Telecontrol standard IEC 60870-6 TASE.2 globally adopted

Dipl.-Ing. Karlheinz Schwarz
Schwarz Consulting Company (SCC)

Im Eichbaeumle 108
D-76139 Karlsruhe
Germany

schwarz@scc-online.de
www.scc-online.de

Abstract. The Information exchange has taken on increasing importance for the restructured energy industry. A standard communications protocol that powers this information exchange, even between incompatible communication systems, enables improved system performance, often accompanied by dramatic cost savings. Developed collaboratively by a team including energy companies, vendors, and EPRI, the Telecontrol Application Service Element or TASE.2 (IEC standard 60870-6 TASE.2 – also known as the Inter-Control Center Communications Protocol or ICCP in the United States) facilitates seamless exchange of time-critical data over local and wide area networks. TASE.2 is the most capable, widely adopted open communications protocol available to the electric power industry today. TASE.2 defines open functions and an object model for application data. TASE.2 supports the integration of instrumentation and control into the corporate wide information and data processing in any application domains, e.g., utilities, manufacturing, or process control.

1 TASE.2 is based on proven technology

The energy markets are characterized by the deregulation worldwide. Production, transport, distribution and sale of electric energy were carried out by a single enterprise till now. In future, these units will form independent companies and compete with each other. Thus, it is becoming possible that a company sells energy of power stations belonging to different companies.

Worldwide, the electric power industry uses more operating data than perhaps any other industry. Energy companies, transmission companies, grid operators and other industry parties obtain a constant flow of information - monitoring and control system data, scheduling data, energy accounting data, and system operator messages. Seamless communication of this information to appropriate locations smoothes the process of generating, transmitting, and distributing the world's electricity.

To achieve this objective, in the past energy companies developed multiple communications protocols to facilitate exchange of these data from one location to another. Unfortunately, these protocols were often developed on an as-needed basis, leading to a proliferation of proprietary, incompatible protocols.

At the same time, the power industries in many countries began undergoing fundamental changes. For instance, the United States has witnessed an increase in cooperative enterprises such as power pools and regional centers. More than ever, U.S. industry participants needed the seamless exchange of data but found themselves hampered by the technical and economic limitations of incompatible communications protocols.

In Europe, the European Union Directive 96/92 EU on the Internal Market for Electricity calls for the opening of transmission systems throughout much of the subcontinent for marketplace use by February 1999. The Union for the Coordination of Production and Transmission of Electricity (UCPTE) is responsible for implementing this requirement.

Clearly, the need for a standard communications protocol transcends national boundaries. With most energy management system (EMS) vendors offering their products internationally, a globally-recognized standard protocol became necessary. TASE.2 was developed as an open interface by energy utility providers in cooperation with manufacturers of control systems.

The design goals of TASE.2 were:

- higher safety of the plant,
- lower costs of components,
- reduced costs for installation and operating,
- shorter times for planning, design and installation,
- simplified selection of the devices and systems,
- increasing interoperability,
- lower training costs,
- higher usage of the operating resources,
- vendor independency,
- more support by the supplier, and
- use of generally available industrial solutions.

TASE.2 is part of the Utility Communications Architecture (UCA version 2). The IEEE SCC 36 (Utility Communications Architecture, UCA) has unanimously decided in April 1999 to publish the UCA Version 2 specification as IEEE Technical Report (IEEE TR 1550) in July 1999. The Utility Communications Architecture (UCA) is a standards-based approach to utility communications which provides for wide scale integration at reduced costs, and which solves many of the most pressing communications problems for today's utilities. The UCA is designed to apply across all of the functional areas within the electric, gas, and water utilities.

2 Overview about the TASE.2

TASE.2 comprises three documents:

- IEC 60870-6-503: TASE.2 Services and Protocol
- IEC 60870-6-802: TASE.2 Object Models
- IEC 60870-6-702: TASE.2 Application Profile

The standard has a three-step number. The proceeding number 60870 stands for "Telecontrol Equipment and Systems". The second number is the 6, it stands for the project "Telecontrol Protocols compatible with ISO and ITU Standards". At third place are the individual documents, both of the series TASE.1 (ELCOM based) and of the series for TASE.2 (ICCP based). The documents IEC 60870-6-1, IEC 60870-6-2, IEC 60870-6-3, and IEC 60870-6-4 define common parts of the two series. The part IEC 60870-6-503 contains the core functionality of TASE.2. The service and protocol definitions (IEC 60870-6-503) are based on MMS (ISO/IEC 9506).

MMS and the underlying protocols are be mapped to ISO transport protocol or to TCP/IP (RFC 1006 or RFC 1070).

The TASE.2 model defines the communication between two control centers. For the communication, TASE.2 models a control center as a TASE.2 server in which the objects (application data) and the defined functions are located. Another control center (the TASE.2 client) accesses that server. The TASE.2 client invokes a function which is then executed in the TASE.2 server. The TASE.2 server answers with the corresponding actions and return codes.

