

**DER Integration – understanding how
IEC 61850 is being developed to support a
more decentralized and flexible energy
system through the intelligent operation of
grid edge assets**

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Questions

- What are we doing?
- Why are we doing it?
- How are we doing it?

Date

What are we doing?

- Transition to a Smart Grid
- Improving the reliability of the electric power system
- Ensuring the secure operation of the grid
- Improving the efficiency of integration of DERs in electric power systems

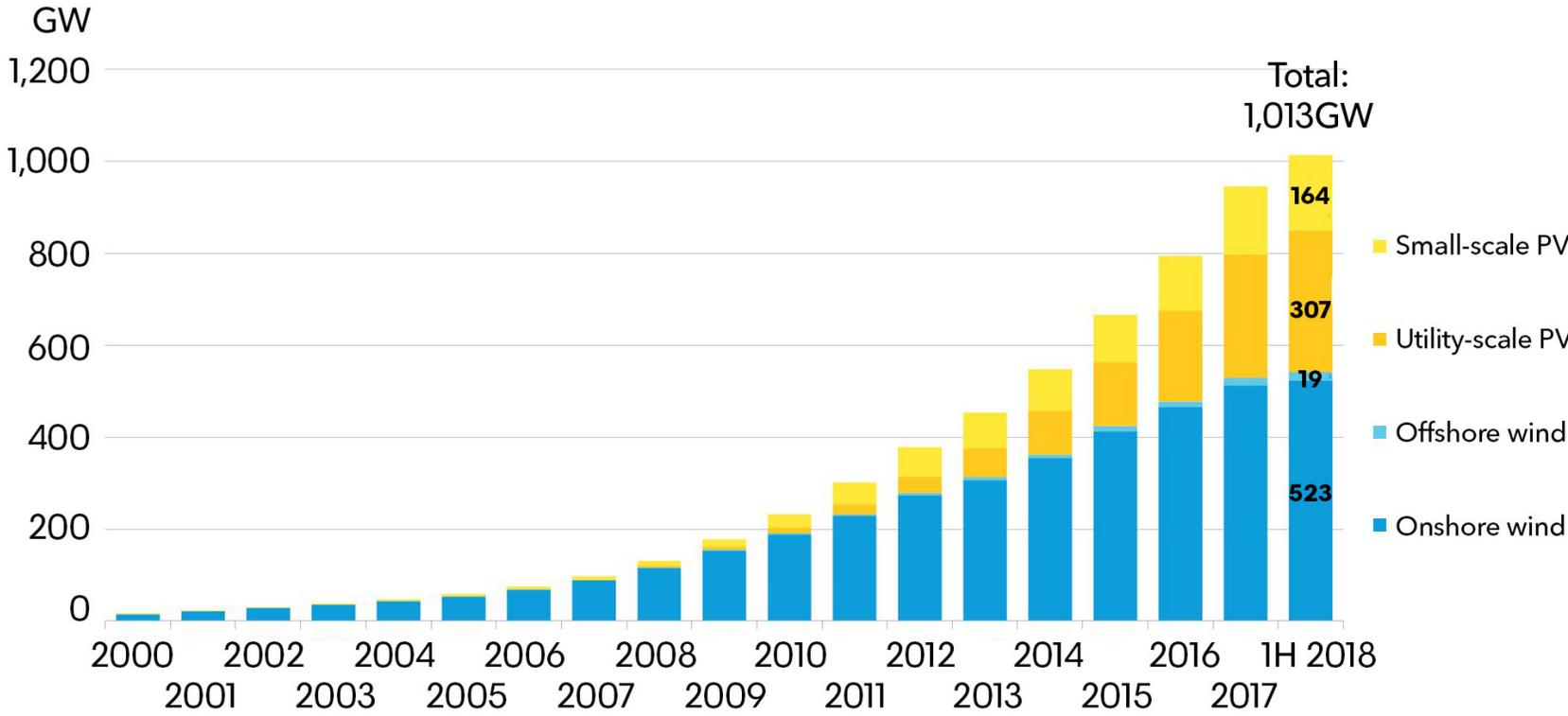
Date

Why are we doing it?

- Increased percentage of wind and solar generation in many countries and in the United States
- Requirements to maintain the reliability of the system during and after short circuit faults

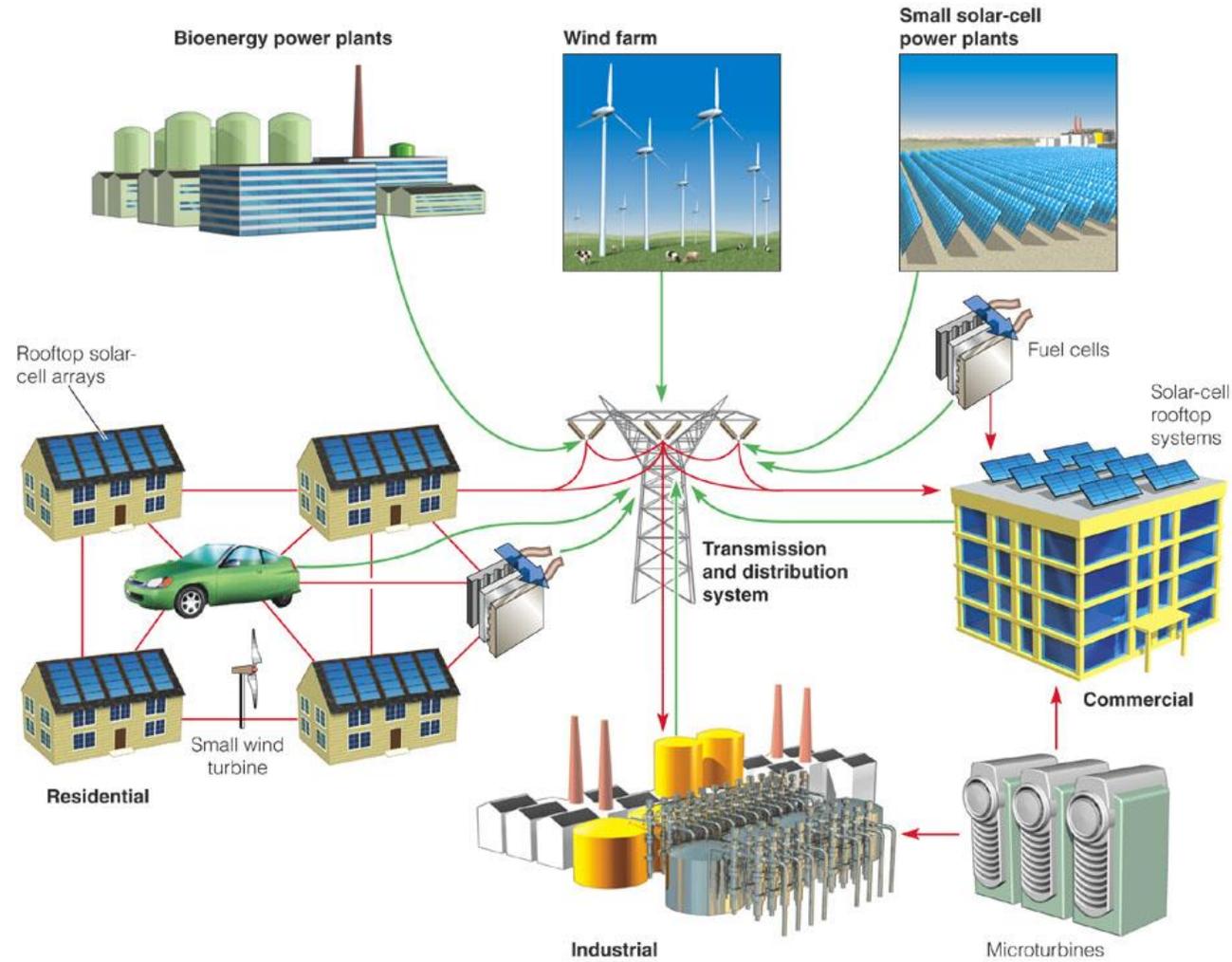
Global Wind and Solar Power 2018

Global wind and solar installations, cumulative to June 30, 2018



Source: Bloomberg NEF. Note: 1H 2018 figures for onshore wind are based on a conservative estimate; the true figure will be higher. BNEF typically does not publish mid-year installation numbers.

DERs



How are we doing it?

- Based on the development of IEC 61850
- Ongoing work by multiple task forces in IEC TC 57 working groups 10 and 17

IEC 61850 Development Status

WG	Title	Document	Ed
10	Guideline to exchange information from a CDC based data model using IEC 60870-5-101/104	61850-80-1	
17	Mapping to Web Services – Requirement Analysis and Technology Assessment	61850-80-3	
10	Mapping between the DLMS/COSEM (IEC 62056) data models and the IEC 61850 data models	61850-80-4	
10	Mapping between Modbus and IEC 61850	61850-80-5	1

IEC 61850 Development Status

WG	Title	Document	Ed
10	Using IEC 61850 for the communication between substations	61850-90-1	
10	Using IEC 61850 for condition monitoring	61850-90-3	
10	Network engineering guidelines for substations	61850-90-4	2
10	Using IEC 61850 to transmit synchrophasor information according to IEEE C37.118	61850-90-5	
17	Using IEC 61850 for Distribution Automation	61850-90-6	1
17	Object models for photovoltaic, storage and other inverter based applications	61850-90-7	
17	Object models for electrical vehicles	61850-90-8	2
17	Object models for electrical energy storage	61850-90-9	1
17	Object models for schedules	61850-90-10	1

