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Smart Grid and modern Excitation

It's all about communication

智能电网与现代励磁系统 的基石——通讯技术

主要内容

Topics

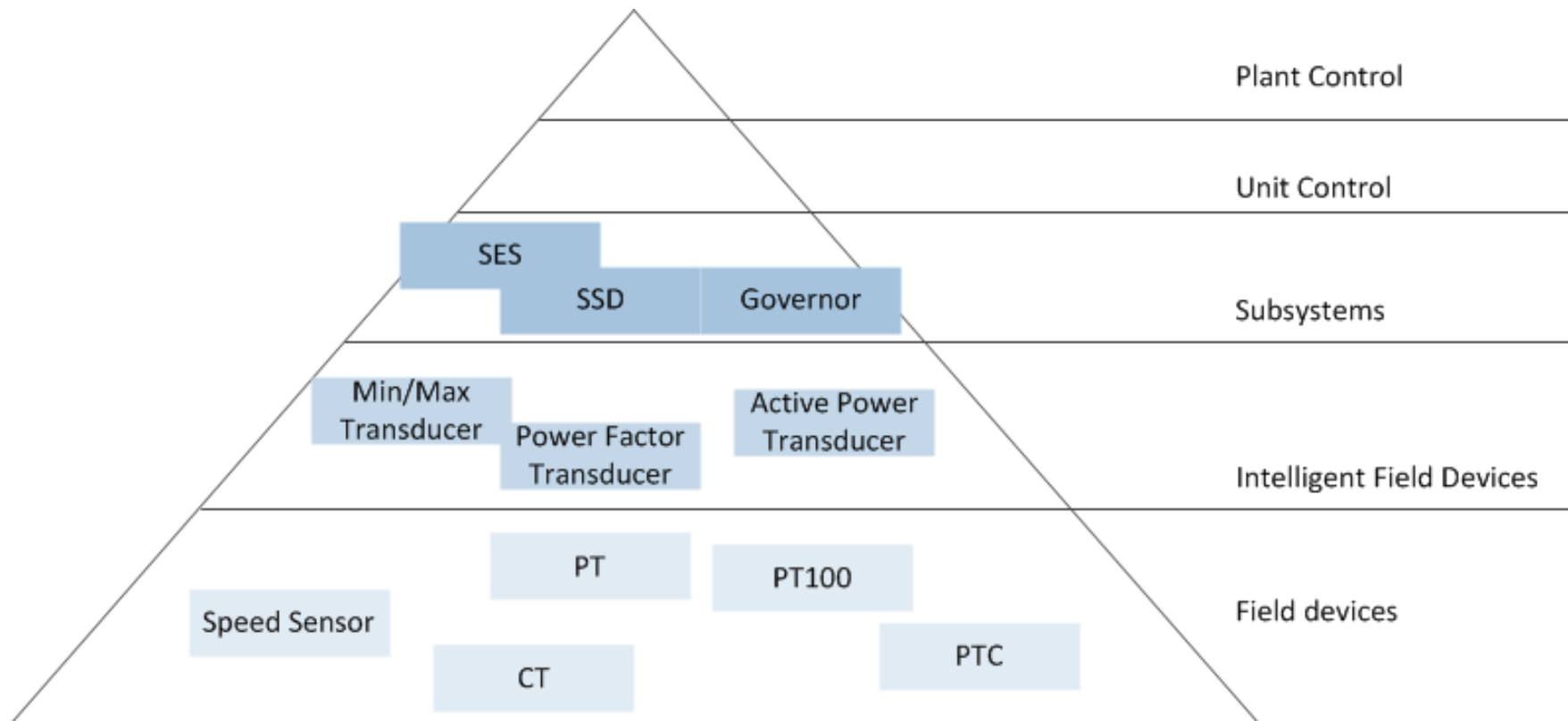
- Serial Communication – An overview
- 串行通讯——技术总览
- Comparison
- 对比
- IEC 60870-5-104

- OPC

- IEC 61850

Serial Communication 串行通讯

An Overview 总览



Vertical Communication: Communication between different segments (upper segment is the master)

Horizontal communication: Communication between different devices in the same segment

纵向通讯: 不同部分之间的通讯 (上层部分为**master**)

