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ENERGY DELIVERY &
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A Look at the North American Power System Puzzle

Three interrelated networks, linked by a communications and information-sharing infrastructure, are supporting the North American power grid as it moves into a new era for the energy industry.

The interconnected power system has evolved rapidly in the last two decades. This evolution has been most dramatic in the intricate web of infrastructures behind the grid:

- A Supervisory Control Data Acquisition (SCADA), or control data, network
- A marketplace infrastructure, using the public Internet, for energy and transmission rights transactions information
- Regional and inter-regional security data networks, to provide grid information from several utilities to one or more regional or national site(s)

In ways unforeseen when the grid itself was first constructed, this web is enabling the power system to continue meeting American society's electric power needs.

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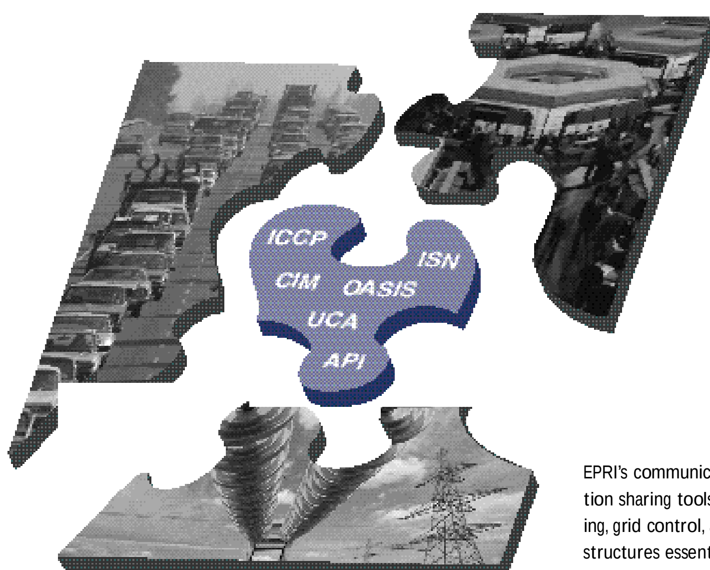

EPRI's communications and information sharing tools link the power trading, grid control, and security infrastructures essential for today's grid operations.

To Our Readers

In this issue of EPRI's Grid Operations and Planning News, we explore the "puzzle" of the North American interconnected power system, and how it is being supported by an intricate web of networks and infrastructures. In the past, the interconnected grid was developed under regulatory oversight, when power plants and transmission facilities were built for economic and reliability reasons; today, as industry restructuring and deregulation continues around the globe, consumers are realizing the benefits of this system. As most industry participants know, developing and operating such a grid–this complex and interactive network–is a continuous challenge, and one which has increased in the face of industry restructuring. Hence, the infrastructures that support the reliable and secure operation of the grid, the "pieces of the puzzle" have become the focus of industry-wide collaborative efforts.

An overview of this wide-ranging area opens the issue in an examination of how these networks evolved and what they are being called upon to perform in the current competitive business environment. At the heart of the puzzle, the control data network (also referred to as the SCADA network), operates the grid. As the article on pages 4-5 relates, technological developments have enabled this network to expand its real-time control capabilities that give system operators moment-by-moment power system data and sophisticated analytical tools to make operating decisions.

Two of the networks are the offspring of industry restructuring. The marketplace infrastructure is the newest piece of the power system puzzle, crafted by industry groups in response to federal mandates for open access. The article on pages 6-7 takes a look at the continuing evolution of this infrastructure to meet the needs of the energy marketplace. The other product of deregulation is the inter-regional and regional security network, described in the article on pages 8-9. This network was implemented in response to concerns about system security in the emerging competitive marketplace. The issue closes with a look at the mesh of information sharing and communications tools that links each of these vital networks together on pages 10-11.

EPRI's Grid Operations and Planning continues to take a leadership role in this effort. Projects include teaming with the North American Electric Reliability Council to continue to refine marketplace systems as well as ongoing development of improved security assessment tools. Similarly, Grid Operations and Planning remains committed to sponsoring broad-based industry groups to enhance the information sharing and communications tools that are integrating the puzzle of grid support networks into a seamless whole. Your feedback on the importance of these efforts guides our progress, and we look forward to our members' continued participation in the evolution of our industry.