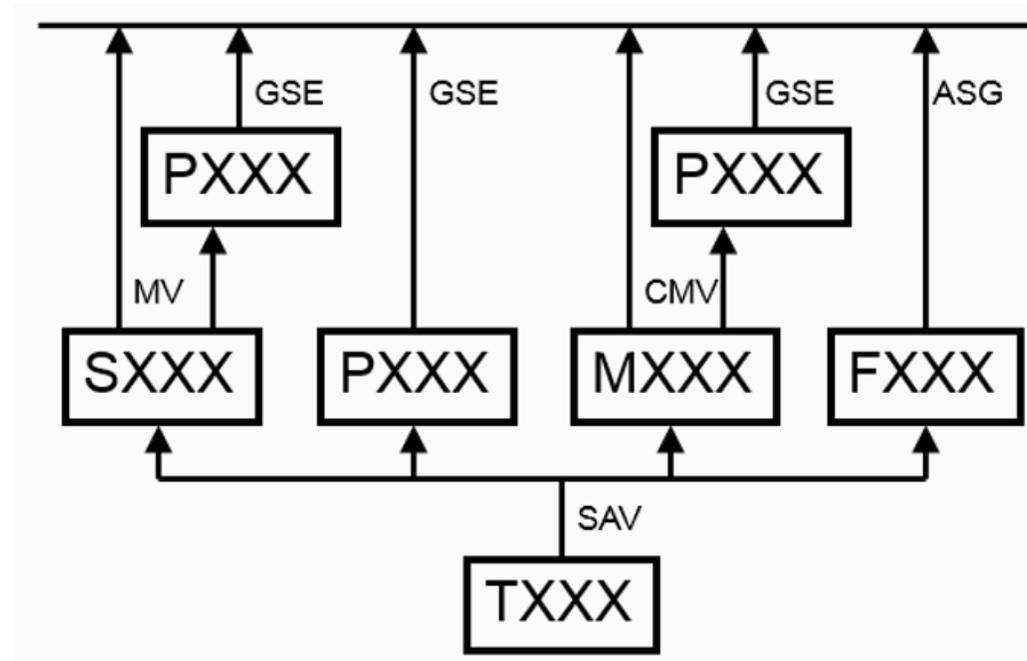
IEC 61850 Development Status

WG	Title	Document	Ed
10	Methodologies for modelling of logics for IEC 61850 based applications	61850-90-11	1
10	Wide area network engineering guidelines	61850-90-12	2
10	Deterministic network topologies	61850-90-13	1
10	Using IEC 61850 for FACTS and power conversion data modelling	61850-90-14	1
17	IEC 61850 based DER Grid Integration	61850-90-15	1
17	Requirements for System Management	61850-90-16	1

IEC 61850 Development Status

WG	Title	Document	Ed
10	Use of IEC 61850 to transmit Power Quality Data	61850-90-17	
10	Modeling Alarmhandling for IEC 61850	61850-90-18	1
10	Applying role based access to IEC 61850	61850-90-19	1
10	Guideline for redundant IEDs with IEC 61850	61850-90-20	1
10	Use of IEC 61850 for traveling wave fault location system	61850-90-21	1

Data sources in the digital grid

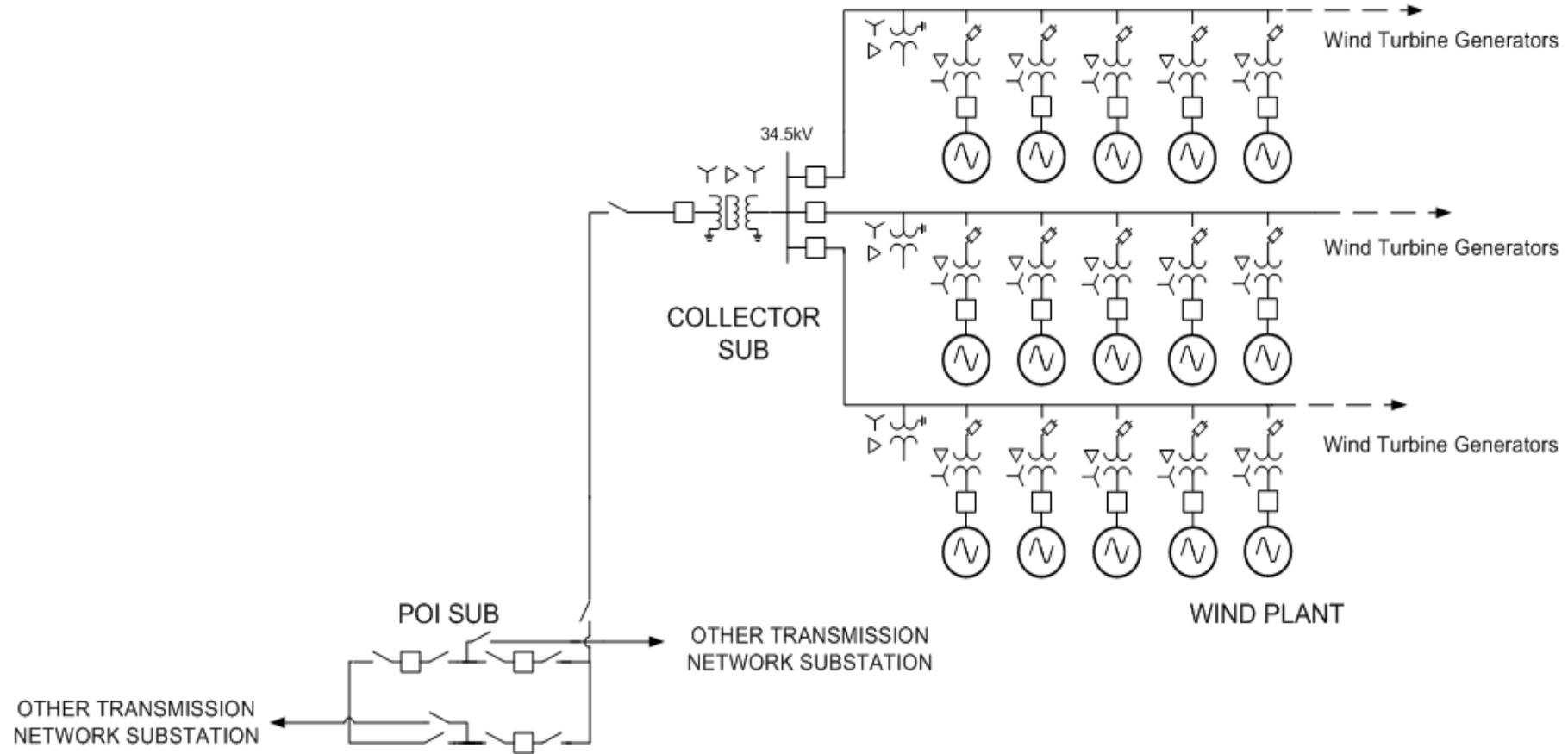


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New LNs in IEC 61850

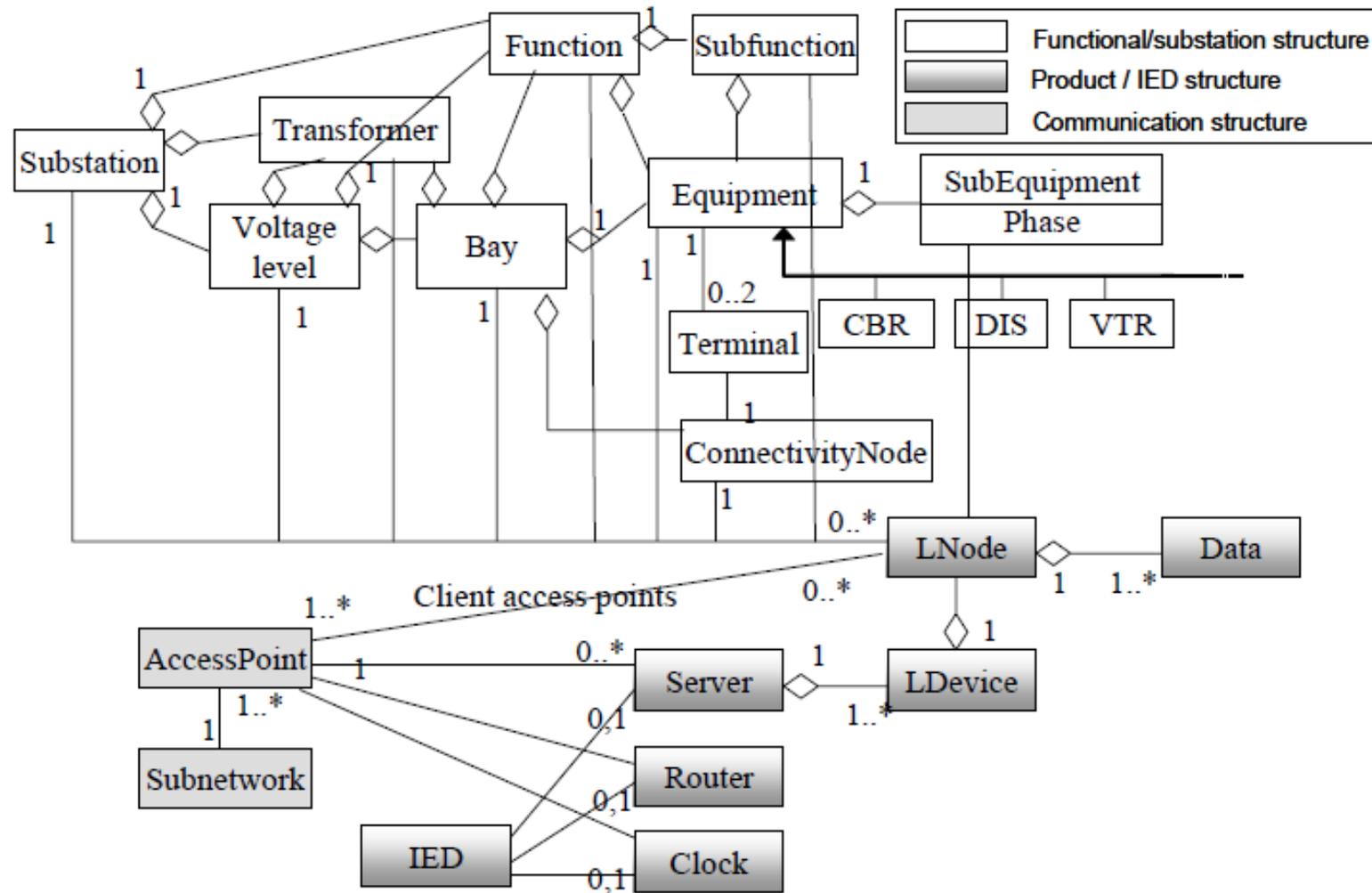
ANCR	MSQI	PTUV	YPSH	ANCR	DPST	GAPC	ISAF	MMDC	PTEF	RDRS	TLEV	WTOW	ZREA
ARCO	MSTA	PUPF	YPTR	ARCO	DPVA	GGIO	ITCI	MMET	PTHF	RFLO	TLVL	WTRF	ZRES
ATCC	PDIF	PVOC	ZAXN	ARIS	DPVC	GLOG	ITMI	MMTN	PTOC	RMXU	TMGF	WTRM	ZRRC
AVCO	PDIR	PVPH	ZBAT	ATCC	DPVM	GSAL	ITPC	MMTR	PTOF	RPSB	TMVM	WTUR	ZSAR
CALH	PDIS	PZSU	ZBSH	AVCO	DRAT	HBRG	KFAN	MMXN	PTOV	RREC	TPOS	WYAW	ZSCR
CCGR	PDOP	RADR	ZCAB	CALH	DRAZ	HCOM	KFIL	MMXU	PTRC	RSYN	TPRS	XCBR	ZSMC
CILO	PDUP	RBDR	ZCAP	CCGR	DRCC	HDAM	KPMP	MPRS	PTTR	SARC	TRTN	XFUS	ZTCF
CLN	PFRC	RBRF	ZCON	CILO	DRCS	HDLS	KTNK	MSQI	PTUC	SCBR	TSND	XSWI	ZTCR
CPOW	PHAR	RDIR	ZGEN	CPOW	DRCT	HGPI	KVLV	MSTA	PTUF	SIMG	TTMP	YEFN	
CSWI	PHIZ	RDRE	ZGIL	CSWI	DREX	HGTE	LCCH	PDIF	PTUV	SIML	TTNS	YLTC	
GAPC	PIOC	RDRS	ZLIN	CSYN	DSCC	HITG	LGOS	PDIR	PUPF	SLTC	TVBR	YPSH	
GGIO	PM	PTUV	ZMOT	DCCT	DSCH	HJCL	LLNO	PIOC	PV	SOPM	TVTR	YPTR	
GSAL	PM	RP	ZREA	DCHB	DSFC	HLKG	LPHD	PTOC	PVP	SPDC	TWPH	ZAXN	
IARC	PO	RP	ZRRC	DCHC	DSTK	HLVL	LSVS	PTOC	PZ	SPTR	WALG	ZBAT	
IHMI	PPAM	RSYN	ZSAR	DCIP	DTRC	HMBR	LTIM	PFRC	QFVR	SSWI	WALM	ZBSH	
ITCI	PSCH	SARC	ZTCF	DCRP	FCNT	HNDL	LTMS	PHAR	QTR	STMP	WAPC	ZBTC	
ITMI	PSDE	SIMG	ZTCR	DCTS	FCSD	HNHD	LTRK	PHIZ	QIUB	SVBR	WCNV	ZCAB	
LLNO	PTEF	SIML		DEXC	FFIL	HOTP	MENV	PIOC	QVTR	TANG	WCON	ZCAP	
LPHD	PTOC	SPDC		DFCL	FLIM	HRES	MFLK	PMRI	QVUB	TAXD	WGEN	ZCON	
MDIF	PTOF	TCTR		DFLV	FPID	HSEQ	MFLW	PMSS	QVVR	TCTR	WMET	ZGEN	
MHAI	PTOV	TVTR		DFPM	FRMP	HSPD	MFUL	POPF	RADR	TDST	WNAC	ZGIL	
MHAN	PTRC	XCBR		DGEN	FSEQ	HUNT	MHAI	PPAM	RBDR	TFLW	WREP	ZINV	
MMTR	PTTR	XSWI		DOPA	FSPT	HWCL	MHAN	PRTR	RBRF	TFRQ	WROT	ZLIN	
MMXN	PTUC	YEFN		DOPM	FXOT	IARC	MHET	PSCH	RDIR	TGSN	WRPC	ZMOT	
MMXU	PTUF	YLTC		DOPR	FXUT	IHMI	MHYD	PSDE	RDRE	THUM	WSLG	ZRCT	

