Virtual power plants with VHPready

Klaus-Dieter Walter

Executive Board Member, Industry Alliance VHPready e. V.

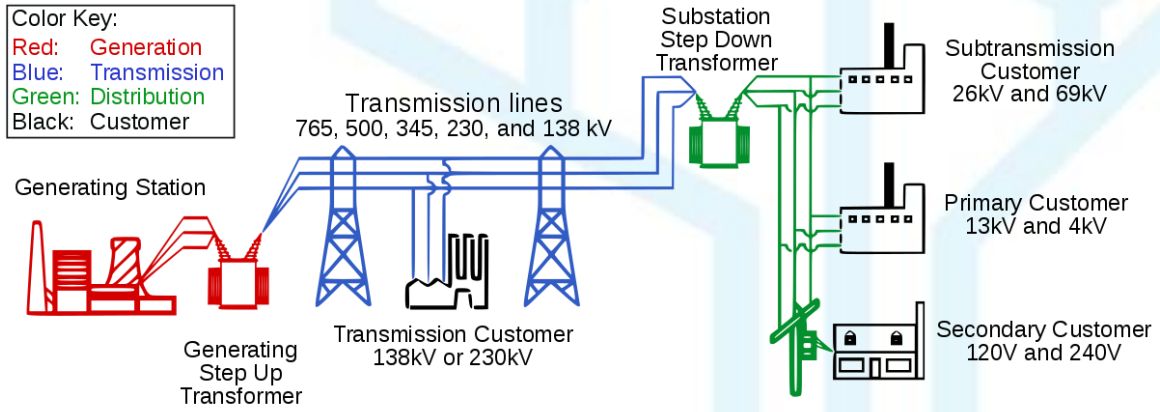
AGENDA

- Introduction to VHPready e. V.
- Virtual Power Plant (VPP) - the VHPready picture
- Some VHPready Building Blocks

WHO IS VHPREADY?

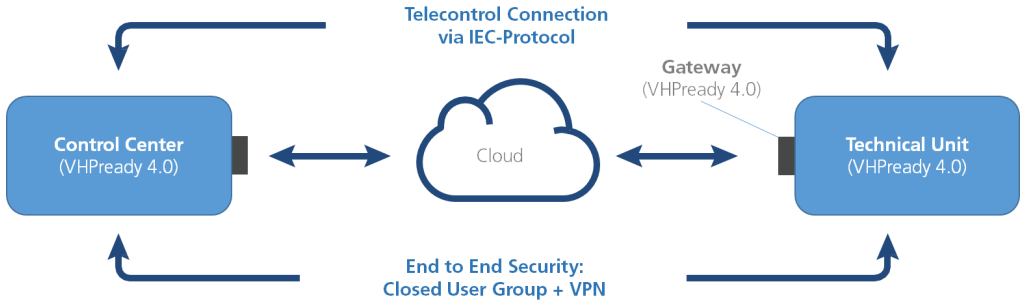
WHAT IS VHPREADY?