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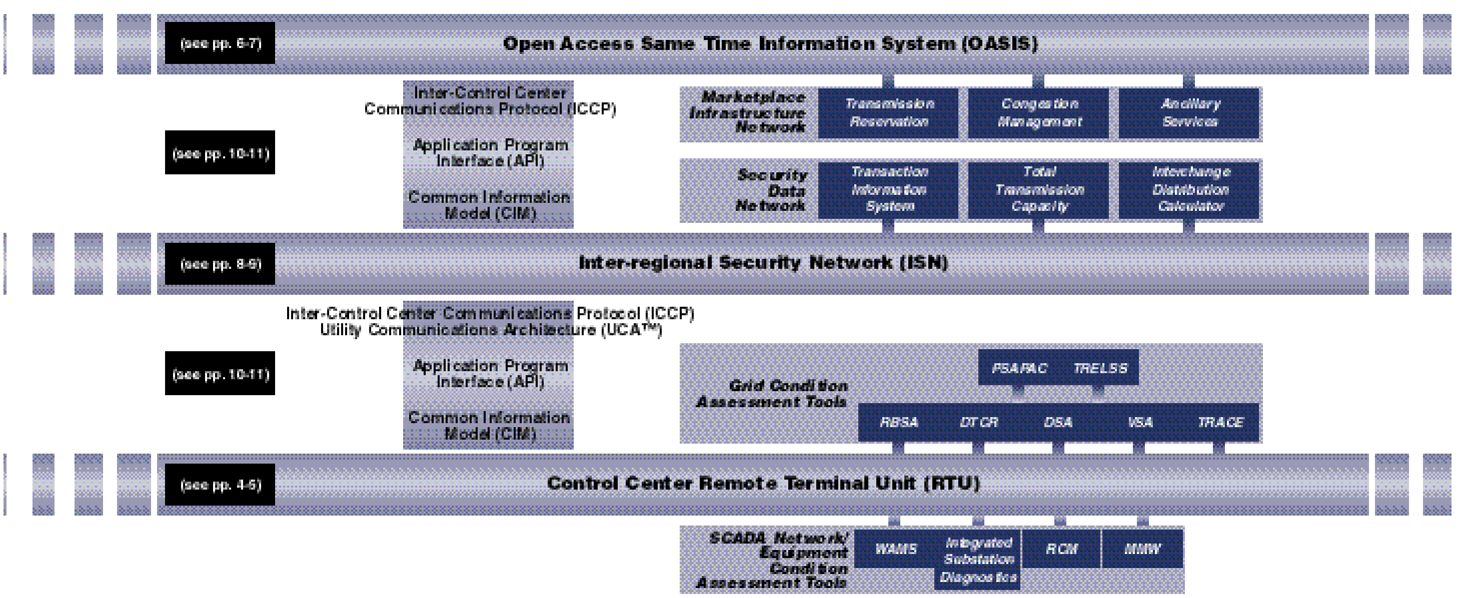
Communications and Information-sharing Infrastructure for the North American Power Grid



The infrastructures outlined in this schematic each provide primary support for specific grid operations and planning, whether it be marketplace trading, controlling the grid, or ensuring power system security.

A Look at the North American Power System Puzzle

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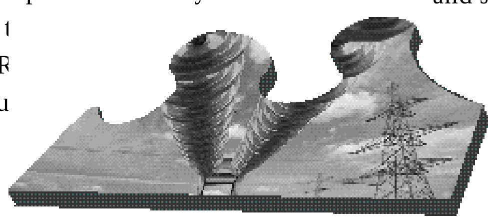
Vhile some of these systems have evolved is a result of emerging technologies, oth- ers have developed under the impetus of leregulation. Weaving them all together is i sophisticated structure of standardized communication and information sharing protocols.

Communications and information-sharing tools link the grid networks together.

Key Networks for Grid Operations

The Supervisory Control and Data Acquisition (SCADA) network, a network of control center and remote terminal inits (RTUs), has its roots in the very beginnings of the interconnected power ystem itself. From the control center, operators could manipulate the slowly expanding grid via t electromechanical R gically located in su tations and other ield locations.



However, the physical grid has evolved and become more complex, with bulk power transfers and an ever-increasing number of transac- ions. As a result, the simple relationship between control center applications and RTUs has also evolved.