Plant configuration language

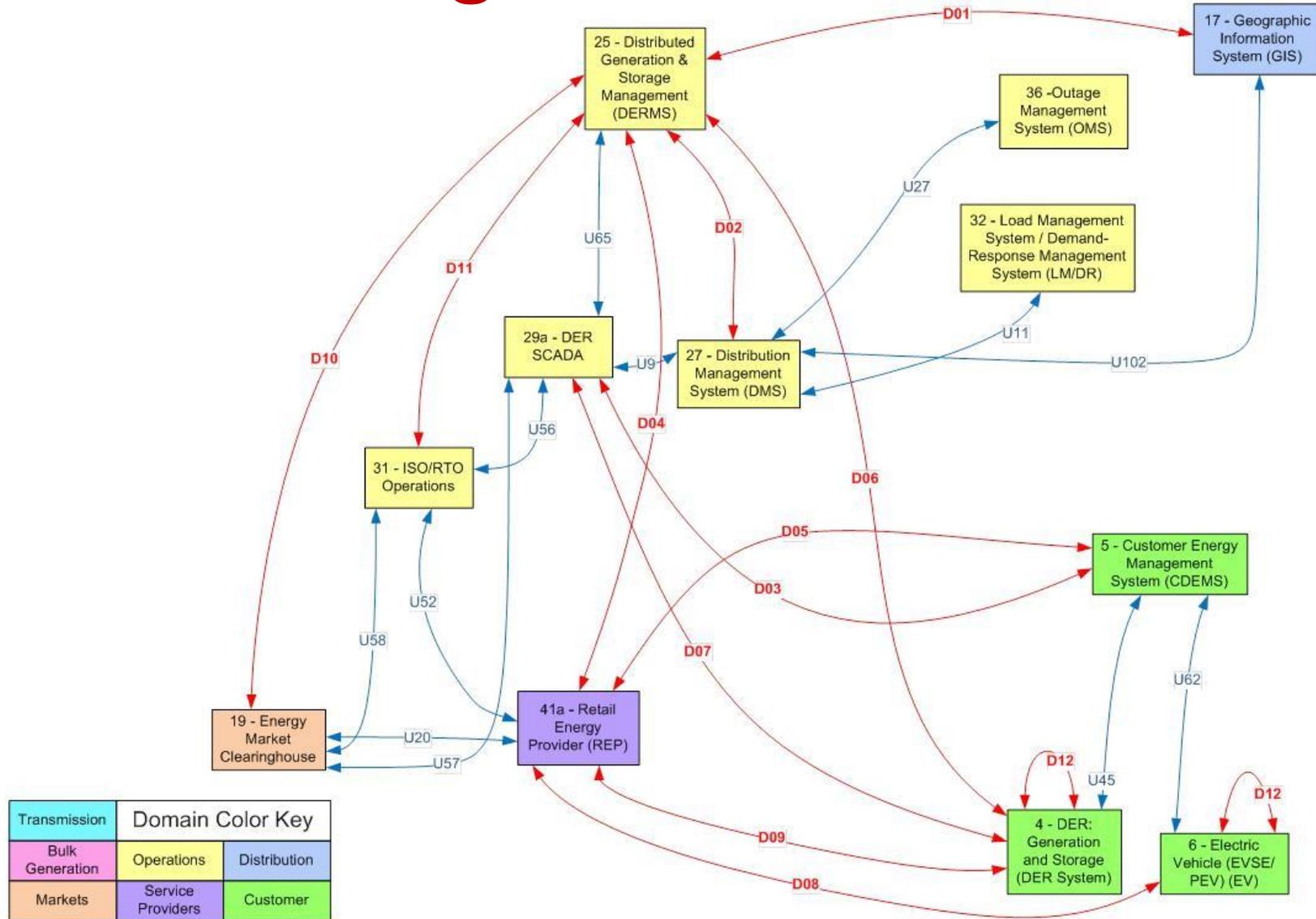


SYSTEM ONE LINE
DIAGRAM

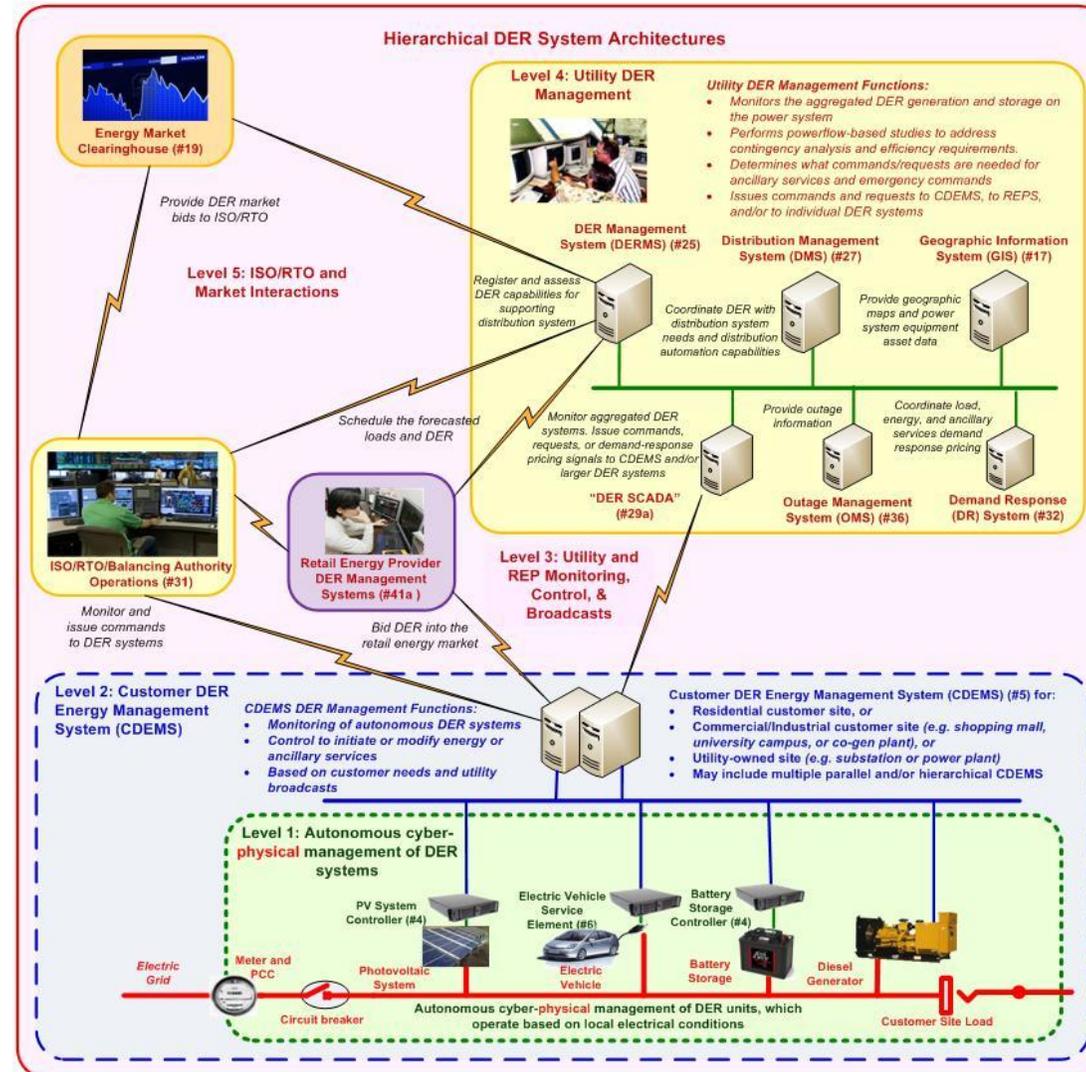
SCL Object Model



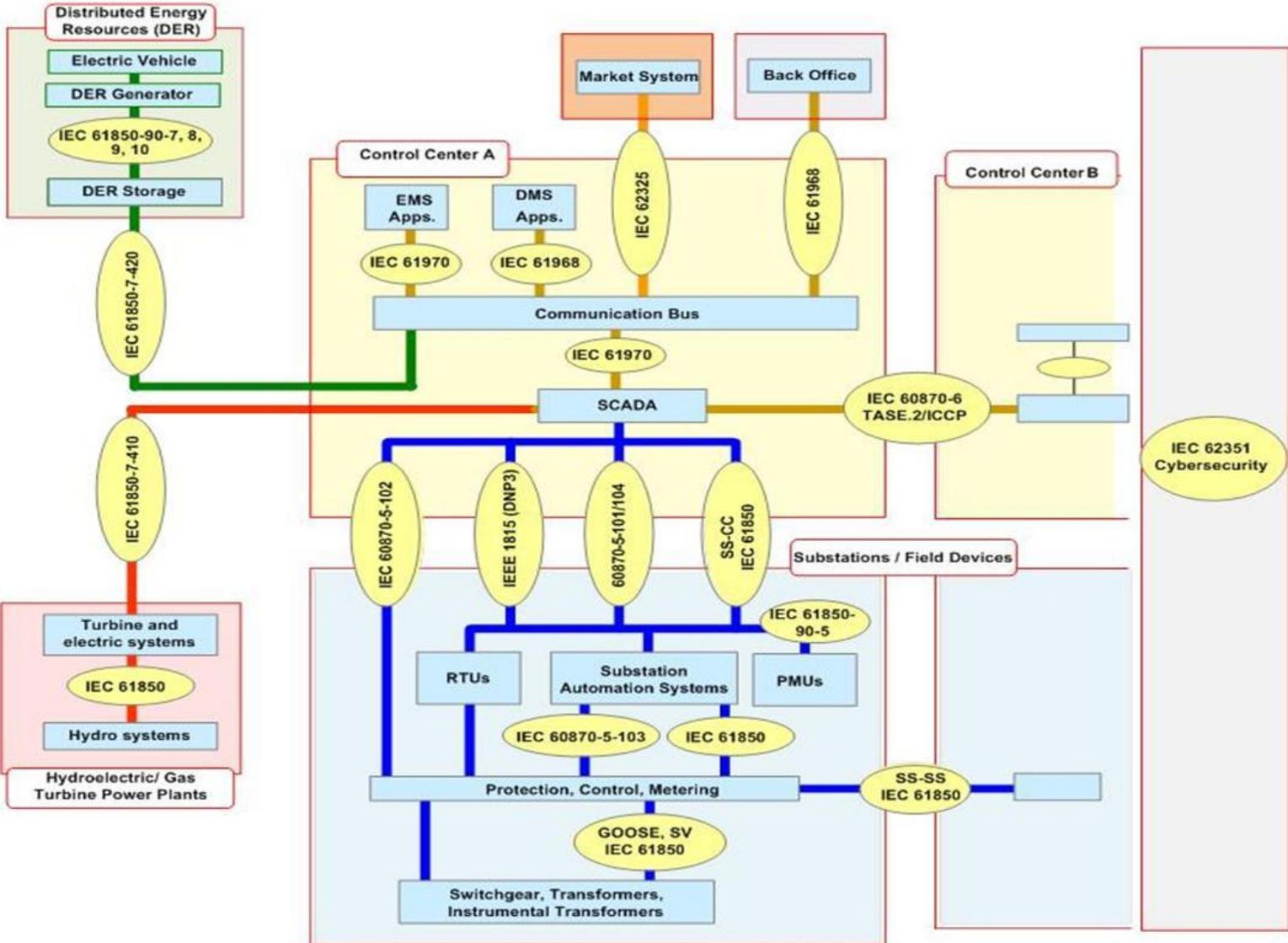