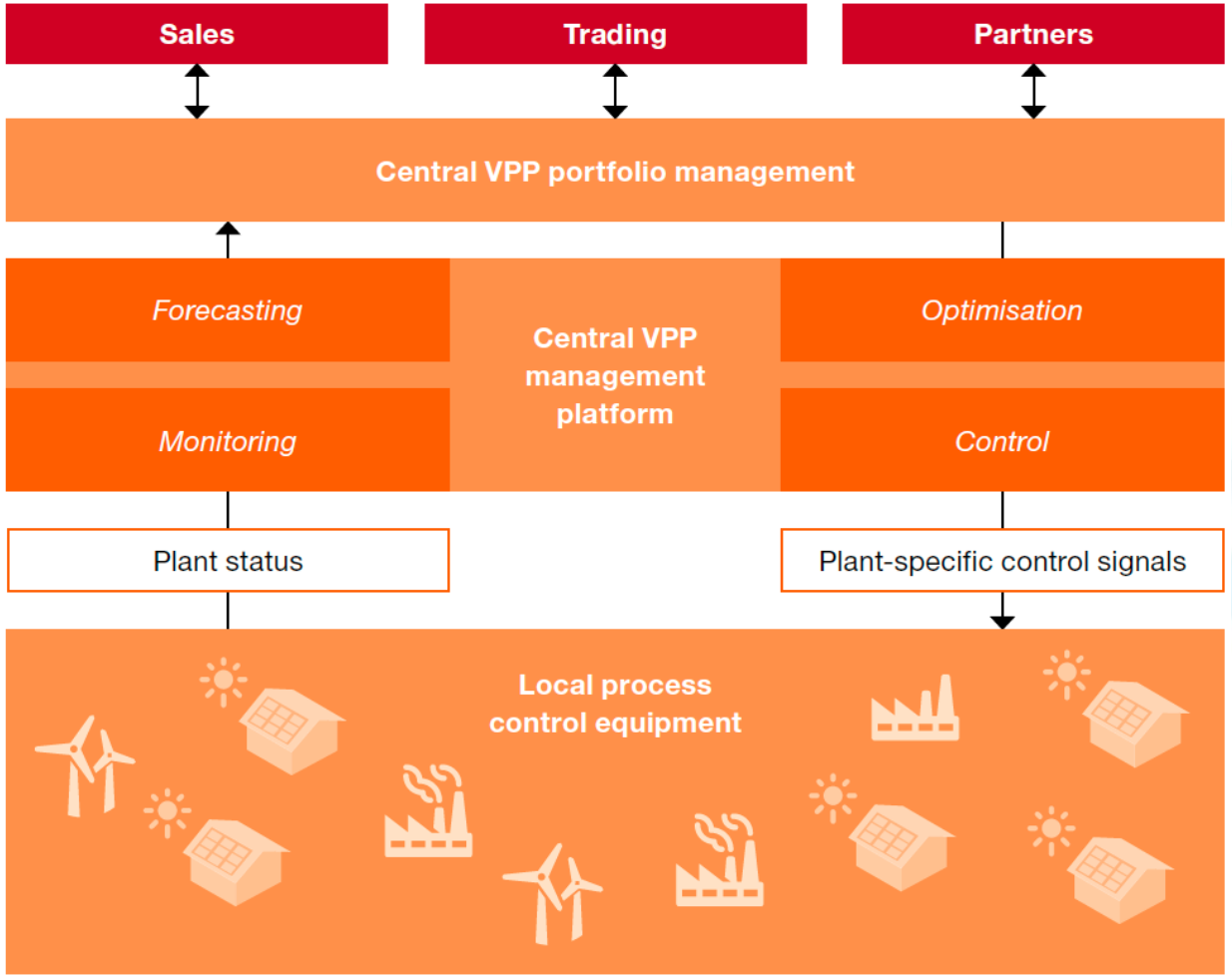
- The virtual heat and power specification (VHPready 4.0) addresses the integration of electrical and thermal energy systems into a Virtual Power Plant.
- A virtual power plant is a network of decentralized and heterogeneous energy systems, monitored and controlled by a central control room (control center)
- VHPready specifies the protocol between control room and any kind of energy system (solar, wind, batteries, heat pumps, micro CHP, biomass plants, process heater …)
- VHPready is based on Internet and IEC technologies
- VHPready is used for trading and balancing energy/power at the transmission grid level



VIRTUAL POWER PLANT (VPP)

- The target architecture of a VPP can be divided into three layers:
  - Business layer
  - Technical operation layer
  - Distributed local process and control layer



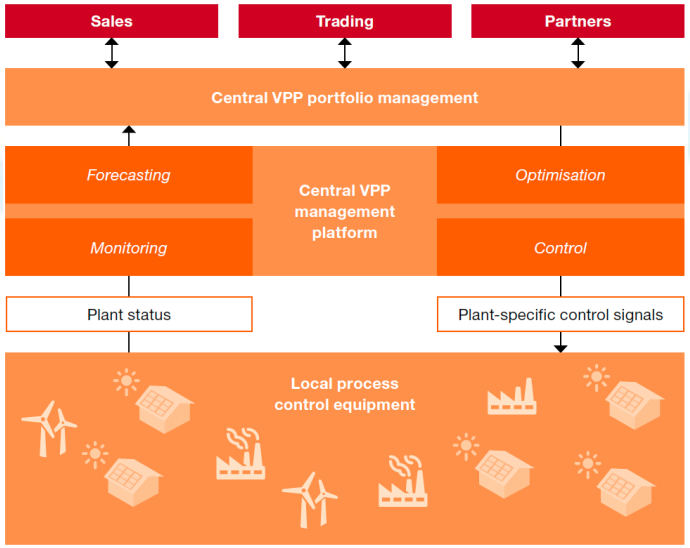


- **Control Center:** Business and technical operation layer
- **Technical Unit:** Distributed local process and control layer

