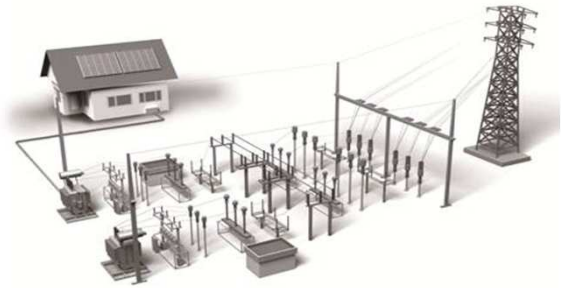
Migration of IEC 61850 to Smart Grid



Budapest, June 2nd, 2016

Our customers can be found in many different industries

These are our markets

Machinery

Machine Tools

Food & Beverage

Automotive

Elevators & Escalators

Conveying Systems

Process

Oil & Gas

Chemical / Pharma

Water Treatment

Energy

Renewables

Traditional

Transmission & Distribution

Transportation

Railway

Infrastructure

Ship Building

Device Manufacturer

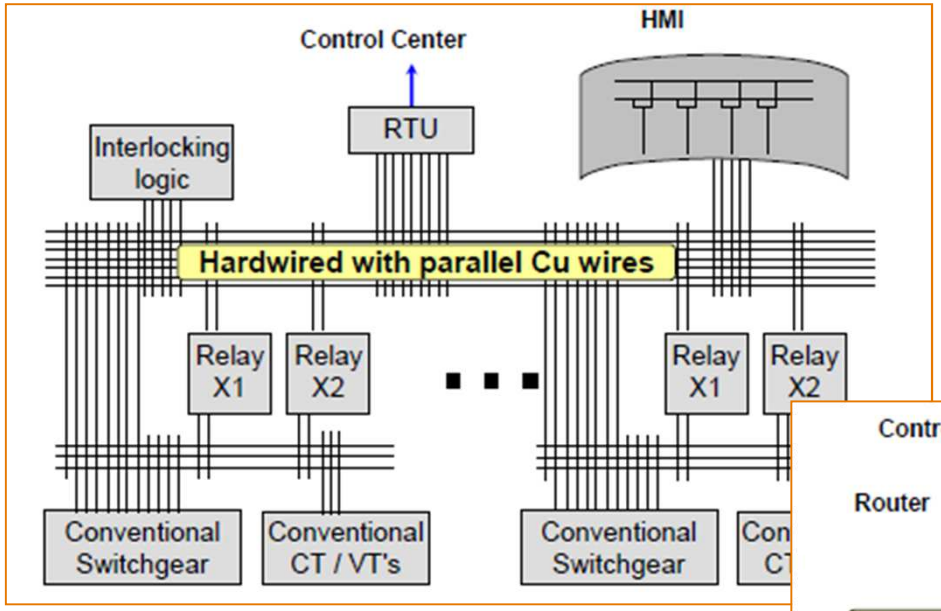
I/O control devices

Drive Controls & Power Electronics

Interface Electronics

Migration of IEC 61850 to Smart Grid – from substation automation system to low and medium voltage energy distribution networks?

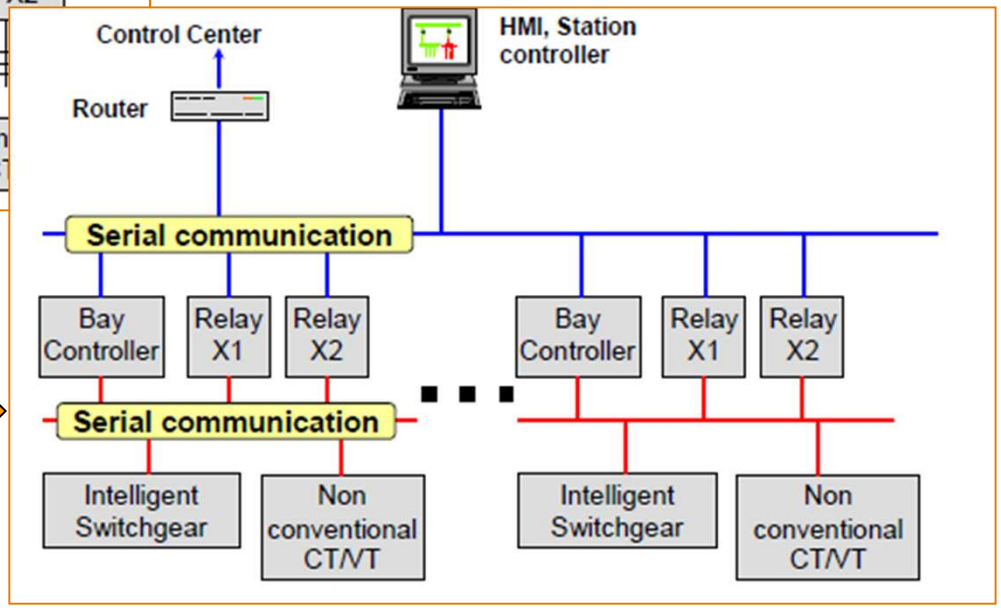
IEC 61850 for serial communication to reduce wiring in a substation