Actors and Logical Interfaces with DERs



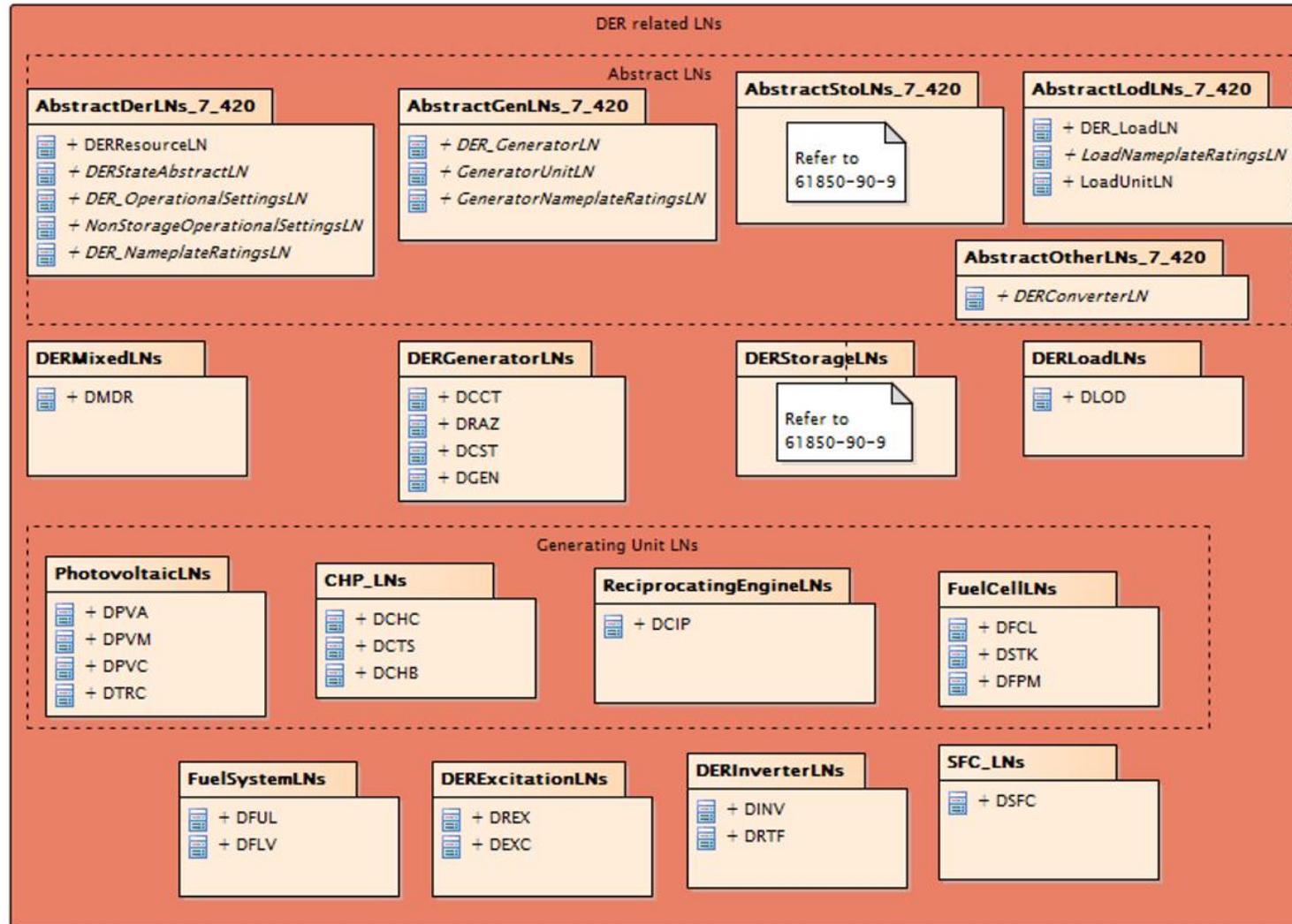
DER Management Architecture



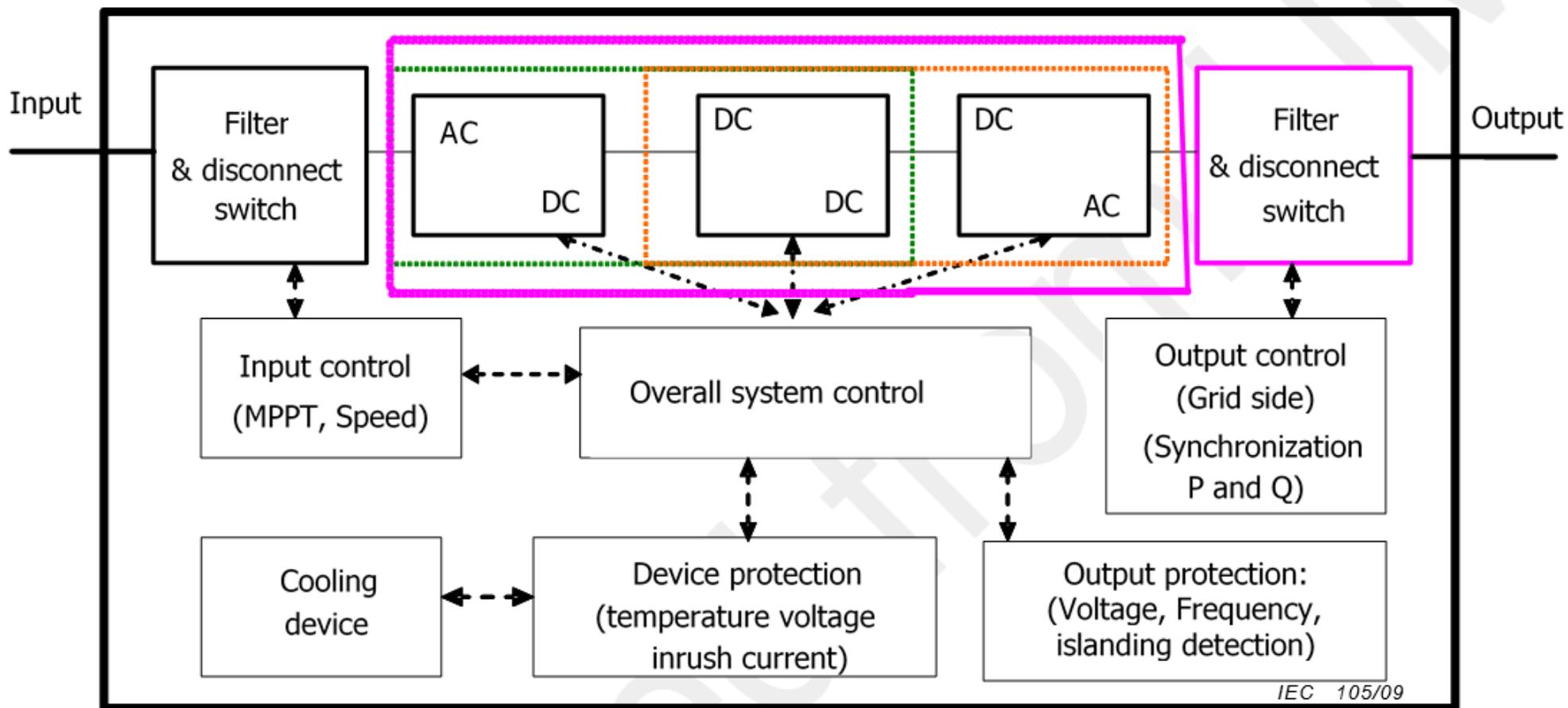
Related Standards