横向通讯: 同一部分的不同设备间的通讯

Serial Communication 串行通讯

An Overview 总览

▪ Modbus RTU/TCP

- Modbus is a serial communications protocol published by **Modicon in 1979** for use with its programmable logic controllers (PLCs). Simple and robust, it has since become one of the de facto standard communications protocols in the industry, and it is now amongst the most commonly available means of connecting industrial electronic devices. **Modbus RTU** is running over a serial RS-232, RS-485 link, **Modbus TCP** running over Ethernet using TCP/IP Stack.
- Modbus是一种串行通讯协议，由Modicon1979年发布，主要用于其可编程逻辑控制器（PLCs）。其简单而可靠的特点，使得它成为了工业领域里运用最多的通讯协议之一，用于连接众多的工业控制设备。Modbus RTU运用于RS-232，RS-485连接；Modbus TCP运用于通过以太网的TCP/IP连接。

▪ Profibus

- The history of PROFIBUS goes back to a publicly promoted plan for an association started in **Germany in 1987** and for which 21 companies and institutes devised a master project plan called "field bus". The goal was to implement and spread the use of a bit-serial field bus based on the basic requirements of the field device interfaces. For this purpose, member companies agreed to support a common technical concept for production (i.e discrete or factory automation) and process automation. There are different Versions such as **DP/PA** and **DP-V0, DP-V1, DP-V2** available
- PROFIBUS的历史可追溯到1987年德国开始的一个合作计划，此计划有十四家公司及五个研究机构参与，目标是要推动一种串行现场总线，可满足现场设备接口的基本需求。为了这个目的，参与的成员同意支持有关工厂生产及程序自动化的共通技术研究。目前有不同版本可供选择，如DA/PA,DP-V0,DP-V1,DP-V2

▪ MMS

- Manufacturing Message Specification (MMS) is an **international standard (ISO 9506)** defined in **1990** dealing with messaging system for transferring real time process data and supervisory control information between networked devices and/or computer applications. The standard is developed and maintained by the ISO Technical Committee 184 (TC184).
- Manufacturing Message Specification (MMS) 是一种国际标准 (**ISO 9506**)，形成于1990。主要处理用于传输实时过程数据及监视不同网络设备/或计算机应用程序间控制信息的信息系统。该标准由ISO技术委员会 184 (TC184) 开发及维护。

Serial Communication 串行通讯

An Overview 总览

▪ IEC61850

- IEC 61850 is a standard for the design of electrical substation automation. IEC 61850 is a part of the **International Electrotechnical Commission's (IEC) Technical Committee 57 (TC57)** reference architecture for electric power systems. The abstract data models defined in IEC 61850 can be mapped to **a number of protocols**. These protocols can run over **TCP/IP networks** and/or substation LANs using high speed switched Ethernet to obtain the necessary **response times of < 4 ms for protective relaying**.
- IEC 61850 是一个变电站自动化设计标准。IEC 61850 作为**International Electrotechnical Commission's (IEC) Technical Committee 57 (TC57)** 的一部分，致力于电力系统构架。定义域 IEC61850 中的简化数字模型可映射与一组协议。该协议可运行于 TCP/IP 网路及/或局域网子站，采用高速以太网切换以获得保护系统需要的快速响应（小于 4ms）。

▪ IEC60870-5-104

- IEC 60870-5-104 (IEC 104) protocol is an extension of IEC 101 protocol with the changes in transport, network, link & physical layer services to suit the complete network access. It was standardized **1990**. The standard uses an open TCP/IP interface to network to have connectivity to the LAN **OPC**
- IEC 60870-5-104 (IEC 104) 协议是 IEC 101 协议的扩展，该协议在传输、网路、链接及物理层设备方面扩展以适应整个网络的访问需求。其产生于 1990 年。该标准对网络采用了开放式 TCP/IP 接口，可连接于 LAN OPC。

▪ OPC

- OLE for Process Control (OPC), which stands for Object Linking and Embedding (OLE) for Process Control, is the original name for a standards specification developed in **1996 by an industrial automation industry task force**. The standard specifies the communication of real-time plant data between control devices from different manufacturers.
- Object Linking and Embedding (OLE) 过程控制中的对象连接与嵌入，称为 OPC (OLE for Process Control)，其名称来源于 1996 年工业自动化特别委员会的一个规格标准。该标准定义了来自不同制造厂商控制设备间实时数据的通讯。

