PEA5016
Automação de sistemas elétricos: especificação, projeto e implantação

Protocolos de comunicação:

Modbus, DNP3, IEC 101/104, IEC 61850(*)

(*) Não é protocolo...

Protocolos de comunicação usuais em sistemas elétricos

- Modbus
- DNP3
- IEC 60870-5-101/104
- MMS, GOOSE, SV (IEC 61850)
- Sincronismos de tempo

Modbus

- Definido pela Modicon, fabricante do primeiro CLP
- De uso livre (RTU, ASCII e TCP), cedido pela Schneider Electric para a Modbus Organization em 2004
- Implementa as camadas 1,2 e 7 do modelo OSI
- Mestre-escravo: somente o mestre pode iniciar as consultas
- Controle de acesso à rede por polling (varredura)
- Informações sem *time stamp*

Modbus (continuação)

- Tipos de redes (camadas 1 e 2 do modelo OSI)
  - Modbus TCP
  - Modbus serial (RTU, ASCII)
  - Modbus Plus (proprietário)
- Endereços dos escravos: de 1 a 247

Modbus – modelo de dados e códigos de funções

- Modelo básico de dados

Tabelas	Tipo	Acesso
Discrete Inputs	Bit	R
Coils	Bit	R/W
Input Registers	16 bits	R
Holding Registers	16 bits	R/W

- Pergunta/resposta (request/reply), códigos de funções:
  - 01/02: Read Coils / Read Discrete Inputs (ler até 2000 endereços contíguos)
  - 03/04: Read Holding Registers / Read Input Registers (até 125 registros contíguos)

Modbus – mais códigos de funções

- 05: Write Single Coil
- 06: Write Single Register
- 15 (0x0F): Write Multiple Coils (em sequência)
- 16 (0x10): Write Multiple registers (em sequência)
- 20/21 (0x14, 0x15): Read/Write File Record

Exemplos de mensagens Modbus

Request Message

Address	Function Code	Initial Coil Offset		Number of Points		CRC
		Hi	Lo	Hi	Lo	
01	01	00	0A	00	02	9D C9

Response Frame

Address	Function Code	Byte Count	Coil Data	CRC
01	01	01	03	11 89

Leituras das bobinas $0A_h$ e $0B_h$, obtendo, como resposta, 1 e 1 (03_h).

Request Message

Address	Function Code	Starting Register		Register Count		CRC
		Hi	Lo	Hi	Lo	
01	03	00	02	00	01	25 CA

Response Frame

Address	Function Code	Byte Count	Register Data		CRC
			Hi	Lo	
01	03	02	07	FF	FA 34

Leitura do registro 0002_h, obtendo, como resposta, $07FF_h$.

DNP3

- Distributed Network Protocol
  - A versão 3 foi disponibilizada pela Harris Control para o DNP Users Group em 1993; o número 3 foi incorporado ao seu nome. Provavelmente não haverá um DNP4 ou DNP3.1
    - IEC 60870-5-101, 1995
  - Juntamente com o IEC 101/104, utilizada largamente no sistema elétrico mundial, com vantagem nos Estados Unidos
  - DNP Users Group
  - Norma IEEE 1815 de 2010, revisada em 2012 (Basic 8)
    - 1815.1-2015 - IEEE Standard for Exchanging Information Between Networks Implementing IEC 61850 and IEEE Std 1815(TM) [Distributed Network Protocol (DNP3)]

Algumas funcionalidades

- Possibilidade de report por exceção, indicações com time-stamp
- Comunicação balanceada
  - Conceitos de : Master / outstation (“não master”)
    - Somente Master pode solicitar informações
    - Outstation são todos os outros nós

Algumas funcionalidades

- Conceitos de comunicação balanceada / desbalanceada
  - Desbalanceada: somente o Master pode iniciar a comunicação; menor risco de colisões
  - Balanceada: ambos podem iniciar a comunicação; a outstation pode acessar a rede para informar ao Master que há novos eventos
- Mensagem primária / secundária
  - No nível de link, a mensagem primária inicia a transação
  - A confirmação de recebimento (acknowledgement) é uma mensagem secundária

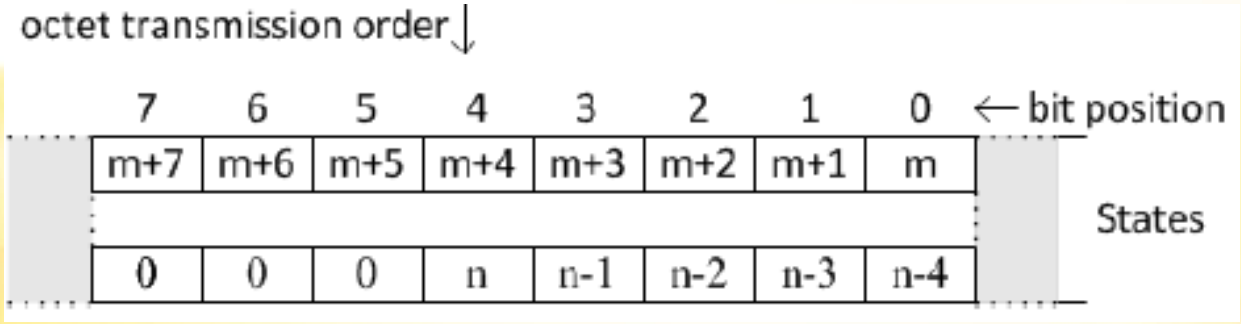
DNP3 – Tipos de objetos de dados, Grupos

- Estrutura mais complexa que Modbus ou IEC 60870-5-101/104

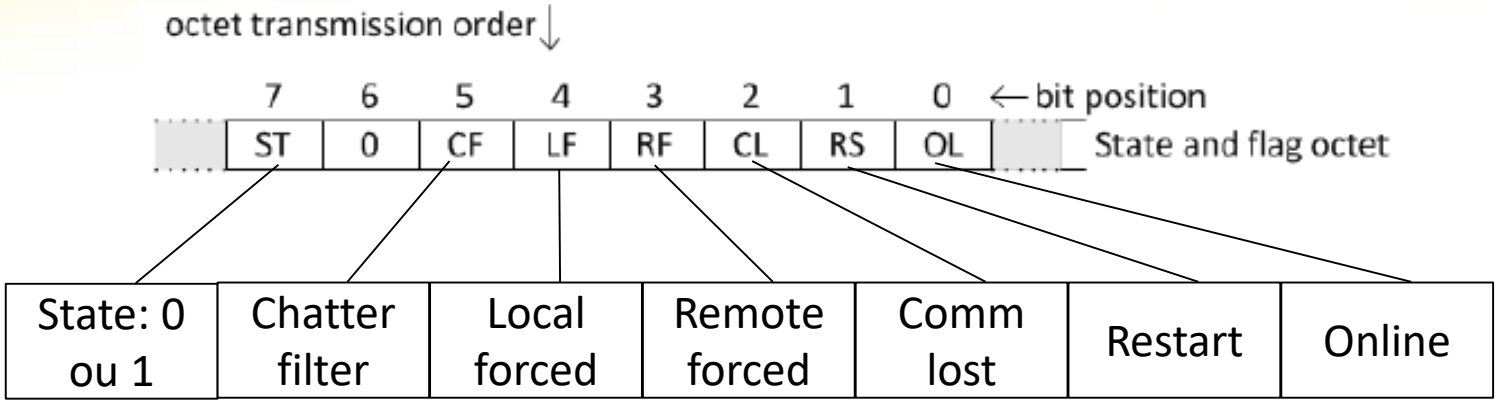
Grupos	
0-9	Binary Input
10-19	Binary Output
20-29	Counter
30-39	Analog Input
40-49	Analog Output
50-59	Time
60-69	Class
70-79	File
80-89	Device
90-99	Application
100	Números com diferentes representação (BCD e outras)

DNP3 – Tipos de objetos de dados, Variações

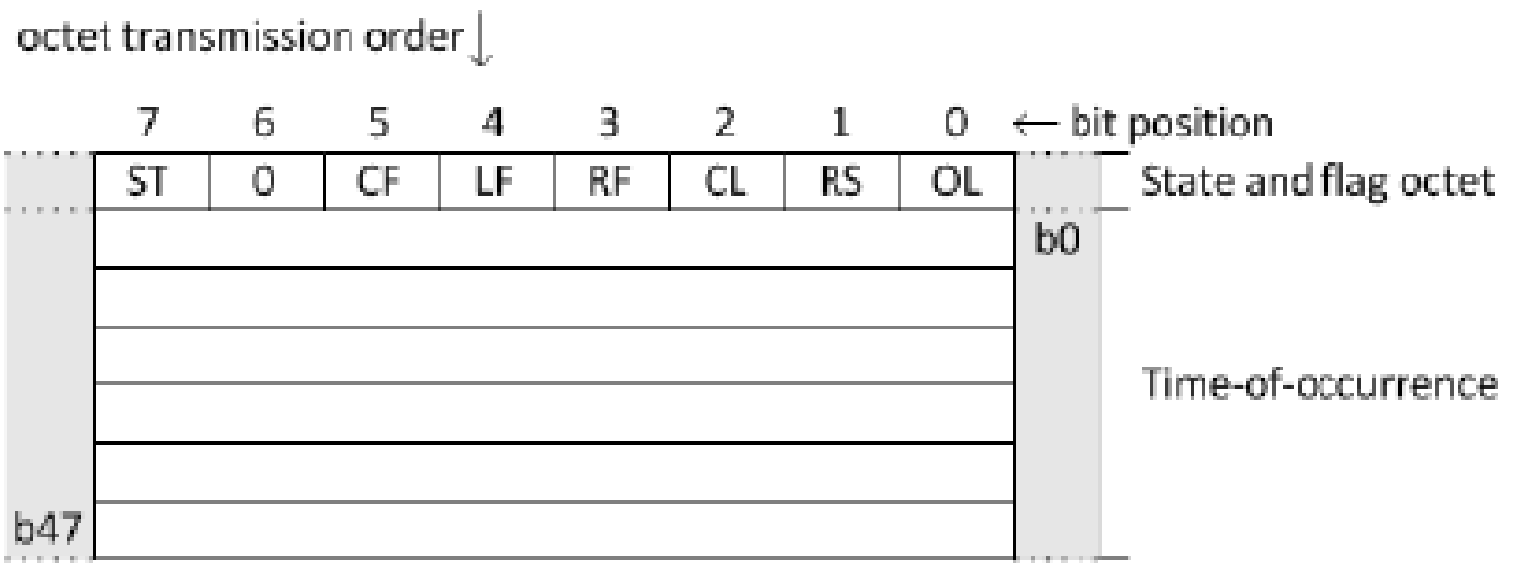
- Exemplos de variações
  - Grupo 1, variação 1: Binary input – packed format, type static