Lower labour costs for connecting devices of the substation

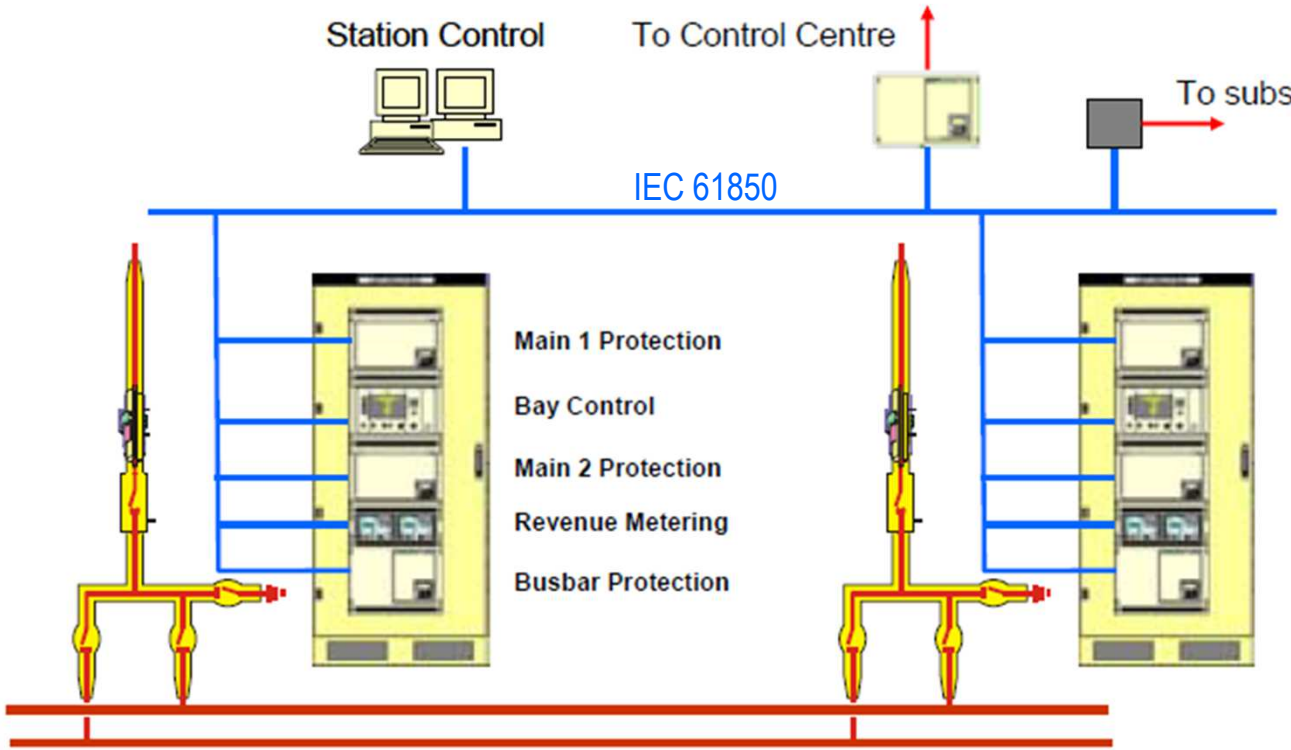
1995

Reduced copper costs by using just communication cables



Original scope – IEC 61850

IEC 61850 is a quite well known ethernet protocol derivate used for communication networks and systems in substations. It has been developed more than 10 years ago with the scope to replace the parallel wiring of the substation by serial communication between the power stations control level and the equipments like switchgears, bay control, protection relays and CT/VT as well as the communication between substations themselves.