Source: PWC Study: VPP - Markets and Technology's

VIRTUAL POWER PLANT (VPP)

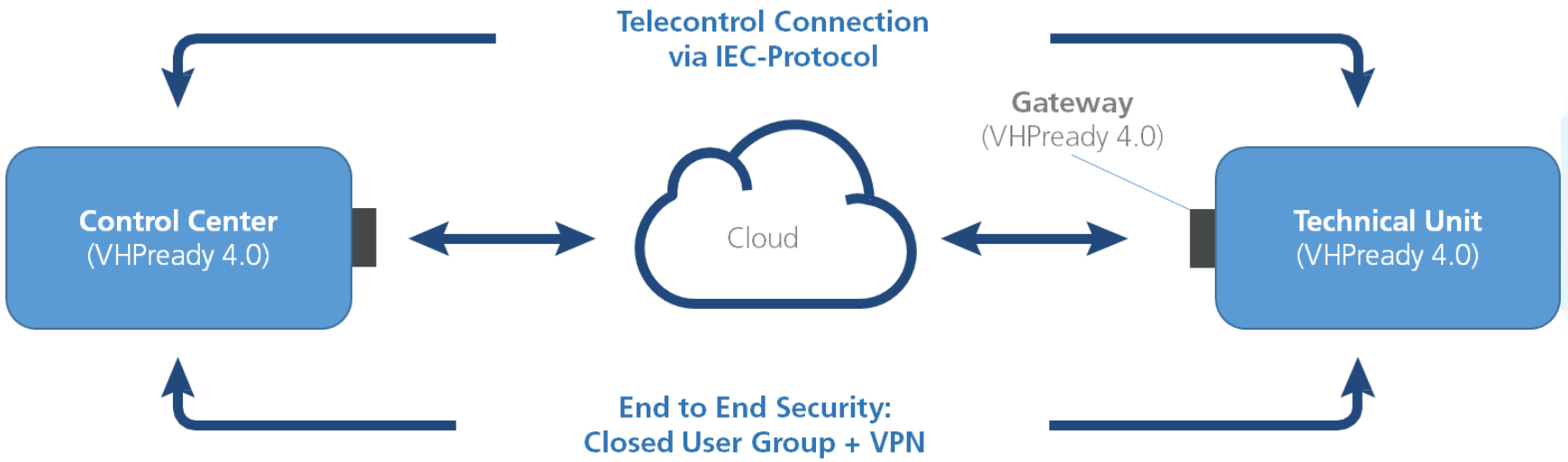
- Business layer:
  - Compares market demands against asset availability, cost against market prices …
  - Runs business processes to generate the commercial performance optimum
- Technical operation layer:
  - IT environment with various software modules (forecasting, monitoring, optimization …)
  - Forecasting: Optimize and dispatch generators, loads, batteries, heat pumps (technical units)
- Distributed local process and control layer:
  - Monitoring channel: Delivers input (current condition of the decentralized energy system, remote meter readings) to the upper layer
  - Control channel: Receive full dispatch schedule or dispatch schedule broken down into individual target values from upper layer