  - Grupo 1, variação 2: Binary input with flags, type static

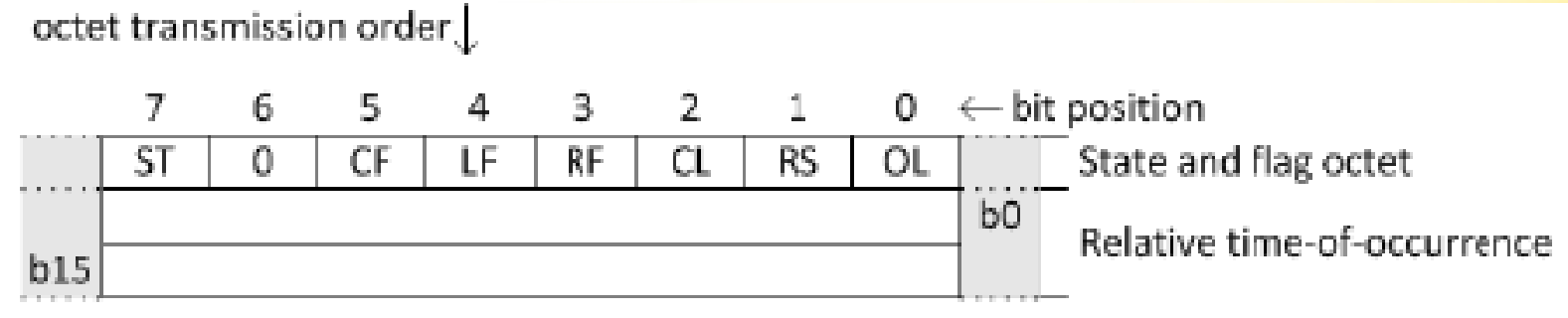


– Grupo 2, variação 2: Binary input event – with absolute time, type event

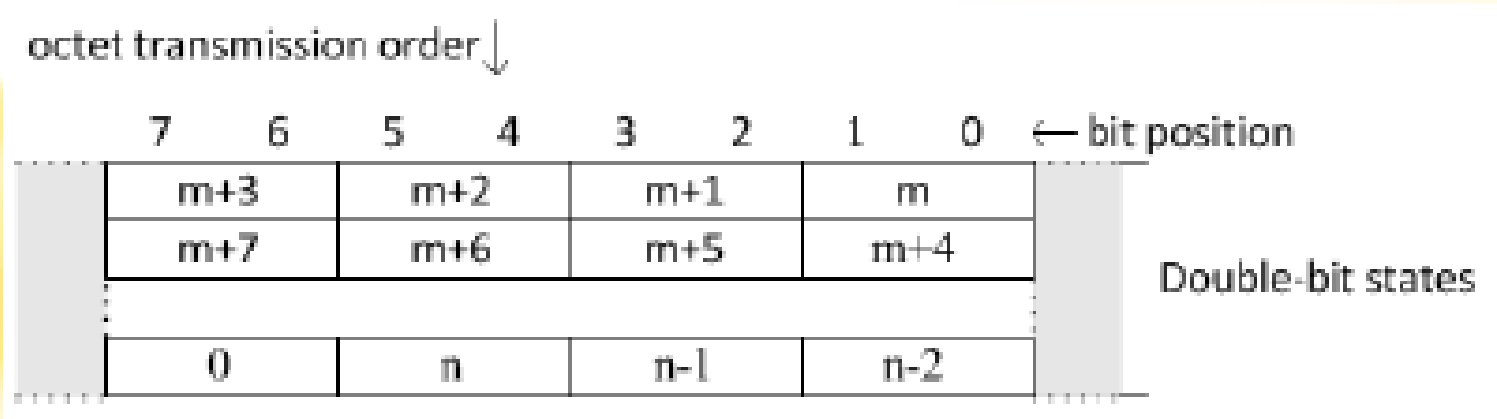


(milissegundos desde 01/01/1970)

– Grupo 2, variação 3: Binary input event – with relative time, type event



– Grupo 3, variação 1: Double-bit binary input, packed format, type event



- 2 bytes para indicar o tempo com precisão de milissegundos
- Maior agilidade para enviar muitos eventos ocorridos até um minuto após uma referência fornecida (avalanche)

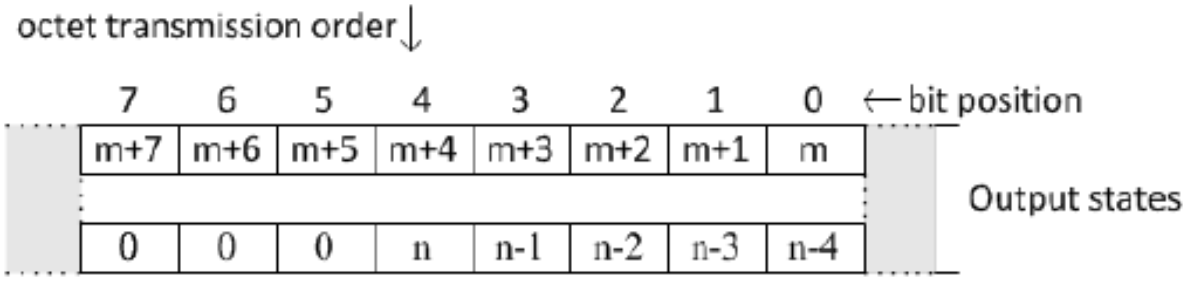
Classes

- Objetos de dados no DNP3
  - Static: valor atual do ponto
    - Ex.: Grupo 1, Grupo 3
  - Event: ocorrência digna de registro (mudança de estado de entrada binária, variação significativa de entrada analógica, entre outras)
    - Ex.: Grupo 2
- Class 0: é reportado apenas o valor atual do objeto
- Class 1, 2 ou 3: são reportados também os eventos relativos ao objeto
  - A norma não faz distinção entre as classes 1, 2 ou 3

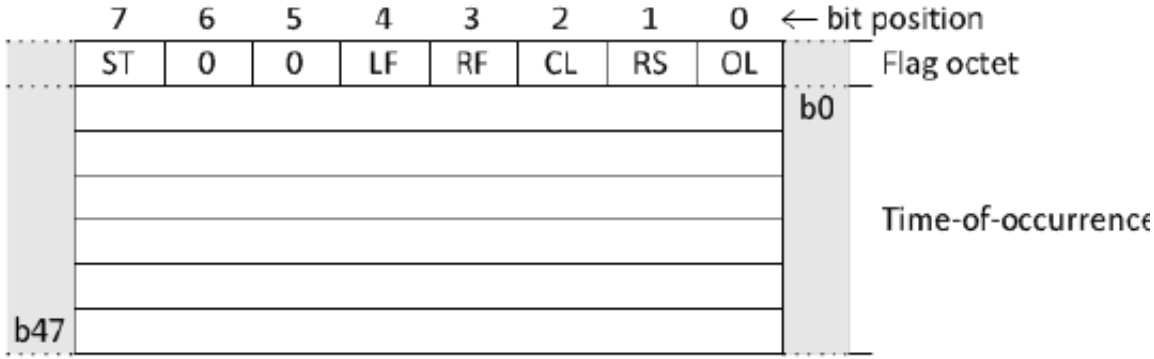
	Point not assigned to any class	Point assigned to Class 0	Point assigned to Class 1	Point assigned to Class 2	Point assigned to Class 3
Present value included in response to static data-type poll?	Yes	Yes	Yes	Yes	Yes
Present value included in response to Class 0 poll?	No	Yes	Yes	Yes	Yes
Events stored and event data included in response to Class 1 poll?	No	No	Yes	No	No
Events stored and event data included in response to Class 2 poll?	No	No	No	Yes	No
Events stored and event data included in response to Class 3 poll?	No	No	No	No	Yes