- Monitoring
  - Status of breakers and disconnectors
  - Energy flow
  - Condition of the process equipment
- Alarm handling
- Event lists
- Control
  - Local and remote control of the substation
  - Interlocking of commands
- Disturbance recording

Goals of IEC 61850 for Primary Substation Automation

Interoperability between IED (intelligent electronic devices) from different suppliers
Through standardized data models and information exchange
Exchange information between IED's from several manufacturers, Logical Nodes

Functional flexibility
Free allocation of functions to devices
Support any philosophy of our customer – centralized or decentralized systems

Long term stability and life time
Future proof
Follow progress in mainstream communication technology
Follow evolving system requirements needed by our customers

Critical task management
Grid protection
Synchronized Measurement

Up to now the technology did not achieve a real breakthrough, just a few 100% "digital substations" have been realized

Possible reasons?

Is the global market too conservative?

Is the technology not safe enough for critical infrastructure?

Is the technology really ready to be used?

Is substation automation not a mass market, is it a mature market?

Are not enough devices , IED available?

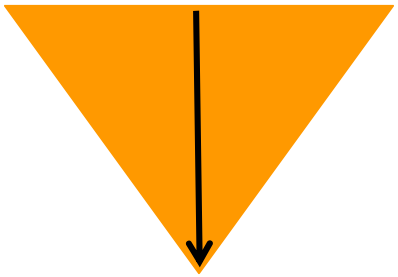
Who is really driving the technology?

IEC61850 new title to indicate extended approach

+

Former title:

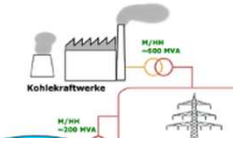
Communication networks and systems in substations



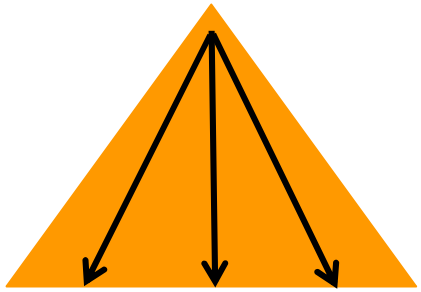
New title

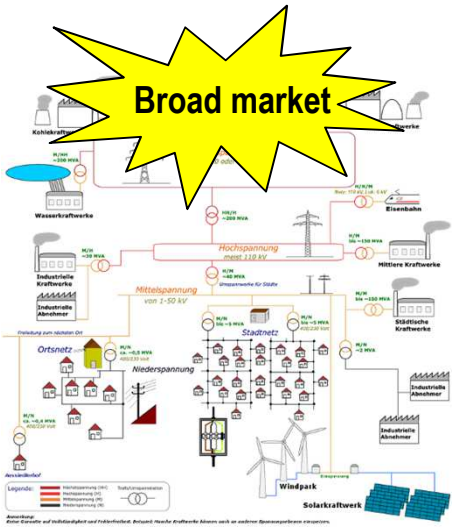
Communication networks and systems for power utility automation

Addressing broader application area because it has to cover all kinds of power generation and storage as well as the power distribution area to the low voltage consumer level.



Narrow market

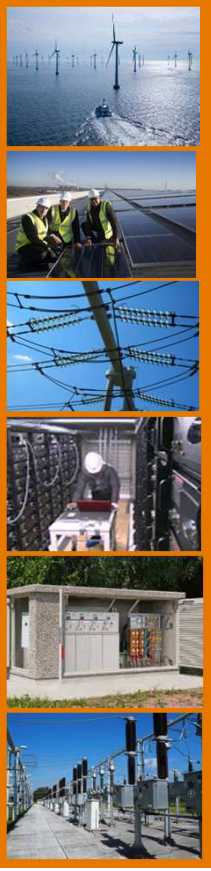




The IEC 61850 way forward…

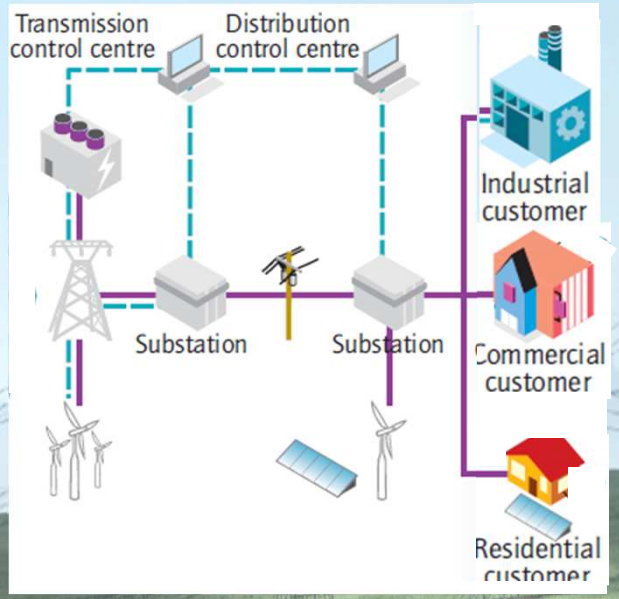
IEC 61850 Substation Definitions 2004/2005 ff

