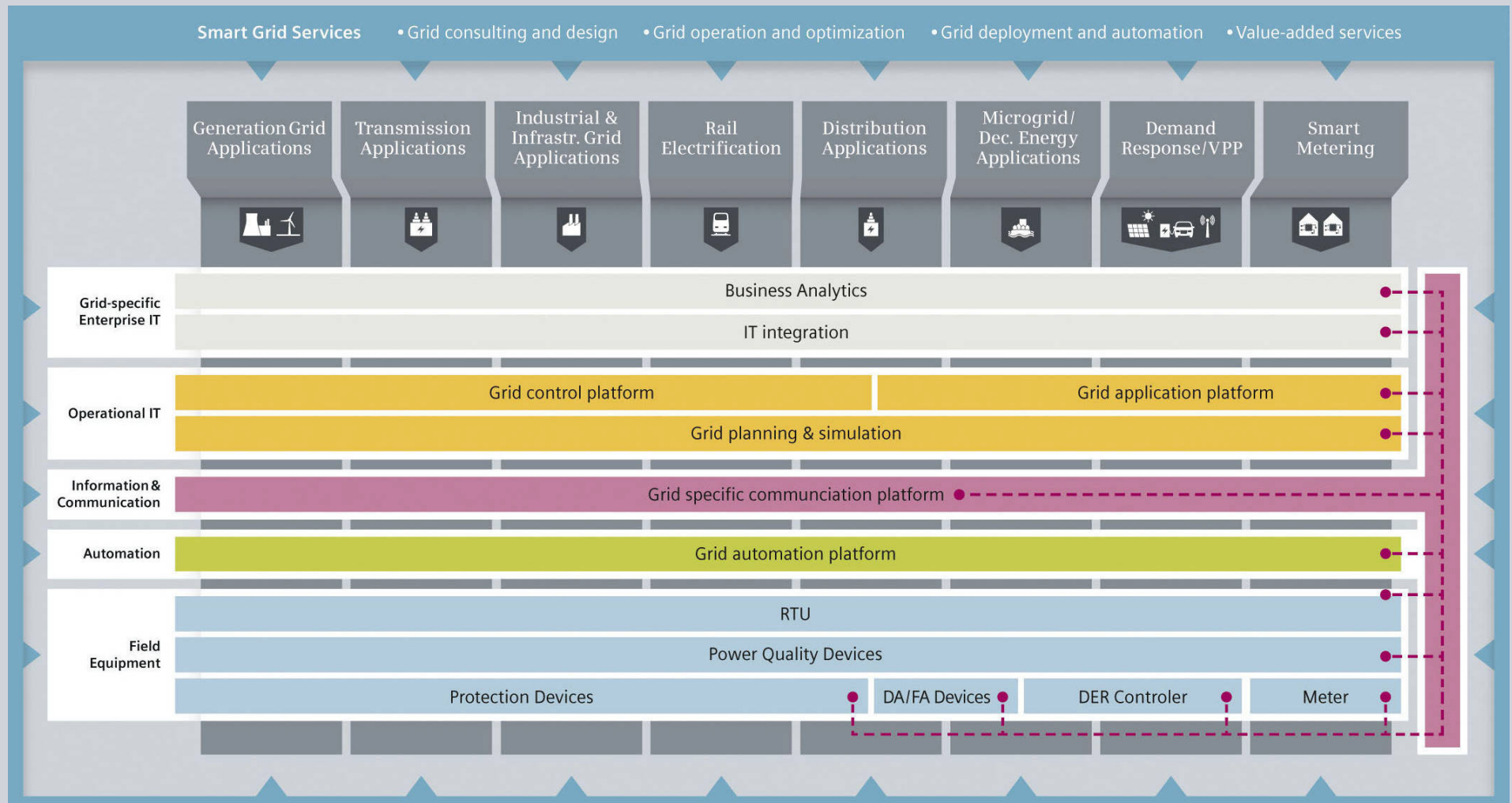


Rozšírenie dispečerského riadenia o funkcie celosieťového chránenia a monitoringu dynamiky chodu siete v reálnom čase