Comparison 对比

Feature	60870-5-101	60870-5-104	60870-5-103	DNP3	60870-6-TASE.2	61850
Application domain	Telecontrol (SCADA)	Telecontrol (SCADA), intra-substation and control-center to substation	Protection	Telecontrol (SCADA), intra-substation and control-center to substation	Control-center to control-center	Substation and feeder automation (open for other domains)
Main coverage	Application Layer (Services and Protocol)	Application Layer (Services and Protocol)	Application Layer (Services and Protocol) and basic Application Semantic	Application Layer (Services and Protocol)	Application Layer (Services and Protocol) and basic Application Semantic	Application Semantic (models of devices and applications), Substation configuration language, and Application Layer (Services and Protocol)
Standardization	IEC Standard (1995) Amendments (2000, 2001)	IEC Standard (2000)	IEC Standard (1997)	Open Industry Specification (1993), IEEE 1379 Recommended Practice (2000)	IEC Standard (1997)	Some parts are IEC Final Draft International Standard (FDIS), other are DIS, CDV, CD (as per 2001-12)

来源: <http://www.nettedautomation.com>

Comparison 对比

Feature	60870-5-101	60870-5-104	60870-5-103	DNP3	60870-6-TASE.2	61850
Standardisation Organization	IEC TC 57 WG 03	IEC TC 57 WG 03	IEC TC 57 WG 03	DNP Users Group (took the specification over in 1993); IEEE	IEC TC 57 WG 07	IEC TC 57 WG 10, 11, and 12
Use in other organizations as base standard				Considered for standardization by Australian water utility industry.		Project 25 of IEC TC 88 (Wind Turbine Systems) uses IEC 61850 as base standard for IEC 61400-25
Crucial design rule used for the development process of the standard	Optimize use of Bandwidth and hardware	Optimize use of Bandwidth and hardware	Optimize use of Bandwidth and hardware	Optimize use of Bandwidth and hardware	Simplify device (data) engineering and integration	Simplify device (data) engineering and integration; re-use models
Further design rules	Merge the features of earlier proprietary protocols, Push the intelligence in the network toward the remote device	Merge the features of earlier proprietary protocols, Push the intelligence in the network toward the remote device	Merge the features of earlier proprietary protocols, Push the intelligence in the network toward the remote device	Merge the features of earlier proprietary protocols, Push the intelligence in the network toward the remote device	Use standard communication protocols. Push the intelligence in the network toward the remote device	Use standard communication protocols. Push the intelligence in the network toward the remote device
Crucial Paradigm	Exchange of numbered lists of simple data points	Exchange of numbered lists of simple data points	Exchange of numbered lists of simple data points	Exchange of numbered lists of simple data points	Exchange of named lists of simple and complex data points	Modeling of application objects and exchange of I/O and Meta data (Data Management)

来源: <http://www.nettedautomation.com>

Comparison 对比

Feature	60870-5-101	60870-5-104	60870-5-103	DNP3	60870-6-TASE.2	61850
Cyclic transmission	+	+	+	Permitted, but interval cannot be remotely adjusted	+	+
Spontaneous transmission	+	+	+	+	Flexible	Flexible
Read	Single	Single	Single	Many	Many	Many
Write	Single	Single	Single	Many	Many	Many
(device) interrogation	+	+	+	+	+	+
Clock synchronisation	+		+	+		+
Control commands	+	+	+	+	+	+
Exchange integrated totals	+	+		+	+	+
Remote substitution (online)						+
Substitution indication	Quality indication	Quality indication		Quality indication	Quality indication	Quality indication
Time series data	+	+	+	+	+	Any data (report and logging)
Sequence of events	+	+	+	+		Status data (report and logging)
Report data values	+	+	+	+	+	Any data (with filter)

来源: <http://www.nettedautomation.com>

IEC60870-5-104

- Details:
 - Protocol running on the TCP/IP-Stack
 - Redundancy possible with RNRP (Redundant Network Routing Protocol)
- 细节:
 - 协议运行于TCP/IP程序
 - 可通过RNRP (Redundant Network Routing Protocol)提供冗余
- Application
 - Often used together with an OPC <-> IEC 60870-5-104
 - Many references in South America
- 应用
 - 常和OPC <-> IEC 60870-5-104一起使用
 - 在南非有很多运用实例