TASE.2 client and server describe the locality of the data (TASE.2 objects) and of the functions (TASE.2 services) and the direction in which a function operates. The function Read Variable, for example, operates from the client to the server, i.e. the client reads the values from the server. Real implementations (computers) generally support both tasks (mostly even on a single connection). Thus, one control center e.g. can read data from another one and vice versa.

TASE.2 offers a series of functions which are generally demanded in the process data communication. The following list shows the functions. The corresponding TASE.2 objects are listed in parenthesis:

- **setting up of connections** between partners with authentication and password protection (Association),
- **access only to data which are unlocked** (Bilateral Table),
- **definition of names and structures** of application data, for example single point information, double-point information with/without quality information/time stamp (Data Value, Data Set),
- **one-time inquiry** of messages, status information (Data Value, Data Set),
- **spontaneous transmissions** of simple or complex information (Transfer Set),
- **notifications** of a change and event indications of arbitrarily simple or complex information with or without buffering (Transfer Set),
- **general interrogation** of arbitrarily simple or complex information (Transfer Set),
- **transmission of equidistant values** in real time or from archives, with/without buffering in the data source (Transfer Set),
- **exchange of long data areas** (Transfer Set),
- **remote definition of groups** with assigning of application-oriented names (Data Set),
- **remote configuration** of the reporting behavior of the data source, for example: log-on and log-off, cyclic transmissions, transmission at change of value, acknowledgment of critical information (Transfer Set),
- **control of devices** with exclusive access right (Device),
- **program control** (Program),
- **exchange of information for deregulated energy markets** between control centers and between control centers and power stations or substations.

3 TASE.2 products

A high quality of the standard was obtained by standardizing and implementing at the same time. IEC 60870-6 TASE.2 is implemented in different forms such as:

- Integrated into a control system.
- As gateway to the port of a proprietary control system (front-end processor to existing control centers).
- As software for example under Unix or Windows 3.1, 95 or NT (OEM-Products).

Among other, the following manufacturers offer one or several of these solutions:

- ABB Systems Control,
- Bailey Network Management Systems,
- CAE,
- Cegelec ESCA,
- Cycle Software, Inc.,
- GE-Harris Energy Control Systems,
- Landis & Gyr,
- QEI,
- Repas AEG,
- Siemens Power Systems Control,
- SISCO,
- Tamarack,
- Valmet.

At first these implementations were intended for the communication between control centers. In the meantime, implementations for smaller devices (MMS for embedded Systems) have been developed, for the most important MMS functions:

- Implemented base models of MMS: Association control, VMD Support, Read, Write, Information Report, Domain Management, Event Management (basic).
- Conformant to the requirements of the EPRI MMS forum (for ICCP, ...).
- Standard ANSI C code.
- Code Space: 9 kByte to 25 kByte.

This MMS solution is already integrated in several devices.

Shortly after having published the TASE.2 standard as IS (International Standard, IEC 60870-6 TASE.2), far more than 100 projects had already been carried out. Also, TASE.2 is more and more being used for the coupling of stations and power substations as well as substations with power control systems.

4 UCPTE Real Time Information Communication Architecture

Electricity market deregulation as imposed by the European Commission has come in force in April 1999. A result of this will be the growth of energy exchanges over the international high-voltage network (380 kV). At present this network is already intensely operated and the members of UCPTE (Union pour la Coordination de la Production et le Transport de l'Energie Electrique - Union for Coordination of Generation and Transmission of Electrical Energy in Western Europe) are fully responsible for energy exchange and power system security. In this changing electricity market, measures must be taken to avoid propagation of incidents throughout the European network. This requires also the putting into place of a network to automatically exchange the relevant data.

At present the international high-voltage grid of UCPTE is interconnected by AC-links with CENTREL and also with NORDEL and Great-Britain by some DC-links. More than 10% of the total generated energy of UCPTE is already exchanged and the members of UCPTE are fully responsible for the management of energy exchange and power system security. Today plenty of information is already exchanged more or less on a bilateral basis in order to make possible the international energy exchange - but there is until now no common UCPTE-information exchange system. At present, practically all information exchanged between UCPTE partners is by facsimile or by telephone.

The member countries of UCPTE are: Austria, Belgium, Croatia, France, Germany, Greece, Italy, The Netherlands, Portugal, Spain, Switzerland, and The Federal Republic of Yugoslavia. At

present, few UCPTE partners exchange real-time telcontrol information using this recommendation, other partners use different communication technologies in complex and inadequate ways.

By the liberalization of the electricity market in Europe an important increase of the energy exchanges and energy exchange players is expected. Following the extension of UCPTE's synchronism area, combined with the significant evolution experienced in new powerful protocols since 1982, it has appeared necessary to review the 1982 recommendation. The objective is to define an information exchange system between the European Transmission System Operators (TSO) which enables an automatic exchange of relevant net-work security data in real time or close to real time.

Three protocols were considered particularly suitable for this type of data exchange: ELCOM-90, TASE.1 and TASE.2. For reasons of openness and interoperability the TASE.2 protocol was finally recommended for data exchanges within the UCPTE (this is also the protocol adopted by IEC as the International Standard IEC 60870-6 TASE.2). The low-level protocol will be TCP/IP, installed in a meshed network dedicated to this project. The UCPTE partners wishing to automatically exchange data with other partners have been recommended to use this standard.

