most communications protocols were not designed to transport the historical information needed by smart systems. In addition, the wide area networks that are employed by SCADA systems often present bandwidth limitations. Historical file transfers lose out in this bandwidth trade-off. While SCADA systems typically include very capable historians, much of the process information is not recorded as historical averages or totals, minima or maxima. Even when this information is available, maintaining a consistent time base can be a problem.

Another issue is that sensors needed for smart system analytics are not connected to the SCADA system. For example, a gas utility SCADA system could exclude many pressure measurements that aren’t necessary for day-to-day operations, but are potentially valuable for the modeling and optimization tools in a smart solution.

Finally, few AMR and SCADA system designs were implemented with smart system interfaces. SCADA servers can interface with these systems by employing extensive, after-the-fact project engineering. But efforts to achieve data transfers, recover missing information, and change data formats for smart solutions can be very expensive.

Smart buildings comprise an application area that presents different challenges from AMR and SCADA technologies. Today’s building management systems are addressing “smart” issues including asset management, energy conservation, indoor air quality, tenant comfort, and security. While the integration of appliances, lighting, and HVAC systems are integral to the smart concept, widespread implementation is hampered by the building’s disparate and unconnected networks and systems. The challenges for effective smart building solutions include efficient and cost-effective data collection and aggregation in a multi-sensor and multi-control environment, plus data interpretation over a broader scale, such as in a Smart City application.

So until now, the collection of data from meter networks, sensors, SCADA/control systems, and buildings has been a laborious and costly effort in smart solution design and implementation.

Introducing Intelligent Infrastructure

Innovative suppliers are now meeting this challenge with unique, easy, and cost-effective technology that enables smart solutions to collect and aggregate data. It’s called intelligent infrastructure, and its devices and software revolutionize the way smart systems can be implemented.

Intelligent infrastructure, such as Semaphore’s TBox products, economically gathers and presents data in the form users want it, when they want it. It provides customers with “smart-ready” infrastructure for the future. The technology feeds data directly to all enterprise systems in an independent, agnostic manner. Intelligent infrastructure is ideal for multi-system, multi-sensor environments in which the integration challenges are the greatest. Finally, intelligent infrastructure allows for continuously current technology with seamless hardware, firmware, and application migration.

Intelligent gateways rapidly bring remote sensors onto the system via Ethernet, serial, and I/O interfaces. Using local alarm/event management, historians, and live data processing, the gateways provide the full spectrum of information required by smart solutions.

Each gateway efficiently transfers information to smart systems via inexpensive cellular and wireless networks. Employing push technology, the intelligent gateway provides timely information without waiting for the server polling approach found in conventional a SCADA system. Using IP-based protocols, the gateway eliminates the shortcomings of SCADA protocols when it comes to transmission of events and historical files, plus live information. Using real-time clocks with support of network time protocol (NTP) and other date/time inputs,
the intelligent gateways ensure a consistent time base for all information. An array of SCADA protocols also allows a gateway to communicate with existing remote terminal units (RTUs) in cases where the user prefers not to use direct sensor interfacing. (See figure 1.)

While each gateway can communicate directly with a smart solution, an intelligent data aggregator also can be used. Employing a combination of IP networking, push technology, and traditional pull communications, the aggregator communicates with remote gateways and RTUs. It consolidates information including alarms, events, live values, and historical data, and transfers it directly to a smart solution for analytics, modeling, and optimization.

Since these intelligent infrastructure devices are further capable of process automation, they can directly apply optimized operating parameters, e.g. pump schedules, from a smart solution and control remote-end devices.
As stated earlier, today’s AMR systems provide inadequate data for Smart Grid solutions. The new AMI concept will greatly simplify smart system application in the metering world. With AMI technology, smart meters are combined with higher-bandwidth communications networks to allow resolution on an hourly rather than monthly basis. They also provide additional information, such as power quality, that is important for analytics, modeling, and optimization. Intelligent infrastructure is an integral part of the AMI concept. These intelligent devices enable the collection and aggregation of data for processing by the smart business system’s analytics and modeling tools. (See figure 2.)

Figure 2: Intelligent infrastructure solution — metering and SCADA

Intelligent infrastructure also helps fulfill the promise of Smart Building solutions. The devices efficiently collect data from the building’s sensors, lighting, meters, HVAC systems, elevators, and security endpoints and provide it to information management systems in an easily digestible format. The result is a cost-effective
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About TBox Technology for Smart Solutions
Semaphore has enabled its TBox products with advanced IP/Web/telemetry technology, an exciting capability that promises to overcome a smart system’s integration and implementation challenges. With this technology, TBox devices serve as gateways for efficient and cost-effective data collection and aggregation — functions that are critical to achieving a smart system’s great potential. They are ideal for multi-system, multi-sensor environments in which the integration challenges are the greatest and most complex.

Smart Building solution that can rapidly achieve reductions in energy consumption, plus provide greater indoor comfort and security. (See figure 3.)

Figure 3: Intelligent infrastructure solution — BMS

Conclusion
The emergence of intelligent infrastructure fulfills the exciting potential of smart systems — to enhance the performance of our organizations and improve our quality of life. Now, city and business leaders can reap the benefits of smart solutions at significantly lower cost and complexity. Their organizations can afford to analyze data, anticipate problems, and coordinate resources in ways that meet the needs of diverse communities, expected services, and aging infrastructure. The result: less energy and water consumption, greater asset availability, reduced traffic congestion, better customer service, and faster emergency response.

Intelligent infrastructure will accelerate the acceptance of smart system technology. It ensures system connectivity today and tomorrow, while “future proofing” infrastructure investments to lower risk and eliminate reengineering. Data will be more secure, and aggregated in ways that enhance information management and presentation.

References