OPC

Object Linking and Embedding for Process Control

过程控制中的对象连接与嵌入

- Details:
 - Based on OLE, COM and DCOM from Microsoft
 - Protocol running on TCP/IP Stack
 - OPC AE => Alarm and Event Handling
 - OPC DA => Data Access
- 细节:
 - 基于微软的OLE, COM 和DCOM
 - 协议运行于TCP/IP程序
 - OPC AE => Alarm and Event Handling报警及事件处理
 - OPC DA => Data Access数据访问
- Application
 - Used for UNITROL HMI
 - Used for integration in upper control systems
- 应用
 - 用于 UNITROL 人机界面
 - 用于上层控制的集成

IEC 61850

Much more than just a protocol

不仅仅只是一个协议

IEC 61850 Timeline of development 开发时间表

IEC

“Committee
Drafts for
vote”

“Final drafts
International
Standard”

“International
Standard”

一个世界
一种技术
一个标准

1995

2001

2002

2003

2005

**IEC
61850**

one world

one technology

one standard

Providers

Common work on
the standard and on
the interoperability
共同合作于
标准的制定

ABB, AREVA, SIEMENS
with the first interoperable
products on the market
ABB, AREVA, SIEMENS
首度合作产品推向市场

IEC 61850

Content内容

IEC 61850 Edition 1

Communication Networks and Systems in Substations

14 parts: IEC 61850-x-y (2002-2005)

Part 1: Introduction and Overview

Part 2: Glossary

Part 3: General Requirements

Part 4: System and Project Management

Part 5: Comm. Requirements for Functions and Device Models

Part 6: Configuration description Language for Communication in electrical Substations related IEDs

Part 7-1: Principles and Models

Part 7-2: Abstract Communication Services (ACSI)

Part 7-3: Common Data Classes

Part 7-4: Compatible Logical Node Classes and Data Classes

Part 8-1: Mapping to MMS and to ISO/IEC 8802-3

Part 9-1: Sampled Values over Serial Unidirectional Multidrop Point-to-Point link

Part 9-2: Sampled values over ISO 8802-3

Part 10: Conformance Testing

More than 1000 pages

IEC 61850

The principle behind 原理

Domain Substation :

What data have to be communicated ?
什么数据需要传输 ?

Communication Technology:

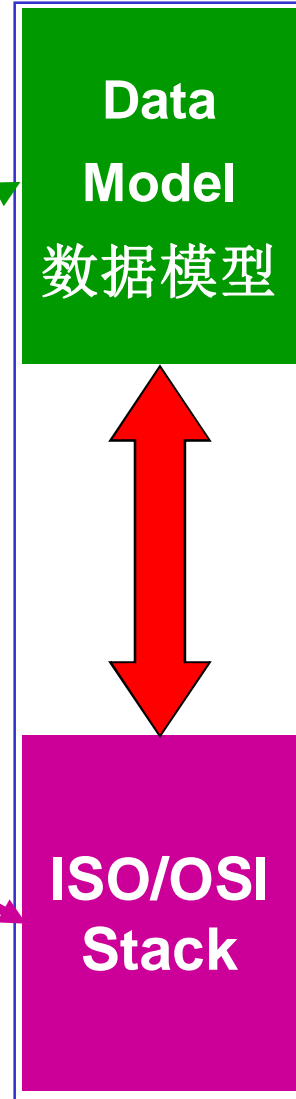
How are the data communicated ?
如何传输数据 ?

Slow Changes
慢速变化



Fast Changes
快速变化

Split !



DEFINITION

Data and Services according to the Domain Substation

定义:
根据Domain Substation 数据与服务

MAPPING

Data Model to the Communication Stack

映射
数据模型到通讯模块

SELECTION

ISO/OSI Stack from the Main Stream

选择
从主数据流中 ISO/OSI Stack

Communication is faster and less overhead needs to be transferred

通讯更快，传输数据更少

IEC 61850 – Overview

The Data Model – a comparison

IEC 61850 – 总览

数据模型 – 一个比方

IEC 61850世界:
IEC 61850 world:

逻辑点
 Logical Node

PID Regulator **FPID**

逻辑设备
 Logical Device

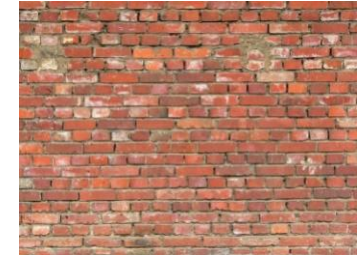
Voltage regulator
 PID Regulator **FPID**
 Set point control **FSPT**

