NettedAutomation GmbH

Information & Communication Systems

IEC 61850 and IEC 61400-25

International Standards for Energy Systems:

**Generation, Transmission, Distribution, ... Smart Grids –
Design, Specification, Engineering, Configuration,
Automation, SCADA, Measuring, Condition Monitoring;
Information Modeling, Exchange and Management**

**Stack and API Integration
Embedded Controller
Software Support
Consultancy
Training**

2,750+ Experts from 700+ Companies from 70+ Countries trained (2011-12)

**NettedAutomation GmbH
Im Eichbaeumle 108
D-76139 Karlsruhe / Germany
Tel +49-721-684844
Fax +49-721-679387
schwarz@scc-online.de
http://nettedautomation.com**

http://blog.iec61850.com

Dipl.-Ing. Karlheinz Schwarz, Karlsruhe/Germany
Editor of IEC 61850 and IEC 61400-25 (Wind Power Plants)
Member of IEC TC 57 WG 10, WG 17 (DER), WG 18 (Hydro Power Plants)
Member of IEC TC 88 PT 25 (IEC 61400-25, Wind Power Plants)
Convenor of IEC TC 88 IEC 61400-25-6 (Condition Monitoring)

You'll get comprehensive, first-hand, and neutral knowledge and experience

IEC 61850 & IEC 61400-25 SCC

Motivation: sustainable interoperability

The standards IEC 61850 „Communication networks and systems for power utility automation“ and IEC 61400-25 „Communications for monitoring and control of wind power plants“ provide support for **sustainable interoperability: Information Models, Information Exchange Methods, Protocol Mappings, and System Configuration Language (SCL)** for Power Systems (Generation, Transmission, and Distribution for HV, MV, and LV, ...).

Data Models

IEC 61850-7-4xx

Substations (7-4)
160 LN
900 DO

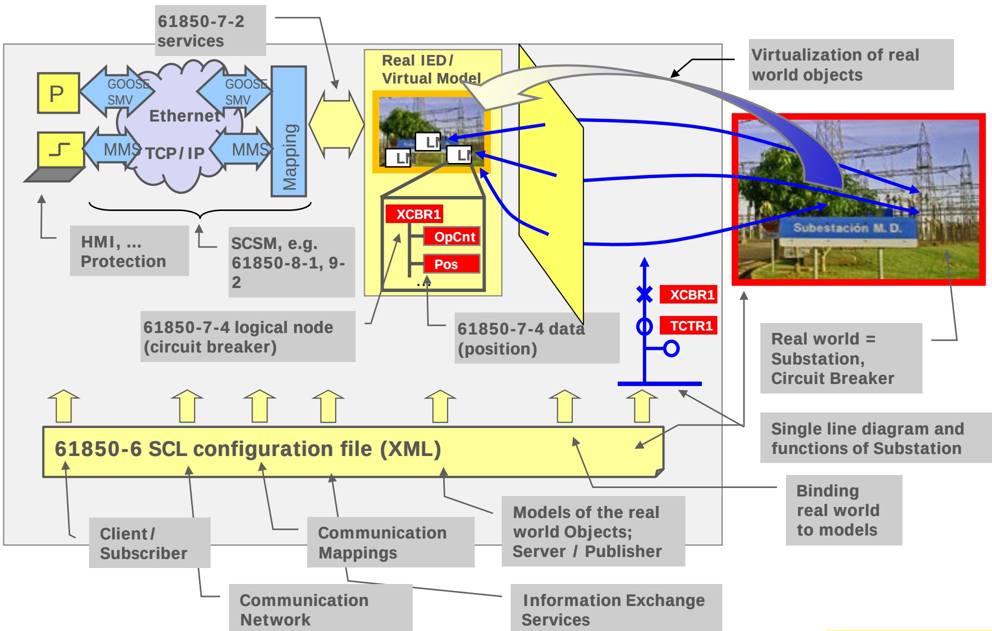
Hydro Power (410)
63 LN
350 DO

Decentralized Energy Res. (420)
50 LN
450 DO

IEC 61400-25-2

Wind Power
16 LN
250 DO

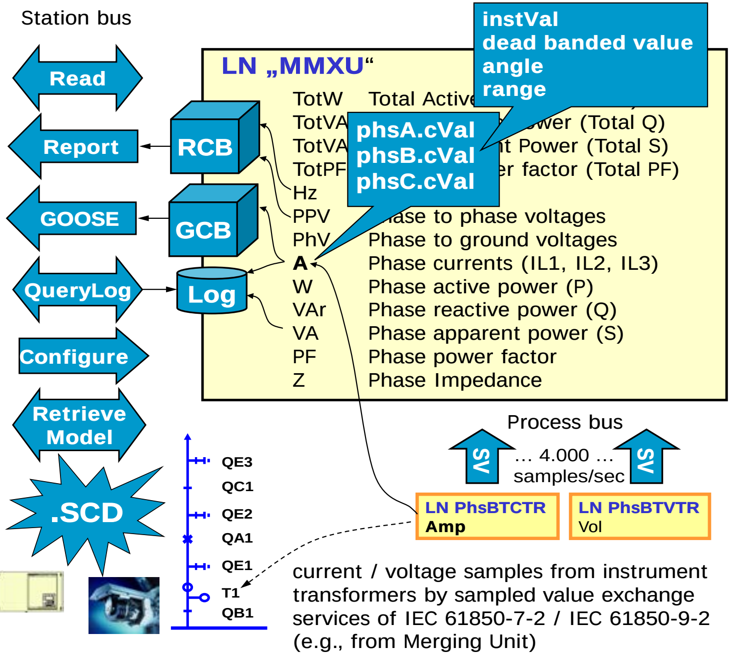
Logical Nodes (LN) represent real-world **Inputs, Outputs, Ratings, and Settings of functions** or **equipment**. A LN provides a list of named data objects (DO). The LN “XCBR” represents a real “circuit breaker” with the data object (DO) “Pos” (Position)**.** IEC 61850-7-2 defines **Information Exchange Methods**, e.g., for the position (with Client/Server services, GOOSE, SMV). **Data flow** is specified by a **SCL** file (IEC 61850-6).



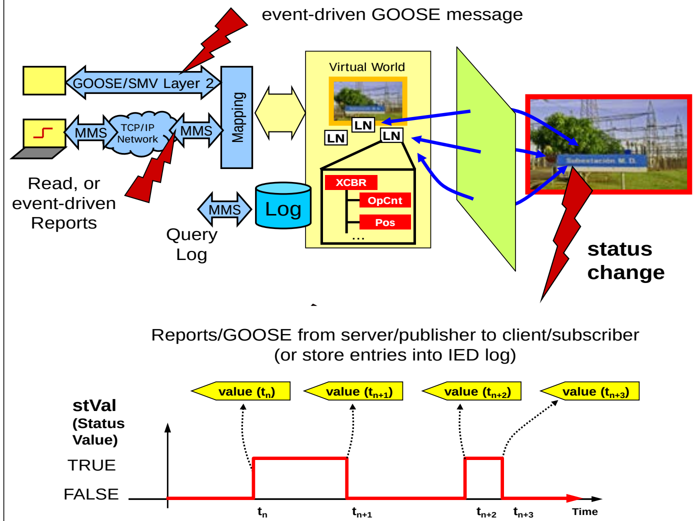
Example see reverse side

Example: Measurement LN “MMXU” represents power, voltages, currents, impedances, … in a three-phase electrical system. The values can be communicated by various services. The LN “MMXU” comprises values for measurements, monitoring, configuration, settings, description, and substitution. These values can be communicated by various services like read (polling), reporting, GOOSE, logging and log query. Recording and logging are build upon monitored value changes. The SCL configuration file .SCD (System Configuration Description) specifies the single line diagram of the substation, the information model, the parameters of the control blocks for reporting and logging, GOOSE, SV, the binding to the process and the data flow.

LN and data objects



Information flow (example)



http://nettedautomation.com/seminars , http://nettedautomation.com/iec61850li , http://blog.iec61850.com

Program: http://nettedautomation.com/seminars/uca/sem.html#fra12-05

Registration Form

(fill in form interactively or print it out first)

I would like to register for the following event on **IEC 61850 and related standards** (as listed above):

3 day General Seminar / Hands-on Training with Real IEDs (embedded controller with Linux, RTOS, ...), Starter Kit (Windows DLL), and several Demo Software (Client / Server and GOOSE messaging)

☐ **09-11 May 2012** **Frankfurt (Germany)**

☐ **17-19 October 2012** **Frankfurt (Germany)**

Fee for Seminar/Training: € 1.950.-

Special offer for Hanover Fair 2012:
1. Receive an IEC 61850 Development Kit (Beck IPC DK61) included in the regular fee, or
2. Get a discounted fee of € 1.150 (without DK61)

(A discount of 20 per cent will be granted if more than one person per organization attends; for any other discount please contact us seminars@nettedautomation.com)

All prices are in EURO (**excluding** costs for transportation and accommodation for attendees and **excluding** Value Added Tax (if applicable)). Course fee includes lunch and breaks. Participants will be notified of the exact training location in due time.

Registration Information:

First & Family Name - (Dr) (Mr) (Mrs) (Ms) ______________________________

Company ______________________________

Department ______________________________

Address ______________________________

City, Zip Code, Country ______________________________

Email Address ______________________________

Telephone ____________________ Fax ____________________

1. Charge my Credit Card:

☐ VISA

☐ MasterCard

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Expiration date: ________________

Name of card holder: ______________________________

OR

2. Regular bank account transfer

☐ We would like to pay by regular bank account transfer

Privacy Policy:
NettedAutomation takes precautions (including administrative, technical, and physical measures) to safeguard your personal information against loss, theft, and misuse, as well as unauthorized access, disclosure, alteration, and destruction.

Cancellation Policy:
Cancellations received **up to 10** business days prior to the start of the event will be fully refunded. Cancellations **within 9** business days to the start of the workshop are subject to the entire event fee. If you don't cancel and don't attend, you are still responsible for payment.
Substitutions can be made at any time.

Signature:

Date:

Please fax / email the signed form OR your company's purchase order to:

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NettedAutomation GmbH
Im Eichbaeumle 108
76139 Karlsruhe/Germany
Email: seminars@nettedautomation.com

2011-10-11

NettedAutomation GmbH

Information & Communication Systems

25+ Years of Excellence

International Standards for Power Systems

Generation, Transmission, Distribution, ..., Smart Grids; Design, Specification, Bidding, Engineering, Configuration, Automation, SCADA, Condition Monitoring, Information Management ...

We bring standards, smart people, intelligent devices, tools, and systems together to build Smarter Grids!

IEC 1906 AWARD

Supplier information, capabilities, and experience profile

Supplier information

Company	**NettedAutomation GmbH**
Address	Im Eichbaeumle 108 76139 Karlsruhe / Germany
Telephone	+49-721-684844
Fax	+49-721-679387
Email	info@nettedautomation.com
URL	http://www.nettedautomation.com
Foundation	2000

Our knowledge and experience are asked all over – more and more!

2,750+ Experts from 700+ Companies from 70+ Countries trained

Ownership Privately held by **Dipl.-Ing. Karlheinz Schwarz**

Registered Amtsgericht Karlsruhe HRB 8866

General Manager Ingeruth Schwarz

Major Customers

Users: AXPO, Bayernwerk, Badenwerk, Con Edison NYC, ENERGI E2, E.ON, Endessa, EdF, EdP, Energex, ETRANS, EVS, EWE, GdF, HEW, Manitoba Hydro, Hydro Quebec, Itaipu Binacional Hydro Power Plant Brazil, KEPCO, Mercedes Benz, PowerLink Australia, RWE, Stattkraft, TNB Malaysia, Terna, Transba, Transpower NZ, Vector, VEW, Vattenfall, ...

More than 30 training sessions in 2011

Vendors: AEG, Beck, Beckhoff, ABB, Alstom, AREVA, Bosch, BTC, Doble, E+H, IDS, Eberle, GE, Hirschmann, Kloeckner & Möller, LG, OMICRON, Pepperl & Fuchs, Phoenix Contact, PSI, Repas AEG, Schweitzer Engineering Labs, Siemens, TNB, VATECH SAT, SMA, VESTAS Wind, Voith Hydro, ...

Consultants: KEPRI, SKM, Teshmont, ...

Vendor independent, up-to-date, neutral, and experienced!

The primary service of NettedAutomation is to provide **consulting** services to all enterprises for feasibility studies, information modeling, system specification, implementation and use of devices and systems; **education and hands-on training** for users, system integrators and vendors in all aspects of Standards used for Power Systems; **support** for marketing, information dissemination, procurement for distributed systems, specifying procurement requirements; and **evaluation** of bidder proposals for devices, systems, tools, and open communications. The application domains cover generation, transmission, and distribution, Smart Grids, RTUs, SCADA and EMS systems, protection, automation and condition monitoring systems.

NettedAutomation has long-time experience in IEC 61850, IEC 61400-25, IEC 60870-5-10x, IEC 60870-6 TASE.2, IEC 62351, DNP3, IEC 61970 CIM, IEC 61968, IEC 61158, IEC 61499, IEEE 802.3, and ISO 9506 MMS to name just a few.

To keep abreast of the latest technical development, NettedAutomation is actively involved in workshops, seminars, hands-on training, task forces, and committees of various professional organizations such as ISO, IEC, IEEE, CEN, CENELEC, DKE, VDI, ZVEI, NIST SGIP, UCA IUG, and USE-IEC61400-25.

Curriculum vitae of Karlheinz Schwarz

Dipl.-Ing. **Karlheinz Schwarz** (58) received his diploma degree in Information and Automation Technology at the University of Siegen (Germany) in 1982. He is married and has four children and seven grandchildren.

As a manager with Siemens Automation & Drives (communication systems) he represented the positions of Siemens and the German national committee in the international standardization of MAP, MMS, MMS companion standards, Fieldbus, and other standardization projects from 1984 until 1997.

He is president of SCC (Schwarz Consulting Company), Karlsruhe (Germany) specializing in distributed automation systems. He is an independent consultant in the area of information modeling, systems and information integration, system and device engineering and configuration, open information exchange, and open communications since 1992. Mr. Schwarz has immense experience in the migration from proprietary or other solutions to standard compliant solutions.

He is involved in many standardization activities within IEC (TC 57, TC 65, and TC 88), ISO (TC 184), CENELEC (TC 65 CX), IEEE (SCC 36 "UCA", 802), and DIN since 1985. He is engaged in representing main industry branches in the global standardization and providing consulting services to users and vendors. Mr. Schwarz is a well-known authority in the application of mainstream information and communication technologies. He provides guidance in the migration from proprietary solutions to advanced seamless and standard-based solutions applicable in substations, and power generation units, and between these and with local, regional, and central SCADA systems. Specifically, his contributions to the publication of many standards are considered to be outstanding.

He has been awarded with the IEC 1906 Award in 2007 ***"For his strong involvement in the edition of the IEC 61850 series, its promotion inside and outside IEC, and specifically its adaptation for wind turbine plant control."***

http://www.nettedautomation.com/download/IEC1906-Award.pdf

NettedAutomation's Capabilities and Experience Profile

Learn firsthand what you need to know about these standards and products!

We assist companies in examining open communications and distributed systems technologies in sub-station automation, Smart Grids, and many other application areas outside the utility industry (for which IEC 61850 was originally designed). We support the design and implementation of IEDs com-pliant with IEC 61850 and other standards. Support for procurement requirements and evaluation of bidder proposals for IEC 61850 related devices, systems and tools can be provided. We have long term experience in implementing and organizing IEC 61850 and IEC 61850 based pilot projects.

Mr. Schwarz is the principal teacher and trainer of the seminars and training services offered and or-ganized by NettedAutomation GmbH. We have given lec-tures all over

http://www.nettedautomation.com/seminars

We offers consulting services outlined above for a wide range of information and device modeling as well as standards-based configuration, communication systems and technical applications oriented to the automation of discrete and continuous automation related to:

- International Fieldbus standard, IEC 61158 (IEC TC 65)
- European Fieldbus, EN 50170 (CENELEC TC 65 CX)
- National Fieldbus standards like PROFIBUS, FIP, P-Net
- Actuator Sensor Interface (ASI) or IEEE 802 LAN/WAN
- Utility Comm. Architecture (UCA™), IEEE SCC 36
- Communication networks and systems for power utiliy automation, IEC 61850 (IEC TC 57)
- Telecontrol equipment and system, IEC 60870-5-10x
- Communications for monitoring & control of wind power plants, IEC 61400-25 (IEC TC 88) and IEC 61400-25-6 on Information models for condition monitoring systems (IEC TC 88)
- Communications Systems for Distributed Energy Resources (DER), IEC 62350 (IEC TC 57)
- Hydroelectric power plants – Communication for monitoring and control, IEC 62344 (IEC TC 57)
- Intercontrol Center Communications Protocol (ICCP), IEC 60870-6 TASE.2 (IEC TC 57)
- Common information models (CIM), IEC 61970 (IEC TC 57)
- Accreditation, Testing and Certification of IT products (DIN Test Lab Auditor), Quality Management
- Standard for the Exchange of Product Model Data (STEP)
- Application and Function block modeling IEC 61499 (IEC TC 65)
- Process Control Functionblocks and Device Description Language, IEC 61804 (IEC TC 65)
- Open Systems Application Frameworks, ISO 15745 (ISO TC 184 SC5)
- Manufacturing Automation Protocol (MAP), MiniMAP/FAIS
- Manufacturing Message Specification, MMS, ISO 9506 (ISO TC 184)

Visit my Blog to get the latest: http://blog.iec61850.com

Appendix: Personal education and qualifications of Karlheinz Schwarz

1. Education

1958 – 1962 Elementary School

1962 – 1965 Secondary School

1965 – 1967 Secondary School (Gymnasium)

1967 – 1969 Technical School

1969 – 1972 Apprenticeship as electrical mechanic and electronics (Siemens)

1973 – 1974 Service technician responsible for alarm systems (Siemens: fire alarm systems, burglar alarm systems, ...)

1975 – 1977 Academic high school (Hessenkolleg)

1977 – 1982 Study of electrical engineering and IT at University Siegen (degree: Dipl.-Ing.)