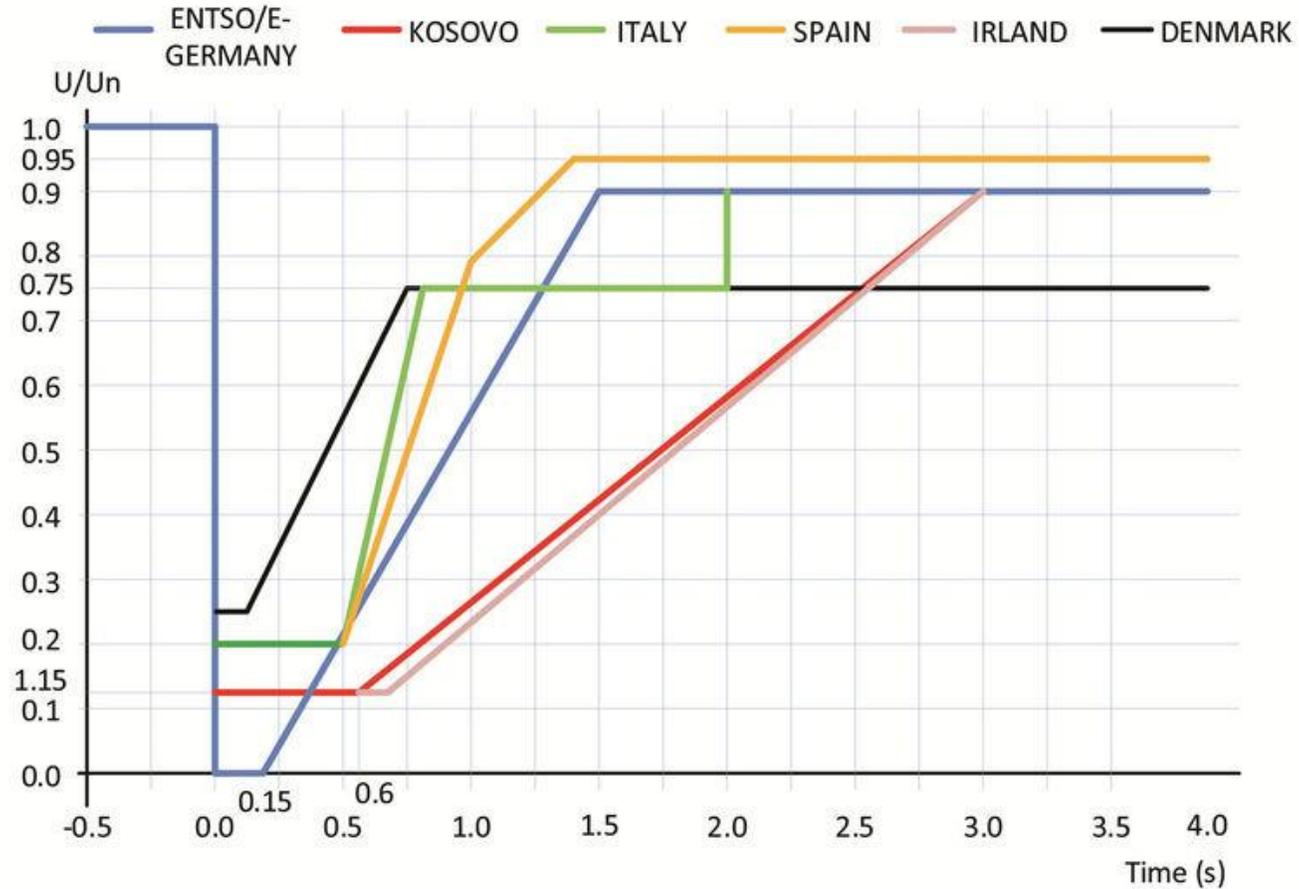
DER LNs



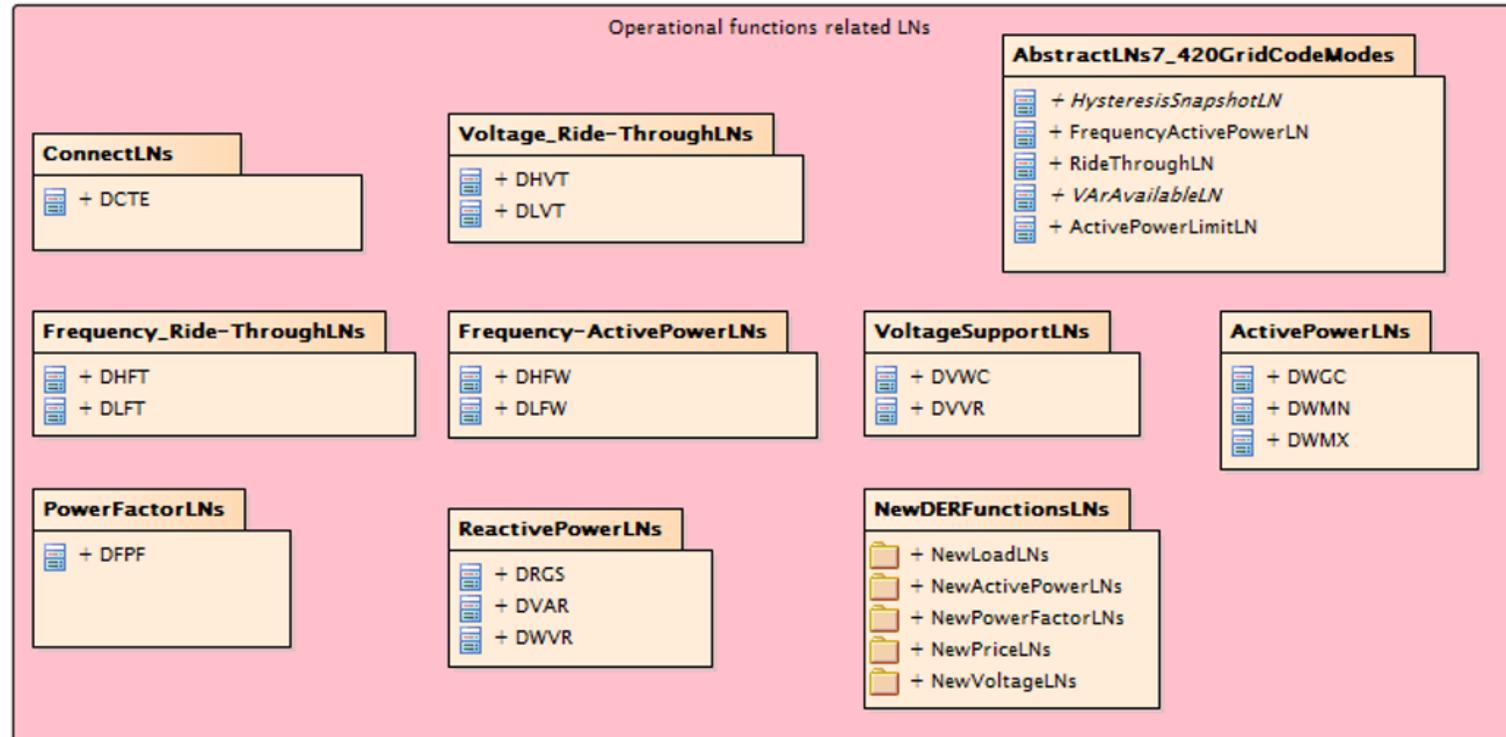
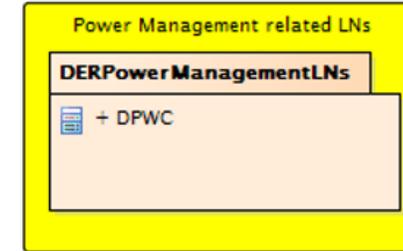
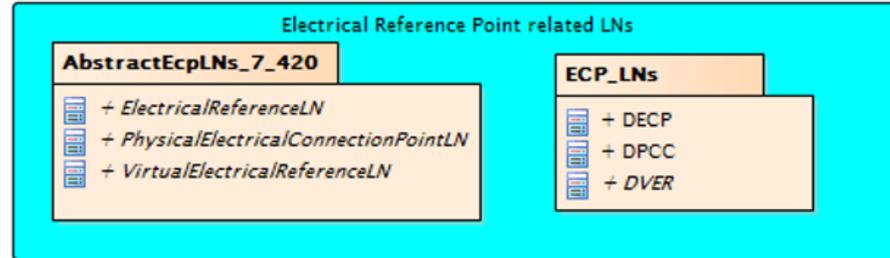
Converter Model