SIGUARD Phasor Data Processor Wide Area Monitoring with Phasor Measurement Data

Ing. Vladimír Kanas, SIEMENS, s.r.o. Bratislava

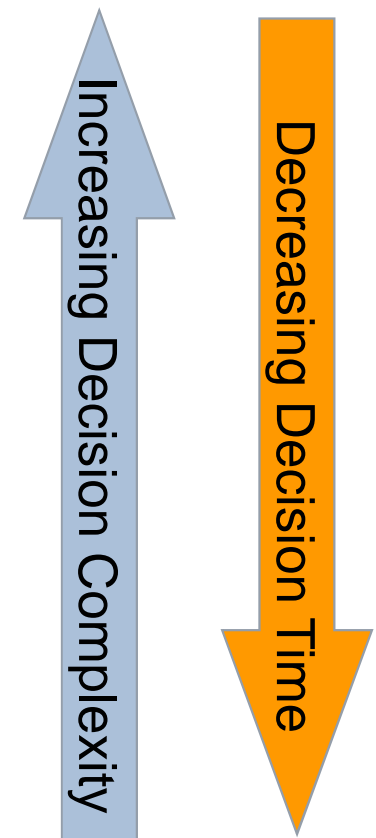


Details of Control Hierarchy

Centralized or Decentralized Automation?

Decision and Control Hierarchy VHV, HV, MV

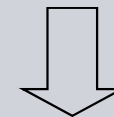
Transmission and Distribution Automation Control Hierarchy	Decision Level	Decision Parameters	Target Configurations
National Control Center	Transmission Grid Supervision	Line and Substation Tie Capacity, Load and Voltage Analysis, Fault	Total Transmission Grid, Substations, Devices and All Interconnections
Distribution Control Center	Distribution Grid Supervision and Delivery Optimization	Substation Tie Capacity, Load and Voltage Analysis, Actual Feeder Connectivity, Energization, Fault	Total Distribution Grid, Substations, Feeders, Devices and All Interconnections
Regional Controller, Secondary Substation	Interconnected Substation and Feeder Circuits	Substation Tie Capacity, Load and Voltage Analysis, Actual Feeder Connectivity, Energization, Fault	Medium/High Load Substations/Feeders with Significant Substation Interconnections
Super Device (Group of Devices)	Feeder Circuit	Implied Feeder Connectivity, Energization, Fault	Low Load Radial Feeders with Few Interconnections
Individual Device	Feeder Circuit Section	Energization, Fault	Low Load Radial Feeders with Few Interconnections



Wide Area Protection and Monitoring

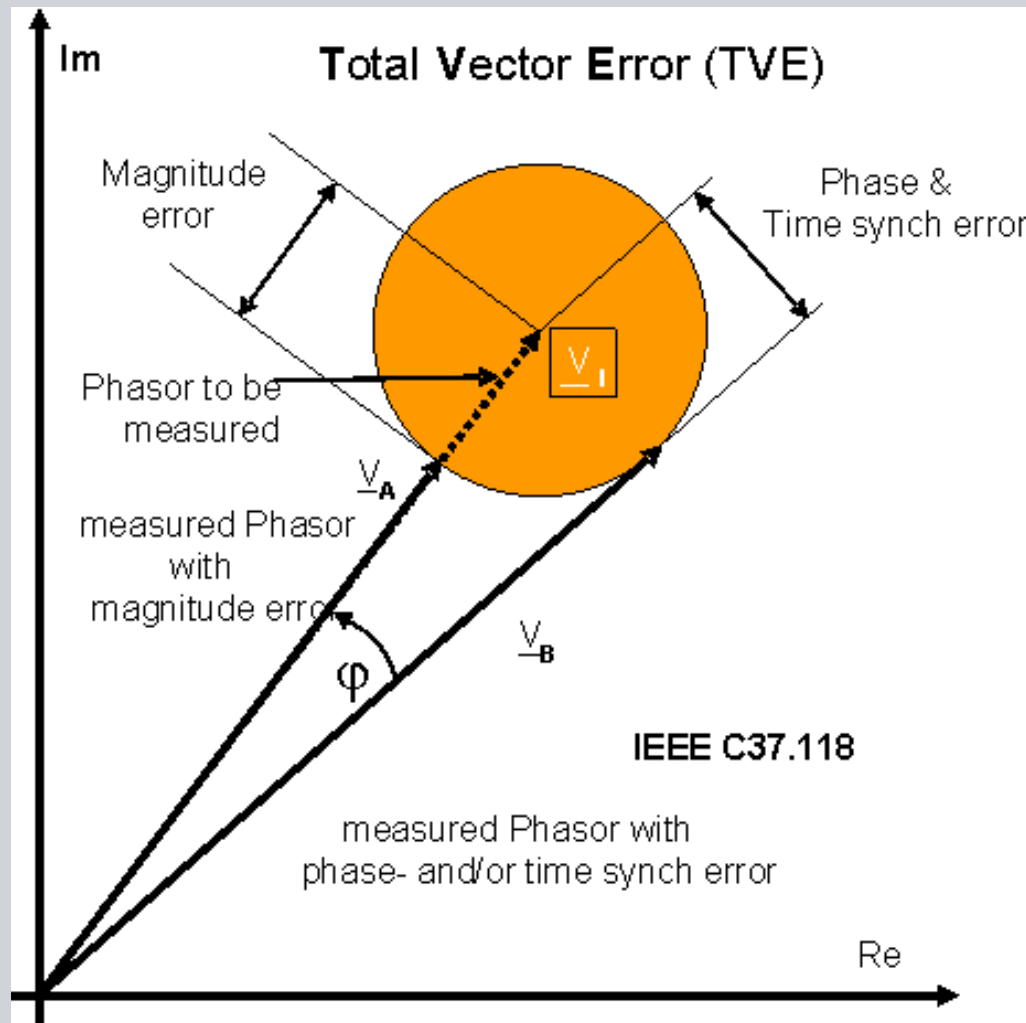
What is new?