- IEC 61400-25 : IEC61850 methodology for wind farms
- IEC 61850 -7-410: Hydroelectric power plants
- IEC 61850 -7-420: DER (Distributed energy resources)
- IEC 61850-90-7, 8, 9: Object models PV, storage, e-mobility
- IEC 61850 -90-1: Communication between substations
- IEC 61850-90-2: Substations and control center communication
- IEC 61850-90-3: Condition monitoring, power quality

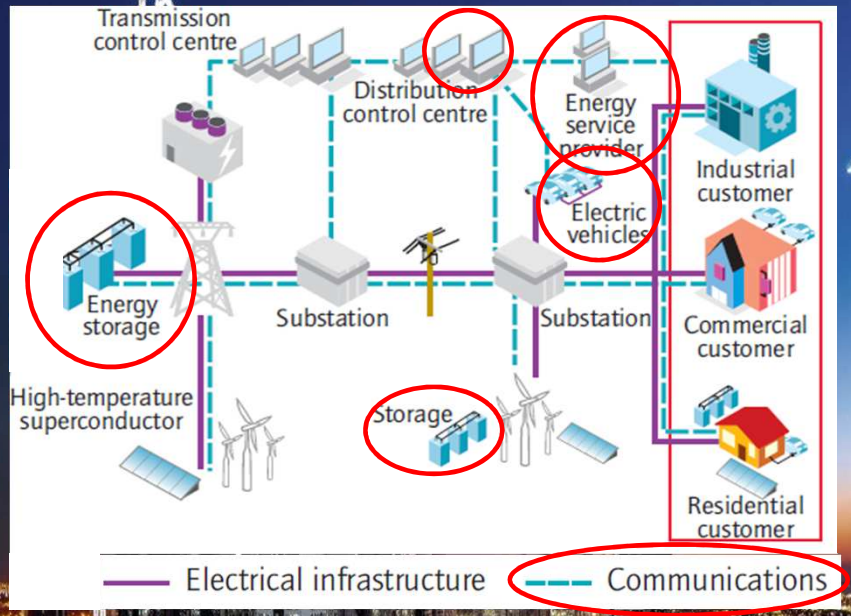


Smart Grid requirements

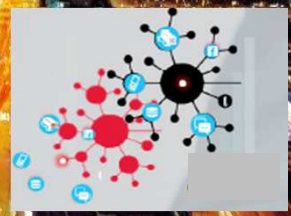
TODAY:



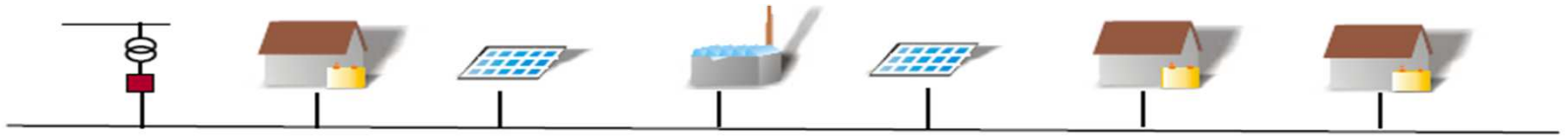
TOMORROW: Smart Grids & IEC 61850



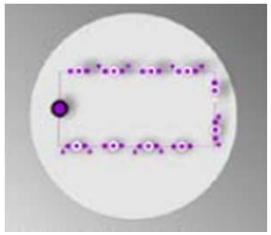
Grid Control and Automation
Monitoring & Metering
Data Communication, IoT, Big Data