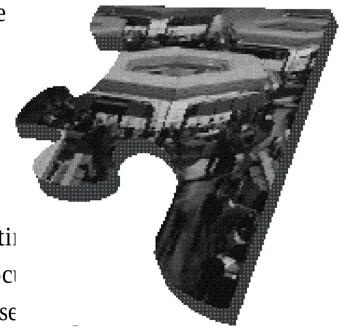
Today, two-way communication between he control center and RTUs is possible. Commands are relayed to the RTUs from he control center, and the control center accepts data on field equipment condition and status from RTUs. Armed with new technological capabilities, RTUs can con- tribute a stream of data about field equip- ment conditions in near real time. This enables more accurate operating decisions back in the control center, as well as improved maintenance activities and replacement purchasing decisions.

Closely related to the technological advances revolutionizing the control cen- ter-RTU relationship are the emerging technological capabilities for wide-area monitoring and auto- mated control. Using the western United States as a laboratory for the application of these technologies, EPRI and its collabo- rators are implement- ing a dynamic data network. The article and sidebar on pages 4-5 nines these develop- ments more closely.

Critical infrastructures for power trading,grid control, and security enable the grid to continue performing in the rapidly changing industry environment.

With the issuance of Orders 888 and 889 in April 1996, open access transmission became a commercial reality, although fu retail competition is still months or even years away in some states.

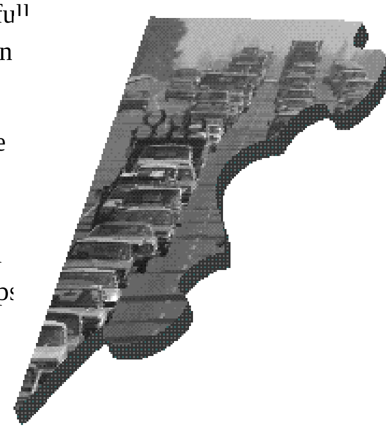
To enable this fundamental marketplace shift, the industry developed a market- place infrastructure, using the public Internet, to facilitate power trading and open access. In doing so, working groups from across the industry arrived at con- sensus-based solutions. As the market- place continues to grow in complexity, industry working groups continue to develop more sophisticated tools with which to tap into this marketplace.



At the same ti groups are foc maintaining se system operation and compli- ance with regulatory requirements. This second network is the subject of the article on pages 6-7.

The third network, the interregional and regional networks for security, developed in response to the need for increased system security in a competi- tive marketplace. In addition to restruc- turing the marketplace, FERC's open access policy also required that formal, coordinated security processes be imple- mented. The result is the interregional security data network.

Undertaken by the North American Electric Reliability Council (NERC), ; infrastruc- the real- ;e of securi- tem data l security vell as con- region.



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Operating the Grid: The Control Data Network

New two-way communications capabilities, together with near real-time control center applications, provide system operators with comprehensive information to maximize grid operation.

Although the earliest of the grid infrastructure networks, the control data network, also referred to as the Supervisory Control Data Acquisition (SCADA) network, has seen technological advances in recent years that are beginning to revolutionize the capabilities of this network. In the past, system operators could only transmit operational signals to remote terminal units (RTUs). Today, sophisticated "intelligent" devices are capable of returning all manner of information about the grid. A host of tools and applications, many developed by EPRI to enhance real-time grid operation and maintain grid components, is also becoming available to maximize the information gained by this two-way communication.

Innovative Operations and Maintenance Tools

New diagnostic tools and expert systems are being created to analyze the data gathered by the intelligent monitoring devices stationed across the grid. For instance, once the data are gathered, tools such as EPRI's Maintenance Management Workstation (MMW) integrate the data from multiple sources and provide personnel with access to various software tools for data analysis. MMW provides a centralized repository for all data-related aspects of a company's maintenance program, integrating other tools such as Reliability Centered Maintenance (RCM). Facilitating the communication of these data among monitoring devices, energy control centers, and company applications is the Utility Communications Architecture (UCA™), a set of common interface standards that enables data integration and system interoperability.

Next-generation on-line tools provide a continuous stream of reliable power system data for optimal operational decision making.

Just as emerging diagnostic tools are enhancing the quality of grid maintenance efforts, a new generation of on-line control center applications is maximizing real-time grid operations. The programs—designed to operate in the real-time energy management system (EMS) environment as well as to run in "study mode" for short-term planning purposes—enable system operators to confidently implement operational decisions having comprehensive knowledge of system conditions.