1981 – 1997 Employee at Siemens Automation (responsible for standardization of comms)

1992 – present Consultant and trainer for communication and automation (see above and below)

2. Training experience since 2002

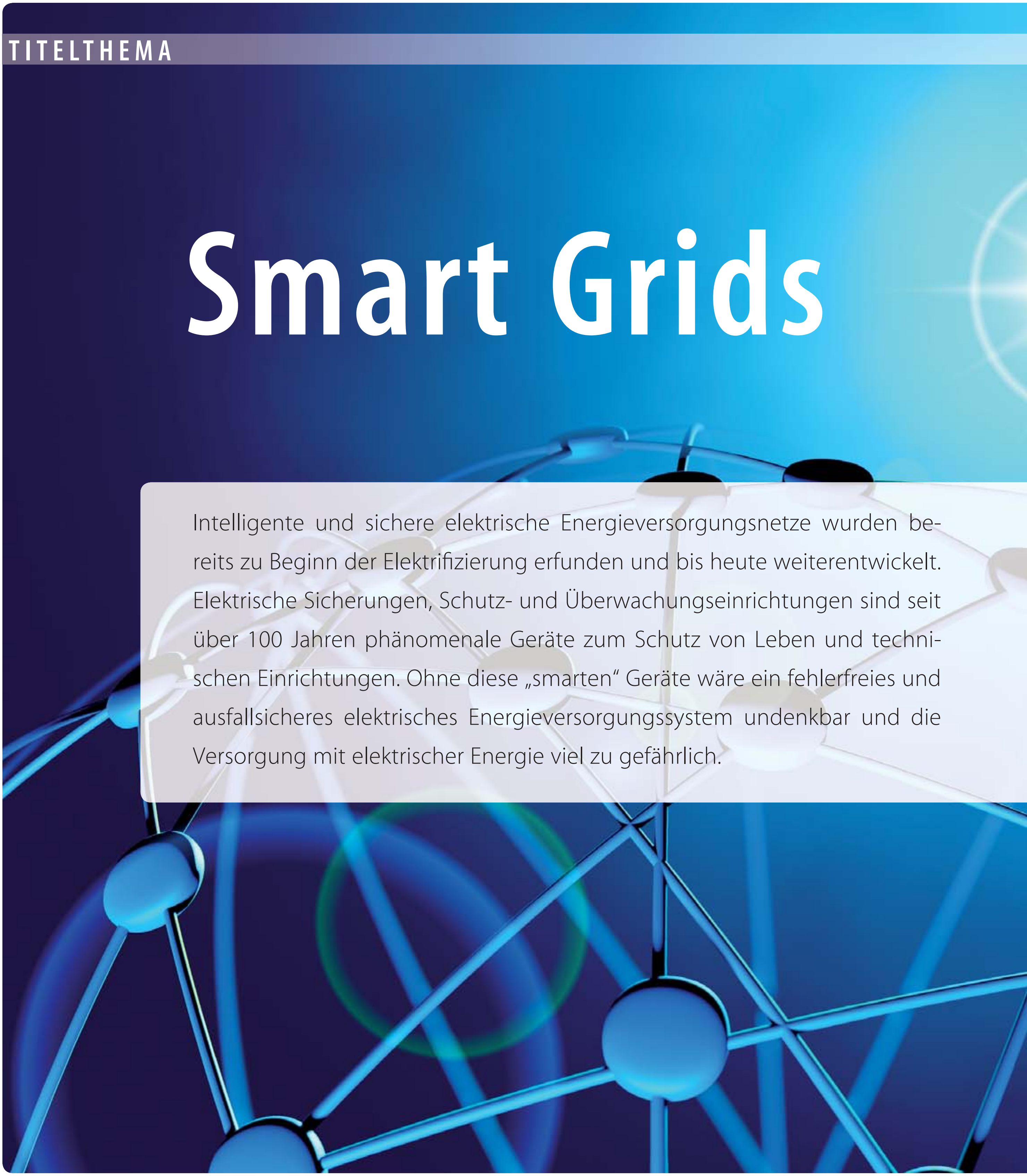
Mr. Schwarz has trained almost 3,000 experts all over. Most seminars have been conducted as in-house courses. Attendees from more than 700 companies have attended. Attendees from small, medium and big utilities and big vendors have attended. An excerpt is shown in the following table:

Year	**Training in Countries**	**Courses**	**Attendees**
2002	China	2	40
2003	Denmark, Spain	2	22
2004	Spain, Germany, France, USA, China, South Africa, Malaysia	8	200
2005	South Korea, Mexico, Denmark, Canada, Switzerland, Germany, South Africa, Australia, Israel	12	295
2006	Germany, Italy, Spain, India, Canada, UK, Portugal, France, Austria, USA	18	545
2007	Germany, Portugal, USA, France, Canada, South Korea, Australia, New Zealand	11	112
2008	Germany, Slovenia, Canada, USA, France, Malaysia, South Korea, Australia, New Zealand, Sweden	20	380
2009	Mexico, Russia, Italy, Germany, Malaysia, USA, Australia	15	220
2010	Iceland, Spain, Ireland, Argentina, Brazil, Germany, Japan, Denmark, USA, Philippines, Sweden, Australia, France	20	280
2011	France, UK, Germany, Australia, South Korea, Switzerland, Zimbabwe, Canada, Belgium, USA, China, Austria, Brazil	33	540

3. Standardization experience

Mr. Schwarz is (was) a principal contributor in the following standardization projects (either project member or as the technical lead), representing many German industries (users and vendors):

ISO	ISO TC 184/SC5	Architecture, Communications, Integration Frameworks	Member	1985-2012
	ISO TC 184/SC5/WG 5	Open Systems Application Frameworks	Member	1985-2005
	ISO TC 184/SC5/WG 2	Communications and interconnection (MMS, ...)	Member/Chairman	1985-2005/1998-2005
IEC	IEC TC 57	Power Systems Control and Associated Communications	Member	1992-2012
	IEC TC 57 SPAG	Strategic Policy Advisory Group	Invited Guest	
	IEC TC 57 WG 07	Protocols compatible with ISO/OSI and ITU	Member	1992-2000
	IEC TC 57 WG 10	Power system IED communication and associated data models / Communication and systems within Substations (IEC 61850)	Member/editor of 61850	1995-2012
	IEC TC 57 WG 17	Communications Systems for Distributed Energy Resources (DER) – based on IEC 61850	Member	2004-2012
	IEC TC 57 WG 18	Hydroelectric power plants – Communication for monitoring and control – based on IEC 61850	Member	2004-2012
	IEC TC 57 WG 19	Interoperability within TC 57 in the long term	Member	2005-2012
	IEC TC 65 WG 6	Functionblocks (IEC 61499)	Member	1990-2002
	IEC TC 65 PJWG	Device Profiles	Member	1998-2002
	IEC TC 65C WG 1	Message data format for information transferred on process and control data highways, Profiles	Member	1983-2006
	IEC TC 65C WG 6	Fieldbus (IEC 61158)	Member	1997-2000
	IEC TC 65C WG 7	Functionblocks and Data Descriptive Language (IEC 61804)	Member	1996-1999
	IEC TC 88 PT 25	Communications for monitoring and control of wind power plants (IEC 61400-25-1/-2/-3/-4/-5) – based on IEC 61850	Member/editor of 61400-25	2001-2012
	IEC TC 88 PT 25 / IEC 61400-6	Communications for monitoring and control of wind power plants (IEC 61400-25-6) – Logical node classes and data classes for condition monitoring	Convenor	2006-2011
IEEE	IEEE 802.3 /.15	LAN, WAN	Member	1998-2001
	IEEE SCC 36	Utility Communication Architecture	Member	1996-2000
CENELEC	CENELEC TC 65 CX	Fieldbus Communication	Member	1992-2000
CEN	CEN TC 310/TG ICOM	Task Group on industrial communications	Member	1994-1996
MMS Forum	EPRI, Electric Power Research Institute	Communications and application modelling in the area of power utilities (UCA, ICCP)	Member	1992-1998
NAM	DKE/NAM/NI 96.5	Architektur und Kommunikation	Member	1985-1998
	DKE/NAM/NI GA 96.5.2	Kommunikation und Datenaustausch (MMS, ...)	Chairman	1985-2002
DKE	DKE FB 9 AK AP	FB 9 Arbeitskreis Arbeitsplanung	Member	1989-2003
	KG-ILT	Koordinierungsgruppe Industrielle Leittechnik	Member	1989-2003
	K 261	Mirror of IEC TC 8: System aspects of electrical energy supply	Member	2003-2008
	DKE K 950	Kommunikation und Informationslogistik	Member	1998-2001
	DKE AK 956.0.2	Kommunikationsdienste, Process Control	Member	1992-1997
	DKE K 956	Feldbus	Member	1986-2012
	DKE AK 956.3.1	Functionblocks and Data Descriptive Language	Chairman	1995-206
	DKE K 952	Netzleittechnik	Vice Chairman/member	1992-2012
	DKE AK 952.0.7	Protocols compatible with ISO/OSI and ITU	Member	1992-2005
	DKE AK 952.0.10	Stationsleittechnik	Member	1995-2012
	DKE AK 952.0.17	Kommunikation für verteilte Energieversorgung (TC 57 WG 17)	Member	2005-2012
	DKE K 383.0.1	Kommunikation für Windenergieanlagen	Chairman	2001-2012
GMA	GMA AK 4.2	Kommunikation in verteilten Systemen	Member	1996-1998
VDMA	Fachverband InCom	Industrial Communications	Member	1990-1996
ZVEI	ZVEI GA IK	Gemeinschaftsausschuss Industrielle Kommunikation	Member	1986-2012



Smart Grids

Intelligente und sichere elektrische Energieversorgungsnetze wurden bereits zu Beginn der Elektrifizierung erfunden und bis heute weiterentwickelt. Elektrische Sicherungen, Schutz- und Überwachungseinrichtungen sind seit über 100 Jahren phänomenale Geräte zum Schutz von Leben und technischen Einrichtungen. Ohne diese „smarten" Geräte wäre ein fehlerfreies und ausfallsicheres elektrisches Energieversorgungssystem undenkbar und die Versorgung mit elektrischer Energie viel zu gefährlich.

SICHERE – ENERGIE – VERSORGUNG

– Eine Erfindung des 19. Jahrhunderts

Ingenieure haben seit dem 19. Jahrhundert für die schnell wachsende Versorgung von immer mehr Anwendungen mit elektrischer Energie, geeignete Lösungen für den sicheren und zuverlässigen Betrieb entwickelt, erprobt, großtechnisch eingesetzt und permanent verbessert. Im Rahmen der nachhaltigen Weiterentwicklung der Versorgungssysteme muss mit den verfügbaren Ressourcen (Energiequellen, technischen Einrichtungen und Menschen mit Erfahrung) sowie die physikalischen Gesetzmäßigkeiten verantwortungsvoll und „smart“ umgegangen werden.

Smart Grids helfen, die Physik zum Wohl der Menschen sicher und zuverlässig nutzbar zu machen – gestern, heute und morgen.

Ein System – viele Ziele

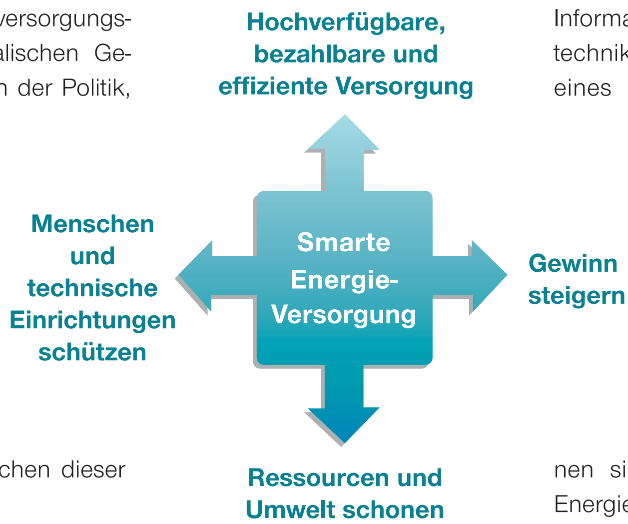
Das System der elektrischen Energieversorgung befindet sich seit mehr als 130 Jahren im Aufbau. Neben der hochverfügbaren Bereitstellung elektrischer Energie hat der Schutz von Leben und technischen Einrichtungen den Ausbau des Versorgungssystems maßgeblich geprägt. Spezielle Konzepte, Verfahren und Geräte waren von Anfang an „smart“ – eine intelligente, selektive Abschaltung eines defekten Stromkreises oder eine intelligent geplante redundante Netz-Topologie führen im Störungsfall zu einer minimalen Versorgungsunterbrechung.

ENERGIEKOMMUNIKATION AUF DEM FORUM „LIFE NEEDS POWER” DER HANNOVER MESSE

Stromnetzbetreiber:
„Wir können die Gesetze von Ohm und Kirchhoff nicht ändern.”

Jurist:
„Einspruch! Jedes Gesetz kann man ändern.
Mit 2/3 Mehrheit sogar das Grundgesetz.”

Ein solch smartes Energieversorgungssystem, das streng physikalischen Gesetzmäßigkeiten folgt, wird in der Politik, Wirtschaft, Wissenschaft und der Öffentlichkeit zunehmend im Zusammenhang mit dem Schonen von in der Erde vorkommenden Ressourcen und der Umwelt sowie dem Streben nach Gewinnsteigerung betrachtet. Smart Grids werden als probate Mittel zum Erreichen dieser Ziele betrachtet.



Die Energiewende und das zunehmende Interesse an erneuerbaren Energiequellen und Speichermöglichkeiten (wie beispielsweise Pumpspeicher, Gas- oder Wärmespeicher) werden immer öfter im Zusammenhang mit neuen technologischen Möglichkeiten des schnellen und sicheren Austauschs von Informationen gesehen – einem Kernthema von Smart Grids.

Der Begriff „Smart Grid“ als intelligentes Energieversorgungssystem umfasst nach den DKE- und IEC-Smart-Grid-Roadmaps „die Vernetzung, Überwachung, Steuerung und Regelung von intelligenten Erzeugern, Speichern, Verbrauchern und Netzbetriebsmitteln in Energieübertragungs- und Verteilungsnetzen mit Hilfe von Informations- und Kommunikationstechnik (IKT). Ziel ist es, auf Basis eines transparenten energie- und kosteneffizienten sowie sicheren und zuverlässigen Systembetriebs, die nachhaltige und umweltverträgliche Sicherstellung der Energieversorgung zu erhalten.“

Neuerdings wird in **Smart Markets** (in denen sich die Marktteilnehmer, die Energie anbieten oder nachfragen, organisieren) und **Smart Grids** (die weiter zu entwickelnden technischen Einrichtungen und Verfahren, die für die hochverfügbare, effiziente und sichere Versorgung auf der Basis der physikalischen Gesetzmäßigkeiten benötigt werden) unterschieden. Obwohl beide eng miteinander verbunden sind, sorgen sie für etwas Orientierung im Dschungel der Diskussionen.

Smart Markets mit der hohen Volatilität der erneuerbaren Energiequellen stellen umfangreiche Anforderungen an Smart Grids; sie zu erfüllen, erfordert vor allem, dass die Lösungen mit den physikalischen Gesetzen des elektrischen Netzes in Einklang stehen. Die Beherrschung der Volatilität des Wasser- und Sonnenangebots in der Versorgung

mit Nahrungsmitteln durch Speicherung, Transport und Verteilung kann als Lehrbeispiel für die smarte Energieversorgung der Zukunft dienen. Die volatilen Angebote an Sonnen- und Windenergie könnten durch zunehmende Speicherung zur sicheren, hochverfügbaren und effizienten Versorgung beitragen.

Wie sicher ist unsere Energieversorgung?

Die derzeitigen Energie-Rohstoffe (Gas, Öl, Kohle, Uran, ...) und auch die volatilen Energiequellen wie Sonne, Wasser und Wind sind nur bedingt sicher. Diese Unsicherheit beschäftigt vor allem den zukünftigen Smart Market – bei der Betrachtung von Smart Grids ist sie von untergeordneter Bedeutung.

Smarte Maßnahmen, um die elektrische Energieversorgung sicher (im Sinne von hochverfügbar) zu gestalten, wurden seit den 1880er Jahren entwickelt und permanent verbessert. Bei der Netzplanung für die oberen Spannungsebenen werden schon lange die sogenannten (n-1)- und (n-2)-Kriterium angewendet – sie besagen, dass bei einem (oder zwei) störungsbedingten Ausfällen eines beliebigen Betriebsmittels (Generator, Transformator, Leitung, ...) das Netz in seiner Gesamtheit die Versorgung innerhalb der vorgegebenen Grenzen sichern muss. Höhere Kosten für deren Implementierung sind gerechtfertigt, weil beispielsweise durch redundante Leitungswege oder Kraftwerke Versorgungsunterbrechungen großer Gebiete vermieden werden können.

Die europäischen Übertragungsnetze sind in einem europäischen Verbundnetz und einige auch in einem Netzregelverbund miteinander gekoppelt, um beim Ausfall einer Komponente in einem Netz oder bei Ungleichgewicht von Stromerzeugung und -abnahme in einem Teilnetz Hilfe aus einem benachbarten Netz in Anspruch nehmen zu können. Diese Transportnetze können zu Recht als Hochspannungs-Smart-Grids bezeichnet werden.

In Verteilungsnetzen (Mittelspannung, Niederspannung) wird meist das Risiko einer Versorgungsunterbrechung im Minuten- bis Stundenbereich in Kauf genommen. Hier wird oft auf einen Netzausbau nach dem (n-1)-Kriterium verzichtet. Entsprechend sind wenige bis gar keine technischen Einrichtungen vorgesehen, die einen Ausfall einer Komponente oder die gestörte Balance zwischen Erzeugung und Abnahme selbstständig kompensieren könnte.

Im Bereich der Energieversorgungssysteme müssen viele systemrelevante Grenzen und Parameter (Auslösestrom für Leistungsschalter, Frequenz, Spannung, Isolation einer Leitung, ...), Sekundär-Geräte (Messsysteme, Steuerungen, Regelungen, ...) und Primär-Geräte

(Transformatoren, Leistungsschalter, Wechselrichter, ...) sowie in Zukunft viele Komponenten der Integrationsebenen (vor allem der Kommunikations-Infrastruktur wie Ethernet-Switches, Router, Stromversorgungen) ständig und meistens in Echtzeit überwacht werden. Bei sich anbahnenden Störungen muss gegebenenfalls innerhalb von Millisekunden regelnd eingegriffen werden. Wird gewartet bis eine Komponente versagt, dann kann ein ganzes System leicht kollabieren mit unabsehbaren Folgen für Menschen und Umwelt, wenn eine ausfallsichere Versorgung unablässig ist.