Main Tasks and Data in Intelligent Distribution Networks, Smart Grids



Grid Control and Automation



Data Communication

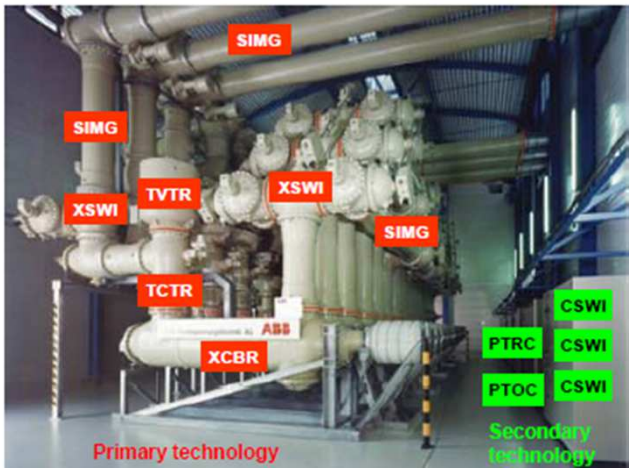
Smart Metering

Tasks	→emote control of circuit breakers →emote monitoring and metering	→control systems and all kind of power generation, wind, PV, hydro power & consumers	→data communication of “smart meters”, → more flexible customer tariffs
	Better quality of supply	**Aggregation by data concentration**	**Motivation for energy efficiency, costs and benefits**
Data	Consumption data ¼ h Metering I, U, P, Q Switching status main switch Switch command main switch Short-circuit indicator Indicator reset	Consumption data¼ h Metering I, U, P, Q, P th, E st Must values P, Q Schedule (P, Q, 96 ¼ h) Switch command Installation conditions	Consumption data 1h Tariff signals, Forecasting Total consumption Costs Interface to “smart home”

U – Voltage, I – current,
P – Power, Q – reactive Power,
E – available Energy,
th - thermal, st - storage

Tasks and data are similar to these already known from substation automation

Logical Nodes with Data Objects represent core functions



Get/Set
Report
QueryLog
Configure
Retrieve selfdescr.

Virtual power plants
Bundling of decentralised producers in virtual power plants

Fault Alarm/Passage System
Indication of faults of substations and decentralised sub-systems

Energy storage systems to balance grids
Control technologies for battery stations, power-to-gas, hydro……

Smart Metering and data access
Remote data aquisition via cyclic communication requests

LV Grid Control stations
Local monitor and control of grid voltage and quality

IEC 61850 Logical Node Classes

L System LN
P Protection
R Protection Relay
C Control
G Generic
I Interface
A Automatic Control
M Metering measurement
S Sensor
X Switchgear
T Instrument transformer
Y Power transformer