Outros grupos e variações

- Grupo 10, variação 1
  - Binary output, packed format, type static

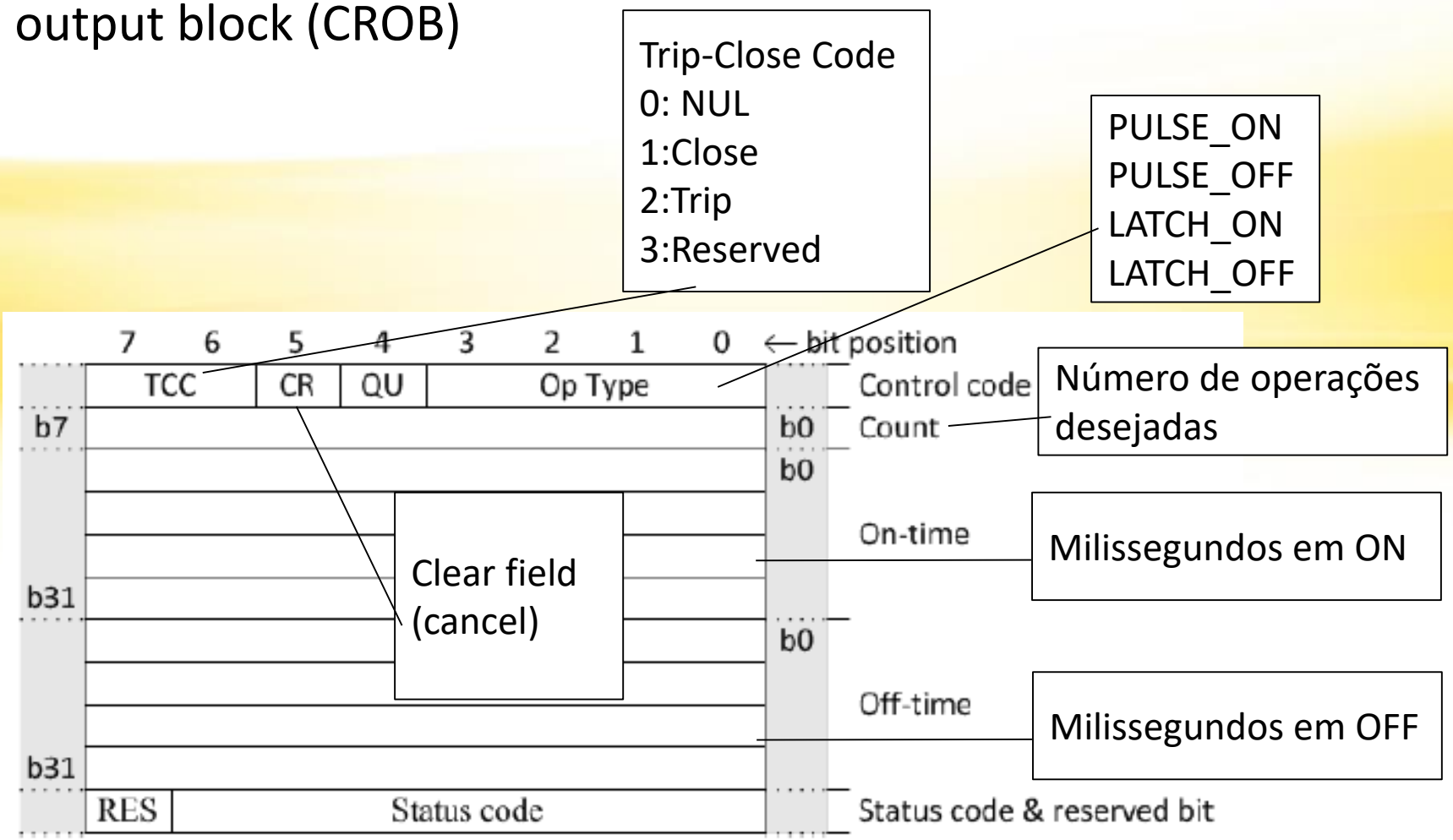


- Grupo 11, variação 1
  - Binary output event, status with time

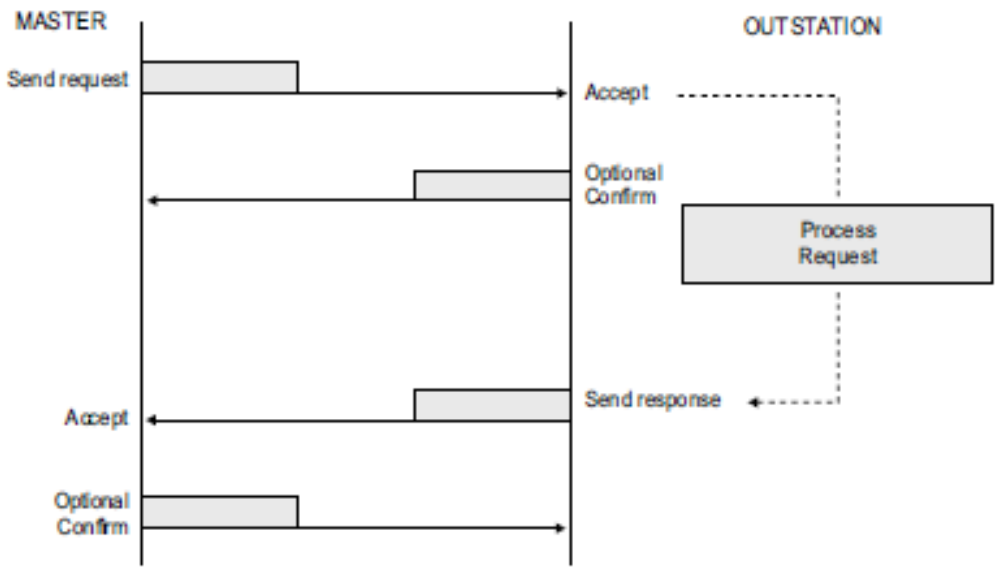


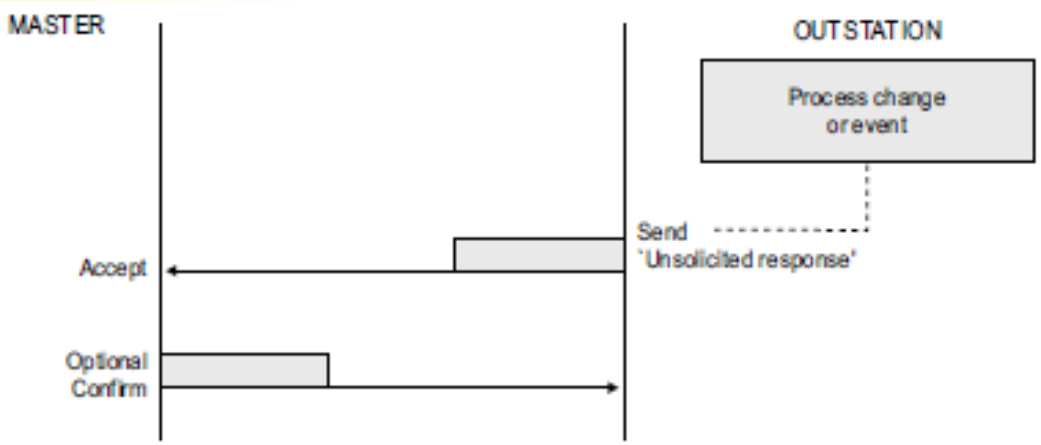
- Modelos de controle para comandos
  - Ativação: cada objeto de comando inicia um único tipo de ação
    - Ex. objetos distintos para abrir e fechar um disjuntor
  - Ações complementares em latch: saída permanece em estado ativo ou inativo, de acordo com a ação desejada
  - Ações complementares: cada objeto de comando tem duas opções de saída, que iniciam ações de “abrir” (trip) ou “fechar”.

- Grupo 12, variação 1: binary output command, control relay output block (CROB)



- No nível de aplicação, há 2 tipos de mensagens em DNP3
  - Request (master)
  - Response (outstations)
    - Unsolicited response





Gordon Clarke, Deon Reynders. Practical Modern SCADA Protocols

Application Layer Message Functions

- Application Function Codes

0	Confirm	Master envia confirmação caso seja solicitado pela outstation
1	Read	
2	Write	Outstation deve armazenar dados informados na mensagem (deadbands, arquivos de configuração etc)
3	Select	Comando
4	Operate	Comando
5	Direct_Operate	Comando
6	Direct_Operate_NR	Não envia response ao master

Comando Select-Before-Operate

- Objeto de controle é selecionado (reservado) e operado em seguida
- Se a operação não ocorre após um tempo de timeout, a seleção é cancelada
- Diálogo de comando (IHM) realiza a seleção e somente envia o comando “Operate” após a confirmação do usuário
- Evita a operação concorrente de um objeto por mais de um mestre

Application Layer Message Functions

- Application Function Codes

7-12	Funções de Freeze	Armazena dados de objetos em um "freeze buffer"
13-18	Funções de controle da outstation	Cold restart, warm restart, inicializar aplicação etc
19	Salvar arquivo de configuração	
20	Habilita unsolicited responses	
21	Desabilita unsolicited responses	
22	Atribuir classe a um ou mais objetos de dados	
25-30	Manipulação de objetos do tipo arquivo	
129	Response	Solicited
130	Unsolicited_Response	

Qualifiers

- Em conjunto com a informação de “Range”, indica se a request é feita para uma faixa contígua de objetos de dados, para todos os pontos, para um único ponto, para uma faixa de pontos não contíguos ou para objetos de tamanho desconhecido

Qualifier code (Hex)	Use in a master request	Use in an outstation response
00, 01	A single point or range of static points.	Static objects.
06	All points.	Not permitted in a response.
07, 08	A limited quantity of events. A single quantity having no index (e.g., Time and Date).	A single quantity having no index (e.g., Time and Date).
17, 28	For controls or other functions, such as reading, that request multiple objects where the indexes are non-sequential or not consecutive.	Event objects (usually one or more unrelated points).
5B	To transmit objects whose size may be unknown to the receiver (e.g., File Open).	To transmit objects whose size may be unknown to the receiver (e.g., File data).

Interoperabilidade

- Níveis de implementação (IEEE 1815)
  - DNP3-L1
    - Implementação mínima entre um master e um IED
  - DNP3-L2
    - IED mais complexo ou pequena RTU
  - DNP3-L3
    - RTU mais avançada
  - DNP3-L4
    - Novas funcionalidades além do L3
      - Auto-endereçamento, binários duplos, eventos de objetos de saída etc
  - Tabelas de implementação para cada nível
    - Grupos, variações e qualifiers que devem estar implementados
- Documentação: Device Profile
  - XML (IEEE 1815)

Protocol document

70022-0126-00
08/2011

PowerLogic ION8650 DNP 3.0 device profile

This document describes the DNP V3.0 communications protocol employed by PowerLogic™ ION8650 meters. The DNP protocol can be selected for the following:

- up to three serial communication ports (which can consist of RS232/RS485/Internal Modem)
- the optical port
- up to three Ethernet connections.

A maximum of three ports/connections in total may be used at the same time.

It is assumed that the reader is familiar with the DNP V3.00 protocol and serial communications in general.

In this document

Schneider Electric
2195 Keating Cross Road
Saanichton, BC
Canada V8M 2A5
Tel: 1-250-652-7100

For technical support:
Global-PMC-Tech-support@schneider-electric.com
(00) + 1 250 544 3010

Contact your local Schneider Electric sales representative for assistance or go to www.schneider-electric.com

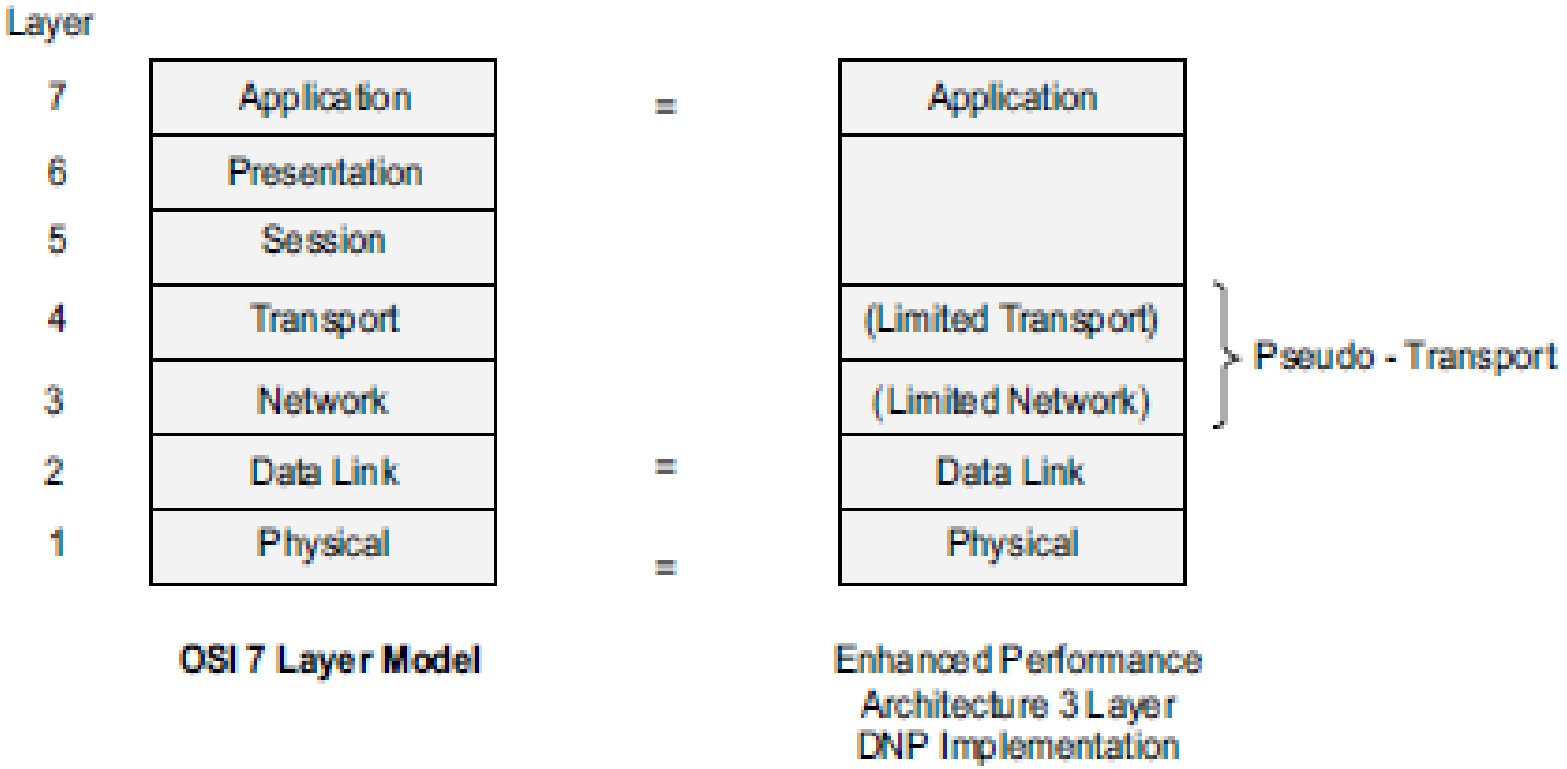
Schneider Electric

UNIPOWER
POWERING TECHNOLOGY

DNP3
Device Profile Document
For
ARE-M Series
Float Chargers
Single-Phase Input

PM990.1072.00, Issue 6

UNIPOWER, LLC
3900 Coral Ridge Drive
Coral Springs, FL 33065
Phone: +1-954-346-2442
Toll Free: 1-800-440-3504
Web site – http://www.unipowerco.com