For instance, security assessment tools such as Dynamic Security Assessment (DSA), Voltage Security Assessment (VSA), and Dynamic Thermal Circuit Rating (DTCR) continuously analyze the real-time information coming from the monitoring devices located throughout the system. With this accurate information, system operators can confidently take the grid closer to system limits without compromising reliability.

Still in development, risk-based security assessment (RBSA) tools promise to enhance the control data network by enabling operators to employ less conservative operating strategies than with traditional deterministic approaches. Adopted from the nuclear and airline industries, RBSA programs will assess all possible system failures, evaluate the economic consequences of an outage event, and identify which party is assuming the risk.

As more and more bulk power transfers pass through the grid, operators and planners need to continually assess the transfer capacity of

Communication between system control centers and monitors and sensors throughout the grid ensure a comprehensive understanding of power system conditions.

their systems. To assist operators with this task, EPRI developed the Transfer Capability Evaluation (TRACE) program. Capable of calculating multi-area simultaneous power transfer capabilities, the program assists personnel in identifying the maximum amount

Collaborative research among EPRI and numerous partners is implementing real-time monitoring and control of wide-area power systems.

of power that can be safely transferred, a key in developing available transfer capacity (ATC) values needed in the marketplace infrastructure (*see pp. 6-7*).

As dynamic events assume a greater importance in grid operations, real-time monitoring and control of the interconnected grid is being implemented in the Western Systems Coordinating Council. Part of the Wide-Area Measurement System (WAMS) project, this dynamic data network complements the functions of the SCADA network (*see sidebar for more information about the dynamic data network*).

Meeting Needs for Short-term Planning

With grid operation becoming less predictable and more dynamic in the competitive marketplace, the need for a new type of short-term planning has become more important. Unlike traditional short-term planning, which focuses on the next several months, this type focuses on the next several hours.

A "study mode" planner can be focused on these planning activities, relaying the information to system operators so that appropriate measures can be taken. For instance, a study mode planner may utilize security assessment tools such as DSA or VSA, which contain screens identical to the on-line versions but that are disabled from carrying out commands on the actual power system. By conducting "what-if" analyses, the planner can identify potential constraints and alert the operator to a specific line or interface. Other study mode tools include Power System Analysis Package (PSAPAC) and Transmission Reliability Evaluation for Large-Scale Systems (TRELSS).

"Study mode" versions of security assessment tools enable operators and planners to prepare for the unpredictable events of the energy marketplace over the course of a few trading hours or days.

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Real-time Grid Control: The Dynamic Data Network

The emergence of a dynamic data infrastructure system has accompanied the evolution of the long-distance bulk power market.

In North America, interconnected power systems carry increasing amounts of bulk power, sometimes over hundreds of miles. For instance, due to cost-effective generation, such as hydropower in the Pacific Northwest, and load centers elsewhere, such as Southern California, power may be transmitted through multiple transmission providers' systems before reaching its destination. Such wide-area interconnected systems have unique vulnerabilities and needs.

Development of the dynamic data infrastructure has also been spurred by new technological developments, capable of monitoring and manipulating large interconnected power systems with a precision not previously possible. These tools include devices developed in the Wide Area Measurement Systems (WAMS) project. In addition, some of the sophisticated control data network tools play a role on the dynamic data network, such as integrated substation diagnostics, MMW, and RCM.

In its initial phases, the WAMS project developed and deployed state-of-the-art digital monitoring tools, such as phasor measurement units, capable of measuring dynamic system data at higher rates than analog counterparts. As a result, system operators and engineers gain a much sharper view of the performance of power system equipment. Sponsored by a collaborative team that includes the Department of Energy, EPRI, national laboratories, Bonneville Power Administration, and other energy companies, the WAMS project is forging ahead with new tasks to complete construction of the dynamic data infrastructure. In work just begun, the project team is developing a dynamic information manager, a major element in managing WAMS-generated information.

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Building a Marketplace Infrastructure: The Public Internet Network and Commu

Broad-based industry efforts have created a functioning energy marketplace, while EPRI continues to support industry efforts to develop greater market efficiency.

With the advent of open access transmission, a marketplace emerged for transmission services and ancillary services, as well as economic mechanisms for dealing with congestion management issues.

Almost immediately, the industry recognized that an entirely new marketplace would be needed. In 1995, the Federal Energy Regulatory Commission (FERC) directed EPRI and the North American Electric Reliability Council (NERC) to lead the industry efforts in constructing this new marketplace via broad-based working groups. Since then, both organizations continue to take leadership roles in refining existing systems as well as developing more effective ones to take the energy industry into the next millennium.