Measurements via RTU / Substation Automation	Synchrophasors via PMU
Update slowly (for example every 5 s)	Continuous update (measurement stream) with for example 10 values per second (= reporting rate)
No time correlation for measurements	Every measurement has a timestamp
RMS values without phase angles	Phasor values (Amplitude and phase angle) for voltage and current



Dynamic View on Power Swings and other dynamic phenomena

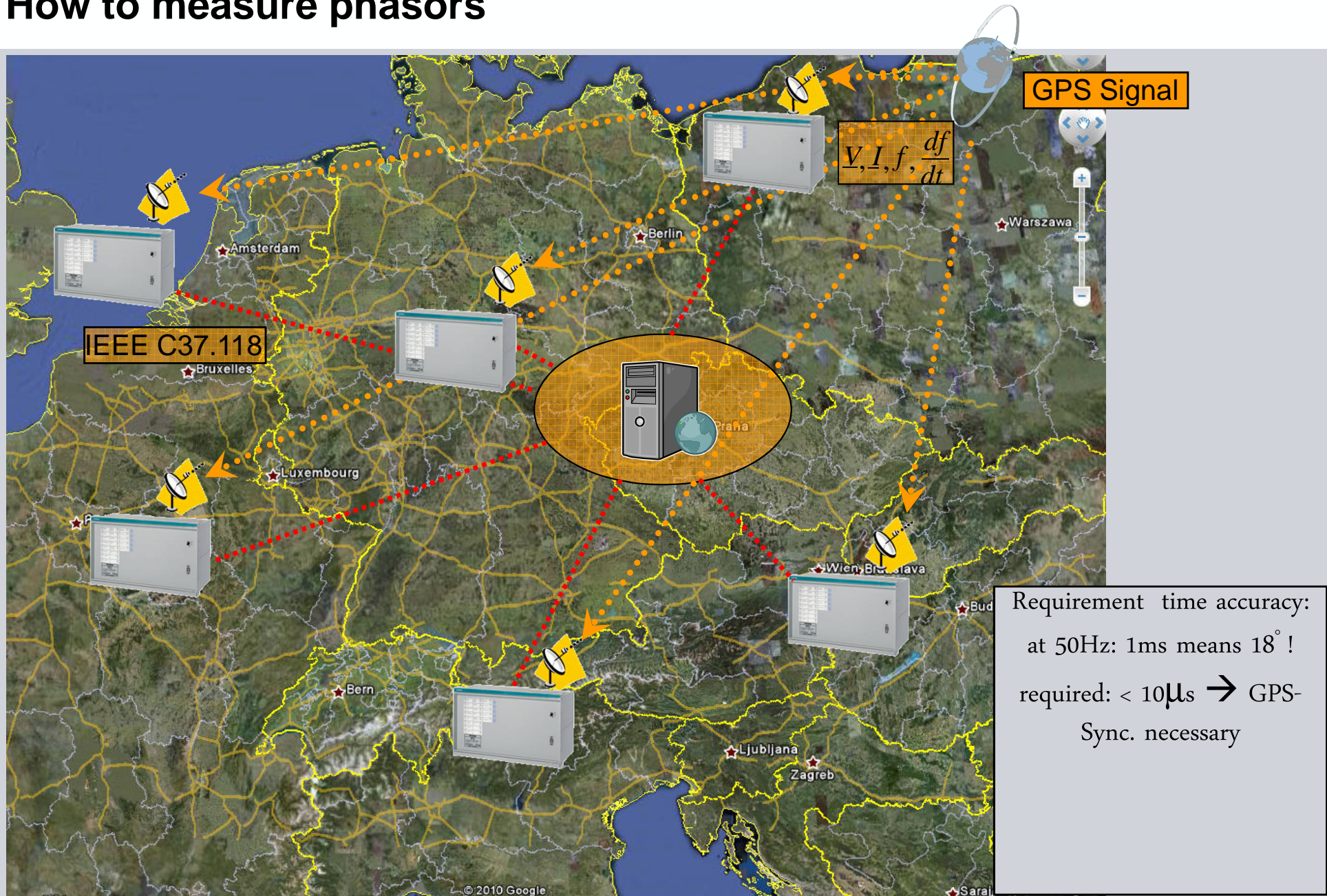
PMU Calculation of Total Vector Error



Both amplitude and phase angle error have to be considered for synchrophasor accuracy.