Real world:
 现实世界:

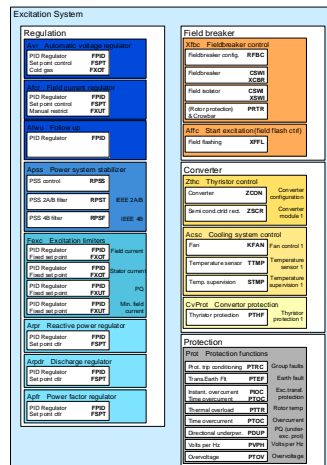


Brick砖

Brickwall
 砖墙



Data model of an application
 e.g. Excitation system
 应用程序的数据模型
 如: 励磁系统



Brickhouse
 砖房



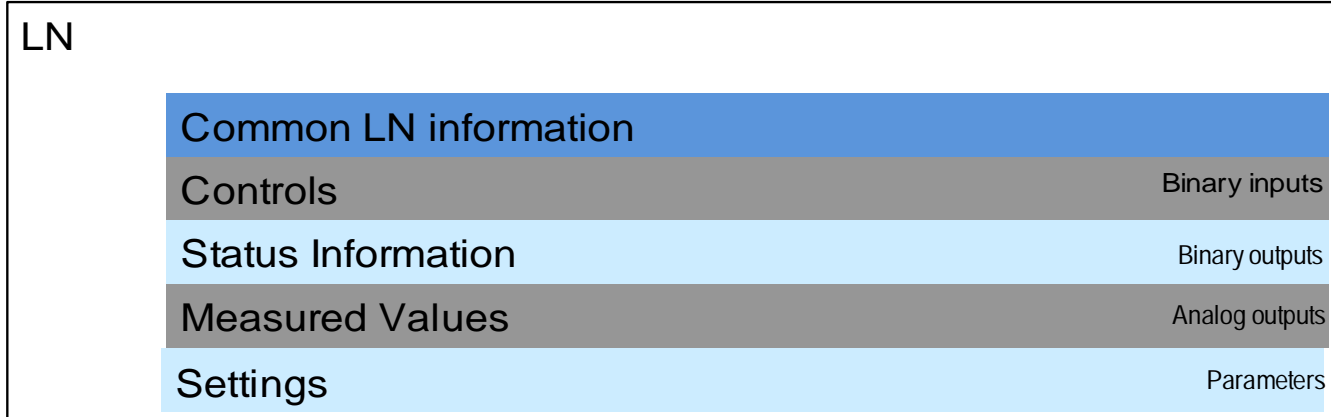
IEC 61850 – Overview

Logical Nodes

IEC 61850 – 总览

逻辑点

- Logical Node (LN) is the smallest unit of the Data model
- 逻辑点 (LN) 是数据模型中的最小单元
- LN includes different types of information
- LN 包含不同类型的信息



- Multiple use of a signal:
- 信号的多重用途:
 - simultaneous use: Multiple instances (several LN's)
 - 并行使用: Multiple instances (several LN's)
 - sequential use: Setting groups (one LN)
 - 串行使用: Setting groups (one LN)

IEC 61850 – Example for Excitation systems

IEC 61850 – 励磁系统的举例

The LN “FSPT”

- Page 33 of IEC 61850-7-4 Ed. 2

5.6.8 LN: Set-point control function

Name: FSPT

Logical Node FSPT shall be used to provide the common characteristics found in all controller or regulator type Logical Nodes. The LN can be standalone or cascaded with other logical nodes to form a complete controller.