Source: PWC Study: VPP - Markets and Technology's

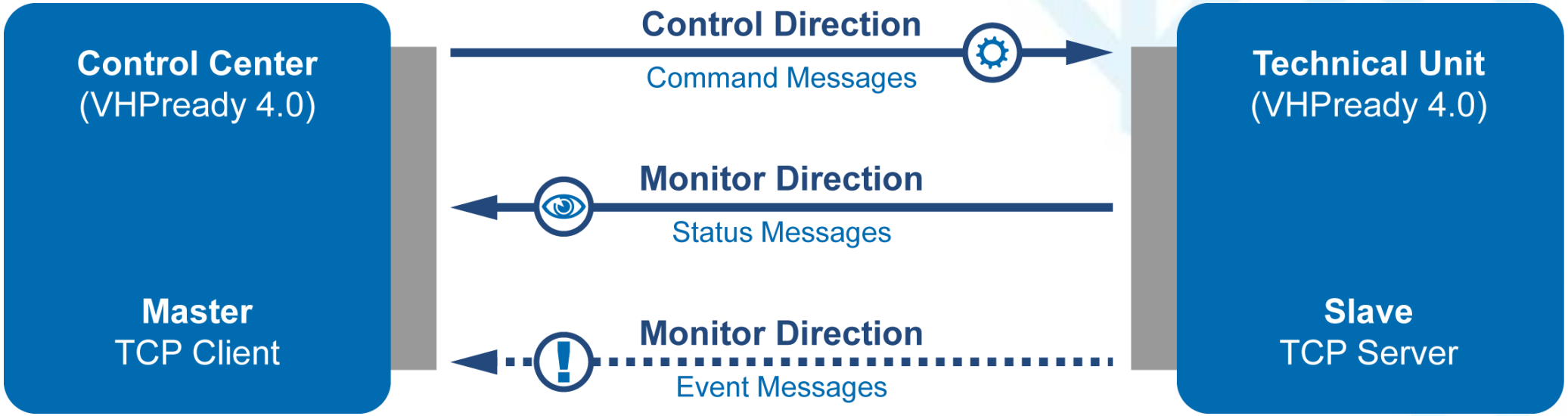
VHPready Building Blocks

- The VHPready 4.0 specification is based on three main building blocks:
  - **Protocols:** IEC 60870-5-104, IEC 61850-7-420, TCP/IP, SNTP and NTP …
  - **Security:** TLS-based, OpenVPN with X.509 certificates ...
  - **Data points for different energy systems:** CHP systems, windmills, solar power plants, battery systems …



VHPready Building Blocks

- Example: Any application with the IEC 60870-5-104 protocol will have a master and slaves
  - IEC 60870-5-104 act as a TCP/IP application protocol with an own message format
  - The RTU (TCP server) use a static IP address within VPN tunnel
  - The master will constantly monitor and control the slaves through the VPN tunnel
  - VHPready describe different message types for the command and monitor direction



VHPready Data Points

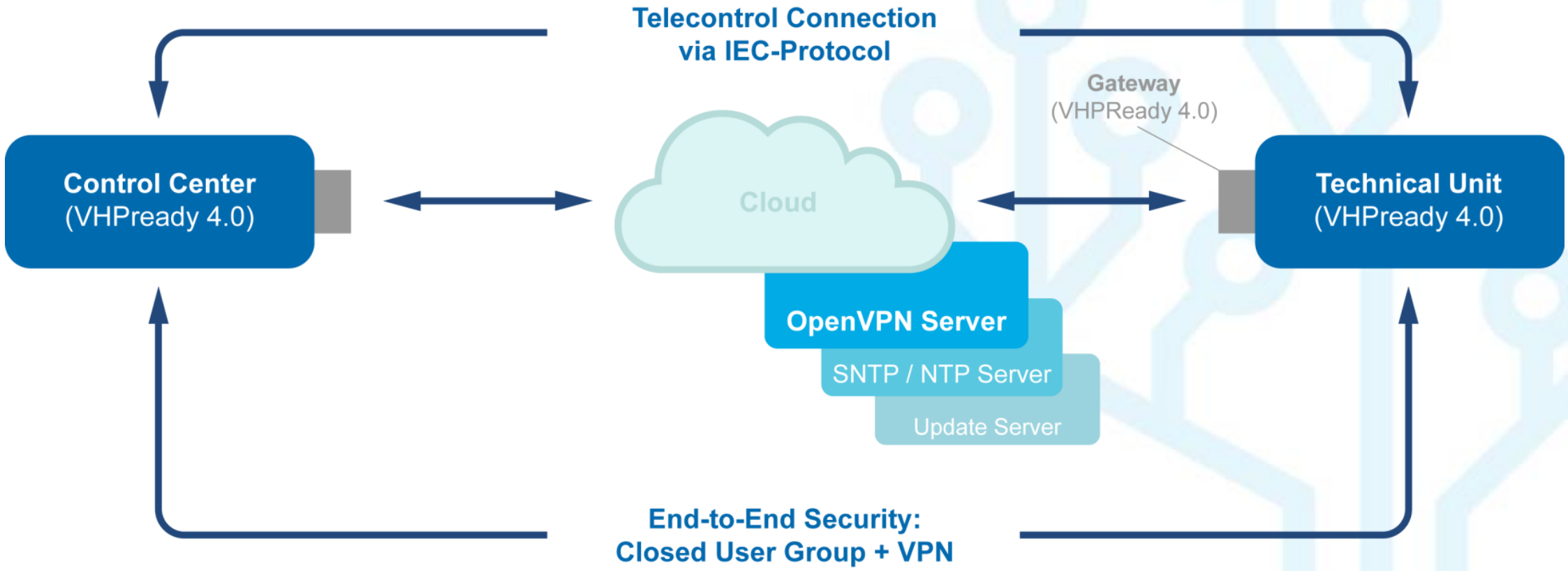
- Data points for different energy systems: CHP systems, windmills, solar power plants …