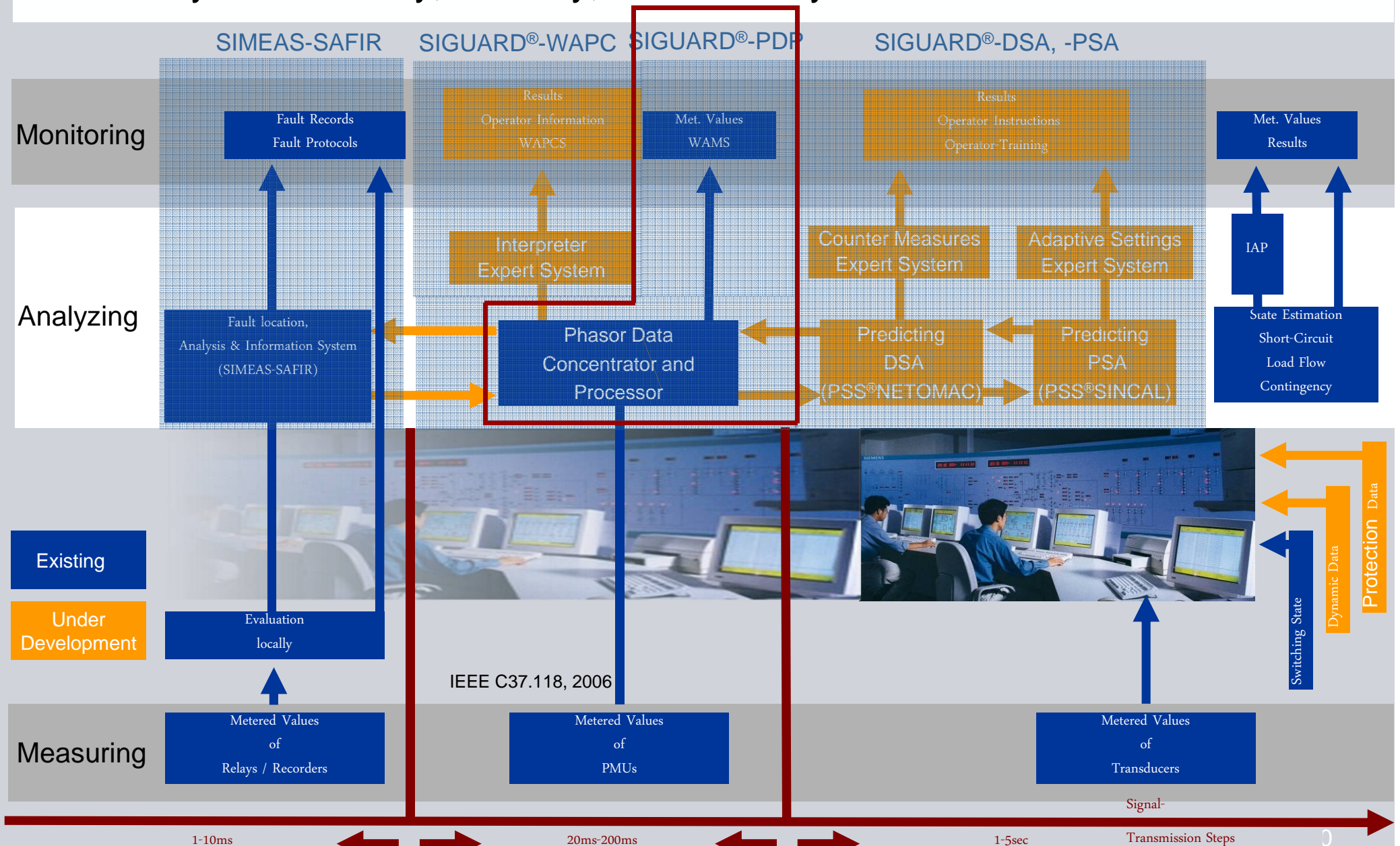
SIGUARD Phasor Data Processor

How to measure phasors



SIGUARD®

Power System Stability, Security, Observability and Blackout Prevention