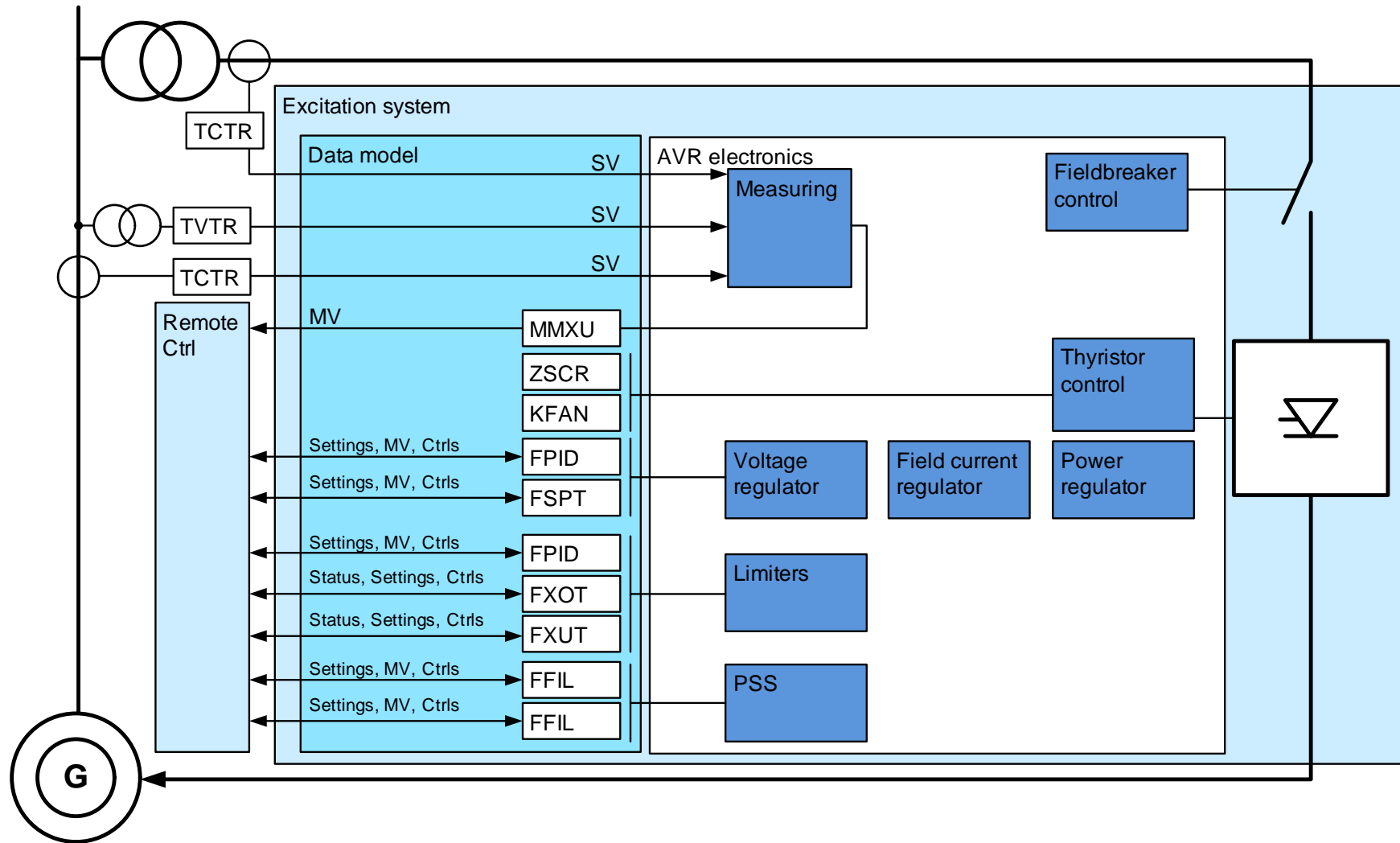
FSPT class				
Data Object Name	Common Data Class	Explanation	T	M/O/C
LNName		The name shall be composed of the class name, the LN-Prefix and LN-Instance-ID according to IEC 61850-7-2 clause 19		
Data Objects				
Loc	SPS	LocalControl Behavior		O
Controls				
SptChg	BAC	Setpoint change (raise, lower)		O
SptVal	APC	Setpoint		M
Measured Values				
SptMem	MV	Setpoint in memory		M
ErrTerm	MV	Control loop termination error value		O
Out	MV	Output		O