Re-use

Data objects

Logical Node MMXU in IEC 61850-7-3 – Measurements of a 3-phase electrical system

Measured data

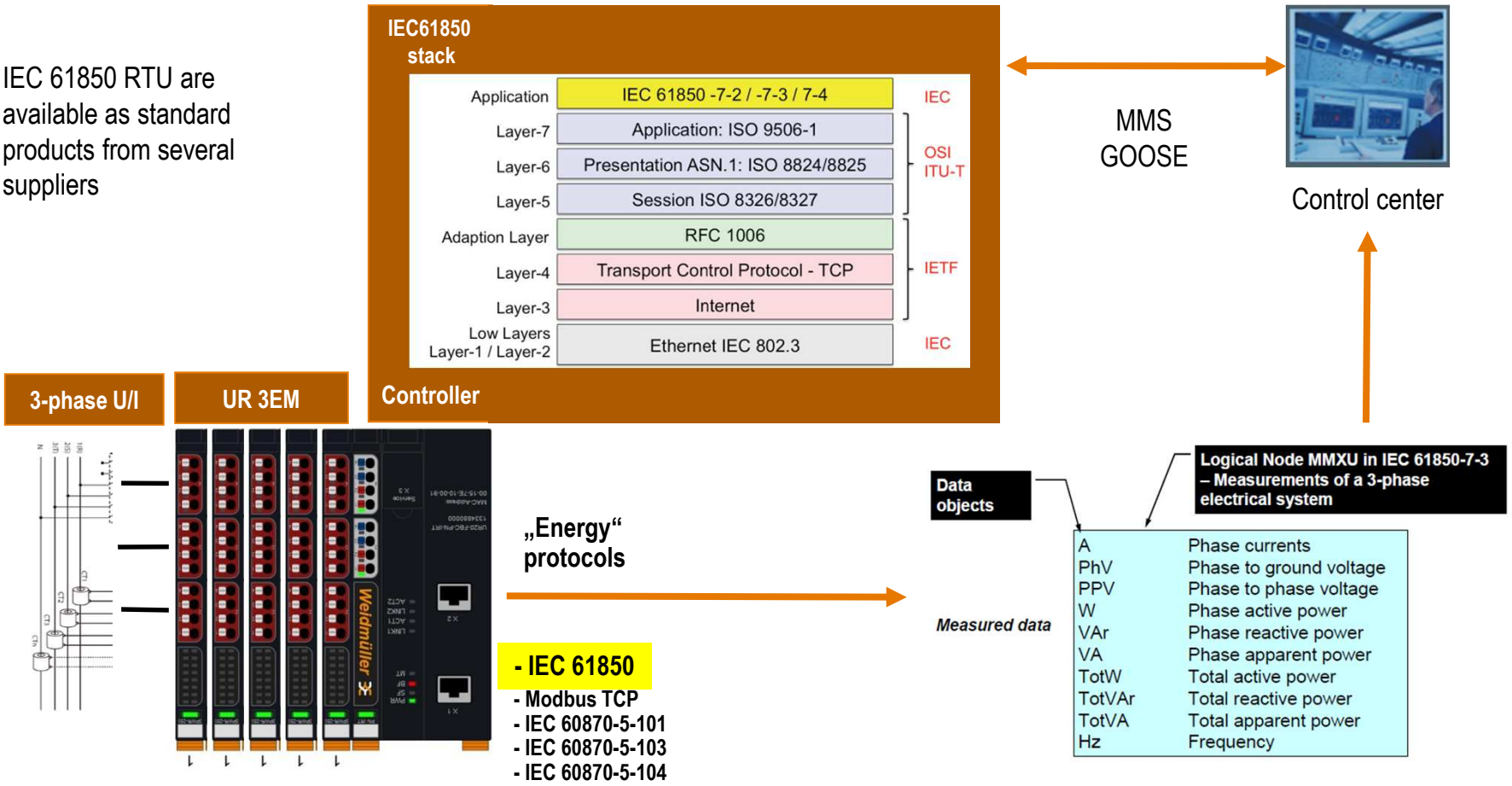
A	Phase currents
PhV	Phase to ground voltage
PPV	Phase to phase voltage
W	Phase active power
VAr	Phase reactive power
VA	Phase apparent power
TotW	Total active power
TotVAr	Total reactive power
TotVA	Total apparent power
Hz	Frequency

Example

IEC 61850 Remote Terminal Unit RTU

One key device is an RTU (remote terminal unit) with embedded IEC 61850 stack and Ethernet IEC 61850 protocol for communication.

IEC 61850 RTU are available as standard products from several suppliers



MMS: Manufacturing-Messaging Specifications
GOOSE: Generic object oriented substation events

It is not all about software……..IEC 61850-3!

IEC 61850-3 covers also extended ambient and EMC conditions for all used devices and installation equipment. This is of course well accepted for decentralized energy applications.

Protection Relay Interface

WIPRO
Testing interface for protection relay gear and automation facilities

POCON
Compact interface system for test-disconnect terminals

Metering Infrastructure

Measuring Terminal Assembly
Terminal assembly for indirect measuring voltage and current

Surge Protection Devices
To protect from over-voltage & lightning the energy meter

VARITECTOR LOGGER
Continuous recording of overvoltage events

CT/VT

Remote Terminal Units

Remote I/O - u-remote

Temperature

Operating temperature -40+75°C (C3)
(Different C-classes are specified)

Vibrations

Earth quake simulations 3.5g @ 10 min

Shock

Shock test 15g for all three axis

EMI/EMC

In line with IEC 60255 / IEC 61000-6-5

Substation Automation

Managed switches
Managed switches for the entry into a configurable network infrastructure .
IEC61850