Possible structure of Wide Area Monitoring System (1/2)

1) Decentralized Structure

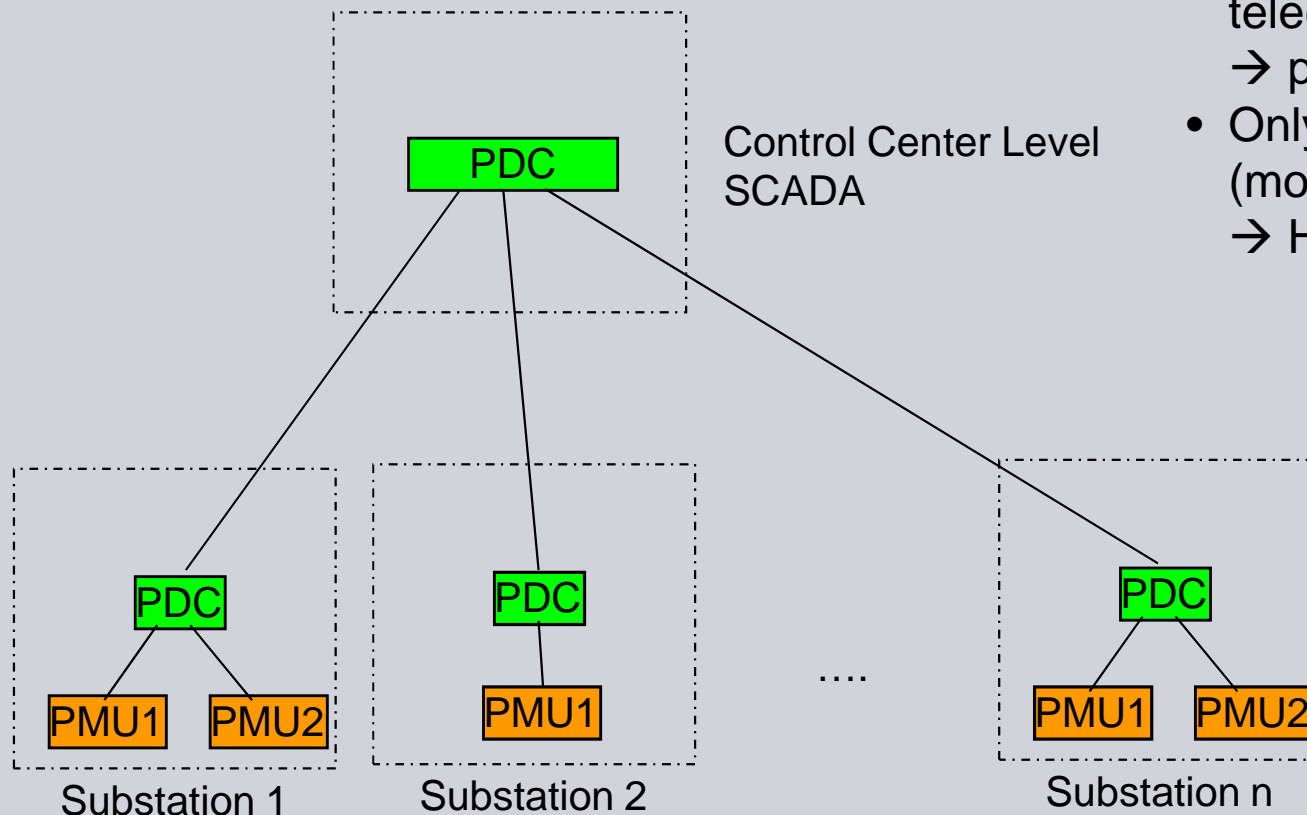
- One PDC in each substation
- Central PDC at Control Center