IEC 61850 – Example for Excitation systems

IEC 61850 – 励磁系统的举例

Basic principle & IEC data model

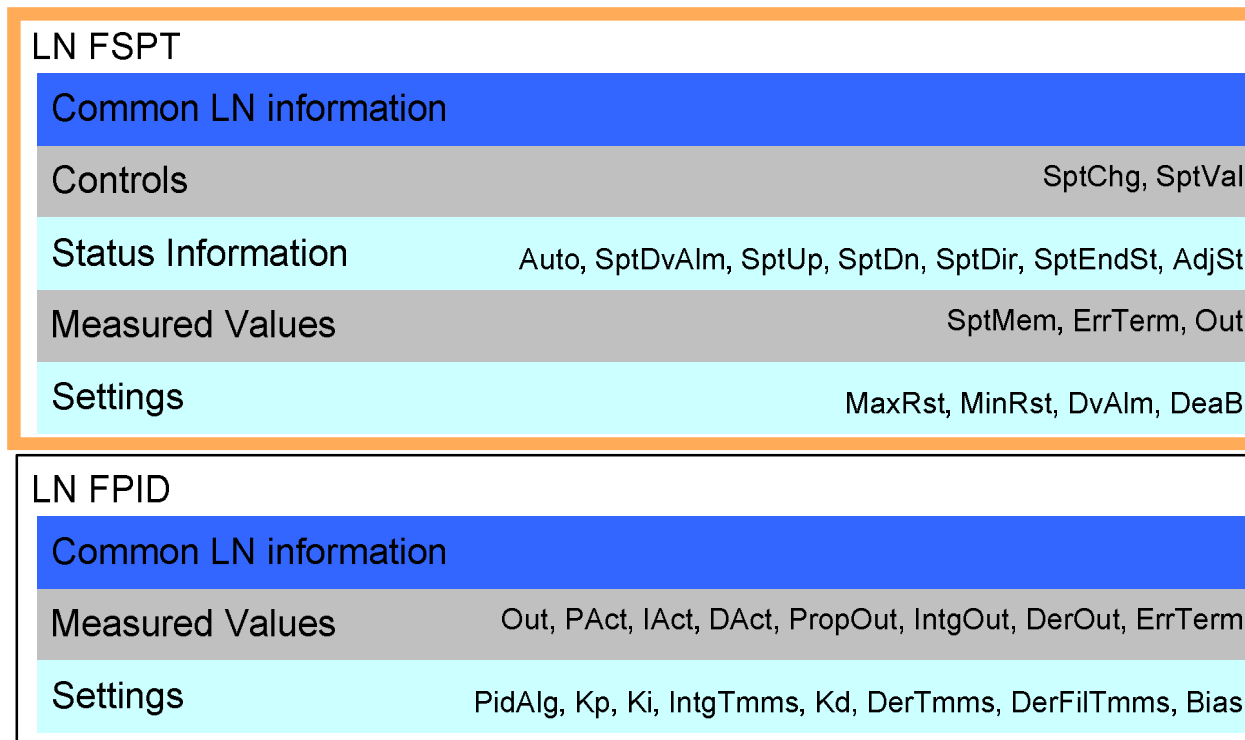
基本原理及IEC数据模型



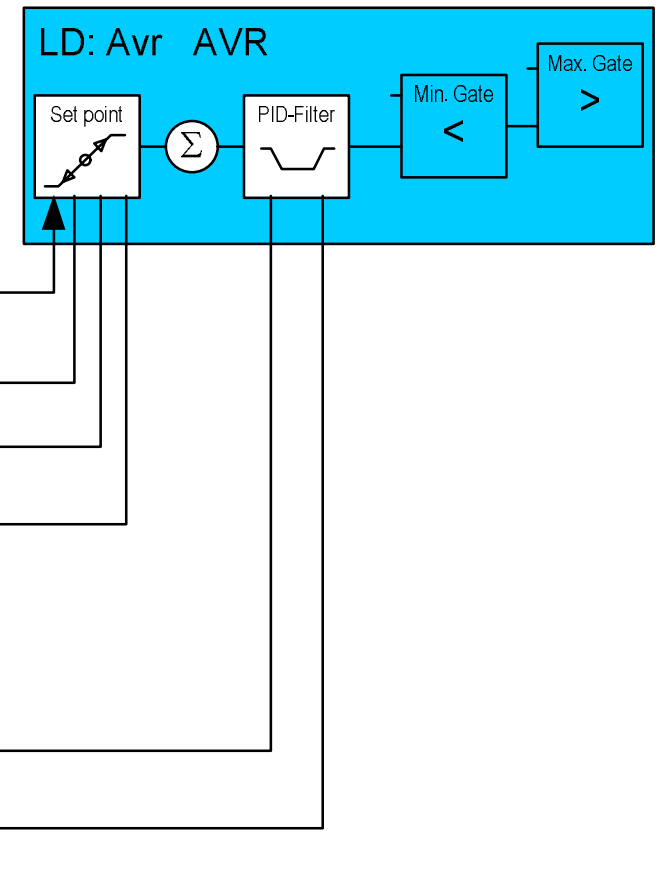
IEC 61850 – 励磁系统的举例