Ride-Through Capability



DER LNs



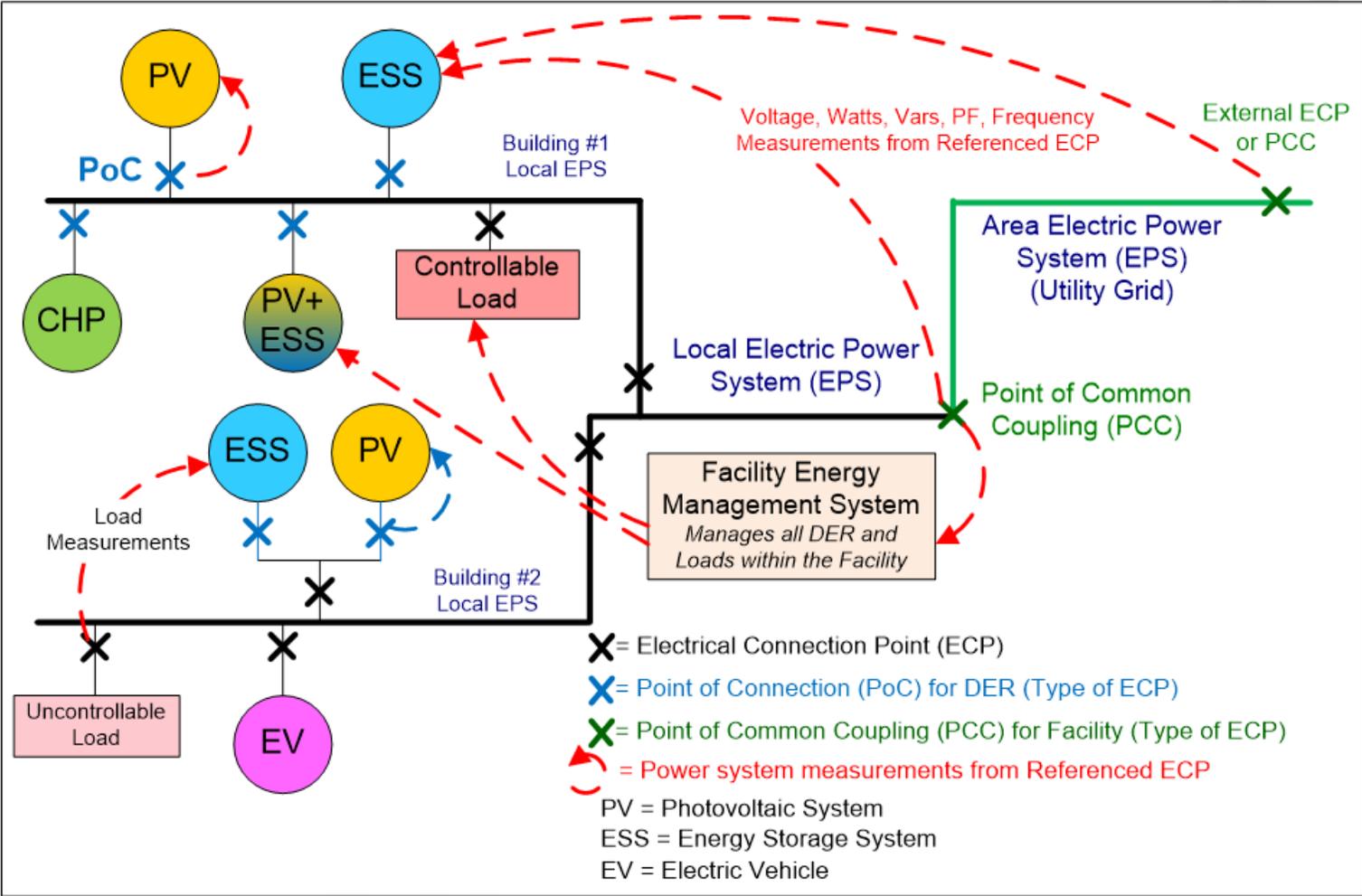
LN use

- Measuring and metering: functions required to obtain electrical measurements like voltage and current.
- AC measurements are covered in MMXU
- DC measurements are covered as MMDC
- Both in IEC 61850-7-4

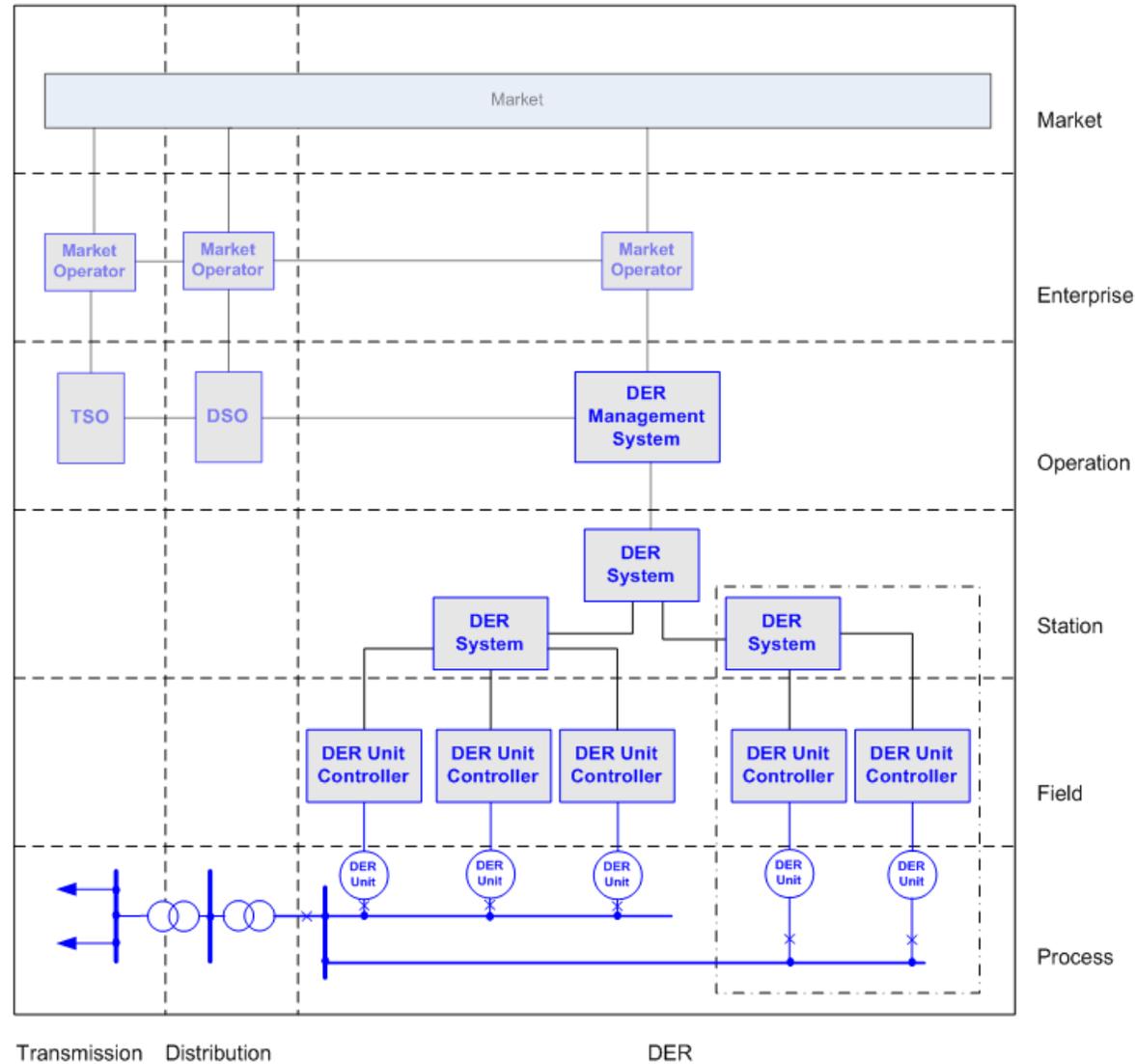
LN MMDC

MMDC 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 22.		
Data objects				
<i>Measured and metered values</i>				
Watt	MV	Power		O
Amp	MV	Current (DC current)		O
Vol	MV	Voltage (DC voltage) between poles		O
VolPsGnd	MV	Voltage between positive pole and earth		O
VolNgGnd	MV	Voltage between negative pole and earth		O
Ris	MV	Resistance in DC circuit		O
RisPsGnd	MV	Resistance between positive pole and earth		O
RisNgGnd	MV	Resistance between negative pole and earth		O