Pro:

- Local PDC as data storage in case of telecomm. Fault

Con:

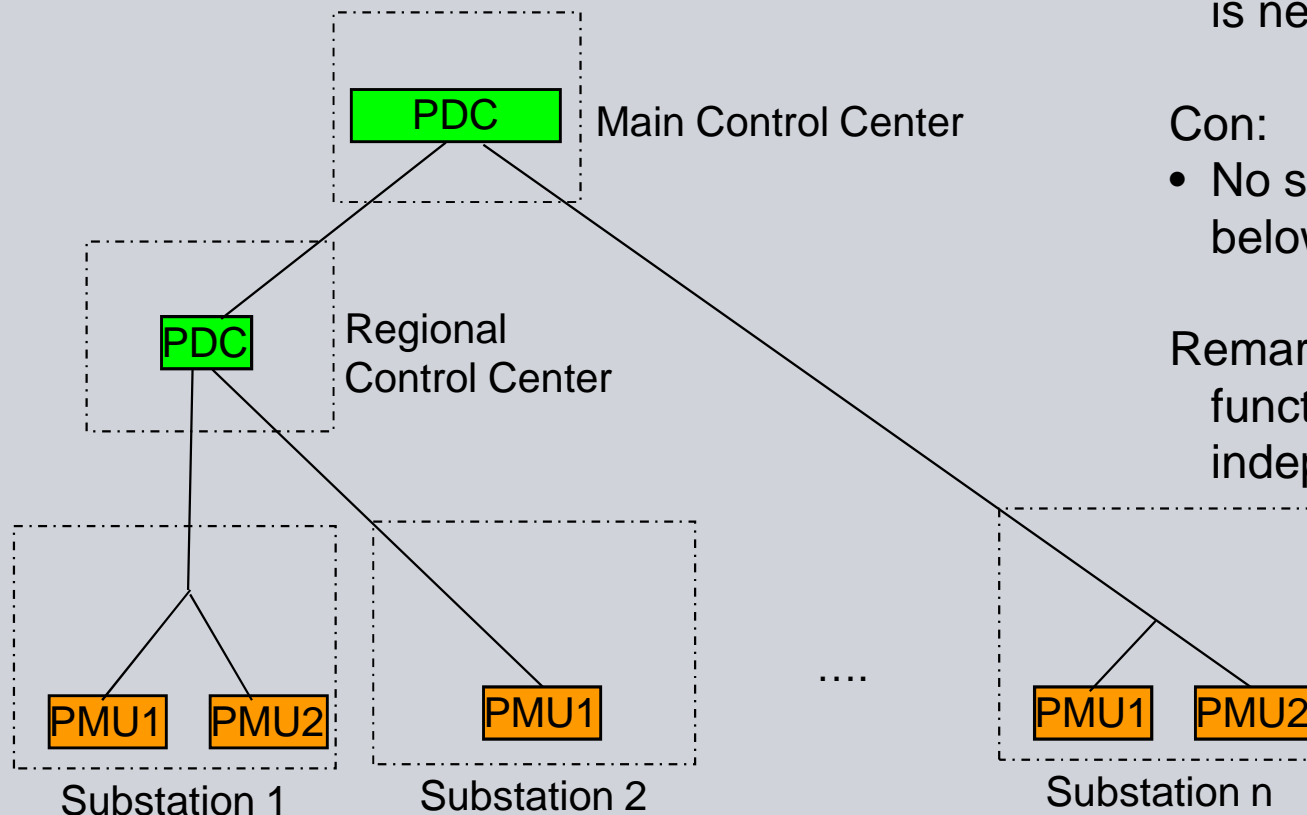
- Recall of information after telecomm.fault is not standardized
→ proprietary solutions only
- Only few PMUs per substation (mostly one is sufficient)
→ High amount of PDCs required