To enable this fundamental marketplace shift,the industry used the public Internet to facilitate power trading and open access.

The Continuing Evolution of OASIS

After an intensive, eight-month development period, industry working groups had crafted specifications for what would be called the Open Access Same-time Information System (OASIS), and submitted them to FERC. Using the public Internet and World Wide Web as a backbone, OASIS began commercial operation on January 3, 1997 with 22 “nodes” located across the United States. Each node corresponded to a communication and information processing system, serving as a hub for wholesale transmission providers and customers in the geographic region. OASIS users could obtain transmission information, such as available transfer capacity (ATC) and total transmission capacity (TTC) as well as make reservations for transmission and ancillary services.

Transmission customers rely on OASIS for timely data and reservation capabilities.

A standard information model and computer interface was designed to make OASIS appear as a seamless reservation system across all transmission providers. However, due to the accelerated development schedule, the working group did not establish all the business standards. Most recently, an upgraded OASIS system was deployed on March 1, 1999. This system provides improved standards and the ability for power marketers to negotiate transmission prices on-line.

New Marketplace Infrastructures

In addition to the efforts related to OASIS, industry working groups have also focused on developing solutions that would enable open access market efficiency through the exchange of energy transaction information.

New circumstances required this step. For instance, participants in the energy market were reselling energy and transmission transactions to other marketers in distant control areas to put together their energy transactions. In addition, this exchange of information was also needed to support system security (*see pp. 8-9*). The solution—called the transaction information system (TIS)—was to require detailed energy transaction data information to be sent over the Internet to parties involved in the transaction.

Industry groups are considering the development of a single, integrated system that

The challenges of the emerging energy marketplace requirec process of power trading.

would encompass the reservation aspects of OASIS, the information management aspects of TIS, and the energy scheduling aspects envisioned by FERC. Such a system would support the goals of data exchange, market efficiency, and grid reliability.

s Protocols

Motivating these considerations are the new complexity of transactions, with greater numbers of transactions, increased distances involved in individual transactions, and an increasing number of parties involved in transactions. The OASIS

Data exchange, market efficiency, and grid reliability remain the goals of the new energy marketplace.

infrastructure has complicated transactions as well. Factors such as these may be placing at risk the capabilities of the system to conduct commerce.

supporting vast amounts of data and multiple users in the

The new system, called the Transaction Management System (TMS) would support the following:

- Transaction information processing, including reservation, validation, scheduling, and storage
- NERC-compliant transaction tagging
- Transaction impact and curtailment analysis, with the Interchange Distribution Calculator (IDC)
- ATC coordination
- User interface for information viewing and updating

In cooperation with NERC, EPRI funded a study to develop a plan for the new system, including architecture design and an implementation plan, and it was submitted to NERC in late 1998. Under this plan, TMS would feature a modular design enabling incorporation of existing systems, such as TIS, as well as regional systems implemented by NERC regions. Robust enough to support next-hour trading and automated transaction tagging, TMS could be used by 140 control area operators, 23 security coordinators, 180 transmission providers, and emerging ISOs in North America.

To implement the TMS, NERC expects to use a phased in approach. For instance, industry groups will implement "stand-alone" TIS and Interchange Distribution Calculator components in 1999. At the same time, working groups will be developing OASIS 2 specifications, to be followed by its implementation. Later, TMS system integration will get underway, which will integrate all the system components into a seamless infrastructure.

For more information contact Peter Hirsch, (650) 855-2206, phirsch@epri.com.

At the OASIS

One key to the new energy marketplace is OASIS, the Open Access Same-time Information System.

OASIS users can include transmission customers as well as transmission providers. In any case, the OASIS user will access a specific OASIS node using a standard Web browser, such as Netscape or Microsoft Internet Explorer, that supports at least HTML version 3.0. To begin, a user will enter the Web address of the OASIS node they want to access into their browser, and connect to the node's home page. Initially, every user was required to register with the node; on subsequent visits, the user usually must input their user name and password that was established at registration to gain access beyond the node's home page. Once registered, the user can begin to browse the transmission capacity information made available by the transmission provider.