Von Anfang der Elektrifizierung an wurde auch ein besonders hoher Wert auf den Schutz des Menschen vor Berührung des elektrischen Netzes gelegt. Weltweit ist es Stand der Technik, den Menschen vor den Gefahren der elektrischen Spannung zu schützen. Eine Reihe von IEC- und anderen Normen definiert geeignete Maßnahmen, die einen hohen Sicherheitsstandard ermöglicht haben.

Elektronische Geräte im Bereich der elektrischen Energieversorgung müssen auch besonders hohe Anforderungen bezüglich der elektromagnetischen Verträglichkeit (EMV) erfüllen, die weit über die Anforderungen aus dem Büro- oder Industrieumfeld hinausgehen. Die „IEC Smart Grid Standardization Roadmap“ von 2010 weist deutlich auf diese Anforderungen hin. In der zweiten Ausgabe der bekannten amerikanischen „NIST Framework and Roadmap for Smart Grid Interoperability Standards“ (2012) werden diese Anforderungen neuerdings neben die Anforderungen der Kommunikations-Sicherheit (Security) gestellt. Die Verfügbarkeit einer Automatisierungs- oder Kommunikationskomponente, muss in einem Energieversorgungssystem viel höher sein, als im Büro- oder Heimbereich.

Darüber hinaus erfordern ausgedehnte Integrationsebenen eine hohe Sicherheit im Sinne von Verfügbarkeit und Verwundbarkeit der Infrastruktur und der Versorgungssysteme, bisher hat das Thema Security praktisch wenig Beachtung bei der Implementierung erfahren. In der zukünftigen Energieversorgung muss das Thema deutlich mehr Eingang in die Implementierungen finden und die Lösungen müssen viel konsequenter angewendet werden.

Smarte Lösungen für eine sichere Energieversorgung werden für die Erzeugung, den Transport, die Verteilung und die Verbraucher benötigt – in öffentlichen Netzen genauso wie in öffentlichen Gebäuden und Betrieben sowie in anderen Infrastrukturen wie Verkehrssysteme oder das Internet.

Was ist in Zukunft neu?

Das zuverlässige und sichere Betreiben des zukünftigen elektrischen Versorgungssystems stellt insbesondere seit der letzten Jahrhundertwende Techniker, Kaufleute und Politiker vor neue Herausforderungen. Notwendige Veränderungen sind zu erwarten wegen:

- → der schnell wachsenden Anzahl von dezentralen Einspeisungen, dem Übergang von einer zentralen zu einer mehr dezentralen Stromerzeugung,
- → des Ausbaus der erneuerbaren Energieerzeugung,
- → des Aufbaus einer Integrationsebene und
- → der alternden Netz-Infrastrukturen.

Diese Veränderungen müssen am „offenen Herz“ (das heißt im laufenden Versorgungs-Betrieb) vor dem Hintergrund folgender Tatsachen vorgenommen werden:

- → einer zunehmend alternden sowie reduzierten technischen Expertise,
- → der Forderung nach mehr Energieeffizienz,
- → der kurzen Zeit zur Umsetzung und
- → der hohen Erwartungen an rentable Investitionen in zunehmend vernetzten Versorgungssystemen für elektrische Energie, Gas, Wärme und Verkehr.

Die seit einiger Zeit zu beobachtenden breiten und heftigen Diskussionen sowie die Veröffentlichung umfangreicher Studien und Stellungnahmen aus der Politik, Forschungseinrichtungen, Verbänden, Vereinen und

„**Energy-on-Demand** wird von vielen als Lösung für den effizienten Umgang mit Energie betrachtet."

aus der Industrie hat es zu keiner Zeit beim Aufbau des elektrischen Versorgungssystems gegeben. Was ist so interessant an der elektrischen Energieversorgung der Zukunft? Für viele traditionell im Bereich der industriellen Automatisierung oder im Bereich der Netzwerktechnologie, dem Internet oder dem Cloud-Computing operierenden Hersteller scheint die zunehmend notwendige Ausrüstung in den Integrations-Infrastrukturen in Verteilungsnetzen ein riesiger neuer Markt zu sein.

Können hier die Internet-Technologien und allgemeine Automatisierungslösungen helfen?

Internet der Energie

Der BDI (Bundesverband der Deutschen Industrie e.V.) führt zum Thema Smart Grid aus: „Der Informations- und Kommunikationstechnologie kommt bei der Entwicklung einer zukunftsfähigen Energieversorgung eine Schlüsselrolle zu. Sie ist die Basis für die Realisierung eines zukünftigen **Internets der Energie**, das heißt der intelligenten elektronischen Vernetzung aller **Komponenten des Energiesystems**. Die größte Herausforderung besteht indes darin, eine **Integrationsebene zwischen betriebswirtschaftlichen Anwendungen und dem physikalischen Netz** zu schaffen, welche eine Kommunikation komplexer, über heterogene Netze und Firmengrenzen hinweg verteilter IT-Komponenten ermöglicht."

Dient eine solche Integrationsebene vornehmlich dem Smart Market oder dem Smart Grid auf Verteilungsebene oder beiden? Die heute installierten Komponenten in den oberen Spannungsebenen sind bereits gut vernetzt (CIM für die netzleitstelleninterne Kommunikation, Fernwirktechnik für Kommunikation mit Netzleitstellen und Erzeugungsanlagen sowie IEC 61850 für Schaltanlagen und Erzeugungsanlagen). Bei der Notwendigkeit der Integration von tausendmal mehr Komponenten in den unteren als in den oberen Spannungsebenen ist noch weitgehend unklar, welche Aufgaben sie haben werden und wie diese helfen können, auch langfristig die Stabilität der Stromversorgung auf dem heutigen Niveau zu halten.

Energy-on-Demand wird von vielen als Lösung für den effizienten Umgang mit Energie betrachtet. Im Rahmen von sozialen Netzwerken könnten Verbraucher plötzlich volatiles Verbrauchsverhalten entwickeln und

„**Entwicklungen** müssen als kontinuierliche „Weiter“-Entwicklungen der vorhandenen Systeme mit all ihren komplizierten Aspekten verstanden werden.“

begrenzt oder großflächig ihren Verbrauch synchron ein- oder abschalten, was zu unerwarteten Rückwirkungen auf die Netze und unter Umständen zu Netzzusammenbrüchen führen könnte.

Eine wesentliche Frage bei der Realisierung zukünftiger Netze ist die Kenntnis von möglichen und wahrscheinlichen Ausfallszenarien. Wie viele Einspeisungen und Lasten an welchen Stellen im Netz können kommunikativ gesteuert werden und welche Regelmechanismen können diese Einflüsse soweit und so schnell kompensieren, dass die Netze auf allen Ebenen in jedem Augenblick stabil betrieben werden können?

Selbst unter der Annahme, dass alle Einflüsse bekannt und entsprechende Mechanismen zum stabilen Netzbetrieb entwickelt und erprobt wurden, so bleiben wesentliche Fragen unbeantwortet: Wer soll diese Automatisierungs-Infrastruktur und die dafür vorgesehenen Internet-basierten Integrationsebenen finanzieren und – vor allem – wer soll sie implementieren, installieren, vernetzen, nutzen und weiter entwickeln? ■

Dipl.-Ing Karlheinz Schwarz
NettedAutomation GmbH

FAZIT:

Der Aufbau von Automatisierungs-Infrastrukturen und Integrationsebenen für die Energieversorgung erfordert Ressourcen, die weit über die derzeitigen Vorstellungen und kurzfristig verfügbaren Ressourcen hinausgehen. Die Förderung smarter Energieversorgungssysteme darf nicht vorrangig ein „Konjunkturförderprogramm“ für die Integrationsebenen sein. Die Aspekte wie die elektrische Sicherheit, die hohe Verfügbarkeit der Energieversorgung, die alternde elektro- und informationstechnische Infrastruktur und vor allem das alternde Personal für die Weiterentwicklung und den Betrieb des elektrischen Netzes müssen eine deutlich höhere Priorität erhalten.

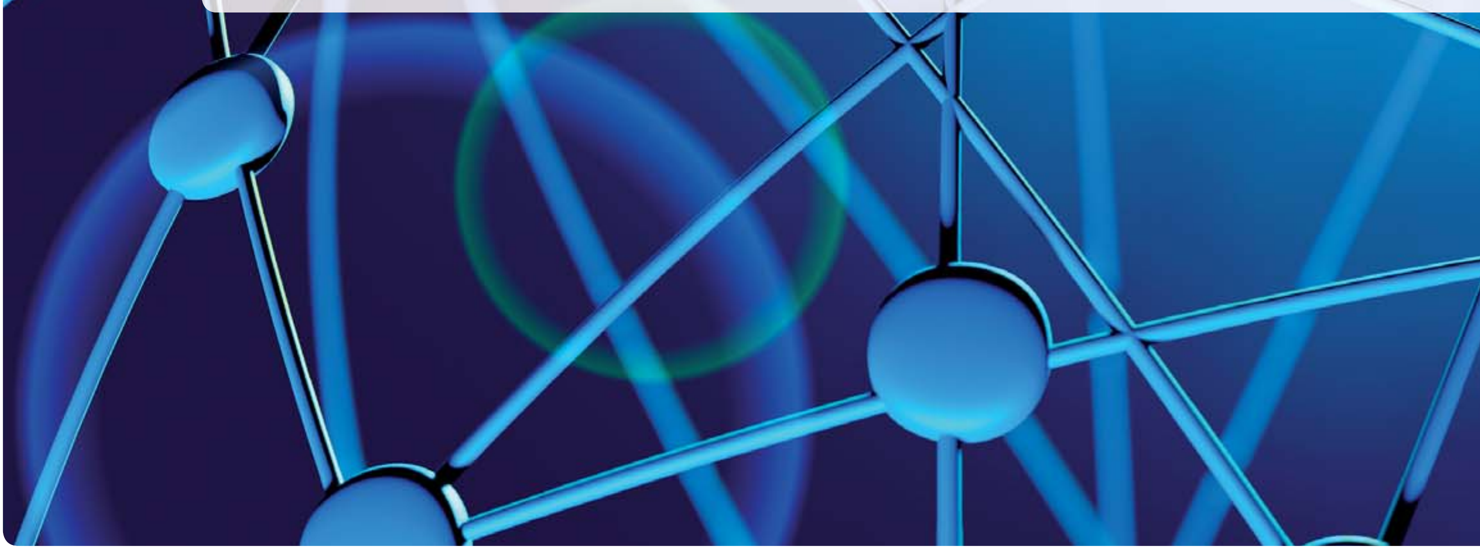
Die zukünftige Energieversorgung muss als Ganzes verstanden werden. Entwicklungen müssen als kontinuierliche „Weiter“-Entwicklungen der vorhandenen Systeme mit all ihren komplizierten Aspekten verstanden werden. Nur so kann auch in Zukunft die bisher gewohnte Versorgungssicherheit gewährleistet werden. Bezogen auf den Umfang als auch die gewünschte kurze Umsetzungszeit werden alle bisherigen Erfahrungen der zurückliegenden 130 Jahre in den Schatten gestellt.

Die derzeit in Planung befindliche Energiewende und damit einhergehend der Aufbau einer schrittweisen Strukturveränderung und einer engeren Verflechtung der Energienetze für Strom, Gas, Wärme und Elektromobilität sowie die dafür notwendigen Infrastrukturen werden mehr einem Marathon als einem Sprint ähneln. Eine domänenübergreifende Zusammenarbeit vor allem mit den Elektro- und Energietechnikern muss deutlich ausgebaut werden. IEC- und andere Normen können – vor allem vor dem Hintergrund der begrenzten Entwicklungs-Ressourcen – einen wichtigen Beitrag zur Vereinheitlichung von Lösungen bei den Integrationsebenen leisten.

Die Smart Grids, die im Rahmen der Energiewende entstehen, werden Erfindungen mehrerer Jahrhunderte vereinen.

Smart Grids

Intelligent, safe electrical power distribution networks were invented at the start of electrification and have been further developed up to the present day. Electrical fuses, protective devices and monitoring devices have been phenomenal in the protection of life and technical installations for more than 100 years. Without these "smart" devices a fault-free, fail-safe electrical energy supply system would be inconceivable and the supply of electrical energy much too dangerous.



RELIABLE – ENERGY – DELIVERY

– A 19th century invention

Since the 19th century engineers have developed, tested, used on a large-scale and continuously improved suitable solutions for the safe and reliable operation of the rapidly growing supply of ever more applications with electrical energy. During the sustained further development of the supply systems, it is necessary to handle the available resources (energy sources, technical installations and individuals with experience) as well as the laws of physics both responsibly and in a "smart" manner.

Smart grids help to make it possible to use physics safely and reliably for the benefit of man – in the past, today and in the future

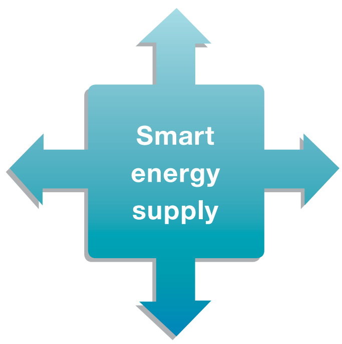
FEATURE

Smart energy supply

The system for the supply of electrical energy has been in construction for more than 130 years. Along with the high-availability provision of electrical energy, the protection of lives and technical installations has had a significant impact on the development of the supply system. Special concepts, processes and devices were "smart" from the start – the intelligent, selective shut down of a faulty electrical circuit or an intelligently planned redundant system topology result in minimal interruption in supply in the event of a malfunction.

> **ENERGY COMMUNICATION AT THE FORUM "LIFE NEEDS POWER" AT THE HANNOVER MESSE**
>
> **Electrical distribution network operator:**
> "We cannot change Ohm's or Kirchhoff's laws."
>
> **Lawyer:**
> "Objection! Every law can be changed.
> Even the constitution with a 2/3 majority."

Such a smart energy supply system that strictly follows the laws of physics is increasing viewed by politics, commerce, science and the public in relation to the conservation of natural resources and the protection of the environment, as well as in relation to the aim of generating profits. Smart grids are viewed as an effective instrument to achieve these goals.



The energy revolution and the increasing interest in renewable energy sources and storage options (for instance pumped storage, gas or heat storage systems) are increasingly frequently viewed in conjunction with new technological capabilities for the quick and safe exchange of information – a core topic of smart grids.

The term "smart grid" as an intelligent energy supply system involves, according to the DKE and IEC smart grid road maps, "the networking, monitoring, control and regulation of intelligent energy producers, storage systems, power consumers and network equipment in energy transmission and distribution networks with the aid of information and communication technology (ICT). The objective is, based on transparent energy-efficient, cost-efficient, safe and reliable system operation, to achieve the sustainable and environmentally acceptable assurance of the supply of energy."

These days a differentiation is made between **smart markets** (in which the market participants who offer or require energy organise themselves) and **smart grids** (the technical installations and processes to be further developed that are needed for high availability, efficient and safe supply based on the laws of physics). Even though both are closely linked, they do provide some orientation in the maze of discussions.

Smart markets with the high volatility of renewable energy sources place comprehensive requirements on smart grids; meeting these requirements requires above all that the solutions are in harmony with the laws of physics for the electrical system. Controlling the volatility of the availability of water and sunlight in the supply of foodstuffs by means of storage, transport and distribution can be taken as an example for the smart supply of energy of the future. The volatile availability of solar and wind energy could contribute to a secure, high-availability, efficient supply by means of increasing storage.

How secure is our supply of energy?

The current raw materials for energy (gas, oil, coal, uranium, ...) and also the volatile sources of energy such as the sun, water and wind are only secure to a limited extent. This uncertainty preoccupies above all the future smart market – it is of lesser importance during the consideration of smart grids.

Smart measures to make the supply of electrical energy secure (in the context of high availability) have been developed and continuously improved since the 1880s. During network planning for the higher voltage networks, the so-called (n-1) and (n-2) criteria have been used for some time – these criteria state that in the event of one (or two) failures due to malfunctions in any item of equipment (generator, transformer, cable, ...) the network as a whole must safeguard the supply within the stipulated limits. Higher costs for their implementation are justified because, for instance, interruptions in the supply to large areas can be prevented by redundant cable routing or power stations.

The European transmission systems are coupled together into an integrated European network and some are also integrated into a grid control network so that, on the failure of a component in a system, or in case of an imbalance in the generation and consumption of power in a sub-system, help can be obtained from a neighbouring system. These transmission systems can quite rightly be termed high-voltage smart grids.

In distribution networks (medium voltage, low voltage) on the other hand the risk of an interruption in the supply for minutes or hours is accepted in the majority of cases. Here the distribution network is often not constructed based on the (n-1) criterion. Accordingly few or even no technical features are provided that could automatically compensate for the failure of a component or an imbalance between generation and consumption.

In the area of energy supply systems a large number of system-related limits and parameters (trigger current for circuit breakers, frequency, voltage, insulation on a cable, ...), secondary devices (measuring systems, controllers, regulators, ...) and primary devices (transformers, circuit breakers, inverters, ...) as well as in future many components at the integration levels (above all the communication infrastructure such as Ethernet switches, routers, backup power supplies) must be constantly monitored, and that mostly in real-time. In the case of developing malfunctions it may be necessary to intervene with control measures within milliseconds. If action is not taken until a component fails, then an entire system may easily collapse with unpredictable consequences for people and the environment if a fail-safe supply is imperative.

Since the start of electrification, particularly high value has been placed on the protection of individuals against physical contact with the electrical system. Worldwide it is state-of-the-art to protect people against the hazards of electrical power. A series of IEC standards and other standards define suitable measures that have made possible a high safety standard.

In relation to electromagnetic compatibility (EMC), electronic devices in the area of the supply of electrical energy must meet particularly high requirements that go way beyond the requirements in the office or industrial environment. The "IEC Smart Grid Standardization Roadmap" from 2010 clearly refers to these requirements. In the second version of the familiar American "NIST Framework and Roadmap for Smart Grid Interoperability Standards" (2012) these requirement were recently placed alongside the requirements for communication security. The availability of an automation or communication component must be much higher in an energy supply system than in the office or residential sector.

Furthermore physically extensive integration levels require high security in relation to the availability and vulnerability of the infrastructure and the supply systems, in the past the topic of security has been largely ignored during the implementation. In the future energy supply, this topic must be taken significantly more into account in the implementation and the solutions must be much more rigorously applied.

Smart solutions for a secure energy supply are required for generation, transport, distribution and the power consumers – in public distribution networks just as in public buildings and offices, as well as in other items of infrastructure such as transport systems or the Internet.

What will be new in the future?

The reliable and secure operation of the future electrical supply system places new challenges on engineers, businessmen and politicians, and has done so particularly since the turn of the century. Necessary changes are to be expected due to:

- → The rapidly growing number decentral feed points, the transition from central to more decentral electricity generation,
- → The development of renewable energy generation,
- → The development of the integration level and
- → The ageing distribution network infrastructure.