The aim of an UCPTE working group is to draw up a comprehensive technical specification describing :

- the implementation of a TASE.2 interface
- a list of available object-models
- the nomenclature rules for these objects.

The specification has been accepted by all the UCPTE partners at the beginning of 1999 so as to ensure full international compatibility.

The UCPTE ad-hoc group was created in September 1997 to define the infrastructure of such a real time information exchange system. This new process data network is named URTICA: UCPTE Real-Time Information Communication Architecture. This “ad-hoc working group” was assisted by an “operating subgroup” for the functional analysis and an “experts subgroup” for technical aspects.

The URTICA-System is not a public information system for all energy exchange players on the market because the technical requirements to exchange financial and economic data are completely different. Nevertheless a special link from URTICA to such a commercial system is planned because a small part of the information can also be important in the commercial system. In order to manage the exchange of purely economic financial and commercial data (prices, exchange contracts, orders etc.) a separate, more open information exchange network system will be created.

The objective of URTICA is the definition of the specifications for a common architecture for inter control center real-time communication between UCPTE partners based on open standards. It bas been strongly recommended that CENTREL follows the proposed URTICA specification to allow a seamless communication throughout the western Europe synchronized transmission network. This common architecture enables each of the partners to achieve the necessary data exchanges with any other partner without having to invest in costly individual hardware and software solutions. These specifications cover all current needs to exchange power system security related data:

- real-time network security-related data:
- voltage, active and reactive powers;
- breakers and disconnectors status.

non real-time data (optional):

- schedules of energy exchanges;
- energy accounts: metering data, exchanges accounts, imbalances, ...
- messages between operators (i.e. outage information) , electronic mail;
- network models.

This specification does not impose which data must be exchanged between UCPTE partners to ensure network security. The basic principle of data exchange between two partners is based on a bilateral agreement: only the two partners are concerned by the data they want to exchange.

The recommendation does not prevent using any particular solutions already in place as a result of existing bilateral agreements. However, each partner is expected to implement the recommendation without unnecessary delay as soon as one of his partners notifies him his wish to exchange with him data via the recommended technology. Any other new individual approach would not be welcomed.

5 Early TASE.2 adoption in the USA

While numerous TASE.2 implementation projects are underway in the United States and abroad, a few serve to illustrate the benefits TASE.2 users can realize.

An early TASE.2 adopter in the United States, the New York Power Pool (NYPP), completed implementation of a TASE.2-compliant communications system. A consortium of the seven investor-owned utilities of New York state and the New York Power Authority, the NYPP was operating a proprietary communications protocol that had limited capabilities. NYPP recognized that a standardized communications protocol that expanded the pool's capabilities and enabled real-time exchange of data would best serve its members in the changing business environment.

Because of the protocol's standardized nature, the NYPP can now utilize the most advanced telecommunications technologies, such as frame relays and ISDN lines, to expedite data transmission. The lower initial cost of the TASE.2-compliant system, com-pared to a proprietary system, provided immediate saving - estimated at $300,000. In addition, the pool's recurring communication costs, such as telephone charges, will be cut in half, saving NYPP an estimated additional $780,000 over five years. Moreover, the system will also provide a communications gateway into the United States for Hydro Quebec, one of the Northeast United States' major power providers.

These savings are typical of the early adopters of TASE.2 in the United States during 1995 and 1996. In 1997, competition and standardization reduced TASE.2 system costs even more – by as much as a factor of four! This price reduction occurred as vendors sold TASE.2-compliant systems as a fully developed standardized product. "Further reductions of more than an additional 40% are feasible in 1998 and beyond," says EPRI's David Becker, "as computer hardware costs decrease and communications system software is increasingly run on relatively low-cost operating systems such as Windows NT."

As a result of these advancements, the cost of transmitting information between power industry sites has decreased substantially. "TASE.2 has been the catalyst for this cost reduction, illustrating the value of standardization," says Becker. "The user, vendor, and technical community are all benefiting."

The collaborative efforts that have produced the TASE.2 standard are reaping rich re-wards for energy companies worldwide. The protocol has gained widespread acceptance over the past year, with numerous vendors offering TASE.2 products. There are an estimated 150-200 completed or current implementations of TASE.2-compliant systems in the United States.

Without TASE.2 utilities would need to establish a variety of independent grow-as-you-go, point-to-point links. Since all major EMS vendors have adopted TASE.2, utilities can use the same protocol to communicate between all of their control areas and members, regardless of the EMS equipment they use.

6 What Is Next?

In a recent talk, EPRI's David Becker sees a continued rollout of more site implementations of TASE.2 from multiple vendors due to real-time data needs and the low costs of implementation in the USA. Europe is following close behind and Asia and Central America are beginning implementations.

In the United States, EPRI has been a catalyst for the development and adoption of TASE.2. A global organization, EPRI is available to work with adopters of TASE.2 compliant communications systems throughout the world to meet their unique needs. EPRI also maintains support of a USA TASE.2 technical working group to review any new issues, monitor interoperability, and review proposed enhancements.

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