Gordon Clarke, Deon Reynders. Practical Modern SCADA Protocols

IEC 60870-5-101/104

- Conjunto de normas: “Telecontrol equipment and systems”, elaborado pelo TC 57 (*Power systems management and associated information exchange*)
- Parte 5 trata de protocolos de transmissão de dados
  - Security no capítulo IEC 60870-5-7
- Parte 6 trata de protocolos de telecontrole compatíveis com normas ISO e recomendações ITU-T (ICCP: *inter-control center protocol*)

- IEC 60870-5-1:1990 - General considerations
- IEC 60870-5-2:1992 - Operating conditions
- IEC 60870-5-3:1992 - Interfaces (electrical characteristics)
- IEC 60870-5-4:1993 - Performance requirements
- IEC 60870-5-5:1995 - Transmission protocols
- IEC 60870-5-6:2006 - Telecontrol protocols compatible with ISO standards and ITU-T recommendations
- IEC TS 60870-5-7:2013 - Security extensions
- IEC 60870-5-101:2003+AMD1:2015 CSV - Companion standard for basic telecontrol tasks
- IEC 60870-5-102:1996 - Companion standard for the transmission of integrated totals in electric power systems
- IEC 60870-5-103:1997 - Companion standard for the informative interface of protection equipment
- IEC 60870-5-104:2006+AMD1:2016 CSV - Network access for IEC 60870-5-101
- …

- IEC 101, T101
  - Primeira versão, 1995
  - IEC 104, primeira versão em 2000
- Estrutura hierárquica
  - Master / slave
  - Comunicação predominantemente desbalanceada
    - Somente o Master pode iniciar a comunicação
  - Comunicação balanceada permitida apenas para links ponto-a-ponto
    - Evitar colisões entre slaves

Objetos de dados IEC 101

<1>	single-point information	M_SP_NA_1
<2>	single-point information with time tag	M_SP_TA_1
<3>	double-point information	M_DP_NA_1
<4>	double-point information with time tag	M_DP_TA_1
<5>	step position information	M_ST_NA_1
<6>	step position information with time tag	M_ST_TA_1
<7>	bitstring of 32 bit	M_BO_NA_1
<8>	bitstring of 32 bit with time tag	M_BO_TA_1
<9>	measured value, normalized value	M_ME_NA_1
<10>	measured value, normalized value with time tag	M_ME_TA_1
<11>	measured value, scaled value	M_ME_NB_1

- Identificação dos objetos de dados (ASDU: application service data unit)
  - Nível 1: M (monitored information), C (control information), P (parameter), F (file transfer)
  - Nível 2: _SP (single-point), _DP (double-point), _SC (single command), _ME (Measurements), ...
  - Nível 3:
    - _Nx/_Tx (sem/com time tag);
    - _xA = valor normalizado com quality, status ou comando
    - _xB = scaled value;
    - _xC = short floating point;
    - _xD = valor normalizado sem quality
  - _1: indica que a ASDU é definida na norma 101

Ex.: M_DP_TA_1 : double-point information with time tag
M_ME_NC_1: measured value, short floating point number with time tag

7.3.1.4 TYPE IDENT 4: M_DP_TA_1
Double-point information with time tag

Sequence of information objects (SQ = 0)

0 0 0 0 0 1 0 0	TYPE IDENTIFICATION	DATA UNIT IDENTIFIER Defined in 7.1
0 Number i of objects	VARIABLE STRUCTURE QUALIFIER	
Defined in 7.2.3	CAUSE OF TRANSMISSION	
Defined in 7.2.4	COMMON ADDRESS OF ASDU	
Defined in 7.2.5	INFORMATION OBJECT ADDRESS	INFORMATION OBJECT 1
IV NT SB BL 0 0 DPI	DIQ = Double-point information with quality descriptor, defined in 7.2.6.2	
CP24Time2a Defined in 7.2.6.19	Three octet binary time	
Defined in 7.2.5	INFORMATION OBJECT ADDRESS	
IV NT SB BL 0 0 DPI	DIQ = Double-point information with quality descriptor, defined in 7.2.6.2	
CP24Time2a Defined in 7.2.6.19	Three octet binary time	

7.2.6.2 Double-point information (IEV 371-02-08) with quality descriptor

DIQ	:=	CP8{DPI,RES,BL,SB,NT,IV}	
DPI	:=	UI2[1..2]<0..3>	(Type 1.1)
<0>	:=	indeterminate or intermediate state	
<1>	:=	determined state OFF	
<2>	:=	determined state ON	
<3>	:=	indeterminate state	
RES = RESERVE	:=	BS2[3..4]<0>	(Type 6)
BL	:=	BS1[5]<0..1>	(Type 6)
<0>	:=	not blocked	
<1>	:=	blocked	
SB	:=	BS1[6]<0..1>	(Type 6)
<0>	:=	not substituted	
<1>	:=	substituted	
NT	:=	BS1[7]<0..1>	(Type 6)
<0>	:=	topical	
<1>	:=	not topical	
IV	:=	BS1[8]<0..1>	(Type 6)
<0>	:=	valid	
<1>	:=	invalid	

Definition of quality descriptor (BL,SB,NT,IV) see 7.2.6.3, quality descriptor QDS

CP56Time2a := CP56{milliseconds,minutes,RES1,invalid,hours,RES2,summer time,day of month,day of week,months,RES3,years,RES4}

This binary time is defined in 6.8 of IEC 60870-5-4.

Day of week := <0> not used

Day of week := <1..7> used (optional)

Monday	:=	<1>
Tuesday	:=	<2>
Wednesday	:=	<3>
Thursday	:=	<4>
Friday	:=	<5>
Saturday	:=	<6>
Sunday	:=	<7>

A1 The summer-time bit SU may optionally be used, but is not recommended. A time tag having the SU flag set will indicate the same time value as time tag having the SU flag clear and indicating a time value exactly one hour earlier. The use of the SU-Bit may be useful to assign the correct hour to information objects which are generated during the first hour after switching from summer-time to standard time. A1

For systems that span time-zone boundaries, the adoption of UTC for all time tags is recommended.

The RES1-bit may be used in the monitor direction to indicate whether the time tag was added to the information object when it was acquired by the RTU (genuine time) or the time tag was substituted by intermediate equipment such as concentrator stations or by the controlling station itself (substituted time).

RES1 := GEN (genuine time)

<0> := Genuine time

<1> := Substituted time

CP24Time2a := CP24{milliseconds,minutes, RES1,invalid}

This binary time is defined in 6.8 of IEC 60870-5-4. It is used for the time tag of an INFORMATION OBJECT. The octets 4 up to 7 are discarded.

The RES1-bit may be used in the monitor direction to indicate whether the time tag was added to the information object when it was acquired by the RTU (genuine time) or the time tag was substituted by intermediate equipment such as concentrator stations or by the controlling station itself (substituted time).

RES1 := GEN (genuine time)

<0> := Genuine time

<1> := Substituted time

7.2.6.20 Two octet binary time

CP16Time2a := UI16[1..16]<0..59 999 ms>

This is used for an elapsed time such as “Relay operating time” or “Relay duration time”.

7.3.2.1 TYPE IDENT 45: C_SC_NA_1
Single command

Single information object (SQ = 0)

0 0 1 0 1 1 0 1	TYPE IDENTIFICATION	DATA UNIT IDENTIFIER Defined in 7.1
0 0 0 0 0 0 0 1	VARIABLE STRUCTURE QUALIFIER	
Defined in 7.2.3	CAUSE OF TRANSMISSION	
Defined in 7.2.4	COMMON ADDRESS OF ASDU	
Defined in 7.2.5	INFORMATION OBJECT ADDRESS	INFORMATION OBJECT
S/E QU 0 SCS	SCO = Single command, defined in 7.2.6.15	

7.2.6.15 Single command (IEV 371-03-02)

SCO	:=	CP8{SCS,BS1,QOC}
SCS=Single command state	:=	BS1[1]<0..1>
<0>	:=	OFF
<1>	:=	ON
RES= RESERVE	:=	BS1[2]<0>
QOC	:=	CP6[3..8]{QU,S/E}

QOC	:=	CP6{QU, S/E}
QU	:=	UI5[3..7]<0..31> (Ty
<0>	:=	no additional definition [5]
<1>	:=	short pulse duration (circuit-breaker), duration determined by a system parameter in the outstation
<2>	:=	long pulse duration, duration determined by a system parameter in the outstation
<3>	:=	persistent output
<4..8>	:=	reserved for standard definitions of this companion standard (compatible range)
<9..15>	:=	reserved for the selection of other predefined functions [6]
<16..31>	:=	reserved for special use (private range)
S/E	:=	BS1[8]<0..1> (Ty
<0>	:=	execute
<1>	:=	select

7.3.1.19 TYPE IDENT 19: M_EP_TC_1
Packed output circuit information of protection equipment with time tag

Single information object (SQ = 0)

0 0 0 1 0 0 1 1	TYPE IDENTIFICATION	DATA UNIT IDENTIFIER Defined in 7.1
0 0 0 0 0 0 0 1	VARIABLE STRUCTURE QUALIFIER	
Defined in 7.2.3	CAUSE OF TRANSMISSION	
Defined in 7.2.4	COMMON ADDRESS OF ASDU	
Defined in 7.2.5	INFORMATION OBJECT ADDRESS	INFORMATION OBJECT
0 0 0 0 CL3 CL2 CL1 GC	OCI = Output circuit information of protection equipment, defined in 7.2.6.12	
IV NT SB BL EI 0 0 0	QDP = Quality descriptor of protection equipment, defined in 7.2.6.4	
CP16Time2a Defined in 7.2.6.20	Relay operating time	
CP24Time2a Defined in 7.2.6.19	Three octet binary time	