These changes must be made "open heart" (that is while providing supply) against the background of the following issues:

- → An increasingly ageing and therefore reducing technical expertise,
- → The demand for more energy efficiency,
- → The short time for implementation and
- → The high expectations on profitable investments in increasingly networked supply systems for electrical energy, gas, heat and transport.

The broad and intense discussion to be observed in recent times and the publication of comprehensive studies and opinions from politics, research institutes, associations, federations and industry is unprecedented in the construction of the electrical supply system. What is so interesting about the supply of electrical energy in the future? For many manufacturers who traditionally operate in the area of industrial automation, or in the area of network technology, the Internet or cloud computing, the increasingly necessary equipment for the integration infrastructure in distribution networks appears to be a massive new market.

Can Internet technologies and general automation solutions help?

„**Energy-on-demand** is considered by many to be solution for the efficient usage of energy."

Internet for energy

The BDI (Bundesverband der Deutschen Industrie e.V.) stated the following on the topic of the smart grid: "Information and communication technology will have a key role during the development of a supply of energy suitable for the future. It is the basis for the realisation of a future **energy internet**, that is the intelligent electronic networking **of all components in the energy system.** ... The biggest challenge here is to create an **integration level between business applications and the physical network** that makes possible the communication between complex IT components distributed across heterogeneous networks and organisational boundaries."

Is such an integration level primarily of service to the smart market or the smart grid at the distribution level, or both? The components installed today at the higher voltage levels are already effectively networked (CIM for grid control centre internal communication, telecontrol for communication with grid control centres and power generation systems as well as IEC 61850 for substations and power generation systems). With the need to integrate thousands of times more components in the lower voltage levels than in the higher voltage levels, it is still largely unclear which tasks they will have and how these can help also in the long-term to maintain the stability of the supply of electrical power at its current level.

Energy-on-demand is considered by many to be solution for the efficient usage of energy. In the context of social networks power consumers could suddenly develop volatile consumption behaviour and synchronously increase or reduce their consumption either in a limited area or over a large area, an event that could have unexpected effects on the systems and in some cases could result in the collapse of the system.

A key question for the realisation of future systems is knowledge of possible and probable failure scenarios. How many feed points

„**Development** must bee understood as continous "further" development of the existing systems with all their complex aspects."

and loads in the distribution networks can be controlled at which points using communication, and which regulation mechanisms could compensate for these effects adequately and quickly enough such that the distribution networks can be operated stably at all levels at all times?

Even under the assumption that all effects are known and corresponding mechanisms for stable system operation have been developed and tested, key questions remain unanswered: who is to finance this automation infrastructure and the related Internet-based integration levels foreseen and, above all, who is to implement, install, integrate, utilise and further develop it? ■

Dipl.-Ing Karlheinz Schwarz
NettedAutomation GmbH

CONCLUSION

The construction of automation infrastructures and integration levels for the supply of energy requires resources that go way beyond current notions and the resources that are available in the short-term. Financial aid for smart energy supply systems must not be primarily an "economic stimulus package" for the integration levels. The aspects such as the electrical safety, the high availability of the supply of energy, the ageing electrical and information technology infrastructure and above all the ageing personnel for the further development and operation of the electrical system must have a significantly higher priority.

The future supply of energy must be understood as a whole. Development must be understood as continuous "further" development of the existing systems with all their complex aspects. Only then can the familiar security of supply of the past also be ensured in the future. The scope and also the required short implementation period will overshadow all the experience of the past 130 years.

The energy revolution currently in planning and the concomitant development of a step-by-step structural change and a closer meshing of the energy networks for electricity, gas, heat and electric mobility, as well as the related necessary infrastructure will be more of a marathon than a sprint. Inter-disciplinary collaboration above all among the electrical engineers and power engineers must be significantly expanded. IEC standards and other standards can, above all against the background of limited development resources, make an important contribution to the simplification of solutions at the integration levels.

The smart grids that will result from the energy revolution will combine the inventions of several hundred years.

Easy, Affordable and Fast Integration of IEC 61850 in Small Power System Devices

Karlheinz Schwarz, NettedAutomation GmbH, Karlsruhe, schwarz@scc-online.de

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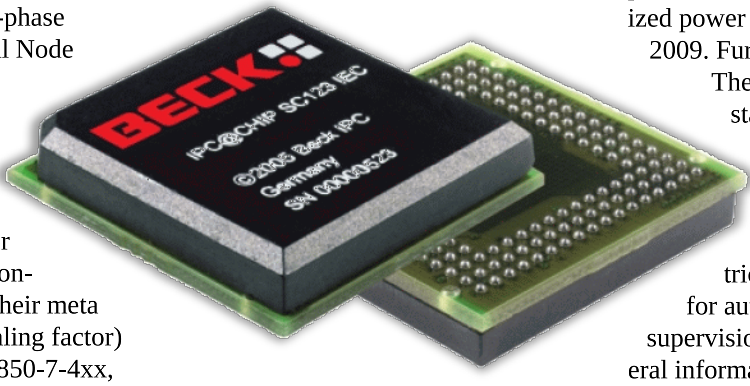
High financial and time expenditures for the implementation of IEC 61850 in control systems and other devices prevented so far a broad market penetration of the standard in the lower voltage levels and in distributed power generation. A reasonable and cost effective solution is now available with the Beck IPC@CHIP. The development of IEC 61850 conformant interfaces in power delivery systems – particularly renewable and decentralized power producers and consumers – can now be realized within very short time to market.

The standard series IEC 61850 [1] defines comprehensive information models, mechanisms for information exchange, a configuration language and a mapping to general communication protocols. It offers a unique and common architecture for many application domains [2,3]. The aspects are mainly the following:

General and user-specific information models like measured values of the voltage of the three-phase electrical network (Logical Node MMXU), rotor speed of a wind turbine (WTUR), switching position of the circuit-breaker (XCBR), temperature measured value (STMP) or the values of a PID loop controller (FPID) as well as their meta data (like SI-Units and scaling factor) are in the focus of IEC 61850-7-4xx, IEC 61850-7-3 and IEC 61400-25-2) [4-7].

Abstract methods for the change of information (ACSI - abstract communication service interface, according to IEC 61850-7-2) offer the most crucial services for the direct access (Read, Write, and Control), Reporting (spontaneous and cyclic; with monitoring of limits and changes), sequences of events (SoE: Sequence OF events), event archives in the devices (Logging), control, configuring and retrieving the self-description of the devices (IEC 61850-7-2 and IEC 61400-25-3) [8,9]. In addition two methods are defined for the transmission of critical information in real time: for the fast exchange of sensor data (typical several thousand sampled values per second of currents and voltages) and the fast exchange of critical information within the millisecond range.

Mapping of the abstract information and exchange methods to the application layer protocols as defined



in IEC 61850-8-1, IEC 61850-9-1, IEC 61850-9-2, and IEC 61400-25-4 [10-13]. The communication stacks for transferring the messages use among other protocols mainly TCP/IP and Ethernet (IEC 61850-8-1 and IEC 61400-25-4).

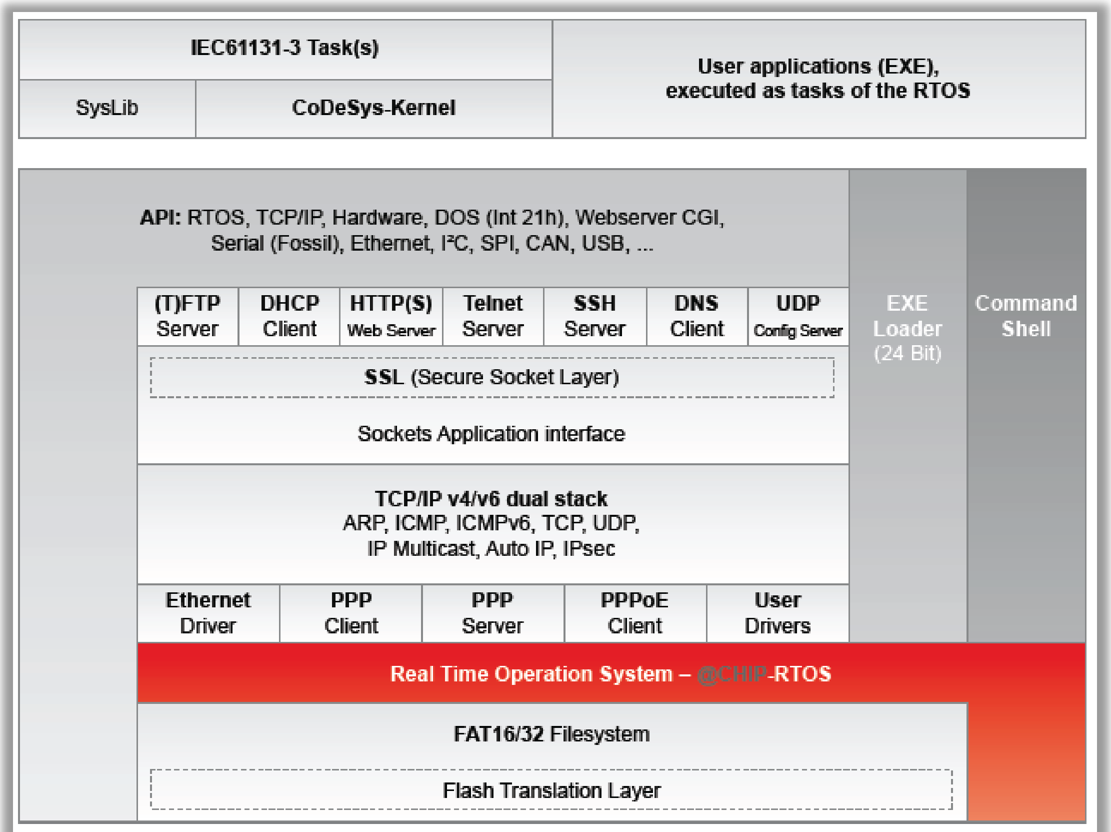
XML based configuration language for the complete description of a plant (IEC 61850-6) and a single device: Description of the plant topology, communication, information models, linkage of sources of information to destinations, and the binding of the models to the process and to internal equipment structures [14].

Toolbox for Multivendor systems

The standard series consists of 14 parts; published between 2003 and 2005. It is a tool box for building multivendor systems for substation protection and automation. The first extensions were published in 2007 in IEC TC 88 (Wind Turbines) with IEC 61400-25-4 for wind power plants. Extensions for hydro-electric power plants in 2007 and for the decentralized power resources followed in 2009. Further parts are in process.

The first fourteen parts of the standard series and the extensions (above all the information models) cover crucial information needed in the electrical power supply network for automation, protection and supervision. Meanwhile many general information models for the applications in general automation domains are defined in the second edition of part IEC 61850-7-4. One of the most crucial and interesting parts is part IEC 61850-90-7 (IEC 61850 object models for inverters in distributed energy resources (DER) systems).

The issue of the information exchange by means of MMS (Manufacturing Message Specification - ISO 9506) and ASN.1 (Abstract Syntax Notation 1 - ISO 8824/8825) – although it is required in the communication stacks of devices – however it is of subordinated importance, if it concerns the contents of the standards. With the realization of standard-



IPC@CHIP® RTOS architecture

conformant products MMS is key because before two devices can communicate in the client-server relation there is a need of an MMS stack on each end of the communication channel – a server and a client.

Applications of IEC 61850

IEC 61850 is used globally in many thousand plants of medium and high voltage networks. All large manufacturers of substations such as ABB, AREVA, GE, Siemens, Toshiba and many smaller manufacturers use IEC 61850 as the preferred solution. In the context of many Smart Grid projects in North America, in Asia and Europe IEC 61850 is regarded as the most important protocol standard. Beyond that, IEC 61850 – particularly because of the uniform and recently defined general information models – is used increasingly also in industrial and process automation systems.

In the contrast to the fieldbus standard IEC 61158 with (too) many standardized solutions in a single standard with almost 100 parts, IEC 61850 has only one protocol stack for TCP/IP-based client-server communication and two simple protocols using native switched Ethernet for real time communication. In many enterprises IP networks are very common. This allows directly and without special modifications to directly employ MMS based client-server communication. All information models of all devices can be accessed this way, fast and without detours from everywhere – also safely with TLS (Transport Layer Security). TLS is required by IEC 61850-8-1 and selected in IEC 62351 – the sister standard of IEC 61850.

These solutions could be achieved so far mostly just by very high financial and temporal expenditures. The implementation of the MMS client-server stack was usually realized by purchasing extensive and relatively expensive licensed software packages. The expected expenditures for porting the licensed MMS software and/or the development of MMS software were estimated so high that in many cases the application of IEC 61850 was questioned – especially when it comes to small devices.

Although the focus of the application of the standard series clearly is on the models and configuration language (which are independent of MMS), the implementation mainly depends on the acceptance of MMS. This is especially true for the use of IEC 61850 in simpler applications. MMS is however necessary for standard-conformant information exchange between clients and servers – no question. IEC 61850 does not support alternative protocols fortunately! The question is now, are there alternative MMS implementations – above all – for the application of IEC 61850 for simple applications? Yes! Thanks to the efforts taken by SystemCorp (Bentley, Western Australia) [15] and Beck IPC (Pohlheim, Germany) [16] to implement IEC 61850 on a small footprint of a simple embedded controller: IEC61850@CHIP.

Chip based solution

At the Hanover fair 2010 Beck IPC presented the integrated solution for IEC 61850 successfully in cooperation with SystemCORP Pty Ltd. (Bentley, Western Australia) at the Beck IPC booth. The embedded controller demonstrated was an industrial proven component that is on the market for five years in industrial automa-

tion systems. It is a modular controller chip (IPC@CHIP). The resonance of the many hundred booth visitors exceeded expectations of all involved people of Beck and SystemCorp by far. In the meantime there are many applications all over that use the Beck IPC controller.

The substantial advantage of the embedded controller based solution is its high efficiency, performance, and the minimum expenditure needed for the implementation of IEC61850-based interfaces for clients and servers. This platform is very economical. From a programming point of view it is a PC and a PLC (programmable logic controller) – it can be programmed with C/C++ as well as with IEC 61131-3 (CoDeSys). All license costs for the compilers and the IEC 61850 communication stack and API (application program interface) are already included in the chip price. Products based on other stacks may require a run-time license fee for the IEC

61850 stack per device that is more expensive than the complete chip. Not to speak about the needed efforts of porting the stack software to your platform (HW and SW). This may take many months and even years – the author has been contacted by many companies that complained that IEC 61850 is quite complex and too expensive to implement (even when using available third party software).

The IPC@CHIP SC123 and SC143 are equipped with the real-time and multitasking operating system IPC@CHIP-RTOS. The following software functions are integrated in the RTOS of the SC123/SC143: IEC 61850, IEC 61400-25, TCP/IPv6/IPv4, SSL, SSH, IPSec, PPPoE, API for CAN, IEC 61131-3 (CoDeSys, PLC), and C/C++

The software architecture is very comprehensive, compact and extremely efficient (Figure above).

The technical specification of the Chips (SC123 und SC143) could be found in the attached document.

For different applications regarding simple integration, mass production and performance three packages are offered.

IEC 61850 lite implementation

All crucial data models, communication services and the device configuration language (SCL) are realized in the stack and API running on the chip. All models from the applications protection and automation substations of any voltage level including power generation and distribution, monitoring of the power quality, automation and monitoring of hydro-electric power plants, wind turbines, decentralized energy generation such as photovoltaic, combined heat and power, diesel generators, battery storage stations, car charging stations to name just a few. The models of the new part IEC 61850-90-7 [17] are supported. The models for PV inverter have already been implemented on the SC143 by major PV inverter vendors in 2010 and 2011.

All models needed for the applications can be uploaded by a standardized SCL files by ftp on the chip. Thus the model and communication configuration is entirely accomplished by a standardized IEC 61850-6 file (SCL – system configuration language).

The IEC 61850 software stack and API can be started by the application easily as client or as server. Both applications can co-exist on the IPC@CHIP at the same time. The stack supports IEC 61850 services inclusive GOOSE and transmission of sampled values.

The SystemCorp IEC 61850 stack and API offers a very simple interface to the application software in the form of a few calls (and call-backs) like for example “Read“, “Write“, “Update”, and “Control”. Only a binding table must be defined, with which the real values of the process or of the application are bound (linked to) the information models according IEC 61850. This table is used, in order to describe the appropriate relations between model and the real world. That relation is implemented in the SCL file by private XML elements, which are interpreted by the IEC 61850 stack and API software as well as by the application software. This model (SCL file) is used for the configuration of the server **and** the client. The API documentation is available online [18]. A video explaining the use of the API function calls and the models at the server and the client side is available [19].

All services like Read, Write, Reporting, GOOSE, data sets and so on are completely configured by a SCL file. Using the same application data, one can configure at any time further logical devices, control blocks and data records simply by an extended or new SCL file transferred to the chip.

Ready to go devices

Beside the chips Beck IPC offers also ready to go modules (com.tom) – the only need is to let your application code understand the few API calls and call-backs – that’s all you need to communicate your data values with IEC 61850 models and services. The development of different gateways to, for example, CAN, IEC 60870-5-10x,

Profibus, DNP3 or Modbus can be realized in short time. This reduces the time to marked tremendously. The modules can be equipped with a data base system which implements the binding of different protocols by configuration software which is based on a Windows configuration tool. Protocol stacks for IEC 60870-5-101/104/103 and DNP3.0 are likewise available.

The com.tom solution for telecontrol is suitable for applications with existing WAN connectivity and existing process control and monitoring applications. Communication of the com.tom BASIC solutions can also directly communicate with a dedicated Web portal. The com.tom communicates with Ethernet and other existing network infrastructures like WiFi, Bluetooth, or GPRS.

The communication with the process can be realized over a serial interface or over digital inputs or outputs. The digital inputs and outputs can be processed additionally with simple PLC functions.

The integrated Web server on the com.tom BASIC provides also a simple WEB based editor for a Web PLC that can be used to for simple control algorithms.

Development Kit Beck IPC DK61

For a cost effective and fast start into the world of IEC 61850 the development kit DK61 is likely the best approach.

The IPC@CHIP DK61 development kit is a complete development system for the embedded controller IPC@CHIP SC123 and SC143.

It contains the Paradigm C/C++ compiler with IPC@CHIP RTOS debugger and many further tools, which can be applied for the simplified development of C/C++ and IEC 61131-3 (CoDeSys) applications on the Embedded controller SC123 and SC143.