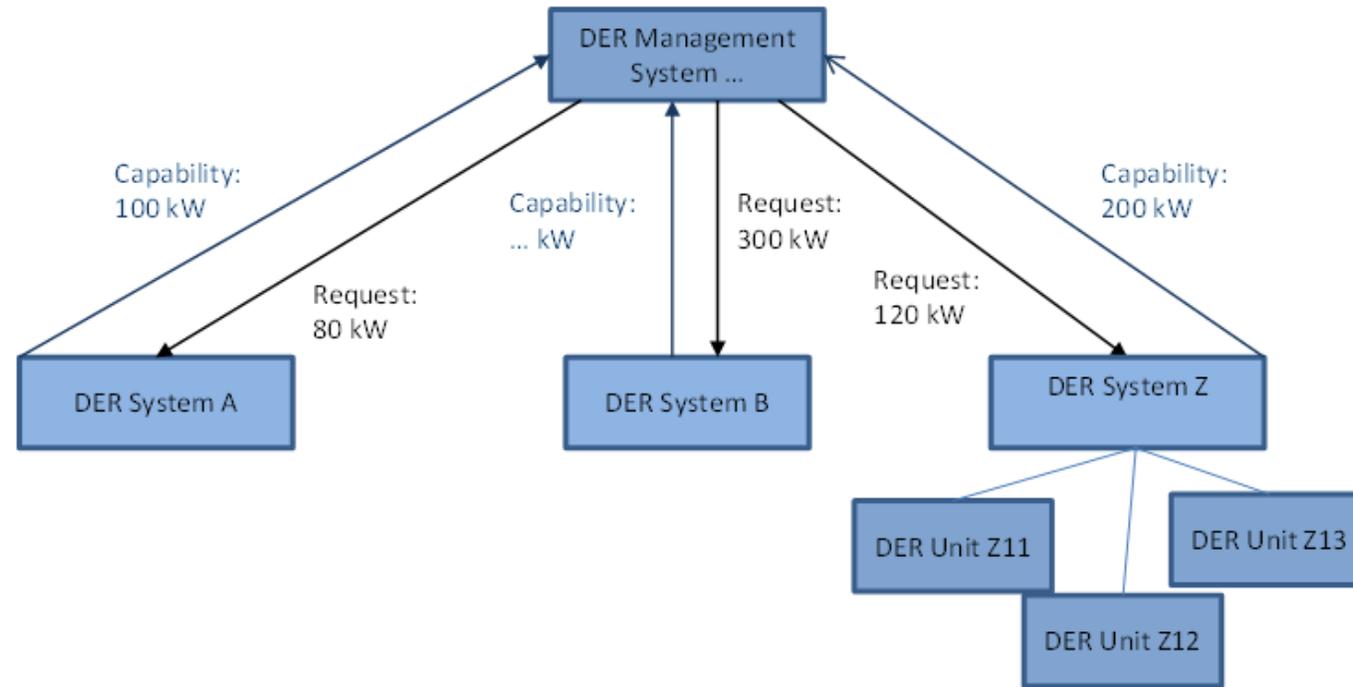
DER System



Hierarchical DER system



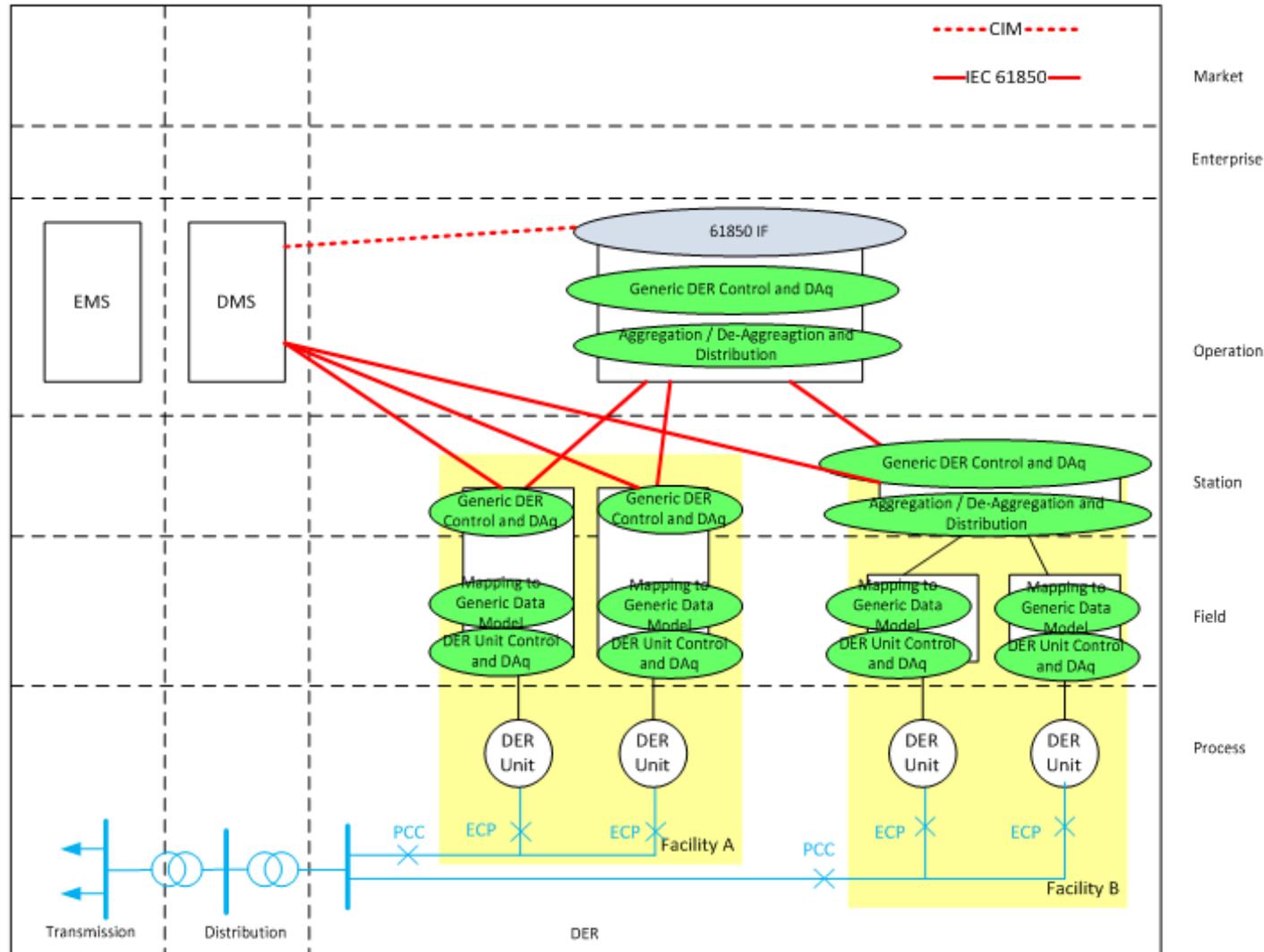
DER aggregation structure



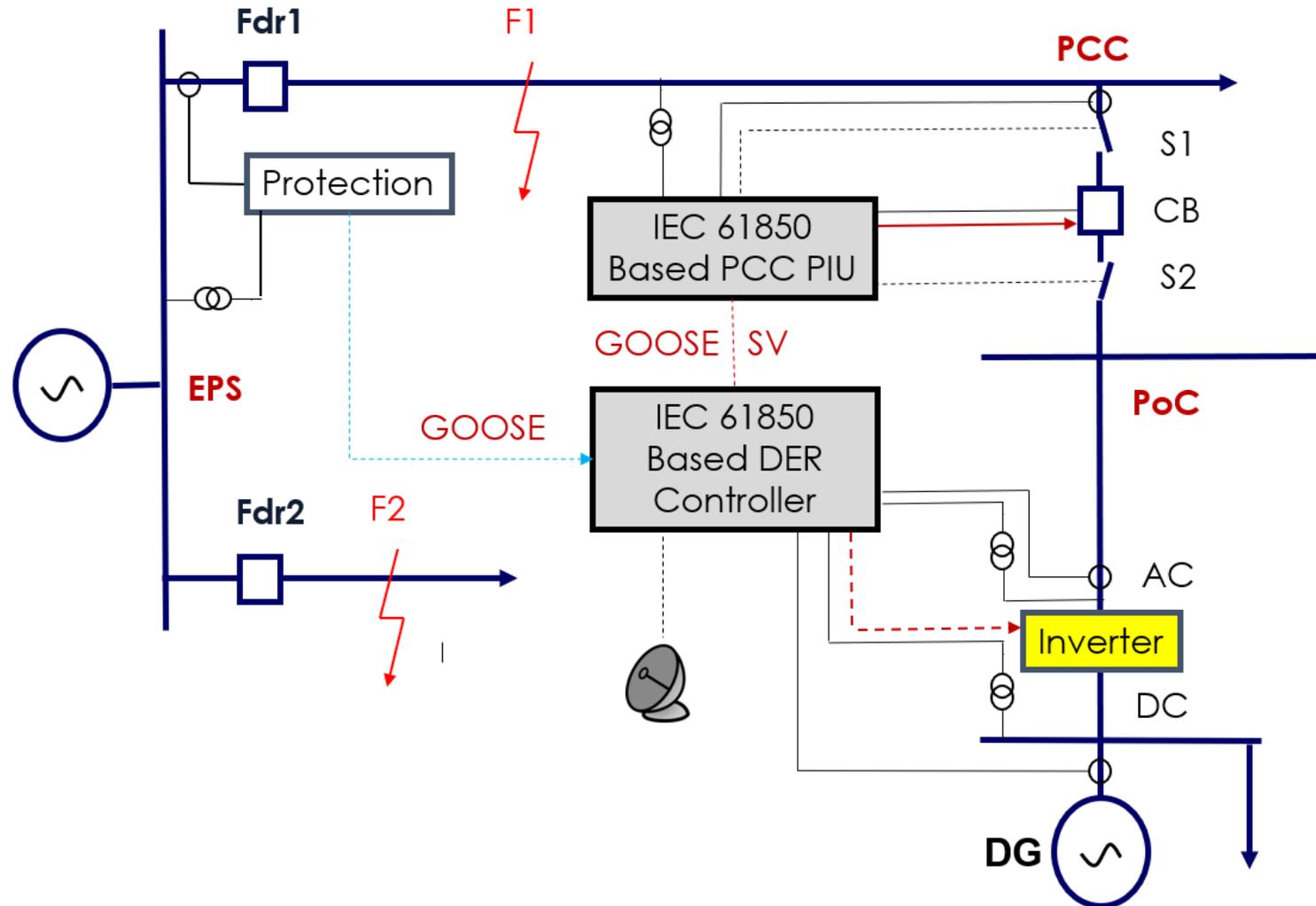
Operating modes

Configuration (Interactions between coloured boxes)				Interactions regarding TLC operation and ancillary services		
				Normal - Green TL	Alert - Yellow TL	Emergency - Red TL
	DERMS at higher hierarchy level	DERMS at lower hierarchy level	DER System	Normal operation acc. contractual schedules	Call-up of contractual services (to avoid red TL)	Direct interactions
1	Utility DMS/EMS	Utility DERMS	DER Systems (direct connected, Feed-in tariffs, acts acc. Grid codes)	Generation supply / Feed-in acc. laws/contracts under consideration of grid codes	Limited automatic reactions acc. Grid codes and/or limited direct control of DER (e.g. reduce power, switch off ect.)	Automatic reactions acc. Grid codes and/or direct control of DER (e.g. reduce power, switch off ect.)
2	Utility DSM/EMS	Utility DERMS	DER Systems (direct connected and operated by DSO)(e.g. owned by utility)	Generation supply acc. schedules	interactions with re-dispatched schedules or schedules for alert situations	Direct control (Generation supply acc. Emergency schedules or setpoints or switch-off of DER/loads)
3	Utility DMS/EMS	Facility DERMS	DER Systems (no direct connection from DSO to DER Systems)	Generation supply acc. contracts Deliver contractual ancillary services (e.g. VVarManagement in a region)	Call up of active and reactive power (positive/negative operating reserve), acc. considered topology	Direct control acc. contractual conditions to Facility DERMS (e.g. ancillary services, black start capability, service restoration)