分配LN至LD: 例如AVR

IEC 61850 Interface

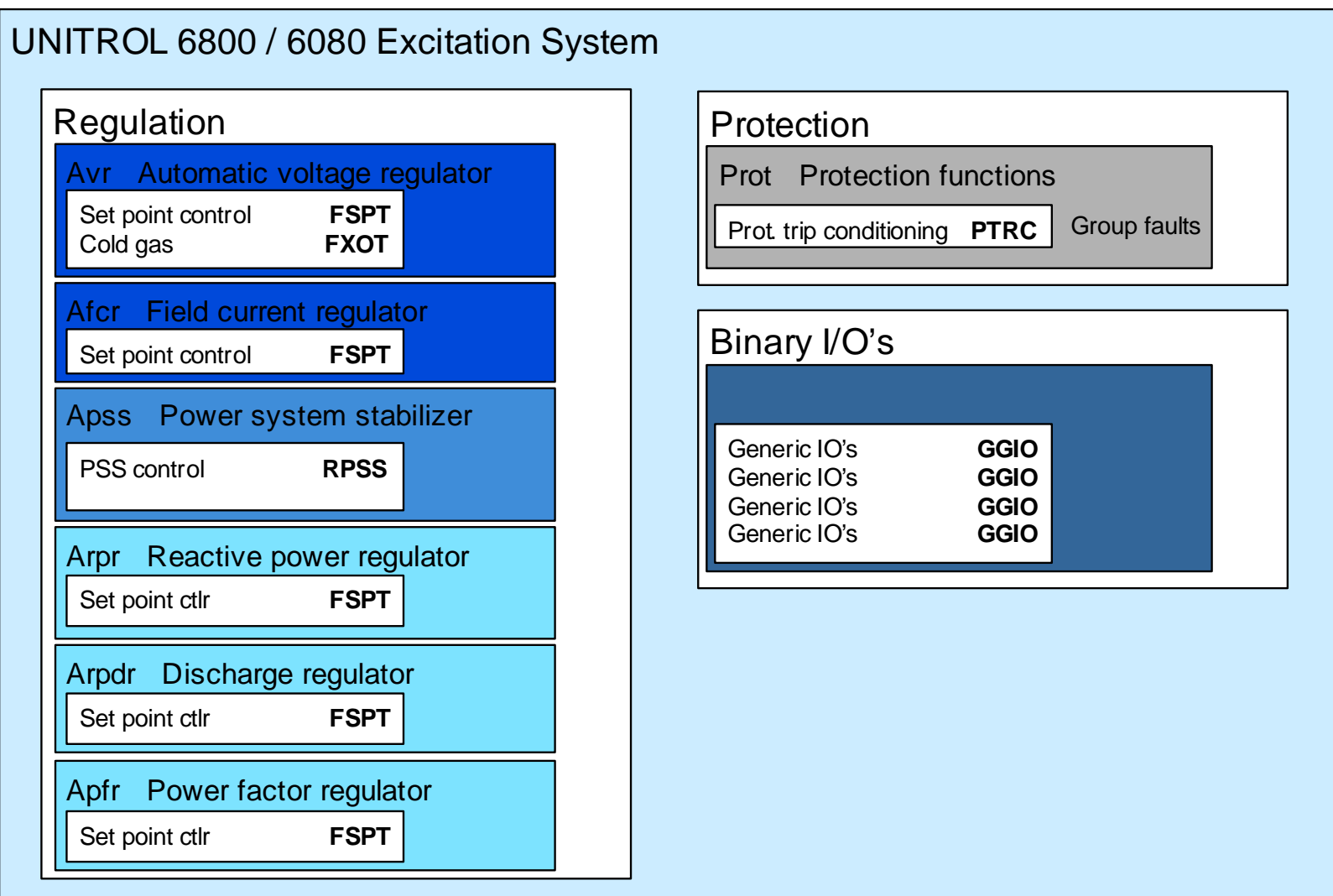


Excitation function



UNITROL® 6800 / 6080 – IEC 61850

Logical Devices 和 Logical Nodes



Power and productivity
for a better world™