Despite the comprehensive hardware of the development board, which makes all interfaces of the SC123 and SC143 available, a start-up is possible within minutes rather than hours or days. This is due to the installed RTOS, the „Getting Started“ manuals and the examples that come with the DK61 development kit.

The extensive hard and software equipment allow a fast and efficient development of customized applications within hours and days.

All aspects of the IEC 61850 Solution on the IPC@CHIP, described above, are available and directly applicable also on the development kit. An extensive example of use with a model for process values (inputs and outputs), with reporting and GOOSE is contained in the kit. The source code of the C application program is likewise provided. C programmers can immediately begin with the programming of their application and – as described in the example – communicate their data values within a short time by IEC 61850.

Special knowledge of MMS and ASN.1 is not necessary – applications can directly use the simple API. The development of an extensive protocol stack and a user interface are not needed – the focus is now on the application of the standard series for the realization of smarter power delivery systems.

The SystemCorp stack and API is available on various embedded controller platforms, e.g., Arm 9 or Arm 11 controllers that run on Linux. The stack and API could be ported to all major platforms; DLLs and libraries for Windows and PCs are also available.

Reduce time to market

Using the approaches of SystemCorp (Lite Implementation and API) and Beck IPC (embedded controller with everything ready-to-go) will help you **control**, **predict** and **reduce** your **time to market**. If the market requires IEC 61850 integrated, e.g., into your PV converter or other devices for controlling or monitoring the electrical system (or other applications) there are several approaches (depending on the time to deliver the device to the customer) you could choose from:

Very short time to market
(week(s) up to a very few months):
Recommended to use the Beck IPC com.tom ready-to-go box with Beck IPC chip as external or internal module.

Short time to market
(few months):
to use the Beck IPC Chip on a small printed circuit board as internal module.

Longer time to market
(several months):
to use the SystemCorp software on the controller of an available design or design a new HW with a new powerful embedded controller, e.g., from Beck (running RTOS) or TQ (running Linux).

In the attachment there is a description of the path to a short time to market using the SystemCorp stack and API.

Further information

More information on the IPC@CHIP can be found in English and German: http://www.beck-ipc.com

Details of the IEC 61850 Stack and API implemented on the IPC@CHIP are available at: http://systemcorp.com.au/PIS10API

General information, trends and news on IEC 61850: http://blog.iec61850.com

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Karlheinz Schwarz
NettedAutomation GmbH
Karlsruhe (Germany)
schwarz@scc-online.de

Dipl.-Ing. Karlheinz Schwarz (president of Schwarz Consulting Company, SCC, and owner of NettedAutomation GmbH; Karlsruhe/Germany) specializing in distributed automation systems. He is involved in many international standardization projects (IEC 61850 – utility automation, DER, hydro power, IEC 61400-25 – wind power, IEC 61158 - Fieldbus, ISO 9506 – MMS, …) since 1984. He is engaged in representing main industry branches in the international standardization of real-time information modeling, configuration, and exchange systems. Core services are consulting and training of utility personal, system integrators, consultants, and vendors. He has educated more than 2,750 experts from more than 700 companies and more than 70 countries. The training courses are considered to be outstanding. Mr. Schwarz is a well-known authority on the application of mainstream information and communication technologies in the utility industry and general automation domain.

NettedAutomation GmbH
Information & Communication Systems

Kostengünstige IEC-61850-Lösung für kurze Entwicklungszeiten

Ein hoher finanzieller und zeitlicher Aufwand bei der Realisierung der IEC 61850 in Steuerungen und andere Geräten hat bisher die breite Anwendung in den unteren Spannungsebenen und in der Energieerzeugung gebremst. Seit der Hannover Messe 2010 ist jedoch eine kostengünstige Komplettlösung auf Basis des Beck IPC@Chip verfügbar, welche die Entwicklung von IEC-61850-konformen Schnittstellen in der Energieversorgung innerhalb kurzer Zeit ermöglicht.

Karlheinz Schwarz

Die Normenreihe IEC 61850 [1] definiert umfangreiche Informationsmodelle, Mechanismen für den Informationsaustausch, eine Konfigurationssprache und eine Abbildung auf allgemeine Übertragungsprotokolle. Sie bietet eine für mittlerweile viele Anwendungsbereiche durchgängige Architektur [2, 3].

Allgemeine und anwendungsspezifische Informationen (Informationsmodelle), wie Messwerte der Spannung des dreiphasigen elektrischen Netzes, die Rotorgeschwindigkeit einer Windenergieanlage, die Schalterstellung von Leistungsschaltern, Temperaturmesswerte oder die Werte eines PID-Reglers sowie deren Metadaten (zum Beispiel SI-Einheiten und Skalierung) stehen im Vordergrund (IEC 61850-7-4xx [4, 5], IEC 61850-7-3 [6] und IEC 61400-25-2 [7]).

Abstrakte Methoden zum Austausch dieser Informationen (ACSI – abstract communication service interface nach IEC 61850-7-2 [8]) bieten die wesentlichen Dienste zum direkten Zugriff (Lesen und Schreiben), zum Melden (spontan und zyklisch; mit Änderungsüberwachung), Sequenzen von Ereignissen (SoE, Sequence of Events), für Ereignisarchive in den Geräten, zum Steuern und Konfigurieren sowie zum Auslesen der Selbstbeschreibung der Geräte (IEC 61850-7-2 [8] und IEC 61400-25-3 [9]). Daneben sind zwei Methoden zur Übertragung von Informationen in Echtzeit definiert: für den schnellen Austausch von Wandlerdaten (typisch mehrere tausend Abtastwerte pro Sekunde) und den schnellen Austausch von kritischen Informationen im Millisekundenbereich.

Bild 1. Der Single Controller Chip IPC@Chip

Die Abbildung der abstrakten Methoden zum Austausch dieser Informationen auf verschiedene Anwendungsprotokolle befindet sich in den Normen IEC 61850-8-1 [10], IEC 61850-9-1 [11] und 9-2 [12] sowie IEC 61400-25-4 [13]. Die Kommunikations-Stacks zum Übertragen der Nachrichten verwenden unter anderem TCP/IP und Ethernet (IEC 61850-8-1[10] und IEC 61400-25-4 [13]).

Die XML-basierte Konfigurationssprache erlaubt die vollständige Beschreibung einer Anlage (IEC 61850-6 [14]) inklusive der Anlagentopologie, der Kommunikation, der Informationsmodelle, der Verknüpfungen von Informationsquellen und -senken, der Geräte und der Zuordnung der Modelle zum Prozess und zu geräteinternen Strukturen.

Werkzeugkasten für Multi-Vendor-Systeme

Die (Basis-)Normenreihe besteht aus 14 Teilen. Sie stellt seit 2004 einen „Werkzeugkasten“ zur Gestaltung von Multi-Vendor-Systemen in der Stationsautomatisierung zur Verfügung. Die erste Erweiterung wurde 2007 im IEC TC 88 mit der IEC 61400-25-4 [13] für Windenergieanlagen vorgenommen. Es folgten Erweiterungen für Wasserkraftwerke in 2007 und für die dezentrale Energieversorgung in 2009. Weitere Teile sind in Arbeit.

Die ersten vierzehn Teile der Normenreihe und die Erweiterungen, vor allem der Informationsmodelle, umfassen einen weiten Teil der im elektrischen Versorgungsnetz vorhandenen Informationen zum Automatisieren, Schützen und Überwachen. Mittlerweile sind in der zweiten Ausgabe des Teils IEC 61850-7-4 [15] viele allgemeine Informationsmodelle für den Einsatz in der allgemeinen Automatisierung definiert.

Die Frage des Informationsaustauschs mittels MMS (Manufacturing Message Specification – ISO 9506 [16]) und ASN.1 (Abstract Syntax Notation 1 – ISO 8824/8825 [17, 18]) – obwohl er unbedingt notwendig ist – bleibt dabei aber insgesamt eher von untergeordneter Bedeutung, wenn es um die Inhalte der Normen geht. Bei der Realisierung normenkonformer Produkte steht MMS immer häufiger im Vordergrund.

Anwendungen der IEC 61850

Die IEC 61850 wird global in vielen tausend Anlagen der Mittel- und Hochspannungsebenen eingesetzt. Alle großen

Dipl.-Ing. Karlheinz Schwarz ist Inhaber der Schwarz Consulting Company in Karlsruhe.

E-Mail: schwarz@scc-online.de

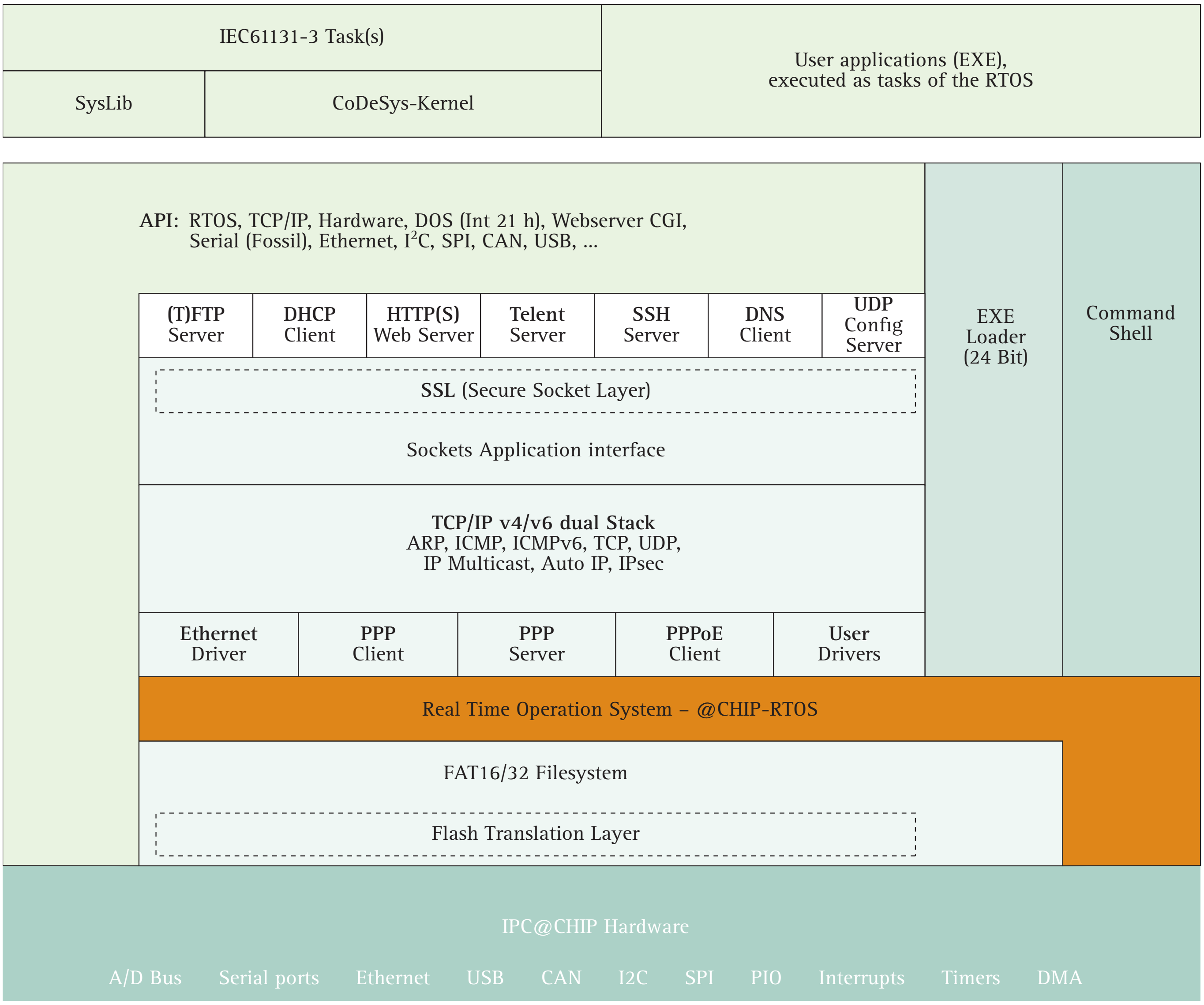

Bild 2*. Das Architekturbild gibt eine Übersicht über die einzelnen Softwarepakete*

Hersteller von Anlagen, wie ABB, Areva, GE und Siemens, sowie viele kleinere Hersteller setzen die IEC 61850 als die Vorzugslösung ein. Im Rahmen vieler Smart-Grid-Projekte in Nordamerika, in Asien und Europa wird sie als die wichtigste Norm betrachtet. Darüber hinaus wird sie vor allem wegen der einheitlichen und neuerdings vielen allgemeinen Informationsmodelle zunehmend auch im industriellen Umfeld und in der Verfahrenstechnik eingesetzt.

Im Gegensatz zur Feldbusnorm IEC 61158 [19] mit vielen „genormten“ Protokoll-Lösungen in einer einzigen Norm hat die IEC 61850 nur einen Protokoll-Stack für die TCP/IP-basierte Client-Server-Kommunikation und zwei einfache, auf Original-Ethernet basierte, für die Echtzeitkommunikation.

In vielen Betrieben sind IP-Netzwerke weit verbreitet. Das erlaubt unmittelbar und ohne Spezialanpassungen direkt den Einsatz der MMS-basierten Client-Server-Kommunikation. Auf alle Informationsmodelle aller Geräte kann auf diesem Weg schnell und auch sicher per TLS (Transport Layer Security) zugegriffen werden.

Dieser Vorteil konnte bisher meistens nur durch einen hohen finanziellen und zeitlichen Aufwand erreicht werden. Die Implementierung des MMS-Client-Server-Stacks wurde in der Regel durch den Kauf von umfangreichen und relativ teuren lizenzierten Software-Paketen realisiert. Die erwarteten Aufwendungen für die Portierung der lizenzierten MMS-Software beziehungsweise die Entwicklung einer eigenen MMS-Software wurden sowohl zeitlich als auch personell so hoch eingeschätzt, dass in vielen Fällen die Einführung der IEC 61850 immer noch grundsätzlich infrage gestellt wird.

Obwohl der Fokus bei der Anwendung der Normenreihe eindeutig auf der von MMS unabhängigen Modellebene und Konfigurationssprache liegt, hat die Implementierung von MMS bisher einen überproportionalen Einfluss auf die Akzeptanz der IEC 61850 für einfache Anwendungen ausgeübt.

MMS ist allerdings für den normkonformen Informationsaustausch zwischen Clients und Server unbedingt erforderlich – alternative Protokolle sieht die IEC 61850 zum Glück nicht vor. Die Frage ist nun: Gibt es alternative MMS-Implementierungen, vor allem für den Einsatz der IEC 61850 bei einfachen Anwendungen?

Chip-basierte Lösung

Auf der Hannover Messe hat Beck IPC [20] in Zusammenarbeit mit der Firma SystemCorp Pty Ltd [21] die integrierte Lösung für die IEC 61850 auf ihren seit fünf Jahren in der Industrieautomation erfolgreich eingesetzten Single Controller Chip IPC@Chip vorgestellt (**Bild 1**).

Der wesentliche Vorteil der Chip-basierten Lösung besteht darin, dass sie leistungsfähig ist, nur minimalen Aufwand bei der Einführung von IEC-61850-basierten Schnittstellen erfordert, die IEC 61850 auf einer stabilen und weit verbreiteten Plattform aufsetzt und vor allem kostengünstig ist. Alle Lizenzkosten sind bereits im Chip-Preis enthalten.

Die Produkte IPC@Chip SC123 und SC143 sind mit dem vorinstallierten Echtzeit-Multitasking-Betriebssystem IPC@Chip-RTOS ausgestattet. Folgende Software-Funktionen sind integriert: IEC 61850, IEC 61400-25, TCP/IPv6/IPv4, SSL, SSH, IPSec, PPPoE, API for CAN, IEC 61131-3 (CoDeSys, PLC) und C/C++.

Die Software-Architektur ist umfangreich, kompakt und leistungsfähig (**Bild 2**).

Bild 3. *Geräte der „com.tom"-Telecontrol-Lösung*

„Lite implementation" der IEC 61850

Alle wesentlichen Datenmodelle, Kommunikations-Services und die Geräte-Konfigurationssprache (SCL) sind realisiert. Alle Modelle aus den Bereichen Schutz- und Automatisierungstechnik in Schaltanlagen jeder Spannungsebene und Ortsnetzstationen, Überwachung der Spannungsqualität, Wasserkraftwerke, Windenergieanlagen, dezentrale Energieerzeugungsanlagen, wie Photovoltaik, Kraft-Wärme-Kopplung und Dieselgeneratoren sowie Batterie-Ladestationen und Stromtankstellen, werden mittels eines genormten SCL-Files direkt per FTP auf den Chip geladen. Damit wird der gesamte IEC-61850-Anteil auf dem Chip komplett konfiguriert.

Der IEC-61850-Software-Stack lässt sich als Client und als Server starten. Beide Applikationen können auf dem Chip zeitgleich koexistieren. Der Stack unterstützt IEC-61850-Services inklusive Goose und die Übertragung von Abtastwerten. Er bietet eine einfache Schnittstelle zur Anwendungs-Software in Form von wenigen Aufrufen, wie „Get", „Set" und „Update". Es muss lediglich eine Tabelle definiert werden, mit der die realen Werte vom Prozess oder von der Anwendung an die Informationsmodelle nach IEC 61850 angebunden werden. Diese Tabelle wird verwendet, um die entsprechenden Beziehungen zwischen Modell und der realen Welt zu beschreiben. Das geschieht über XML-Private-Elemente im SCL-File, die von der IEC-61850-Software interpretiert werden. Es muss lediglich sichergestellt werden, dass die Anwendungs-Software die so referenzierten Informationen auch bereitstellt.

Der gesamte Bereich der Methoden, wie Lesen, Schreiben, Melden, Goose, Datensätze und so weiter, ist durch das SCL-File vollständig konfiguriert. Bei gleichen Anwendungsdaten können jederzeit weitere logische Geräte, Control-Blöcke und Datensätze einfach durch ein erweitertes oder neues SCL-File auf dem Chip konfiguriert werden.

Bild 4. *Das Kit DK61 enthält alle Komponenten für die schnelle Entwicklung von Applikationslösungen*

Fertige Module für bekannte Schnittstellen

Neben den Chips bietet der Hersteller auch unmittelbar einsetzbare Module an, was die Entwicklung verschiedener Gateways, zum Beispiel zu CAN, zur IEC 60870-5-10x, zu Profibus, DNP3 oder Modbus, erleichtert. Die Module können mit einem Datenbanksystem ausgestattet werden, das die Anbindung der verschiedenen Protokolle durch eine auf Windows basierende Konfigurations-Software vereinfacht. Protokoll-Stacks für die IEC 60870-5-101/104/103 und DNP3.0 sind ebenfalls verfügbar.