OCI := BS8{GC,CL1,CL2,CL3,RES}
GC = general command to output circuit := BS1[1]<0..1>
<0> := no general command to output circuit
<1> := general command to output circuit
CL1 = command to output circuit phase L1 := BS1[2]<0..1>
<0> := no command to output circuit phase L1
<1> := command to output phase circuit L1
CL2 = command to output circuit phase L2 := BS1[3]<0..1>
<0> := no command to output circuit phase L2
<1> := command to output circuit phase L2
CL3 = command to output circuit phase L3 := BS1[4]<0..1>
<0> := no command to output circuit phase L3
<1> := command to output circuit phase L3
RES = RESERVE := BS4[5..8]<0>

7.3.1.17 TYPE IDENT 17: M_EP_TA_1
Event of protection equipment with time tag

Sequence of information objects (SQ = 0)

0 0 0 1 0 0 0 1	TYPE IDENTIFICATION	
0 | Number i of objects	VARIABLE STRUCTURE QUALIFIER	DATA UNIT IDENTIFIER Defined in 7.1
Defined in 7.2.3	CAUSE OF TRANSMISSION	
Defined in 7.2.4	COMMON ADDRESS OF ASDU	
Defined in 7.2.5	INFORMATION OBJECT ADDRESS	
IV NT SB BL EI 0 | ES	SEP = Single event of protection equipment, defined in 7.2.6.10	
CP16Time2a Defined in 7.2.6.20	Two octet binary time elapsed time	INFORMATION OBJECT 1
CP24Time2a Defined in 7.2.6.19	Three octet binary time	
Defined in 7.2.5	INFORMATION OBJECT ADDRESS	
IV NT SB BL EI 0 | ES	SEP = Single event of protection equipment, defined in 7.2.6.10	
CP16Time2a Defined in 7.2.6.20	Two octet binary time elapsed time	INFORMATION OBJECT i
CP24Time2a Defined in 7.2.6.19	Three octet binary time	

SEP := CP8{ES,RES,EI,BL,SB,NT,IV}
ES=Event State := UI2[1..2]<0..3>
<0> := indeterminate state
<1> := OFF
<2> := ON
<3> := indeterminate state
RES = RESERVE := BS1[3]<0>
EI := BS1[4]<0..1>
<0> := elapsed time valid
<1> := elapsed time invalid
BL := BS1[5]<0..1>
<0> := not blocked
<1> := blocked
SB := BS1[6]<0..1>
<0> := not substituted
<1> := substituted
NT := BS1[7]<0..1>
<0> := topical
<1> := not topical
IV := BS1[8]<0..1>
<0> := event valid
<1> := event invalid

7.3.1.18 TYPE IDENT 18: M_EP_TB_1

Packed start events of protection equipment with time tag

0 | 0 | SRD | SIE | SL3 | SL2 | SL1 | GS	SPE = Start event of protection equipment, defined in 7.2.6.11	INFORMATION OBJECT
IV | NT | SB | BL | EI | 0 | 0 | 0	QDP = Quality descriptor for events of protection equipment, defined in 7.2.6.4	
CP16Time2a Defined in 7.2.6.20	Relay duration time	
CP24Time2a Defined in 7.2.6.19	Three octet binary time	

SPE := BS8{GS,SL1,SL2,SL3,SIE,SRD,RES}

GS = general start of operation := BS1[1]<0..1>
- <0> := no general start of operation
- <1> := general start of operation

SL1 = start of operation phase L1 := BS1[2]<0..1>
- <0> := no start of operation L1
- <1> := start of operation L1

SL2 = start of operation phase L2 := BS1[3]<0..1>
- <0> := no start of operation L2
- <1> := start of operation L2

SL3 = start of operation phase L3 := BS1[4]<0..1>
- <0> := no start of operation L3
- <1> := start of operation L3

SIE = start of operation IE (earth current) := BS1[5]<0..1>
- <0> := no start of operation IE
- <1> := start of operation IE

SRD = start of operation in reverse direction := BS1[6]<0..1>
- <0> := no start of operation in reverse direction
- <1> := start of operation in reverse direction

RES = RESERVE := BS2[7..8]<0>

COT – Cause of Transmission

Para cada COT, a informação (ASDU) é direcionada para uma tarefa específica na aplicação

Cause	:=	UI6[1..6]<0..63>
<0>	:=	not used
<1>	:=	periodic, cyclic
<2>	:=	background scan[3]
<3>	:=	spontaneous
<4>	:=	initialized
<5>	:=	request or requested
<6>	:=	activation
<7>	:=	activation confirmation
<8>	:=	deactivation
<9>	:=	deactivation confirmation
<10>	:=	activation termination
<11>	:=	return information caused by a remote command
<12>	:=	return information caused by a local command
<13>	:=	file transfer
<14..19>	:=	reserved for further compatible definitions
<20>	:=	interrogated by station interrogation
<21>	:=	interrogated by group 1 interrogation
<22>	:=	interrogated by group 2 interrogation
<23>	:=	interrogated by group 3 interrogation
<24>	:=	interrogated by group 4 interrogation
<25>	:=	interrogated by group 5 interrogation
<26>	:=	interrogated by group 6 interrogation
<27>	:=	interrogated by group 7 interrogation
<28>	:=	interrogated by group 8 interrogation
<29>	:=	interrogated by group 9 interrogation
<30>	:=	interrogated by group 10 interrogation
<31>	:=	interrogated by group 11 interrogation
<32>	:=	interrogated by group 12 interrogation
<33>	:=	interrogated by group 13 interrogation
<34>	:=	interrogated by group 14 interrogation
<35>	:=	interrogated by group 15 interrogation
<36>	:=	interrogated by group 16 interrogation
<37>	:=	requested by general counter request
<38>	:=	requested by group 1 counter request
<39>	:=	requested by group 2 counter request
<40>	:=	requested by group 3 counter request
<41>	:=	requested by group 4 counter request
<42..43>	:=	reserved for further compatible definitions
<44>	:=	unknown type identification
<45>	:=	unknown cause of transmission
<46>	:=	unknown common address of ASDU
<47>	:=	unknown information object address
<48..63>	:=	for special use (private range)

IEC 60870-5 – Possibilidades para aquisição de informação

- Polling
- Transmissão cíclica
- Aquisição de eventos
- General Interrogation

- IEC 60870-5-101: comunicação predominantemente desbalanceada
  - General interrogation é executada logo após a inicialização do master. Pode ser configurada para ser executada logo após algum slave recuperar a comunicação
  - Após a ocorrência de eventos (mudança de estados digitais ou variação de analógica acima da banda-morta), são gerados eventos com COT = 3 (spontaneous)
    - Possibilidade de transmissão dupla: envio da informação com time tag (< prioridade) e sem time tag (> prioridade)
  - Transmissão cíclica (valores analógicos)
  - Background scan (dados digitais, maior intervalo entre leituras, espécie de backup dos eventos, para que a informação do estado da rede não seja perdida por uma eventual falha na transmissão de eventos)

Interoperabilidade

IEC 60870-5-101 (Unbalanced)
Remote Communication
Protocol for REC 523

Technical Description

ABB

VAMP
Protection Relays

30.10.2007 JL

IEC 101 Profile checklist

The document contains a checklist of the IEC 60870-5-101 functional profile of VAMP devices and WIMO 6CP10.

The checklist template is derived from the IEC standard documentation, edition 2002.

This checklist presents the sets of parameters and alternatives from which subsets have to be selected to implement particular telecontrol systems. Certain parameter values, such as the number of octets in the common address of ASDUs represent mutually exclusive alternatives. This means that only one value of the defined parameters is admitted per system. Other parameters, such as the listed set of different process information in command and in monitor direction allow the specification of the complete set or subsets, as appropriate for given applications. This clause summarizes the parameters of the previous clauses to facilitate a suitable selection for a specific application. If a system is composed of equipment stemming from different manufacturers it is necessary that all partners agree on the selected parameters.

The supported options are marked with black boxes. ■

The unsupported options are left with white boxes. □

In addition, the full specification of a system may require individual selection of certain parameters for certain parts of the system, such as the individual selection of scaling factors for individually addressable measured values.

Vaasa Electronics Group VAMP

1/26

Comparação DNP3 x IEC 101

(Gordon Clarke, Deon Reynders. Practical Modern SCADA Protocols)

- Aplicação
  - IEC 101: Apenas um comando por mensagem
    - DNP3 permite realizar vários comandos em uma única mensagem
  - Objetos de dados mais complexos no DNP3; mais orientados a dados de subestação no IEC 101
    - DNP3: Group, variation
    - IEC 101: ASDU
- Interoperabilidade
  - DNP3: Entidades certificadoras e níveis de implementação definidos pelo Users Group
  - IEC 101: não há uma definição oficial sobre certificação e não há níveis de implementação

IEC 61850

IEC TR 61850-1:2013
IEC TS 61850-2:2003
IEC 61850-3:2013
IEC 61850-4:2011
IEC 61850-5:2013
IEC 61850-6:2009
IEC 61850-7-1:2011
IEC 61850-7-2:2010
IEC 61850-7-3:2010
IEC 61850-7-4:2010
IEC 61850-7-410:2012+AMD1:2015 CSV
IEC 61850-7-420:2009
IEC TR 61850-7-500:2017
IEC TR 61850-7-510:2012
IEC 61850-8-1:2011
IEC 61850-9-2:2011
IEC/IEEE 61850-9-3:2016
IEC 61850-10:2012
IEC TS 61850-80-1:2016
IEC TR 61850-80-3:2015
IEC TS 61850-80-4:2016
IEC TR 61850-90-1:2010
IEC TR 61850-90-2:2016
IEC TR 61850-90-3:2016
IEC TR 61850-90-4:2013
IEC TR 61850-90-5:2012
IEC TR 61850-90-7:2013
IEC TR 61850-90-8:2016
IEC TR 61850-90-12:2015
IEC TR 61850-90-17:2017