Fiber Optic cables and patches

Accessories: TOOL SET IE-POF
F/O Tools Kit

Relays
Term, D-Series, Safe-Series

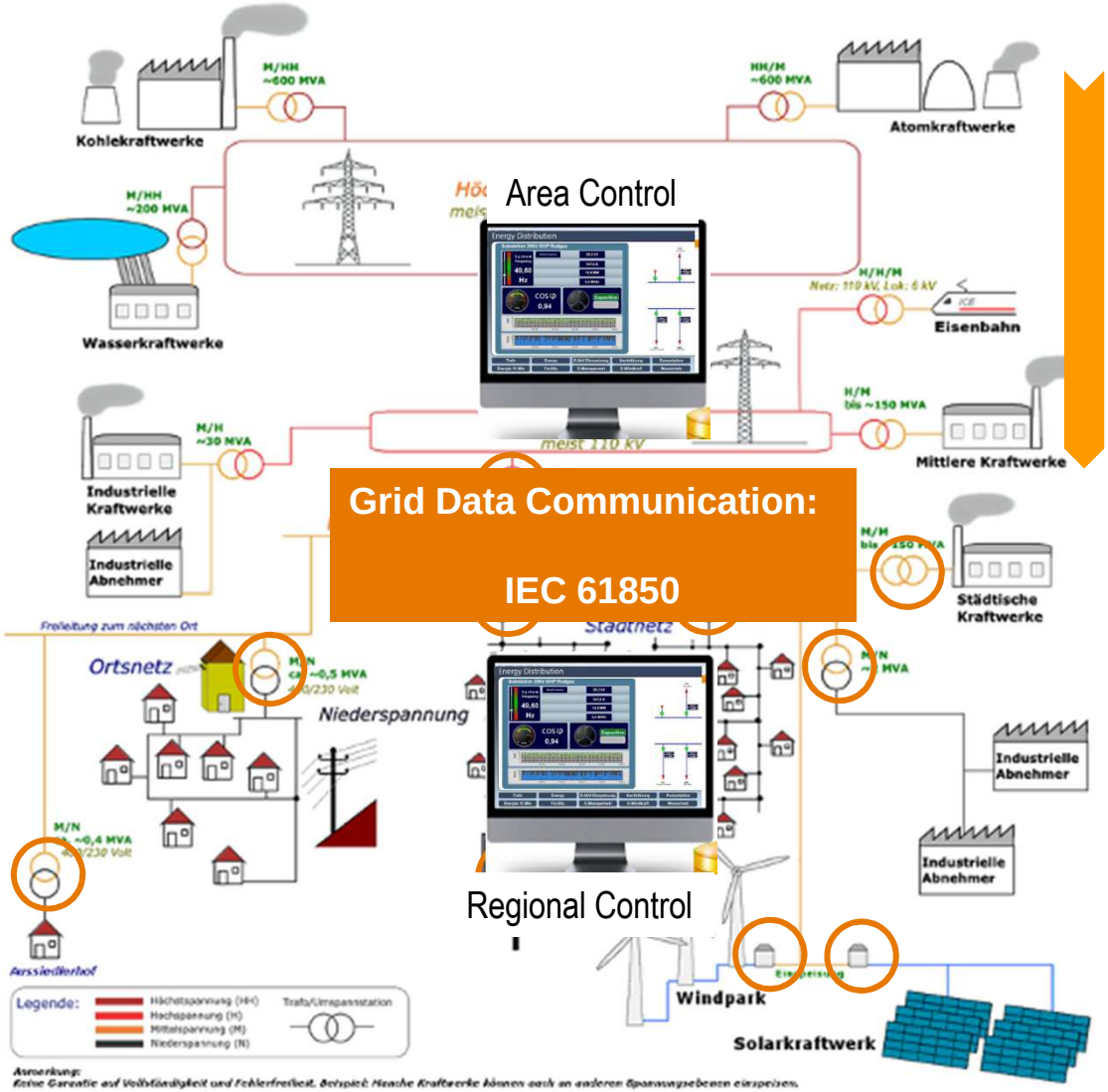
Terminals
WDU, SAK, WTD, WTL, HDC Marker

Power supplies and UPS system

Serial/fiber-optic converter

It is a question to the device manufacturing companies to increase their product portfolio and to combine state-of-the-art software functionality with extended environmental features in their modules.

IEC 61850 from power generation to power consumption



IEC 60870-5-101/4 with data models of IEC 61850:
IEC 61850-7-410 hydro stations
IEC 61850-80-1 or complete: IEC 61850-90-2

IEC 61850-8.1 in all and IEC 61850-90-1 between substations

IEC 61850-7-4 switch gears
IEC 61850-7-420 DER
IEC 61400-25 wind turbines
IEC 61850-7-x new data models e.g. smart meter, smart terminal

Conclusions

The functionality and the general standards of IEC 61850 seem to fit to the requirements of grid communication on all levels. It can be expected that the migration of IEC 61850 technology from substation automation to smart grid automation will continue. An unique network from power generation to the households becomes closer to reality.