Die „com.tom"-Telecontrol-Lösung ist für Umgebungen mit vorhandener WAN-Anbindung und bestehender Prozesssteuerung geeignet (**Bild 3**). Die Kommunikation der „com.tom"-Basic-Geräte auf das Web-Portal erfolgt über Ethernet. Der Kommunikationsmechanismus hat ein geringes Datenaufkommen und lässt sich problemlos in die vorhandene Netzwerkstruktur integrieren. Schnittstellen zu Wifi, GPRS, Bluetooth und anderen Protokollen sind bereits integriert.

Mit der Prozessseite wird über eine serielle Schnittstelle oder über digitale Ein- und Ausgänge kommuniziert. Die lokalen digitalen Ein- und Ausgänge können zusätzlich mit einfachen SPS-Funktionen verknüpft werden. Auf dem Webserver des „com.tom"-Basic befindet sich der Web-basierende Editor Web-PLC für kleine Ablaufsteuerungen.

Entwicklungs-Kit

Für den Einstieg eignet sich das Entwicklungs-Kit DK61 (**Bild 4**). Es ist ein komplettes System für die Embedded Controller SC123 und SC143. Es enthält neben dem Development Board DK60 auch den Paradigm C/C++-Compiler mit IPC@Chip RTOS Debugger und viele weitere Tools, die zur einfacheren Erstellung von C-Applikationen auf den Embedded Controllern benötigt werden.

Trotz der umfangreichen Hardware-Ausstattung des Development Boards, das alle Schnittstellen des SC123 und SC143 verfügbar macht, ist die Inbetriebnahme dank des vorinstallierten RTOS und der „Getting Started"-Anleitung in wenigen Minuten möglich (inklusive einem Beispiel für die IEC 61850). Die Hard- und Software-Ausstattung ermöglicht die effiziente Entwicklung kundenspezifischer Applikationen.

Das DK61 enthält das Codesys-IEC-61131-3-Software-Development-Kit zur Entwicklung eigener IEC-61131-3-programmierbarer Steuerungsanwendungen auf dem SC123/SC143. Der IEC-61850-Software-Stack kann als Client und als Server gestartet werden. Alle beschriebenen Aspekte der IEC-61850-Lösung auf dem IPC@Chip sind auch auf dem Entwicklungs-Kit verfügbar und direkt anwendbar. Ein Anwendungsbeispiel mit einem Modell für Prozesswerte (Ein- und Ausgänge), mit Reporting und Goose wird mit ausgeliefert. Der Quell-Code des C-Anwendungsprogramms ist ebenfalls beigefügt. C-Programmierer können auf dieser Basis unmittelbar mit dem Programmieren ihrer

Anwendung beginnen und ihre Daten in kurzer Zeit per IEC 61850 kommunizieren.

Spezielle Kenntnisse von MMS und ASN.1 sind nicht erforderlich – die Anwendung kann unmittelbar auf einem einfachen Interface aufsetzen. Die Entwicklung eines umfangreichen Protokoll-Stacks und eines Anwender-Interfaces sind überflüssig – der Fokus liegt auf der Anwendung der Normenreihe.

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[13] IEC 61400-25-4:2008-08 Wind turbines – Part 25-4: Communications for monitoring and control of wind power plants – Mapping to communication profile. Genf/ Schweiz: Bureau Central de la Commission Electrotechnique Internationale

[14] IEC 61850-6:2009-12 Communication networks and systems for power utility automation – Part 6: Configuration description language for communication in electrical substations related to IEDs. Genf/ Schweiz: Bureau Central de la Commission Electrotechnique Internationale

[15] IEC 61850-7-4:2010-03 Communication networks and systems for power utility automation – Part 7-4: Basic communication structure – Compatible logical node classes and data object classes. Genf/ Schweiz: Bureau Central de la Commission Electrotechnique Internationale

[16] ISO 9506 Industrielle Automatisierungssysteme und Integration – Festlegung der Nachrichtenformate für Fertigungszwecke. Berlin: Beuth

[17] ISO/IEC 8824 Informationstechnik – Notation Eins für Abstrakte Syntax (ASN.1). Berlin: Beuth

[18] ISO/IEC 8825 Informationstechnik – Codierungsregeln für ASN.1. Berlin: Beuth

[19] DIN EN 61158-2 Norm, 2008-09 Industrielle Kommunikationsnetze - Feldbusse. Berlin: Beuth

[20] Beck IPC GmbH, Pohlheim: www.beck-ipc.com

[21] SystemCorp Pty Ltd, Perth/Australien: www.systemcorp.com.au

Annex:

What does IEC 61850-90-7 (IEC 61850 object models for inverters in distributed energy resources (DER) systems) provide?

The following is based on IEC 61850-90-7 (final draft 2012-02)

The main purpose of the document is to define **information models** of the known functions of PV inverters. These functions are those that are **already implemented** in today's controllers of inverters installed all over. The information models defined in IEC 61850-90-7 just define **standard names** of the "signals" found in most PV inverters – the standard just follows the market. The standard also provides a **common way to access and distribute the information** needed to configure, control, and monitor real inverters. Due to the single model and communication profile (independent of the vendors) it is easy to communicate with the inverters of many different vendors with one single standard.

The advent of decentralized electric power production is a reality in the majority of the power systems of the world, driven by the need for new types of energy converters to mitigate the heavy reliance on non-renewable fossil fuels, by the increased demand for electrical energy, by the development of new technologies of small power production, by the deregulation of energy markets, and by increasing environmental constraints.

These pressures have greatly increased the demand for Distributed Energy Resources (DER) systems which are interconnected with distribution power systems, leading to high penetrations of these variable and often unmanaged sources of power. No longer can they be viewed only as "negative load". Their large numbers, their unplanned locations, their variable capabilities, and their fluctuating responses to both environmental and power situations make them difficult to manage, particularly as greater efficiency and reliability of the power system is being demanded.

This paradigm shift in management of power systems can be characterized by the following issues:

The numbers of interconnected DER systems are increasing rapidly. The advent of decentralized electric power production is a reality in the majority of power systems all over the world, driven by many factors:

- The need for new sources of energy to mitigate the heavy reliance on externally-produced fossil fuels.
- The requirements in many countries and US states for renewable portfolios that have spurred the movement toward renewable energy sources such as solar and wind, including tax breaks and other incentives for utilities and their customers.
- The development of new technologies of small power production that have made, and are continuing to improve, the cost-effectiveness of small energy devices.
- The trend in deregulation down to the retail level, thus incentivizing energy service providers to combine load management with generation and energy storage management.
- The increased demand for electrical energy, particularly in developing countries, but also in developed countries for new requirements such as Electric Vehicles (EVs).
- The constraints on building new transmission facilities and increasing environmental concerns that make urban-based generation more attractive.

These pressures have greatly increased the demand for Distributed Energy Resources (DER) systems which consist of both generation and energy storage systems that are interconnected with the distribution power systems.

DER systems challenge traditional power system management. These increasing numbers of DER systems are also leading to pockets of high penetrations of these variable and often unmanaged sources of power which impact the stability, reliability, and efficiency of the power grid. No longer can DER systems be viewed only as "negative load" and therefore insignificant in power system planning and operations. Their unplanned locations, their variable sizes and capabilities, and their fluctuating responses to both environmental and power situations make them difficult to manage, particularly as greater efficiency and reliability of the power system is being demanded.

At the same time, DER devices could become very powerful tools in managing the power system for reliability and efficiency. The majority of DER devices use inverters to convert their primary electrical form (often direct current (dc) or non-standard frequency) to the utility power grid standard electrical interconnection requirements of 60Hz or 50Hz and alternating current (ac). Not only can inverters provide these basic conversions, but inverters are also very powerful devices that can readily modify many of their electrical characteristics through software settings and commands, so long as they remain within the capabilities of the DER device that they are managing and within the standard requirements for interconnecting the DER to the power system.

DER systems are becoming quite "smart" and can perform "autonomously" most of the time according to pre-established settings or "operating modes", while still responding to occasional commands to override or modify their autonomous actions by utilities and/or energy service providers (ESPs). DER systems can "sense" local conditions of voltage levels, frequency deviations, and temperature, and can receive emergency commands and pricing signals, which allow them to modify their power and reactive power output. These autonomous settings can be updated as needed. To better coordinate these DER autonomous capabilities while minimizing the need for constant communications, utilities and ESPs can also send schedules of modes and commands for the DER systems to follow on daily, weekly, and/or seasonal timeframes.

Given these ever more sophisticated capabilities, utilities and energy service providers (ESPs) are increasingly desirous (and even mandated by some regulations) to make use of these capabilities to improve power system reliability and efficiency.

Inverter configurations and interactions

Bulk power generation is generally managed directly, one-on-one, by utilities. This approach is not feasible for managing thousands if not millions of DER systems.

DER systems cannot and should not be managed in the same way as bulk power generation. New methods for handling these dispersed sources of generation and storage must be developed, including both new power system functions and new communication capabilities. In particular, the "smart" capabilities of inverter-based DER systems must be utilized to allow this power system management to take place at the lowest levels possible, while still being coordinated from region-wide and system-wide utility perspectives.

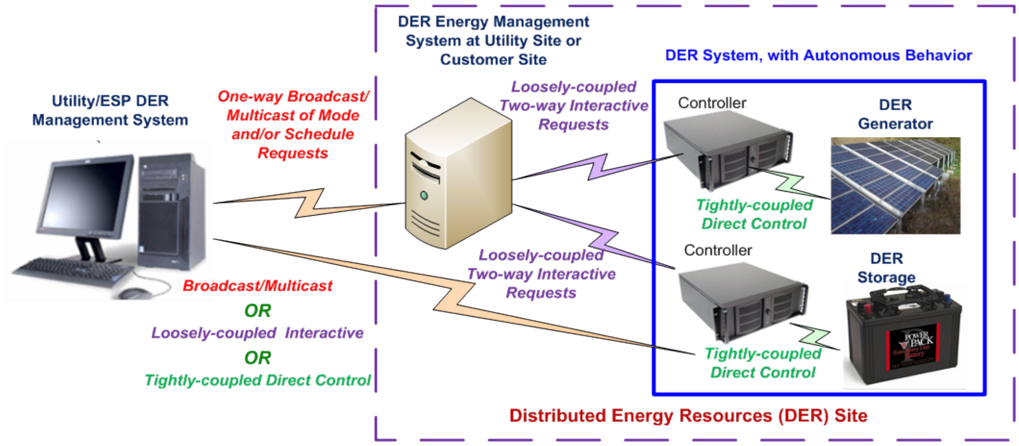
This "dispersed, but coordinated intelligence" approach permits far greater efficiencies, reliability, and safety through rapid, autonomous DER responses to local conditions, while still allowing the necessary coordination as broader requirements can be addressed through communications on an as-needed basis. Communications, therefore, play an integral role in managing the power system, but are not expected or capable of continuous monitoring and control. Therefore the role of communications must be modified to reflect this reality.

Inverter-based DER functions range from the simple (turn on/off, limit maximum output) to the quite sophisticated (volt-var control, frequency/watt control, and low-voltage ride-through). They also can utilize varying degrees of autonomous capabilities to help cope with the sophistication.

At least **three levels of information exchanges** are envisioned:

- **Tightly-coupled interactions** focused on direct monitoring and control of the DERs with responses expected in "real-time".
- **Loosely-coupled interactions** which request actions or "modes" that are interpreted by intelligent DER systems for undertaking **autonomous reactions** to local conditions or externally provided information. Information is then sent back on what actions they actually performed.
- **Broadcast/multicast** essentially one-way requests for actions or "modes", without directly communicated responses by large numbers of DERs.

These different DER management interactions are shown in the following figure.



DER Management: Interactions between Components

Inverter functions

Inverter functions range from the simple to the complex. Most inverter functions are based on settings or curves that allow them to respond autonomously to local conditions, while some require direct control commands:

- **Immediate control functions** for inverters
  - Function INV1: connect / disconnect from grid
  - Function INV2: adjust maximum generation level up/down
  - Function INV3: adjust power factor
  - Function INV4: request active power (charge or discharge storage)
  - Function INV5: request action through a pricing signal

- **Volt-var management modes**
  - Volt-var mode VV11: available vars mode with no impact on watts
  - Volt-var mode VV12: maximum var support mode based on maximum watts
  - Volt-var mode VV13: static inverter mode based on settings
  - Volt-var mode VV14: passive mode with no var support

- **Frequency-watt management modes**
  - Frequency-watt mode FW21: high frequency reduces active power or low frequency reduces charging
  - Frequency-watt mode FW22: constraining generating/charging by frequency
  - Frequency-watt mode FW23: watt generation/absorption counteractions to frequency deviations

- **Dynamic reactive current support during abnormally high or low voltage levels**
  - Dynamic reactive current support TV31: volt-var support during abnormally high or low voltage levels

- **Functions for “must disconnect” and “must stay connected”**
  - “Must disconnect” MD curve
  - “Must stay connected” MSC curve
  - Reconnect settings

- **Watt-power factor management modes**
  - Watt-power factor WP41: feed-in power controls power factor (parameters)
  - Watt-power factor WP42: feed-in power controls power factor (curves)

- **Voltage-watt management modes**
  - Voltage-watt mode VW51: smoothing voltage deviations by watt management
  - Voltage-watt mode VW52: charging by voltage

- **Non-power-related modes**
  - Temperature-function mode TMP: ambient temperature indicates function
  - Pricing signal-function mode PS: pricing signal indicates function to execute

- **Parameter setting and reporting**
  - Function DS91: modify inverter-based DER settings
  - Function DS92: event/history logging
  - Function DS93: status reporting
  - Function DS94: time synchronization

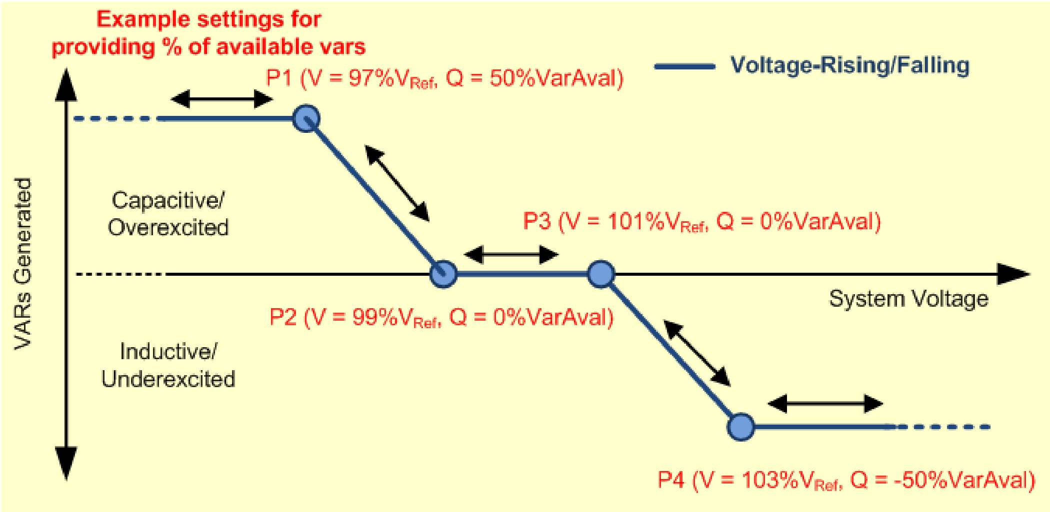
It is expected that additional functions will be added in the future, for instance for handling intentional and unintentional islanding.

The following figure provides an example of volt-var settings for this mode. It is assumed that the var value between VMin and V1 is the same as for V1 (shown as 50% VArAval, in this example). The equivalent is true for the var value between V4 and VMax (which is assumed to be 50% VArAval in this example).