Consider one of the most typical activities that takes place on an OASIS node, the process of purchasing transmission capacity. First, the transmission customers will review the transmission capacity that is available for the interval for which they are interested in obtaining transmission capacity. This information contains all the elements required by FERC standards and the OASIS Protocols. If transmission customers wish to request reservation of transmission capacity, they complete an online form and transmit it. Following transmittal, the customer can monitor the status of the request, as the transmission provider updates the request status during processing. Finally, when the transmission provider grants the request, the customers must confirm that they are accepting the granted transmission capacity.

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Protecting the Grid: Inter-regional and Regional Security Data Networks

Consensus-based security solutions, involving new assessment tools as well as coordinated security processes, are helping smooth the transition to a competitive energy marketplace while maintaining system security.

With the development of the competitive marketplace, system security issues became increasingly important to industry participants. As they observed, grid conditions were steadily becoming more stressed with greater volumes of inter-regional power transfers. Industry leaders, including the Federal Energy Regulatory Commission (FERC), the North American Electric Reliability Council (NERC), and EPRI, recognized these stresses, and began to work together to implement effective solutions.

Coordinated Security Processes

At the outset, FERC's open access policy also required formal, coordinated security processes. Ultimately, coping with these threats to grid security required the development of a comprehensive new infrastructure to coordinate regional security processes and enable security information sharing. Toward this end, NERC recommended the following:

- Sharing of operational data among control areas
- Establishment of an interregional security network
- Identification of a security coordinator for each NERC Region, subregion, or interregional coordinating group
- Development of regional security plans

In addition, EPRI began the development of new security tools to support these enhanced security efforts. These security assessment tools provide system operators with on-line tools to identify and respond to problems as they develop on the grid. One tool, the Voltage Stability Assessment (VSA) program, continuously monitors the grid using energy management system data. VSA enables operators to pinpoint voltage stability problems and select measures (e.g., voltage regulation) to prevent events that might compromise grid security. A second tool, Dynamic Security Assessment (DSA), accurately identifies dynamic stability problems at critical power system interfaces. DSA also calculates stability limits continuously, providing operators with timely data on dynamic transfer limits and stability margins.

EPRI's online security assessment applications strengthen the industry's arsenal of security-related tools and procedures.

The cornerstone of the security data network is the North American Inter-regional Security Network (ISN), implemented in each of NERC's ten regions with support from EPRI. Utilizing a frame relay communications system, the network contains 22 nodes between which real-time system data are transmitted. These data, such as MW, MVAR, kV, and breaker status, allow instant assessment of the interconnected grid. The first node was implemented in September 1997, and the entire network was in place and operational in January 1998. In the early months, limited amounts of real-time data have been exchanged; ultimately, as many as 2800 different data points will be transmitted from individual control centers to their respective security coordinators.

Moving Beyond Information Sharing

Effectively coordinated security, however, involves more than information sharing. The Interchange Distribution Calculator (IDC), scheduled to be on-line in the summer of 1999 to replace an interim tool for the Eastern Interconnection, will provide transaction impact analysis, transmission loading relief (TLR), and next-

Much like traffic laws ensure the safe and orderly flow of vehicles on a busy freeway, the coordinated security processes serve as "rules of the road" for the new energy marketplace.

hour coordination (for halting transactions in the next hour that would create congestion). It will also support a pilot project for testing a method of market redispatch in the event of a TLR event. These tools and procedures will provide advanced analytical capabilities to security coordinators and marketers alike. Together, they comprise the security aspects of the Transaction Management System (*see pp. 6-7*).

The IDC will assist operators in assessing the power flow impact of each interchange transaction. To do this, the program computes power transfer distribution factors (PTDFs), which represent the portions of an interchange transaction that are distributed by the laws of physics on various parts of the transmission network. IDC-generated values provide important information in the regional security data network, and in the marketplace infrastructure as well. In the former, they provide the foundation for mitigative procedures such as TLR. In the latter, they furnish transmission providers with a criterion by which to accept or reject transmission reservations. This information also has a direct impact on their decision-making ability and purchase/sale strategies.

The Interregional Security Network connects critical points of the nation's power grid and transmits real-time security-related power system data.

Operators can employ the IDC in two different ways. Prospectively, operators can use the IDC in a predictive mode for the next hour to identify whether any transactions should be halted. In real time, operators turn to the IDC when a transmission security limit violation has occurred and the impacted provider is seeking relief.

TLR procedures also play an important, albeit controversial, role in the regional security data network. These may be implemented when it appears that transmission flows may violate transfer limits. TLR procedures identify transactions that contribute the most to power flow in overloaded transmission facilities and determine the needed transaction curtailments as well as revised ATC values.