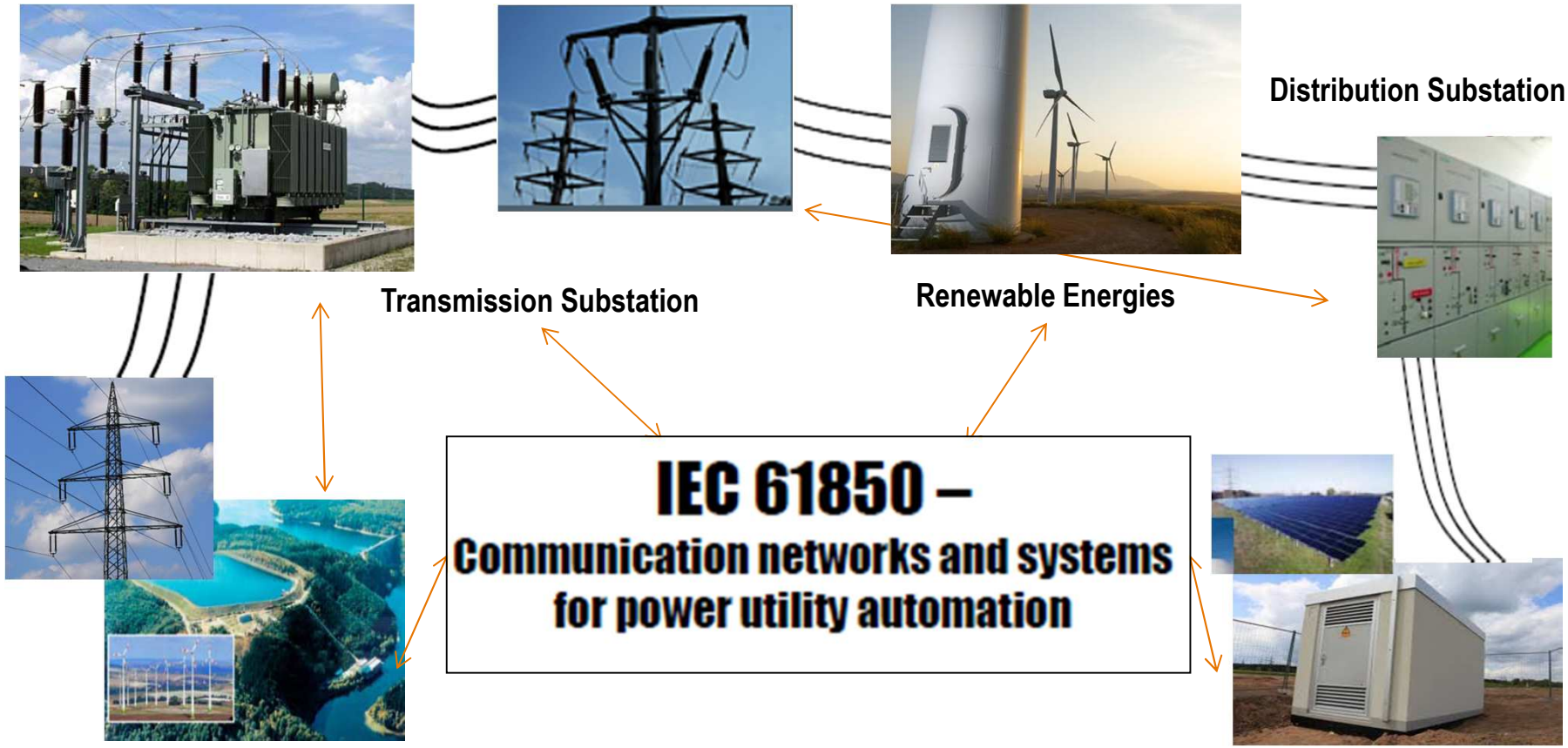
Conclusions:

- The application of the three pillars of smart distribution networks started
- The adaption effort for data models for the distribution network is fairly low
- New data models are to be adopted to the standards
- Commercially available IEC 61850-stacks lead to efficient device development
- The usage of several physical media of the existing communication infrastructure is unproblematic due to the availability of communication adapter on the market.
- The first control centers for SmartDistribution are realized with IEC 61850

With the application of IEC 61850 in the distribution network the circle is closing: now we can finally rely on the IEC 61850 as single uniform standard from the socket to the control center.

Communication Network and Systems for Power Utility Automation

IEC 61850 provides all applications up to the distribution network



Thanks for your attention!