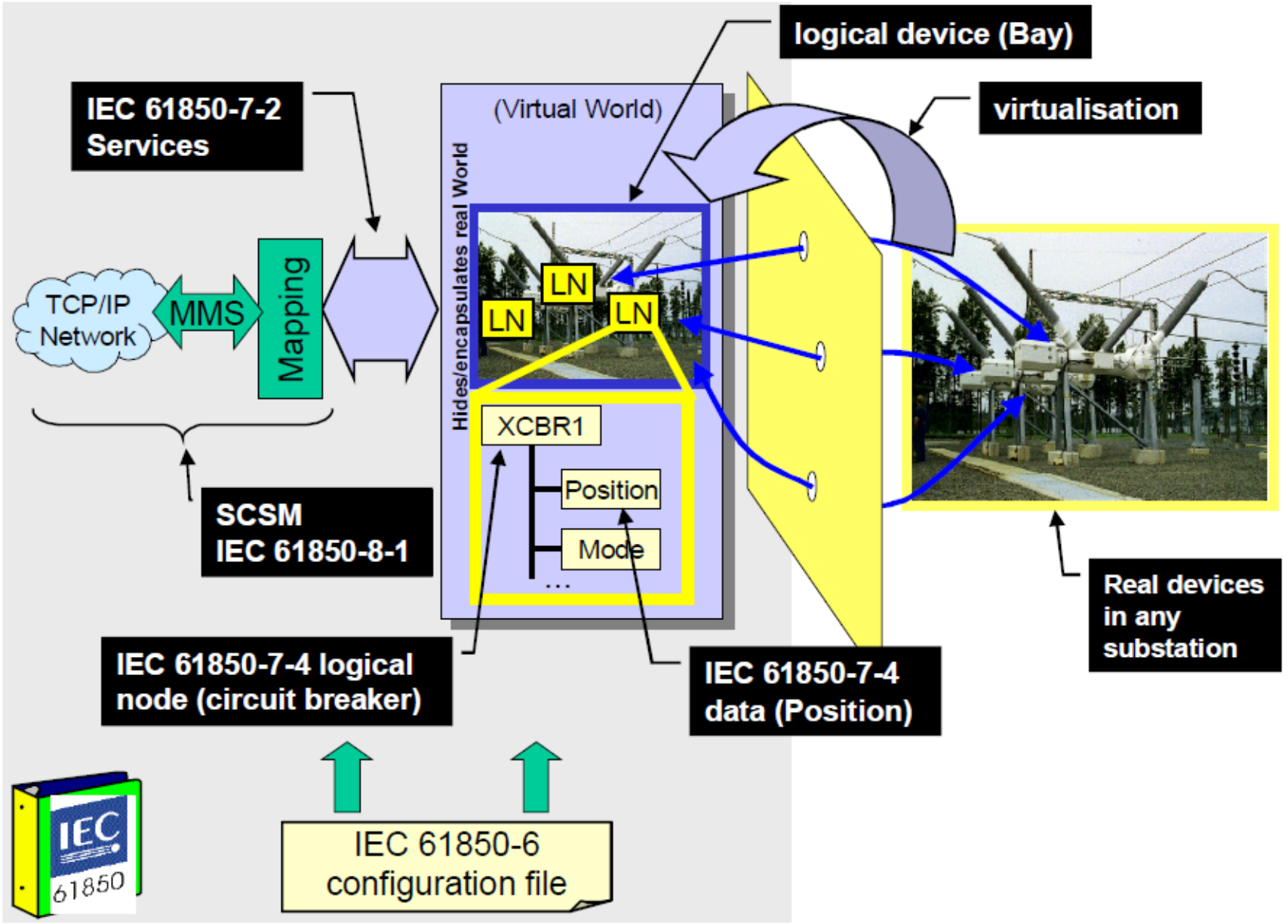
- Part 1: Introduction and overview
- Part 2: Glossary
- Part 3: General requirements
- Part 4: System and project management
- Part 5: Communication requirements for functions and device models
- Part 6: Configuration description language for communication in electrical substations related to IEDs
- Part 7-1: Basic communication structure – Principles and models
- Part 7-2: Basic communication structure – Abstract communication service interface (ACSI)
- Part 7-3: Basic communication structure – Common data classes
- Part 7-4: Basic communication structure – Compatible logical node classes and data classes
- Part 7-410: Hydroelectric power plants – Communication for monitoring and control
- Part 7-420: Basic communication structure – Distributed energy resources logical nodes

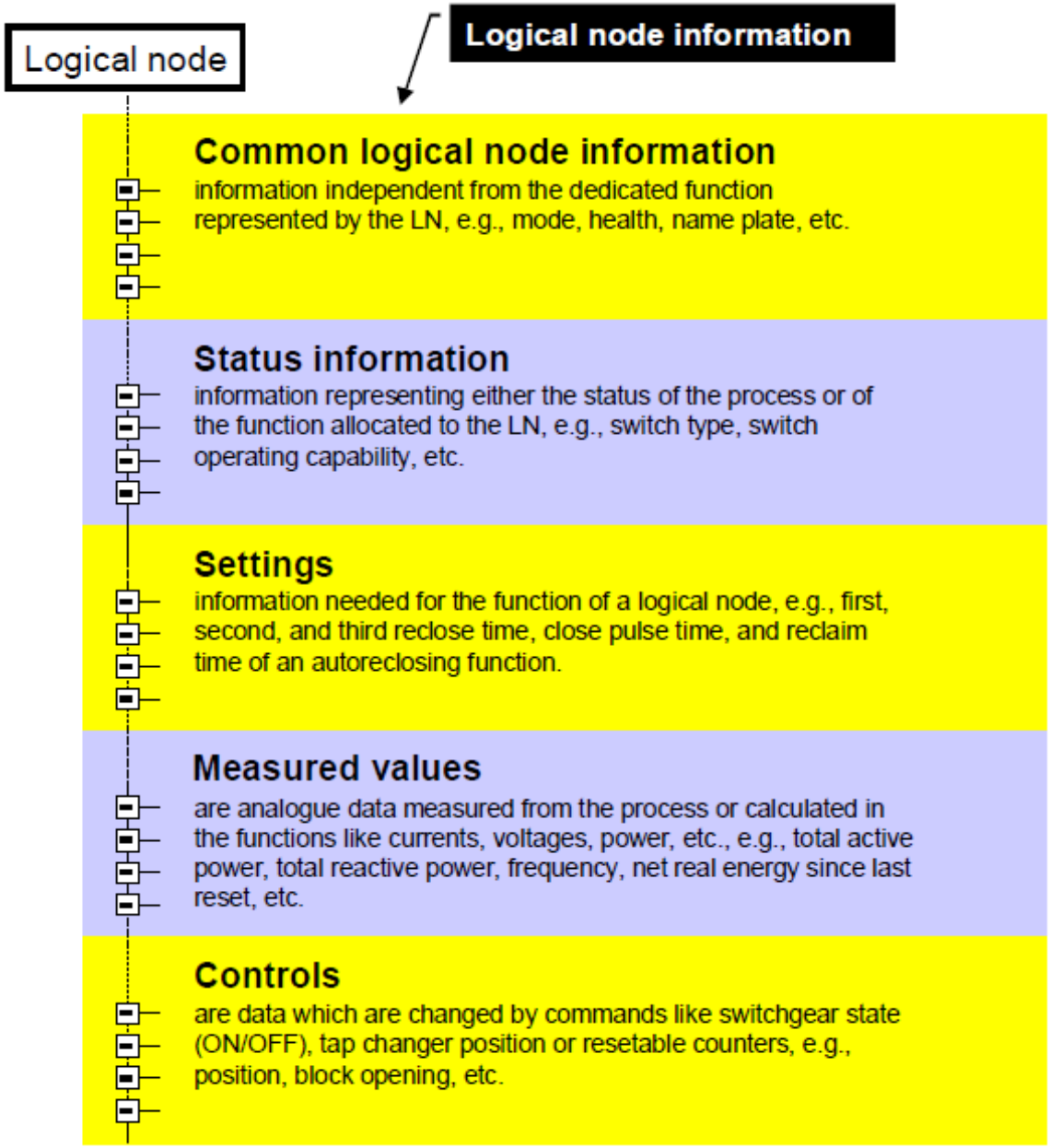
- Part 7-5: IEC 61850 – Modelling concepts1 Part 7-500: Use of logical nodes to model functions of a substation automation system
- Part 7-510: Use of logical nodes to model functions of a hydro power plant
- Part 7-520: Use of logical nodes to model functions of distributed energy resources
- Part 8-1: Specific communication service mapping (SCSM) – Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3
- Part 80-1: Guideline to exchange information from a CDC based data model using IEC 60870-5-101/104
- Part 9-2: Specific communication service mapping (SCSM) – Sampled values over ISO/IEC 8802-3
- Part 90-1: Use of IEC 61850 for the communication between substations
- Part 90-2: Using IEC 61850 for the communication between substations and control centres
- Part 90-3: Using IEC 61850 for condition monitoring1 Part 90-4: Network Engineering Guidelines - Technical report
- Part 90-5: Using IEC 61850 to transmit synchrophasor information according to IEEE C37.118
- Part 10: Conformance testing

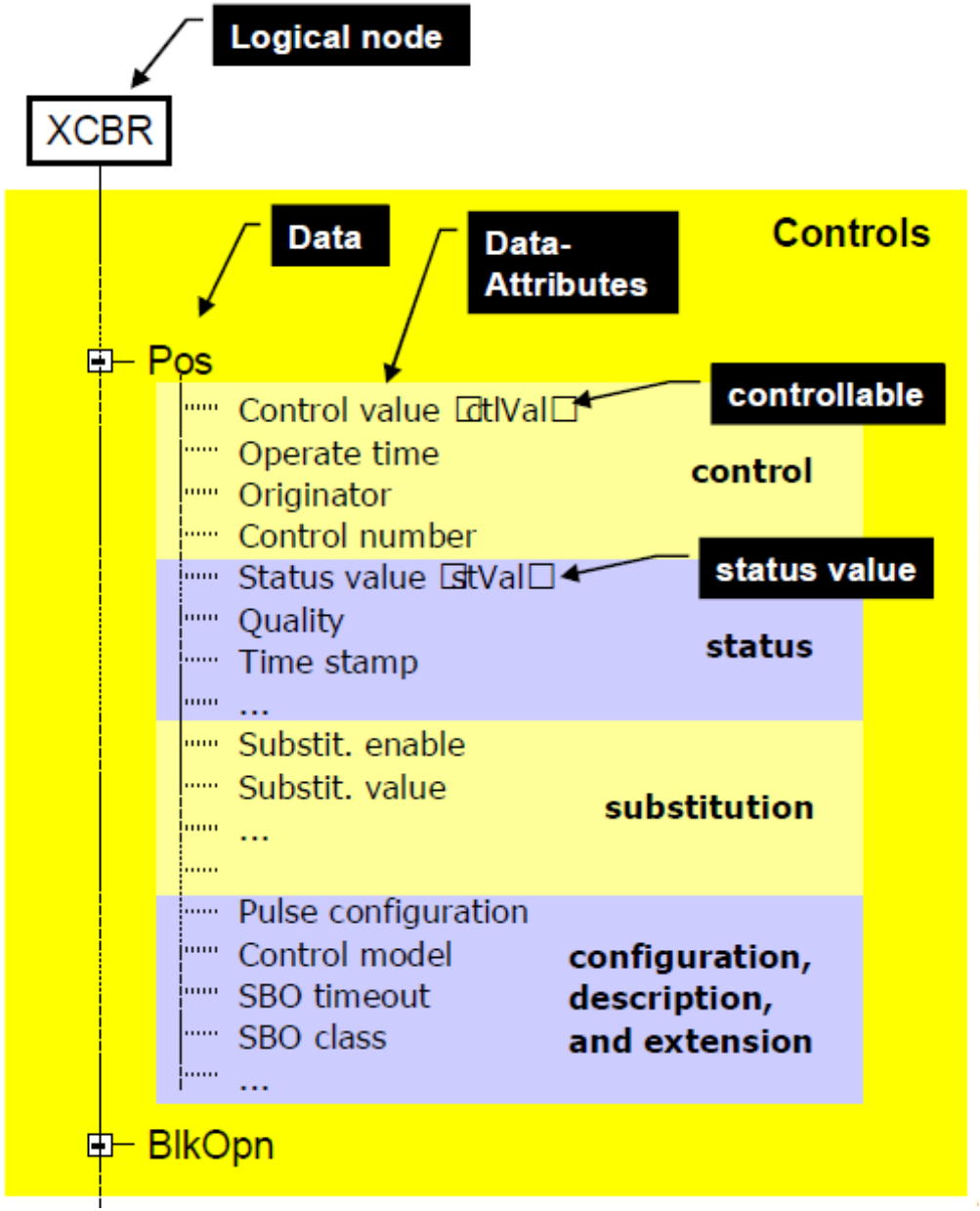
- UCA: Utility Communication Architecture
  - Iniciativa liderada pelo EPRI, em 1988