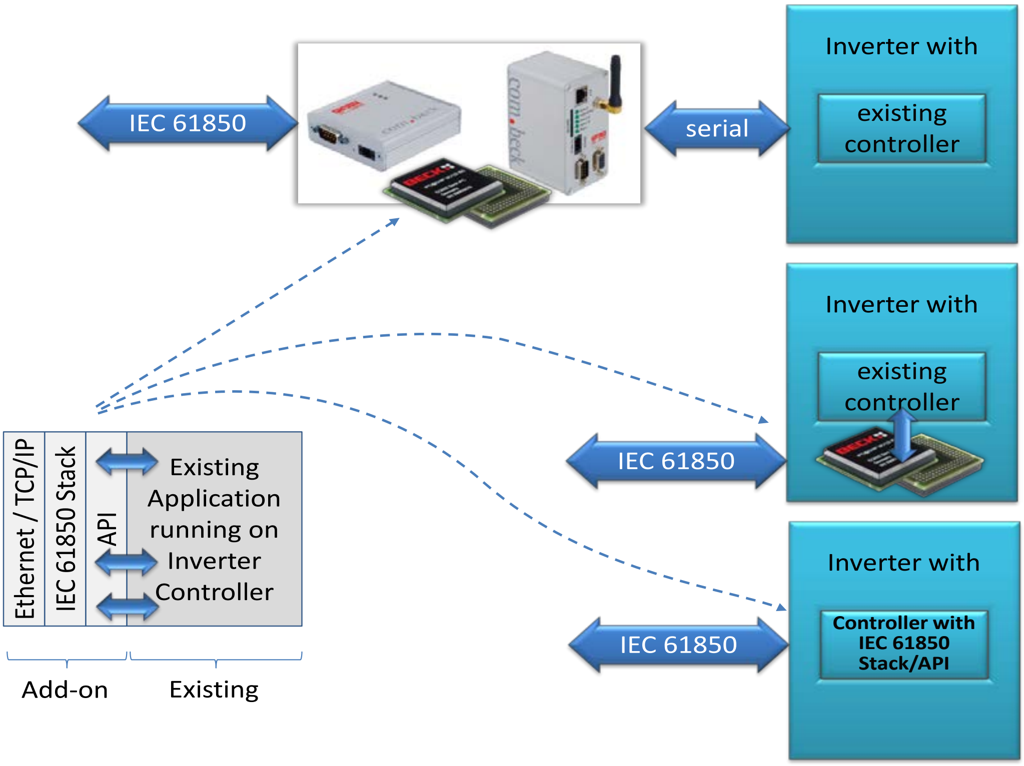
Example Settings

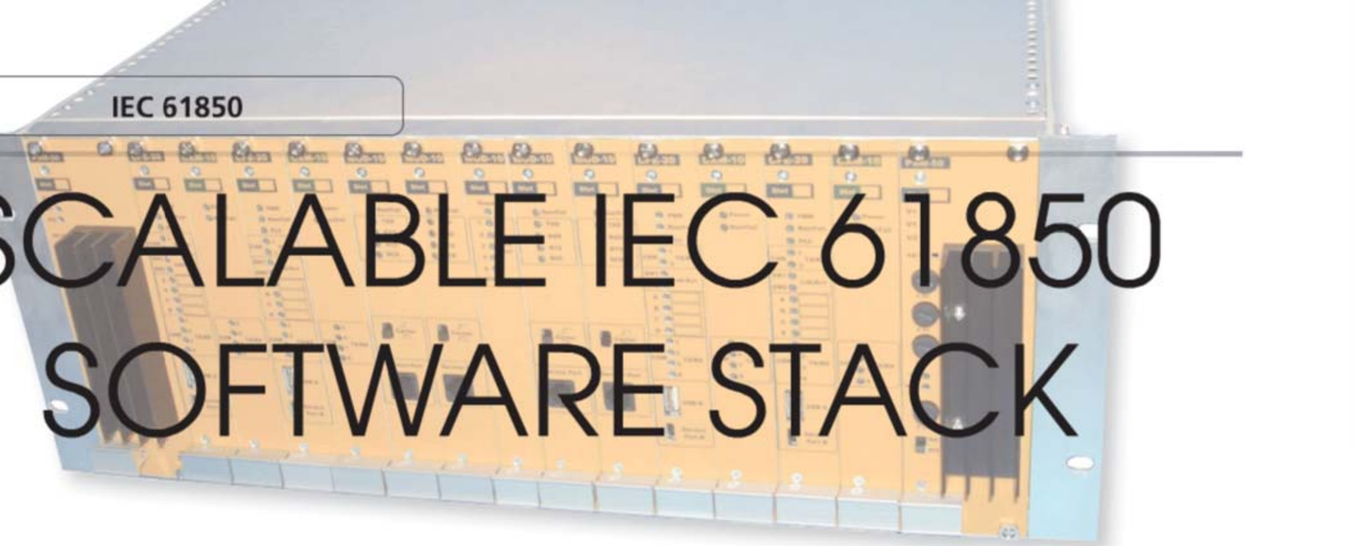
Voltage Array (% VRef)		VAr Array (% VArAval)	
V1	97	Q1	50
V2	99	Q2	0
V3	101	Q3	0
V4	103	Q4	-50

VAr Ramp Rate Limit – fastest allowed decrease in VAR output in response to either power or voltage changes	50 [%VArAval/second]
VAr Ramp Rate Limit – fastest allowed increase in VAR output in response to either power or voltage changes	50 [%VArAval/second]
The time of the PT1 in seconds (time to accomplish a change of 95%).	10 seconds
Randomization Interval – time window over which mode or setting changes are to be made effective	60 seconds



The information needed for this application is defined in corresponding Logical Nodes of IEC 61850-90-7 and IEC 61850-7-4. From an implementation point of view the standard just provides an external view of the inverter internal information and information exchange (**for the inverter functions, e.g., volt-var control**). It could be assumed that the functions are **already implemented in the existing inverter controller**. Possible implementation architectures are:





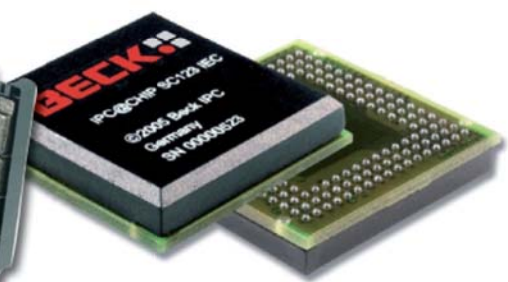
SCALABLE IEC 61850 SOFTWARE STACK

A new enormously scalable, lively, and affordable IEC 61850 Software Stack is now available for Smart Grid and other application domains. SystemCORP Embedded Technology Pty Ltd offers a Lite solution across various operating systems and hardware platforms. The new stack offers an extremely easy to use API (Application Programming Interface) creating instant results for software programmers.

By Detlef Raddatz, SystemCORP Embedded Technology, Australia and Karlheinz Schwarz, Netted Automation, Germany

IEC 61850 is *THE* most successful International Standard for protection, control, and automation systems in substations. The standard is intended to be used in centralised and distributed power generation as well as in distribution, factory, and process automation domains.

IEC 61850 is more than just a date communication protocol. The standard defines information models, information exchange services for real-time and SCADA applications in substation automation systems, renewable energy generation and power distribution systems. The configuration of systems and devices is standardised using a standardised XML file.



COMMUNICATION STACK

High costs for implementing IEC 61850 is one of the crucial factors for the standard being used in relatively few applications outside substations. This has now changed. SystemCORP Embedded Technology has developed a portable IEC 61850 communication stack suitable for different operating systems including Microsoft Windows™ and LINUX, and applicable for any application domain including protocol gateways for IEC 870-5101/103/104 and DNP3.0.

CONCEPT OF A SIMPLE API

The API provided by the stack is extremely easy to use by application programmers. It hides all details of the underlying protocols like MMS (ISO 9506). The operational API services are Set, Get, and Update. The information model of the device and the binding of the real world information to the model is completely configured by a standardised XML file (ICD file – IED Capability Description) engineered with the tool "ICD Designer". Any standardised or extended model can be created.

The stack with the simple API has been ported to multiple system platforms.

SINGLE CHIP SOLUTION

The stack has been ported onto SoC (System on Chip) processor specific operating systems such as the Beck-IPC@CHIP™. The SC143 SoC is a powerful but also an inexpensive choice for many IEC 61850 real-time applications. The controller provides the complete IEC 61850 (IEC 61400-25) MMS, GOOSE and Sampled Value communication stacks. The stacks and the device data models are configurable by a standard SCL File (IEC 61850-6) uploaded by FTP to the controller. Applications can be developed in C/C++ and IEC 61131-3. The focus shifts from communication (especially MMS) programming to user applications. The development of affordable standard conformant interfaces for distributed energy resources can now be shortened to days or weeks – from months and years.

DEVELOPMENT KIT APPLICATIONS

The fastest way getting started with real-time applications is developing application on the Beck-IPC@CHIP™ using the development kit DK61. The kit comes with all hardware and software components (including all licenses for C/C++ and IEC 61131-3 compiler and IEC 61850 software).

A "Getting started" CD ROM comes with application examples (including source code).

IEC 61850 AND LINUX

When using the IEC 61850 software stack on LINUX systems the target hardware platform and software development tool chain play an important role when porting packet driver software for GOOSE messaging. Currently the stack supports ARM™, Freescale Coldfire™ and X86 based LINUX systems.

MICROSOFT WINDOWS™

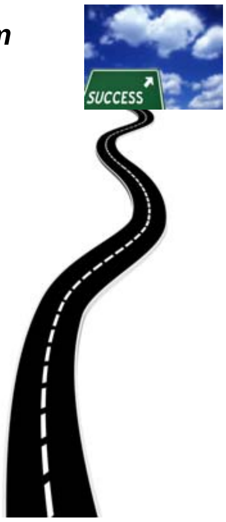
A free IEC 61850 evaluation DLL (IEC 61400-25) as a Starter Kit for Client/Server and Publisher/Subscriber is now available. The Kit contains executable software, C source code and .Net Applications (projects) as well as "Getting started manuals". The Protocol Integration Stack (PIS-10) DLL provides the same simple API. Client and server (publisher/subscriber – GOOSE) install on one or different PCs.

Suite 4/12 Brodie Hall Drive
Technology Park
Bentley WA 6102
Australia
Tel: +61 (8) 9472 8500
Fax: +61 (8) 9472 9500
Email: info@systemcorp.com.au

PIS-10 IEC 61850 Product Road Map

The SystemCORP Embedded Technology PIS-10 IEC 61850 Products are accessible by 5 Routes:

1. ***Hardware Specific Application – ARM, Coldfire, Power PCs***
2. ***Linkable IEC 61850 Stack Library using Linux on your Product Platform***
3. ***IEC 61850 DLL on Windows PC***
4. ***IEC 61850 Linux X86 Library – PC platform***
5. ***Beck-IPC SC143 IEC 61850 Single Chip Solution***



With any Route choose the IEC 61850 implementation – "Lite" or "eXtended":

ICE 61850 Server/Client Application "Lite"
MMS

OR

ICE 61850 Server/Client Application "eXtended"		
MMS	***GOOSE***	***Sample Value***

Choose Server and/or Client:

- ***Server and Client,***
- ***Server only, or***
- ***Client only***

After choosing the IEC 61850 Route, Lite or eXtended, and Server and/or Client you'll need:

- ***ICD Designer,***
- ***Annual Maintenance Contract (included Free in first year), and***
- ***Training***

The SystemCORP Embedded Technology IEC 61850 PIS-10 Route:

- ☑ API provides simple integration with IEC 61850
- ☑ We maintain the PIS-10 Library
- ☑ Low Development Expenses
- ☑ Per platform license at Low Price
- ☑ Less resources to develop and deploy product
- ☑ Training: API and Online Manual + Personalized On-site Training
- ☑ We Port to your System
- ☑ Low-cost annual maintenance agreement
- ☑ Start developing your IEC 61850 application NOW
- ☑ SystemCORP has own KEMA certified substation control products
- ☑ Highly customizable single-chip solution available at a low cost
- ☑ Downloadable Demo 61850 Tools

The Alternative Route to Your IEC 61850 Embedded Applications:

- ☐ API provides complex integration with IEC 61850
- ☐ You maintain your own software
- ☐ Large Start-up Development Expenses
- ☐ Per product license at High Cost
- ☐ Longer Start-up development time and longer time to market
- ☐ Training: You get a DVD + Manual
- ☐ You Port to your System
- ☐ Expensive product-based annual maintenance contracts
- ☐ Takes months just to start developing your actual IEC 61850 application
- ☐ Only customer certified products
- ☐ Only Protocol Data Gateways with pre-defined communication protocols
- ☐ No demo tools provided

Choose Your Route

BECK THE POINT OF SYNERGY

Simple components for effective and fast to market solutions

IPC@CHIP®
The heart of applications

Development-Kit
For simple implementations – Ready to Go

com.tom BASIC
Communication gateway

com.tom RADIO
Communication gateway with GSM/GPRS

com.tom GRAPHIC
Communication gateway with graphic display

■ ■ ■

Your IED

Partners for IEC 61850 and IEC 61400-25

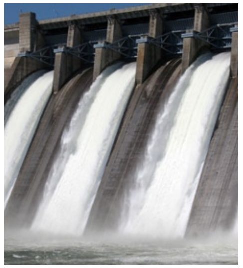
Hard-/Software
SystemCORP
- IEC 61850
- IEC 61400-25
- SCL Tool
- Modbus, DNP3
- IEC 60870-5-101/103/104

Hardware
Exor
- HMI & Scada Solutions

Peopleware
NettedAutomation
- Education
- Training
- Consulting

Beck IPC GmbH
Grüninger Weg 24
35415 Pohlheim-Garbenteich / Germany

Tel. +49 6404 695-0
Fax +49 6404 695-500
E-Mail info@beck-ipc.com
Web www.beck-ipc.com



IEC 61850 Lite Implementation

IEC 61850 Client/Subscriber and Server/Publisher Integration on the IPC@CHIP®.

The IPC@CHIP® embedded platform facilitates the quick and cost-effective integration of your information into a standardized format.

Secure Communication

IEC 61850 and IPC@CHIP® for simple to complex applications

Hardware specifikation SC1x3

- CPU SC186-EX / 96 MHz
- RAM (free) 8 MByte (approx. 7 MB)
- Flash memory SC123: 2 MByte (approx. 1 MB)
  SC143: 8 MByte (approx. 7 MB)
- Ethernet 1 x 10/100BaseT / PHY, 1 x MII
- Temp. range -25 to 85°C

IEC 61850 Software implementation

- MMS over TCP/IP
- GOOSE Publisher/Subscriber
- Sampled Values
- Data sets
- Buffered reporting
- Unbuffered reporting
- Control
- Data Logging
- Time synchronization via SNTP
- File Transfer via MMS and FTP

Programming software included

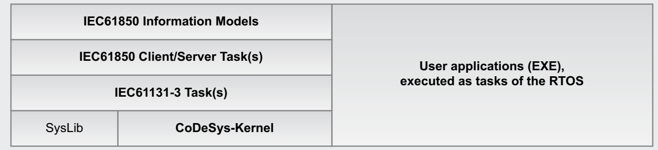
Program your application in C/C++ or IEC 61131-3 and configure the IEC 61850 API with standard SCL (System Configuration Language).

Additional benefits

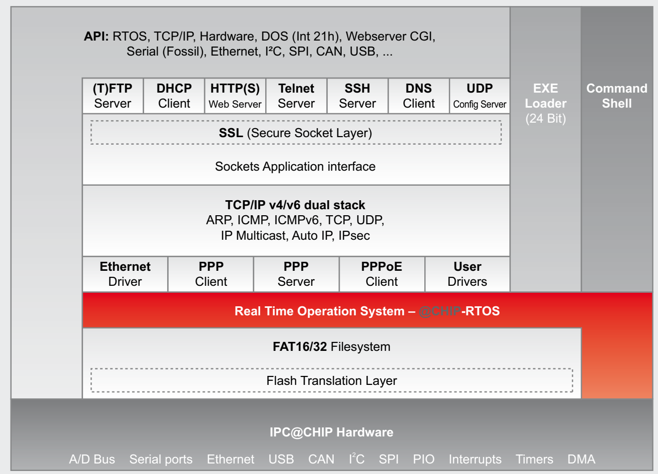
Useful source code sample files are available for free download from **www.beck-ipc.com/examples** :

- CAN
- Industrial communication (Modbus, EasyIP ...)
- etc.

Software implementation



IPC@CHIP® RTOS architecture



SC2x
Flexible, simple and powerful

SC1x3
Maximum functionality in a minimum of space

SC2x3
Maximum performance for demanding automation tasks

Simple extension with Add ons

Additional extensions in preparation

Wireless LAN

Bluetooth

GSM/GPRS

Graphic

IEC 61131-3 CoDeSys

EtherCAT EtherCAT Technology Group

M2M Communication

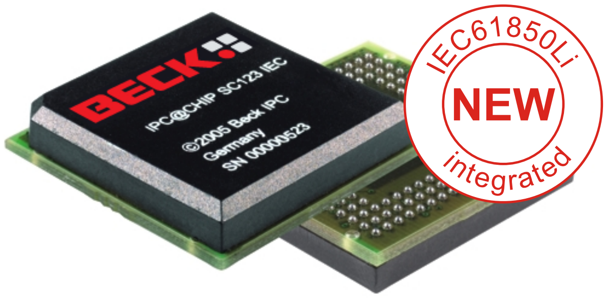
Fieldbus

Development Kits for all Hardware Platforms

Up and Running in 15 Minutes

THE POINT OF SYNERGY

Information Sheet: IPC@CHIP® SC123 / SC143



The SC123/SC143 is a further addition to the IPC@CHIP® product series, offering more performance, more memory and more functions whilst still maintaining full software compatibility with existing SC11 and SC13 controllers.

All the critical and well-established hardware functions and interfaces of SC11/SC13 are retained on the SC123/SC143, and have been enhanced with a number of additional key functions.

The new BGA design supports larger unit volumes in all aspects of industrial control and communication.

	SC123	SC143
Design	BGA177, 25x25x5mm	
CPU	SC186-EX / 96 MHz	
RAM (free)	8 MByte (approx. 7 MB)	
Flash memory (free as Flash disk)	2 MByte (approx. 1 MB)	8 MByte (approx. 7 MB)
Ethernet	1 x 10/100BaseT / PHY, 1 x MII	
Serial	4 x TTL	
CAN	2 x CAN 2.0B master / slave, 1 Mbit/s	
Other interfaces	USB1.1, I2C, SPI	
I/O	31 freely prog. PIO pins (GPIO), 3 x IRQ, 2 x external DMA, 2 timer inputs/outputs, 24-bit address bus, 16-bit data bus	
Operating voltage	3.3V	
Heat dissipation	typ. 1 Watt	
Temp. range	-25 to 85 °C	

Software

Like the well-established SC11/SC13, the IPC@CHIP® SC123 and SC143 products are equipped with the IPC@CHIP®-RTOS preinstalled real-time/multi-tasking operating system and downwards compatible API interface, and are therefore software compatible with SC11 and SC13. Existing SC1x applications can be reused after recompiling with the new Paradigm C/C++ compiler contained in the Development Kit.

The following software functions are also integrated in the RTOS of the SC123/SC143:

- IPv6 (in addition to IPv4)
- Security protocol SSL, SSH and IPSec
- PPPoE
- API for CAN controller (CANopen stack available as option)
- API for elementary USB slave and host functions, support for USB storage devices (USB sticks)
- Only one RTOS version with all available functions (incl. PPP and SNMP)

IEC 61131-3 CoDeSys SP runtime system

The runtime system is derived from CoDeSys SP 2.3 and is available as C library, which makes it easy to implement individual adaptations and enhancements. Besides the extended program memory for CoDeSys-projects the runtime system contains as well a CANopen-stack and supports all 4 serial interfaces.

IEC 61850Li (Lite implementation) integrated

IEC 61850 is a standard for utility automation systems including Smart Grids. It provides a comprehensive data models, communication services, and device and system configuration language (SCL). All models for protection, monitoring and automation for substations in transmission and distribution, monitoring of power quality, hydro power plants, wind turbines, decentralized energy resources like photo voltaic, combined heat and power, diesel gensets, or batteries can be implemented and configured by SCL files.

The IEC 61850-compliant PIS-10 software stack can be launched as a client and as a server. Both applications can coexist at the same time on the IPC@CHIP®. The stack supports IEC 61850 services including GOOSE and sampled values.

More information can be obtained from our website at http://www.beck-ipc.com

Beck IPC GmbH
Grüninger Weg 24
35415 Pohlheim/Germany
E-mail: info@beck-ipc.com
www.beck-ipc.com

Information Sheet: IPC@CHIP® DK61 Development Kit

The Development Kit for the IPC@CHIP® SC123 and SC143 Embedded Controller

Information Sheet: IPC@CHIP® DK61 Development Kit

The Development Kit for the IPC@CHIP® SC123 and SC143 Embedded Controller

The IPC@CHIP® DK61 Development Kit is a complete development system for the new IPC@CHIP® SC123 and SC143 Embedded Controllers.