An aspect of coordinated security that has not yet been implemented as part of TMS is ATC coordination. Currently, transmission providers or customers may encounter multiple posted ATC values for identical interfaces, making transmission service reservations uncertain. However, coordinating ATC values is no easy task. While the basic ATC definition is commonly accepted, transmission providers employ a variety of assumptions in calculating the underlying margins. Establishing ATC coordination procedures will involve the collection of ATC data from all regions for all interfaces and determining the appropriate ATC values for posting.

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The State of the System

Like the flow of electricity, power systems are constantly changing.

Even so, systems are usually in one of three states. Perhaps as much as 80% of the time, power systems are in a normal state. That is, the system enjoys a complete topology: all equipment is in service that should be in service, and all measurements are within normal limits. By contrast, an emergency or restorative state indicates that the topology is incomplete (e.g., a generating unit has tripped or some other violation of limits has occurred). When a power system enters one of these states, some human error, equipment failure, or weather-related factor is usually responsible. Then, the operator must return the system to a normal state, either directly or after maintaining it in a restorative state for a time.

When the system is in the normal state, an operator must be concerned about system security, or the ability of the system to remain in a normal state in the event of a contingency. What compromises system security? The answer is that various power systems suffer from different types of security constraints. The basic types of insecurity are thermal overload, dynamic insecurity, and voltage insecurity. Shorter transmission lines, such as many in the eastern United States, can be vulnerable to voltage and thermal constraints. Longer lines, such as many in the western part of the country, may be susceptible to oscillations. In determining the state of grid affairs, the operator needs data–about the power system, individual components, activities in neighboring systems, and more. The interlinking data networks provide this essential information to system operators so they can maintain the state of the system.

For more information contact Peter Hirsch, (650) 855-2206, phirsch@epri.com

Connecting the Networks: Communications & Information-Sharing Tools

The capabilities of new communication and information sharing tools link the supporting networks behind today's interconnected power system.

Forming an intricate web with many overlapping aspects, these networks rely on continuous and accurate communication and data exchange.

Continuous and accurate communication and data exchange are the "glue" connecting the grid's supporting networks.

In the competitive era, this free flow of real-time information can no longer be achieved by older, slower methods such as faxes and telephone calls. Moreover, standardized tools that can be easily implemented by all market participants will streamline the continuing transition to a fully competitive marketplace.

EPRI has been at the forefront of the industry in developing such tools, leading broad-based project teams to consensus-based protocols and guidelines that have become international standards. The Control Center Application Program Interface (CCAPI) project has developed standards and guidelines that promote real-time information sharing among applications. The Inter-Control Center Communications Protocol (ICCP), part of the broader Utilities Communication Architecture (UCA™) project, provides a uniform communications protocol by which organizations and companies can exchange energy information vital to security, trading, and power system control.

An Information-Sharing Link: Application Program Interface (API)

A standardized interface, the API can be used to integrate various applications by specifying what data is to be shared and how the respective applications will share it. A key element of the API, the Common Information Model (CIM), provides a standardized definition of the power system. With this CIM-based "language," not only can internal applications share power system data, but applications at different locations can share it as well.

For instance, the Common Power System Model project, involving the North American Electric Reliability Council's Inter-regional Security Network (ISN), has taken advantage of the CIM to model most of the U.S. interconnected power system in a CIM format. Using this common format, control center operators can more easily communicate with ISN node security coordinators, providing data on the interregional and regional security network (*see pp. 8-9*).

A standardized interface, the API enables information sharing among otherwise incompatible applications.

Another key element of the API, the message bus interface, enables the sharing of critical system information among applications within an energy enterprise.

At Kansas City Power & Light (KCPL), an early implementation of the API concept demonstrates the possibilities when information from the various infrastructures can be shared. Currently connecting the company's energy management system (EMS) with its distribution facilities management system, the message bus may alsc connect KCPL's interchange scheduler for marketplace applications (*see pp. 6-7*), capacitor bank controllers for system control (*pp. 4-5*), and ICCP security data network (*pp. 8-9*) in the future.

For instance, power system information from the EMS can be used by another application (i.e., the capacitor bank controllers in the future) to make operational changes in real time, maximizing use of the control data network. Alternatively, historical data may be used by a power marketing application to facilitate power trading, in a meshing of the marketplace infrastructure and communication and information networks.