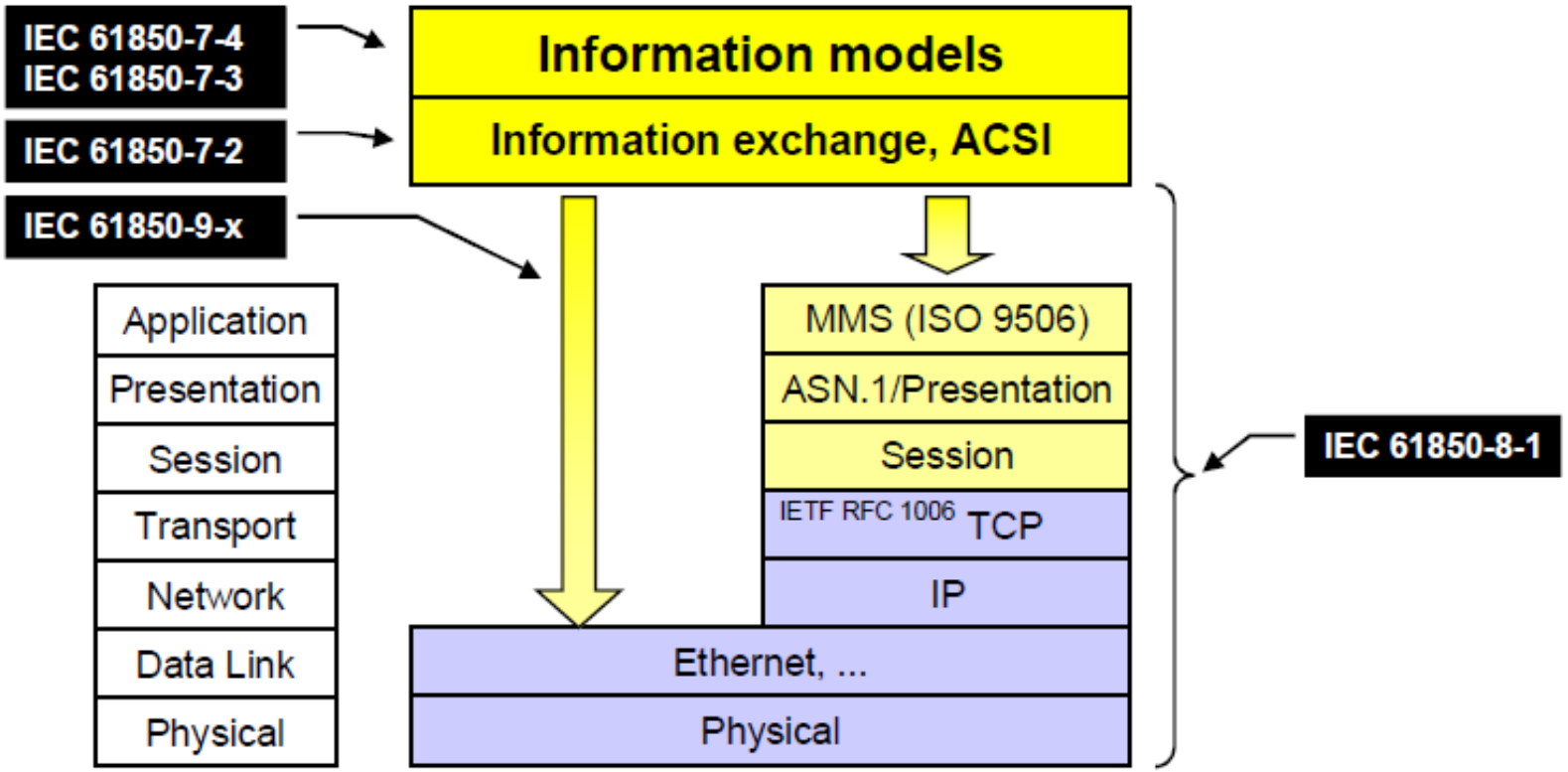
  "The industry agreed data relevant to that device will be automatically transferred to SCADA and IT systems identifying themselves as requiring it." (Gordon Clarke, Deon Reynders. Practical Modern SCADA Protocols)
- MMS: (Manufacturing Message Specification, ISO 9506)
- Primeira versão da norma IEC 61850: 2005

User		IEC 61850-1 (Introduction and overview)	IEC 61850-5 (Requirements)	IEC 61850-7-1 (Principles)	IEC 61850-7-4 (Logical nodes and data classes)	IEC 61850-7-3 (Common data classes)	IEC 61850-7-2 (Information exchange)	IEC 61850-6[a] (Configuration language)	IEC 61850-8-x IEC 61850-9-x[a] (Concrete communication stack)
Utility	Manager	x	□	**Clause 5**	□	□	□	□	□
Utility	Engineer	x	x	x	x	x	**In extracts**	x	□
Vendor	Application engineer	x	x	x	x	x	**In extracts**	x	**In extracts**
Vendor	Communication engineer	x	x	x	□	□	x	□	x
Vendor	Product manager	x	x	x	x	**In extracts**	**In extracts**	**In extracts**	□
Vendor	Marketing	x	x	**Clause 5**	**In extracts**	**In extracts**	**In extracts**	**In extracts**	□
Consultant	Application engineer	x	x	x	x	x	□	x	□
Consultant	Communication engineer	x	□	x	□	□	x	x	x
All others		x	x	x	□	□	□	□	□


logical device (Bay)
IEC 61850-7-2
Services
(Virtual World)
virtualisation
Hides/encapsulates real World
TCP/IP
Network
MMS
Mapping
LN
LN
LN
XCBR1
Position
Mode
...
SCSM
IEC 61850-8-1
Real devices
in any
substation
IEC 61850-7-4 logical
node (circuit breaker)
IEC 61850-7-4
data (Position)
IEC
61850
IEC 61850-6
configuration file


Logical node
Logical node information
Common logical node information
information independent from the dedicated function represented by the LN, e.g., mode, health, name plate, etc.
Status information
information representing either the status of the process or of the function allocated to the LN, e.g., switch type, switch operating capability, etc.
Settings
information needed for the function of a logical node, e.g., first, second, and third reclose time, close pulse time, and reclaim time of an autoreclosing function.
Measured values
are analogue data measured from the process or calculated in the functions like currents, voltages, power, etc., e.g., total active power, total reactive power, frequency, net real energy since last reset, etc.
Controls
are data which are changed by commands like switchgear state (ON/OFF), tap changer position or resetable counters, e.g., position, block opening, etc.


Logical node
XCBR
Data
Data-Attributes
Controls
Pos
controllable
Control value dtlVal
Operate time
Originator
Control number
control
status value
Status value stVal
Quality
Time stamp
...
status
Substit. enable
Substit. value
...
substitution
Pulse configuration
Control model
SBO timeout
SBO class
...
configuration, description, and extension
BlkOpn


IEC 61850-7-4
IEC 61850-7-3
IEC 61850-7-2
IEC 61850-9-x
Information models
Information exchange, ACSI
Application
Presentation
Session
Transport
Network
Data Link
Physical
MMS (ISO 9506)
ASN.1/Presentation
Session
IETF RFC 1006 TCP
IP
Ethernet, ...
Physical
IEC 61850-8-1

IEC 61850-8-1: Specific Communication Service Mapping (SCSM) – Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3

MMS OBJECT	IEC 61850 OBJECT	MMS SERVICES IN USE
Application Process VMD	Server	Initiate Conclude Abort Reject Cancel Identify [1]
Named Variable Objects	Logical Nodes and Data	Read Write InformationReport GetVariableAccessAttribute GetNameList
Named Variable List Objects	Data Sets	GetNamedVariableListAttributes GetNameList DefineNamedVariableList DeleteNamedVariableList GetNameList Read Write InformationReport
Journal Objects	Logs	ReadJournal InitializeJournal GetNameList
Domain Objects	Logical Devices	GetNameList GetDomainAttributes StoreDomainContents
Files	Files	FileOpen FileRead ObtainFile FileClose FileDirectory FileDelete
[1] Required by ISO 9506 for conformance.		

MMS: Manufacturing Messaging Specification

Logical Node	IEC 61850	IEEE C37.2-1996	Description or comments
Transient earthfault protection	**PTEF**		Transient earth faults happen if there is a fault to ground (isolation breakdown) in compensated networks. The fault disappears very fast since there is not sufficient current to feed it. No trip happens but the fault direction/location has to be detected to repair the faulted part. At least the degradation of the impacted line/cable is reported.
Zero speed and underspeed protection	**PZSU**	14	An underspeed device is a device that functions when the speed of a machine falls below a pre-determined value.
Distance protection	**PDIS**	21	A distance relay is a relay that functions when the circuit admittance, impedance, or reactance increases or decreases beyond a predetermined value. The change of the impedance seen by PDIS is caused by a fault. The impedance characteristic is a closed line set in the complex impedance plane. The reach of the distance protection is normally split into different zones (for example 1 to 4 forward and 1 backward) represented by dedicated characteristics.
Volt per Hz protection	**PVPH**	24	Voltage per Hertz relay is a relay that functions when the ratio of voltage to frequency exceeds a preset value. The relay may have an instantaneous or a time characteristic.
(Time) Undervoltage protection	**PTUV**	27	An undervoltage relay is a relay which operates when its input voltage is less than a predetermined value.
Directional power/reverse power protection	**PDPR**	32	A directional power relay is a relay which operates on a predetermined value of power flow in a given direction, or upon reverse power flow such as that resulting from the motoring of a generator upon loss of its prime mover.