4	Utility DMS/EMS	DERMS with geographical distributed DER (VPP) (DSO linked to DER Systems)	DER Systems (interaction just in Red TL)			Direct control acc. contractual conditions to DER Systems (e.g. ancillary services, black start capability, service restoration)
5	Utility DMS/EMS	DERMS with self-operated EPS (Microgrid, Small utility) (can be islanded)	DER Systems (interaction just in Red TL)			
6		DERMS (Utility DERMS, Facility DERMS, VPP, Microgrid DERMS)	DER Systems (interaction just in Red TL)	Generation supply acc. Schedules/setpoints by DERMS (disaggregation to maximize target)	Generation supply acc. (alert) schedules/setpoints by DER MS (to maximize targets and acc. network topology)	Direct interactions (Generation supply acc. emergency setpoints or sitch-off of DER/loads)
7	DERMS (Utility DERMS, Facility DERMS, VPP, Microgrid DERMS)	Sub-DERMS = DERMS (Facility DERMS, VPP, Microgrid DERMS)	DER Systems (interaction just in Red TL)	Generation supply acc. Schedules/setpoints by higher level DERMS (disaggregation to maximize targets)	Generation supply acc. (alert) schedules/setpoints by DER MS (at higher level)(to maximize targets and acc. network topology)	Direct interactions (Generation supply acc. emergency setpoints or switch-off of DER/loads)

DER system in Emergency Situation

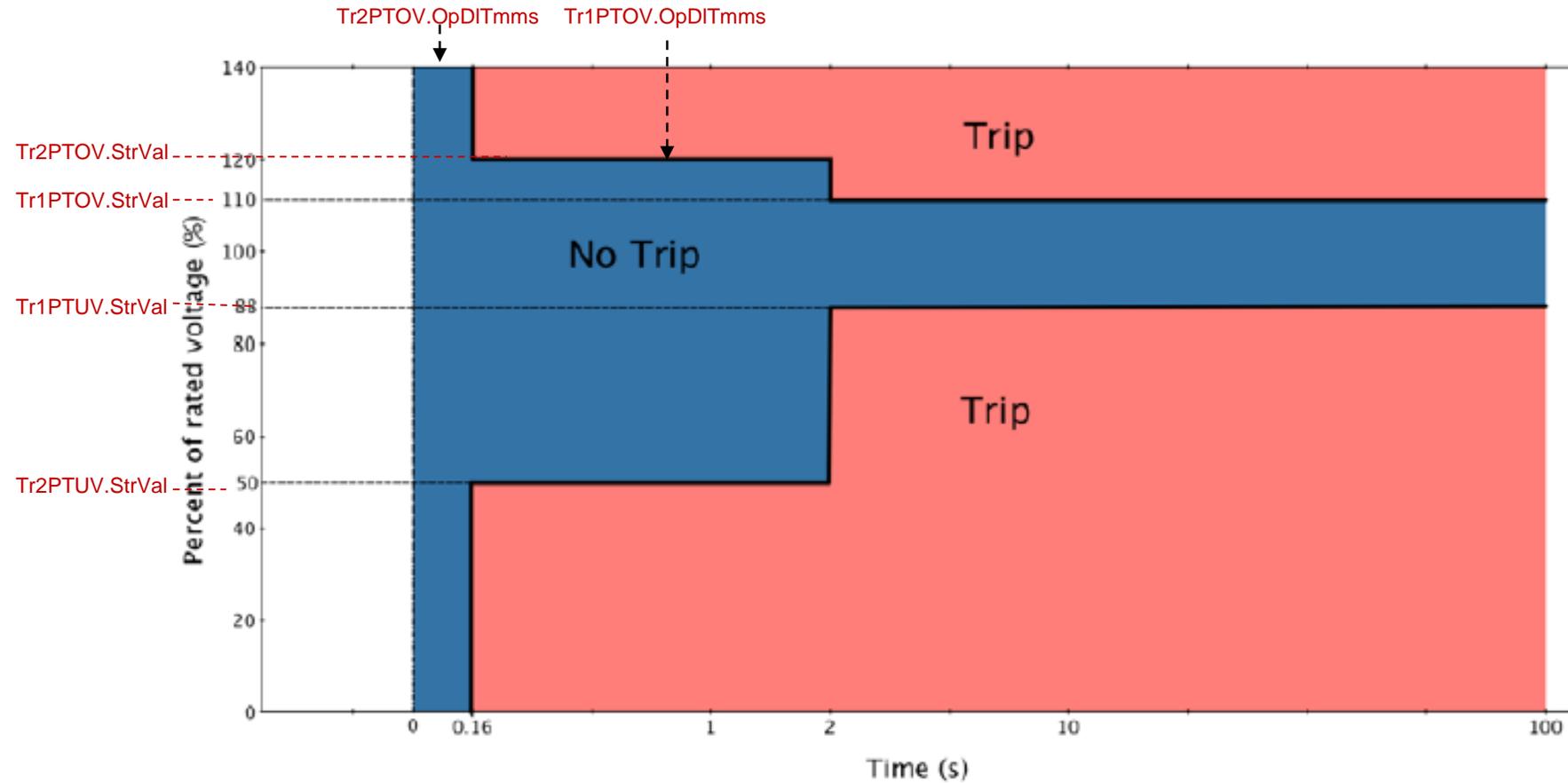


IEC 61850 based PCC Process Interface

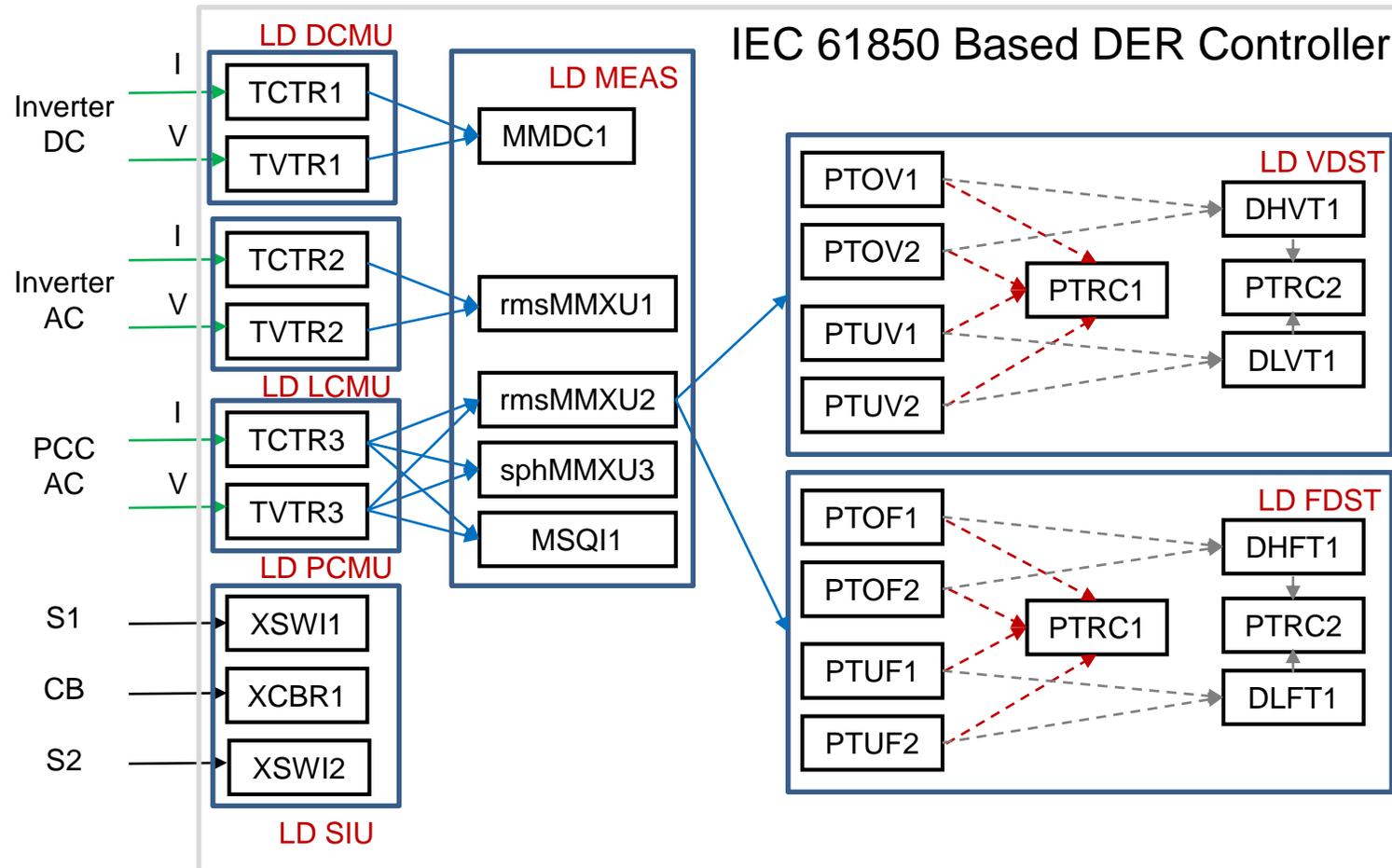


IEEE 1547

Standard for Interconnecting Distributed Resources with Electric Power Systems



Voltage and Frequency Disturbance Model



Conclusions

- DER integration is one of the most complex and challenging applications of IEC 61850
- It requires excellent understanding of both the DER systems domain and the IEC 61850 standard
- It can be accomplished through the cooperation of teams of domain and standardization experts