Another example of the meshing of the various networks is the role the API may play in the Transaction Management System infrastructure (TMS), an integral element in the evolving marketplace infrastructure (*see pp. 6-7*). Both the message bus and the CIM are being considered for use in the development of the TMS infrastructure as information sharing tools. These information sharing tools would facilitate the linking of the market-

PRI's communication and information sharing tools enable industry participants to link the trading, security, control,and ynamic data infrastructures together into a seamless network supporting the grid.

lace infrastructure and regional security lata networks.

he Communications Link: ICCP

he need for real-time exchange of power ystem information became apparent in he early 1990s. In response to this need, PRI and American echnical leaders egan development of design to accomplish his exchange, which esulted in a new nternational tandard, known as CCP in the United tates. This truly provided the standard- zation necessary for the foundation of eal-time exchange, including the new requirements emerging from deregulation, such that more than ten vendors have developed products that provide essential interoperability.

ICCP has become the main solution of real-time data exchange in North America,Europe, and most recently, Asia.

Currently, the ICCP standard is widely used by energy companies as the communications protocol enabling real-time data exchange between locations. A modern, comprehensive client/server protocol that employs the Manufacturing Message Specification (MMS) as a foundation, ICCP supports the exchange of real-time and historical power system monitoring and control data. These include measured values, scheduling data, energy accounting data, and operator messages.

Adopted as an international Standard by IEC, the International Electrotechnical Commission (and known as TASE.2 in some parts of the world), ICCP is being used in the United States by individual organizations as well as networks of organizations.

On a continental scale, ICCP has been implemented as the communications protocol that powers the ISN. Linking together individual control centers with regional coordinators, ICCP enables real-time exchange of system data, such as MW, MVAR, kV, and breaker status, allowing instant assessment of the interconnected networks.

In addition, TCP/IP, Hypertext Markup Language (HTML), and Hypertext Transport Protocol (HTTP) Internet protocols are also used for communications standards where low cost is required and security concerns are somewhat less.

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A Look at the North American Power System Puzzle

(CONTINUED FROM PAGE 3)

Armed with this accurate information, regional security coordinators, independent system operators (ISOs), and control center operators can make more informed operating decisions. Pages 8-9 take a closer look at these security measures.

The "Glue" for These Networks

Linking each of these networks together is an array of communications and information-sharing tools. Developed via broad collaborative industry efforts spearheaded by EPRI, these tools are enabling the free flow of real-time informa- ntial to an and secure electricity marketplace. At the same time, such standards are streamlining the transition to a fully competitive market, while becoming industry standards worldwide.

Two such tools developed by the industry for secure data transfer include the control center application program interface (CCAPI), and Inter-Control Center Communication Protocol (ICCP). Read more about these tools on pages 10-11.

Looking Ahead

As the electric power marketplace continues to evolve so, too, will the infrastructures that enable it to function effectively. Continuing the efforts to integrate these networks into a seamless whole, industry participants are focusing their efforts in a number of areas.

One vital overlap exists with the marketplace infrastructure and regional security data networks. To smooth the integration between these networks, industry groups are working to refine the Open Access Same-time Information System (OASIS) and the Transaction Information System (TIS) to become the multi-faceted, comprehensive Transaction Management System (TMS).

Other regions in the world are recognizing the benefits of interconnected grid operation.

In the areas of control data and dynamic data, tools such as Maintenance Management Workstation (MMW) and integrated substation diagnostics provide vital equipment data, not only to the immediate control center but to a wider area as well, enabling a clear picture of the grid from a larger perspective.

Because the North American grid is an international one, its evolution crosses national boundaries as well. But the interconnected grid is no longer a North American phenomenon. In Europe, a multi-national grid is developing that encompasses western countries as well as former Eastern Bloc nations. Other regions of the world may follow suit as the benefits of interconnected grid operation become more important.

While the challenges involved in constructing a tightly integrated grid can be formidable, the benefits are real. The ability to transfer power from one region to another is one of the advantages of the interconnected design of the grid. The design also inherently affords redundancy of power generation and transmission capability. Of course, the interconnected nature of the North American grid is also its vulnerability; events that occur in one region can escalate out of control and affect numerous other areas. Ultimately, the greatest protection for the interconnected grid—and the society it supports—is the seamless integration and operation of the infrastructures that support it.

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