Logical node	IEC 61850	IEEE C37.2-1996	Description or comments
Automatic reclosing	**RREC**	79	AC closing relay is a relay that controls the automatic reclosing and locking out of an AC circuit interrupter (IEEE C37.2-1996). After any successful protection trip, the automatic reclosing tries 1 to 3 times to reclose the open breaker again with different time delays assuming a transient fault.
Breaker failure	**RBRF**	50BF	Instantaneous overcurrent or rate-of-rise relay is a relay that functions instantaneously on an excessive value of current or on an excessive rate of current rise (IEEE C37.2-1996). In case of a breaker failure, the fault is not cleared. Therefore, neighboring breakers have to be tripped.
Carrier or pilot wire protection[1]	**RCPW**	85	Carrier or pilot-wire receiver relay is a relay that is operated or restrained by a signal used in connection with carrier-current or DC pilot-wire fault relaying (IEEE C37.2-1996).
Fault locator	**RFLO**		The fault locator calculates from the protection information (for example the fault impedance of the LN distance function) the location of the fault in km

Switch controller Controls any switchgear, i.e. the devices described by XCBR and XSWI	**CSWI**	The switch control LN handles all switchgear operations from the operators and from related automatics. It checks the authorization of the commands. It supervises the command execution and gives an alarm in case of an improper ending of the command. It asks for releases from interlocking, synchrocheck, autoreclosure, etc. if applicable.
Point-on-wave breaker controller Controls a circuit breaker with point-on-wave switching capability	**CPOW**	The point-on-wave breaker controller LN provides all functionality to close or open a circuit breaker at a certain instant of time, i.e. a certain point of the voltage or current wave. It is started by a request either from CSWI or from RREC. Comparing the voltages on both sides of the open breaker in the same way as the synchrocheck function (LN RSYN) it tries to close the contacts exactly at this time when the voltage difference is at an absolute minimum (preferable zero) to get the lowest stress for switchgear and line. This also applies if one of the voltages is zero. For opening, the point of minimum stress is calculated referring to the current wave. The selection command activates the voltage selection. It calculates the point of minimum stress and issues a closing or opening (depending on the intended command) execute command with an absolute time referring to the requested point-on-wave. For these calculations, the conditions in all three phases are considered. If switching per phase is applicable, three execution times are provided.

Table 14 – Single point status common data class definition

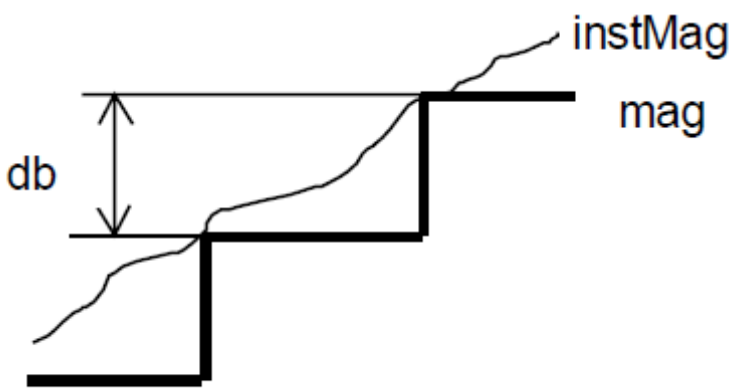
SPS class					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataName	Inherited from Data Class (see IEC 61850-7-2)				
DataAttribute					
status					
stVal	BOOLEAN	ST	dchg	TRUE | FALSE	M
q	Quality	ST	qchg		M
t	TimeStamp	ST			M
substitution					
subEna	BOOLEAN	SV			PICS_SUBST
subVal	BOOLEAN	SV		TRUE | FALSE	PICS_SUBST
subQ	Quality	SV			PICS_SUBST
subID	VISIBLE STRING64	SV			PICS_SUBST
configuration, description and extension					
d	VISIBLE STRING255	DC		Text	O
dU	UNICODE STRING255	DC			O
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M
dataNs	VISIBLE STRING255	EX			AC_DLN_M
Services					
As defined in Table 13					

Table 15 – Double point status common data class specification

DPS class					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataName	Inherited from Data Class (see IEC 61850-7-2)				
DataAttribute					
status					
stVal	CODED ENUM	ST	dchg	intermediate-state | off | on | bad-state	M
q	Quality	ST	qchg		M
t	TimeStamp	ST			M
substitution					
subEna	BOOLEAN	SV			PICS_SUBST
subVal	CODED ENUM	SV		intermediate-state | off | on | bad-state	PICS_SUBST
subQ	Quality	SV			PICS_SUBST
subID	VISIBLE STRING64	SV			PICS_SUBST
configuration, description and extension					
d	VISIBLE STRING255	DC		Text	O
dU	UNICODE STRING255	DC			O
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M
dataNs	VISIBLE STRING255	EX			AC_DLN_M
Services					
As defined in Table 13					

Table 17 □ Protection activation information common data class specification

ACT class					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataName	Inherited from Data Class (see IEC 61850-7-2)				
DataAttribute					
status					
general	BOOLEAN	ST	dchg		M
phsA	BOOLEAN	ST	dchg		O
phsB	BOOLEAN	ST	dchg		O
phsC	BOOLEAN	ST	dchg		O
neut	BOOLEAN	ST	dchg		O
q	Quality	ST	qchg		M
t	TimeStamp	ST			M
configuration, description and extension					
operTm	TimeStamp	CF			O
d	VISIBLE STRING255	DC		Text	O
dU	UNICODE STRING255	DC			O
cdcNs	VISIBLE STRING255	EX			AC_DLNDA_M
cdcName	VISIBLE STRING255	EX			AC_DLNDA_M
dataNs	VISIBLE STRING255	EX			AC_DLN_M
Services					
As defined in Table 13					

Data attribute name	Semantics
hwRev	HW-revision.
instCVal	Instant value of a vector type value.
instMag	Magnitude of a the instantaneous value of a measured value.
ldNs	Logical device name space. For details see IEC 61850-7-1.
lnNs	Logical node name space. For details see IEC 61850-7-1.
location	Location, where the equipment is installed.
mag	Deadbanded value. Shall be based on a dead band calculation from instMag as illustrated below. The value of mag shall be updated to the current value of instMag when the value has changed according the configuration parameter db.  NOTE 7 The figure above is an example. There may be other algorithms providing a comparable result; for example as an alternate solution, the dead band calculation may use the integral of the change of instMag. The algorithm used is a local issue. NOTE 8 This value mag is typically used to create reports for analogue values. Such a report sent "by exception" is not comparable to the transfer of sampled measured values as supported by the CDC SAV.

Functional constraint (FC)					
	Semantic	**Services allowed**	**Initial values/storage/ explanation**	**D[a]**	**CB[b]**
ST	Status information	**DataAttribute** shall represent a status information whose value may be read, substituted, reported, and logged but shall not be written	Initial value of the **DataAttribute** shall be taken from the process	X	
MX	Measurands (analogue values)	**DataAttribute** shall represent a measurand information whose value may be read, substituted, reported, and logged but shall not be written	Initial value of the **DataAttribute** shall be taken from the process	X	
CO	Control	**DataAttribute** shall represent a control information whose value may be operated (control model) and read	N.a.	X	
SP	Setpoint	**DataAttribute** shall represent a set-point information whose value may be controlled (control model) and read. Values controlled shall become effective immediately	Initial value of the **DataAttribute** shall be as configured; value shall be non-volatile	X	X
SV	Substitution	**DataAttribute** shall represent a substitution information whose value may be written to substitute the value attribute and read	If the value of the **DataAttribute** is volatile then the initial value shall be FALSE, else the value should be as set or configured	X	
CF	Configuration	**DataAttribute** shall represent a configuration information whose value may be written and read. Values written may become effective immediately or deferred by reasons outside the scope of this standard	Initial value of the **DataAttribute** shall be as configured; value shall be non-volatile	X	

5.4.18 LN: Time overcurrent Name: PTOC

For a description of this LN, see IEC 61850-5 (LN PTOC). This LN shall also be used to model the Directional Time Overcurrent (PDOC/IEEE 67). The Definite Time overcurrent (also PTOC/IEEE 51) shall be modelled by use of PTOC and selecting the related curve.

PTOC class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
OpCntRs	INC	Resetable operation counter		O
Status Information				
Str	ACD	Start		M
Op	ACT	Operate	T	M
TmASt	CSD	Active curve characteristic		O
Settings				
TmACrv	CURVE	Operating Curve Type		O
StrVal	ASG	Start Value		O
TmMult	ASG	Time Dial Multiplier		O
MinOpTmms	ING	Minimum Operate Time		O
MaxOpTmms	ING	Maximum Operate Time		O
OpDlTmms	ING	Operate Delay Time		O
TypRsCrv	ING	Type of Reset Curve		O
RsDlTmms	ING	Reset Delay Time		O
DirMod	ING	Directional Mode		O

XCBR class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
Loc	SPS	Local operation (local means without substation automation communication, hardwired direct control)		M
EEHealth	INS	External equipment health		O
EEName	DPL	External equipment name plate		O
OpCnt	INS	Operation counter		M
Controls				
Pos	DPC	Switch position		M
BlkOpn	SPC	Block opening		M
BlkCls	SPC	Block closing		M
ChaMotEna	SPC	Charger motor enabled		O
Metered Values				
SumSwARs	BCR	Sum of Switched Amperes, resetable		O
Status Information				
CBOpCap	INS	Circuit breaker operating capability		M
POWCap	INS	Point On Wave switching capability		O
MaxOpCap	INS	Circuit breaker operating capability when fully charged		O

MMXU class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health (external sensor)		O
Measured values				
TotW	MV	Total Active Power (Total P)		O
TotVAr	MV	Total Reactive Power (Total Q)		O
TotVA	MV	Total Apparent Power (Total S)		O
TotPF	MV	Average Power factor (Total PF)		O
Hz	MV	Frequency		O
PPV	DEL	Phase to phase voltages (VL1VL2, ...)		O
PhV	WYE	Phase to ground voltages (VL1ER, ...)		O
A	WYE	Phase currents (IL1, IL2, IL3)		O
W	WYE	Phase active power (P)		O
VAr	WYE	Phase reactive power (Q)		O
VA	WYE	Phase apparent power (S)		O
PF	WYE	Phase power factor		O
Z	WYE	Phase Impedance		O

MSQI class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health (external sensor)		O
EEName	DPL	External equipment name plate		O
Measured values				
SeqA	SEQ	Positive, Negative and Zero Sequence Current		C
SeqV	SEQ	Positive, Negative and Zero Sequence Voltage		C
DQ0Seq	SEQ	DQ0 Sequence		O
ImbA	WYE	Imbalance current		O
ImbNgA	MV	Imbalance negative sequence current		O
ImbNgV	MV	Imbalance negative sequence voltage		O
ImbPPV	DEL	Imbalance phase-phase voltage		O
ImbV	WYE	Imbalance voltage		O
ImbZroA	MV	Imbalance zero sequence current		O
ImbZroV	MV	Imbalance zero sequence voltage		O

GGIO class				
Attribute Name	**Attr. Type**	**Explanation**	**T**	**M/O**
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2)		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class		M
EEHealth	INS	External equipment health (external sensor)		O
EEName	DPL	External equipment name plate		O
Loc	SPS	Local operation		O
OpCntRs	INC	Resetable operation counter		O
Measured values				
AnIn	MV	Analogue input		O
Controls				
SPCSO	SPC	Single point controllable status output		O
DPCSO	DPC	Double point controllable status output		O
ISCSO	INC	Integer status controllable status output		O
Status Information				
IntIn	INS	Integer status input		O
Alm	SPS	General single alarm		O
Ind	SPS	General indication (binary input)		O