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
OA1(8bit)	0	1	2	3	4	5	6	7	8	9	10			IEC 60870-5-104			IEC 61850
LD:	Plant	CHP	Wind Plant	SolarPlant	HeatPump	Battery	ElectricalHeating	Boiler	HeatStorage	Meter	Detector	Signal Name	Signalling Direction	Type	Type Identifier	LN	MI
IOA3 / ID (12 bit)	lage/Park	IKW	ndkraftanlage	laranlage	ärmepumpe	tterie	Heizung	ssel	fferspeicher	hler	itere Melder	Signal Bezeichnung	Melderichtung	Typ	Typ kennung	LN	DO
0	X	X	X	X	X	X	X	X	X	X	X	UUID	X	Bit mask	33 (M_BO_TB_1)		
1	X	X	X	X	X	X	X	X				Standby (ready / not ready)	X	Binary	30 (M_SP_TB_1)		Health, Reporting of stVal
2	O	O	O	O	O	O	O	O				Status (on / off)	X	Binary	30 (M_SP_TB_1)	DRCS	ModOnConn, Reporting of stVal
3	O	O	O									Starting sequence finished	X	Binary	30 (M_SP_TB_1)		ModOnAvl, Reporting of stVal
4	O	O	O	O	O	O	O	O	O			Fault Code	X	Bit mask	33 (M_BO_TB_1)	Dist_GGIO	Ind, Ind..., Ind32
8	X	X	X	X	X	X	X	X	X	X		positive installed capacity	X	Floating Point Number	36 (M_ME_TF_1)		
9	X	X	X	X	X	X	X	X	X	X		negative installed capacity	X	Floating Point Number	36 (M_ME_TF_1)		
10	X	X	X	X	X	X	X					generated/absorbed electrical power	X	Floating Point Number	36 (M_ME_TF_1)	MMXU	TotW
11	O	O	O	O	O	O	O					idle power	X	Floating Point Number	36 (M_ME_TF_1)		TotVAr
12	O	O	O	O	O	O	O					current on L1	X	Floating Point Number	36 (M_ME_TF_1)		A.phsA
13	O	O	O	O	O	O	O					current on L2	X	Floating Point Number	36 (M_ME_TF_1)		A.phsB
14	O	O	O	O	O	O	O					current on L3	X	Floating Point Number	36 (M_ME_TF_1)		A.phsC
15	O	O	O	O	O	O	O					voltage between L1 and L2	X	Floating Point Number	36 (M_ME_TF_1)		PPV.phsBA
16	O	O	O	O	O	O	O					voltage between L1 and L3	X	Floating Point Number	36 (M_ME_TF_1)		PPV.phsCA
17	O	O	O	O	O	O	O					voltage between L2 and L3	X	Floating Point Number	36 (M_ME_TF_1)		PPV.phsCB
18	O	O	O	O	O	O	O					voltage between L1 and N	X	Floating Point Number	36 (M_ME_TF_1)		PNV.phsA
19	O	O	O	O	O	O	O					voltage between L2 and N	X	Floating Point Number	36 (M_ME_TF_1)		PNV.phsB
20	O	O	O	O	O	O	O					voltage between L3 and N	X	Floating Point Number	36 (M_ME_TF_1)		PNV.phsC
21	O	O	O	O	O	O	O					grid frequency	X	Floating Point Number	36 (M_ME_TF_1)		Hz
22	O	O	O	O	O	O	O					phase angle cos(phi)	X	Floating Point Number	36 (M_ME_TF_1)		TotPF, Reporting of instMag

36 (M_ME_TF_1)
36 (M_ME_TF_1)
36 (M_ME_TF_1)
36 (M_ME_TF_1)
36 (M_ME_TF_1)
36 (M_ME_TF_1)
36 (M_ME_TF_1)
36 (M_ME_TF_1)
36 (M_ME_TF_1)
36 (M_ME_TF_1)
36 (M_ME_TF_1)
36 (M_ME_TF_1)
36 (M_ME_TF_1)

VHPready Security

- Main parts: closed user group, TLS 1.2-based VPN, X.509 certificates, media break …



Thank You For Your Attention