In addition to the DK60 Development Board it also contains the Paradigm C/C++ Compiler with the IPC@CHIP® RTOS Debugger and many other tools required for creating C applications on the SC123 and SC143 Embedded Controllers.

Despite the powerful hardware features of the Development Board, providing all the interfaces of the SC123 and SC143, commissioning can be carried out easily in a few minutes thanks to the pre-installed RTOS and the supplied “First Steps” guide.

The extensive hardware and software features enable customized applications to be developed quickly and efficiently.

Programming and debugging are carried out via Ethernet as standard, and are also possible via RS232 or USB.

The DK61 contains the CoDeSys IEC61131-3 software development kit for developing custom IEC61131-3 PLC applications on the SC123/SC143.

IEC 61850Li (Lite implementation) integrated

The IEC 61850-compliant PIS-10 software stack can be launched as a client and as a server. Both applications can coexist at the same time on the IPC@CHIP®. The stack supports IEC 61850 services including GOOSE and sampled values.

DK61 Development Kit

The DK61 contains all the hardware and software components required for the fast development of custom applications:

- DK60 Development Board
- Paradigm C/C++ Compiler (Beck IPC edition for IPC@CHIP®), RTOS Remote Debugger and other tools
- CoDeSys IEC61131-3 SDK for SC123/SC143
- IEC 61850 stack (Client/Server, GOOSE) and a configuration Tool based on SCL
- 100-240V / 24V plug-in power supply unit for DK60 (with adapters for international use)
- 2 PC programming cable (RS232 and USB)
- Ethernet patch cable und cross over cable
- SD card
- Practical systainer

DK60 Development Board

The development board provides on a double Eurocard all the functions required for working with the SC123/SC143 Embedded Controllers:

- SC143-IEC Embedded Controller (96 MHz, 8 MB RAM, 8 MB Flash)
- 2 x RS232 (Sub-D socket)
- 2 x RS232/TTL (connector)
- 1 x USB1.1 (can be configured as host or device)
- 2 x CAN 2.0b
- 2 x Ethernet 100Base-T
- MMC/SD and Compact Flash socket
- Extension port for custom hardware expansions
- Directly programmable I/O pins with LED indication
- Power Fail and Reset buttons
- Power supply, 24 VDC input
- Binding of real data to IEC 61850 models by CID file loaded to controller

Read more about the IPC@CHIP® product range at: http://www.beck-ipc.com

Beck IPC GmbH
Grüninger Weg 24
35415 Pohlheim/Germany

E-mail: info@beck-ipc.com
www.beck-ipc.com

Test Case			KEMA Verdict	Short Test Description	Function is Integrated in PIS-10 Stack	Function in User Application	Comments
Documentation	**G**	**A**					
Doc1	M	A	PASSED			yes	Template can be provided by SET
Doc2	M	A	PASSED	Verify MICS describes the semantics of all non-standard Logical Nodes, Data Objects, Data Attributes and enumerations		yes	Template can be provided by SET
Configuration	**G**	**A**					
Cnf1	M	A	PASSED	Test if the ICD configuration file conforms to the SCL document type definition or schema (IEC 61850-6)		yes	User to create and conform to model
Cnf2	M	A	PASSED	ICD == MMS datamodel		yes	
Cnf3	M	A	PASSED	Change configuration		yes	Use ICD Designer to extract ICD from CID
Cnf4	M	A	PASSED	Check if the server capabilies in the ICD "services" section do match with the IED capabilites		yes	Manually to be added to configuration
Cnf5	M	A	PASSED	For fixed control model verify the ICD correctly initializes the ctlModel values for all controllable objects		yes	User to create and conform to model
Modelling	**G**	**A**					
Mdl1	M	A	PASSED	Verify presence of mandatory objects for each LN		yes	ICD Designer has auto-error checker
Mdl2	M	A	PASSED	Verify presence of conditional presence true objects for each LN		yes	User to define
Mdl3	M	A	PASSED	Verify non-presence of conditional presence false objects.		yes	User to define
Mdl4	M	A	PASSED	SCSM name length and object expansion		yes	**User to define**
Mdl5	M	A	PASSED	SCSM organisation of functional components		yes	User to define
Mdl6	M	A	PASSED	SCSM concerning naming of control blocks and logs		yes	User to define
Mdl7	M	A	PASSED	Verify data type of all objects for each LN.		yes	User to define
Mdl8	M	A	PASSED	Verify data attribute values from the device are in specified range (this is a continuous effort during the whole conformance test)		yes	User to define
Mdl9	M	A	PASSED	Data model extensions should be implemented according to the extension rules in IEC 61850-7-4 Annex A.		yes	User to define
Mdl10	M	A	PASSED	Check if the order of the data attributes within the Data Object types match with IEC 61850-7-3		yes	User to define
Mdl11	M	A	PASSED	Check if the order of the data objects within the Logical Node types match with IEC 61850-7-4		yes	User to define
1: Basic	**G**	**A**					
Ass1	M	A	PASSED	Associate and release a TPAA association	✓ Yes		
Ass2	M	A	PASSED	Associate and client-abort TPAA association	✓ Yes		
Ass3	M	A	PASSED	Associate with maximum number of clients simultaneously	✓ Yes		
AssN2	M	A	PASSED	Incorrect association parameters	✓ Yes		
AssN3	M	A	PASSED	Set up maximum+1 associations, last associate is refused	✓ Yes		
AssN4	M	A	PASSED	Disconnect the communication interface, the DUT should detect link lost within a specified period	✓ Yes		
AssN5	M	A	PASSED	Interrupt and restore the power supply	✓ Yes		
Srv1	M	A	PASSED	GetServerDirectory(LOGICAL-DEVICE)	✓ Yes		
Srv2	M	A	PASSED	GetLogicalDeviceDirectory	✓ Yes		
Srv3	M	A	PASSED	GetLogicalNodeDirectory(DATA)	✓ Yes		
Srv4	M	A	PASSED	GetDataDirectory / GetDataDefinition / GetDataValues	✓ Yes		
Srv5	M	A	PASSED	GetDataValues request with the maximum number of data values	✓ Yes		
Srv6	C	A	PASSED	SetDataValues of writable attributes	✓ Yes		
Srv7	C	A	PASSED	SetDataValues request with the maximum number of data values	✓ Yes		
Srv8	C	A	PASSED	Request GetAllDataValues for each functional constraint	✓ Yes		
SrvN1abcd	M	A	PASSED	a: – GetLogicalDeviceDirectory with wrong parameters b: – GetLogicalNodeDirectory with wrong parameters c: – GetAllDataValues with wrong parameters d: – GetDataValues with wrong parameter	✓ Yes		
SrvN1e	C	A	PASSED	– SetDataValues with wrong parameter	✓ Yes		
SrvN3	C	A	PASSED	SetDataValues with mismatching data type	✓ Yes		
SrvN4	M	A	PASSED	SetDataValues for read-only data values	✓ Yes		
2: Dataset sel	**G**	**A**					
Dset1	M	A	PASSED	GetLogicalNodeDirectory(DATA-SET) followed by GetDataSetValues and GetDataSetDirectory	✓ Yes		
Dset10a	M	A	PASSED	Compare GetDataSetValues with GetDataValues	✓ Yes		
DsetN1ae	M	A	PASSED	a = GetDataSetValues response- e = GetDataSetDirectory response-	✓ Yes		
5: Unbuf.Reporting	**G**	**A**					
Rp1	M	A	PASSED	GetLogicalNodeDirectory(URCB) and GetURCBValues	✓ Yes		
Rp2	M	A	PASSED	Optional fields	✓ Yes		
Rp3	M	A	PASSED	Trigger conditions	✓ Yes		
Rp4	M	A	PASSED	General Interrogation	✓ Yes		
Rp7	M	A	PASSED	Buffering events in one report	✓ Yes		
Rp8	C	A	PASSED	Verify the DUT can send reports with data objects	✓ Yes		
Rp9	C	A	PASSED	Verify the DUT can send reports with data attributes	✓ Yes		
Rp10	M	A	PASSED	Verify that all buffered events shall be sent before integrity reports can be sent (IEC 61850-7-2 clause 14.2.3.2.3.3)	✓ Yes		
RpN1	M	A	PASSED	GetURCBValues with wrong parameters	✓ Yes		
RpN2	M	A	PASSED	No triggerconditions	✓ Yes		
RpN3	M	A	PASSED	IntPd=0	✓ Yes		
RpN4	M	A	PASSED	Configure URCB when enabled	✓ Yes		
RpN5	C	A	PASSED	Exclusive use of URCB	✓ Yes		
RpN6	C	A	PASSED	Configure unsupported URCB options	✓ Yes		
6: Buf.Reporting	**G**	**A**					
Br1	M	A	PASSED	GetLogicalNodeDirectory(BRCB) and GetBRCBValues	✓ Yes		
Br2	M	A	PASSED	Optional fields	✓ Yes		
Br3	M	A	PASSED	Trigger conditions	✓ Yes		
Br4	M	A	PASSED	General Interrogation	✓ Yes		
Br7	M	A	PASSED	Buffering events	✓ Yes		
Br8	M	A	PASSED	Buffering reports on lost association, buffer overflow	✓ Yes		
Br9	M	A	PASSED	Set EntryID	✓ Yes		
Br10	C	A	PASSED	Verify the DUT can send reports with data objects	✓ Yes		
Br11	C	A	PASSED	Verify the DUT can send reports with data attributes	✓ Yes		
Br12	M	A	PASSED	Verify that all buffered events shall be sent before integrity reports can be sent (IEC 61850-7-2 clause 14.2.3.2.3.3)	✓ Yes		
BrN1	M	A	PASSED	GetURCBValues with wrong parameters	✓ Yes		
BrN2	M	A	PASSED	No triggerconditions	✓ Yes		
BrN3	M	A	PASSED	IntPd=0	✓ Yes		
BrN4	M	A	PASSED	Configure BRCB when enabled	✓ Yes		
BrN5	M	A	PASSED	Exclusive use of BRCB	✓ Yes		
BrN6	C	A	PASSED	Configure unsupported BRCB options	✓ Yes		
9ab: GOOSE	**G**	**A**					
Gop1	C	A	PASSED	GetGoCBValues	✓ Yes		
Gop2	M	A	PASSED	GOOSE slow retransmit	✓ Yes		
Gop3	M	A	PASSED	Initial GOOSE stNUm=1, sqNum=1	✓ Yes		
Gop4	M	A	PASSED	GOOSE datachange - fast retransmit	✓ Yes		
Gop5	C	A	PASSED	Test mode / Test flag	✓ Yes		
Gop6	C	A	PASSED	Disable a GoCB	✓ Yes		
Gop7	M	A	PASSED	ConfRev not changed after restart	✓ Yes		
Gop10	C	A	PASSED	GOOSE with data objects (attributes are mandatory?)	✓ Yes		
GopN1	C	A	PASSED	When GoEna=TRUE, no attributes of the GoCB control block can be set except for GoEna	✓ Yes		

Test Case			KEMA Verdict	Short Test Description	Function is Integrated in PIS-10 Stack	Function in User Application	Comments
9b: GOOSE Subscribe	**G**	**A**					
Gos1	M	A	PASSED	Send single GOOSE message with new data	✓ Yes		
Gos2	M	A	PASSED	Test or NdsCom is set	✓ Yes		
Gos3	M	A	PASSED	sqNum rollover	✓ Yes		
GosN1	M	A	PASSED	Missing GOOSE	✓ Yes		
GosN2	M	A	PASSED	Double GOOSE	✓ Yes		
GosN3	M	A	PASSED	Delayed	✓ Yes		
GosN4	M	A	PASSED	Out-of-order	✓ Yes		
GosN5	M	A	PASSED	No GOOSE	✓ Yes		
GosN6	M	A	PASSED	Invalid GOOSE	✓ Yes		
12a: DOns	**G**	**A**					
Ctl2	C	A	PASSED	Test flag	✓ Yes		
CtlN3	M	A	PASSED	Operate value is the same as the actual value	✓ Yes		Current position of switch to be provided by user application, depends on hardware design
CtlN8	M	A	PASSED	Operate a direct control object twice from 2 clients		yes	User implementation according to hardware design
CtlN11	C	A	PASSED	Status remote - controls are accepted; Status local - controls are rejected		yes	User implementation according to hardware design
DOns1	M	A	PASSED	Correct Operate request		yes	User implementation according to hardware design
DOns3	M	A	PASSED	Client requests Oper resulting in Test not ok	✓ Yes		
12b: SBOns	**G**	**A**					
Ctl2	C	A	PASSED		✓ Yes		
Ctl3	M	A	PASSED		✓ Yes		User application to interact with stack internal control state machine according to hardware design via API
CtlN1	M	A	PASSED		✓ Yes		
CtlN2	M	A	PASSED		✓ Yes		
CtlN3	M	A	PASSED		✓ Yes		User application to interact with stack internal control state machine according to hardware design via API
CtlN4	M	A	PASSED			yes	User implementation according to hardware design
CtlN11	C	A	PASSED	Status remote - controls are accepted; Status local - controls are rejected		yes	User implementation according to hardware design
SBOns2	M	A	PASSED		✓ Yes		sboTimeout needs to be defined in the model and it should have a timeout value
12c: DOes	**G**	**A**					
Ctl2	C	A	PASSED	Test flag	✓ Yes		
CtlN3	M	A	PASSED	Operate value is the same as the actual value	✓ Yes		User configuration according according to functionality, executed by stack
CtlN8	M	A	PASSED	Operate a direct control object twice from 2 clients		yes	User implementation according to hardware design
CtlN11	C	A	PASSED	Status remote - controls are accepted; Status local - controls are rejected		yes	User implementation according to hardware design
DOes2	M	A	PASSED	Client requests Oper resulting in Test not ok	✓ Yes		
DOes5	M	A	PASSED	Send a correct Operate request: 1) with value change, 2) no value change, 3) intermediate value change	✓ Yes		User configuration according according to functionality, executed by stack
12d: SBOes	**G**	**A**					
Ctl2	C	A	PASSED	Test flag	✓ Yes		
Ctl3	M	A	PASSED	Select all SBO control objects and cancel them in opposite order		yes	User implementation according to hardware design
CtlN1	M	A	PASSED	Operate (without select) a SBO control object	✓ Yes		
CtlN2	M	A	PASSED	Select twice, second select should fail (or resets the select timeout)	✓ Yes		
CtlN3	M	A	PASSED	Operate value is the same as the actual value		yes	User implementation according to hardware design
CtlN4	M	A	PASSED	Select the same control object from 2 different clients		yes	User implementation according to hardware design
CtlN9	M	A	PASSED	Operate with different value then the SelectWithValue	✓ Yes		
CtlN11	C	A	PASSED	Status remote - controls are accepted; Status local - controls are rejected		yes	User implementation according to hardware design
SBOes1	M	A	PASSED	Incorrect Select	✓ Yes		
SBOes2	M	A	PASSED	SelectWithValue then 1) cancel, 2) timeout, 3) operate test not ok	✓ Yes		User configuration according according to functionality, executed by stack
SBOes3	M	A	PASSED	SelectWithValue - correct Operate request: 1) with value change, 2) no value change, 3) intermediate value change	✓ Yes		User configuration according according to functionality, executed by stack
13: Time Sync	**G**	**A**					
Tm1	M	A	PASSED	Verify the DUT supports the SCSM time synchronisation	✓ Yes		Time synchronization to be linked with time management of system firmware
Tm2	M	A	PASSED	Check report/logging timestamp accuracy matches the documented timestamp quality of the server	✓ Yes		
TmN1	M	A	PASSED	Verify that when time synchronisation communication lost is detected after a specified period	✓ Yes		

M: Mandotary
A: Applicable
C: Conditional
n/a: Not Applicable

IEC 61850 Certificate Level A[1]

No. 74100344-NMEA 11-0597

Issued to:
SystemCORP Embedded Technology Pty Ltd
Suite 4/12 Brodie Hall Drive
Technology Park
Bentley WA 6102
Australia

For the product:
WebCAN Substation Control and
Monitoring System PIS-10
Firmware V1.36.00

Software runs on the
Beck IPC SC143

Issued by: KEMA

The product has not shown to be non-conforming to:

IEC 61850-6, 7-1, 7-2, 7-3, 7-4 and 8-1

Communication networks and systems in substations

The conformance test has been performed according to IEC 61850-10 with product's protocol, model and technical issue implementation conformance statements: "IEC 61850 SET Protocol Implementation Conformance Statement (PICS) WebCAN, version 4.01", "IEC 61850 SET Model Implementation Conformance Statement (MICS) WebCAN, version 1.02", "IEC 61850 SET TISSUES Implementation Conformance Statement (TICS) WebCAN, version 1.02" and product's extra information for testing: "IEC 61850 SET Protocol implementation eXtra Information for testing (PIXIT) WebCAN, version 1.05".

The following IEC 61850 conformance blocks have been tested with a positive result (number of relevant and executed test cases / total number of test cases as defined in the UCA International Users Group Device Test procedures v2.2):

1	Basic Exchange (19/24)	12a	Direct Control (6/11)
2	Data Sets (3/6)	12b	SBO Control (8/14)
5	Unbuffered Reporting (14/18)	12c	Enhanced Direct Control (6/13)
6	Buffered Reporting (16/20)	12d	Enhanced SBO Control (11/19)
9a	GOOSE Publish (9/12)	13	Time Synchronization (3/4)
9b	GOOSE Subscribe (9/10)		

This Certificate includes a summary of the test results as carried out at KEMA in the Netherlands with UniCAsim 61850 version 3.21.02 with test suite 3.21.02 and UniCA 61850 analyzer 4.22.02. The test is based on the UCA International Users Group Device Test Procedures version 2.2. This document has been issued for information purposes only, and the original paper copy of the KEMA report: No. 74100344-NMEA 11-0596 will prevail.

The test has been carried out on one single specimen of the product as referred above and submitted to KEMA by SystemCORP. The manufacturer's production process has not been assessed. This Certificate does not imply that KEMA has certified or approved any product other than the specimen tested.

Arnhem, 15 Maart 2011

M. Adriaensen
Regional Director Management & Operations Consulting

Robin Massink
Test Engineer

1 Level A - Independent Test lab with certified ISO 9000 or ISO 17025 Quality System

KEMA Nederland B.V.
Utrechtseweg 310, 6812 AR Arnhem P.O.Box 9035, 6800 ET Arnhem The Netherlands
T +31 26 356 61 42 F +31 26 351 36 83 sales@kema.com www.kema.com