Possible structure of Wide Area Monitoring System (2/2)

2) Centralized Structure

- PDC on control center level only
- Regional control center may have own PDC



Pro:

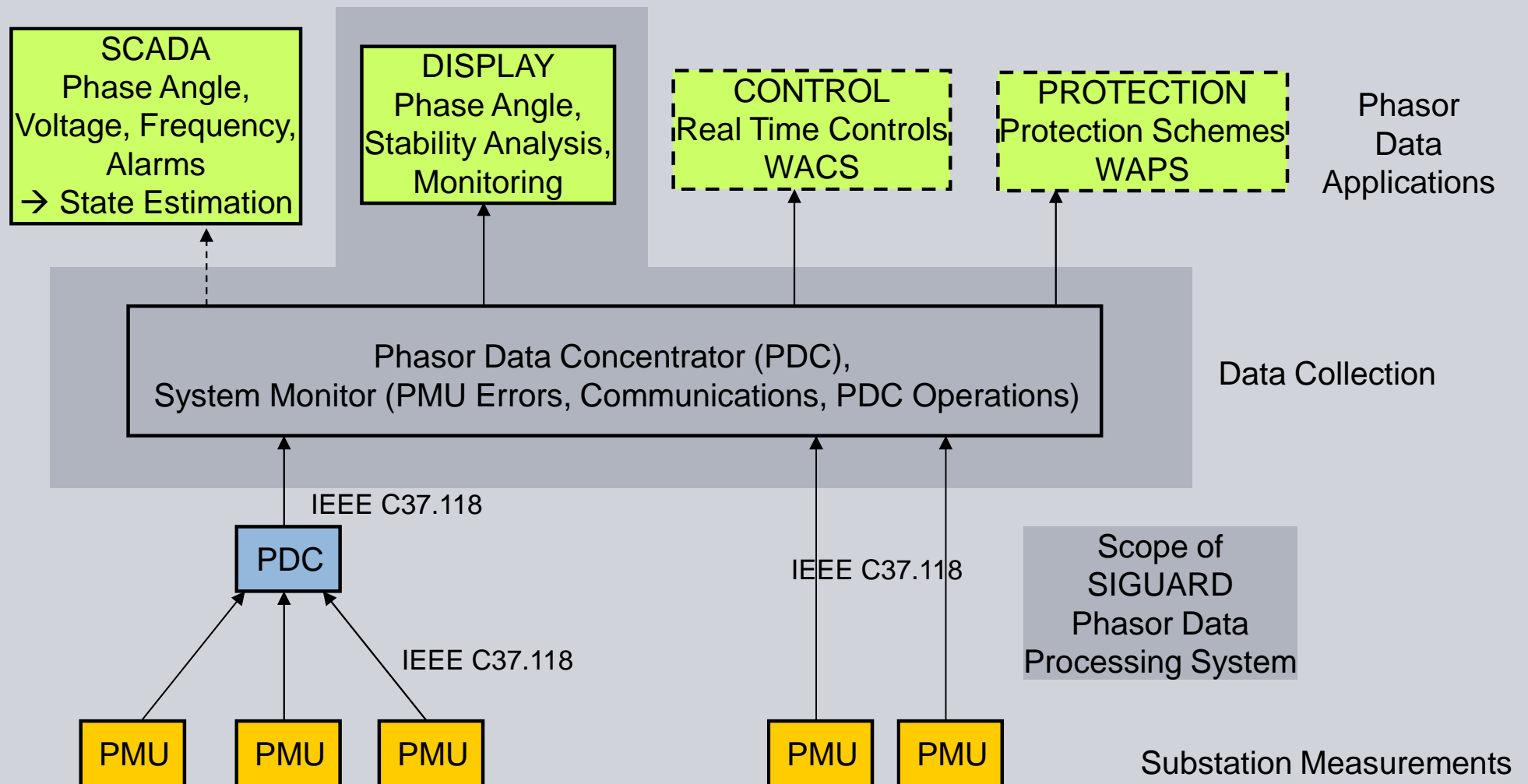
- Better balance between number of PDCs and number of PMUs
→ Less Costs
- Flexible Concept: PDCs to be placed where Phasor information is needed

Con:

- No storage for telecomm. fault below „lowest“ PDC

Remark: Local fault recorder functionality may serve as independent archive.

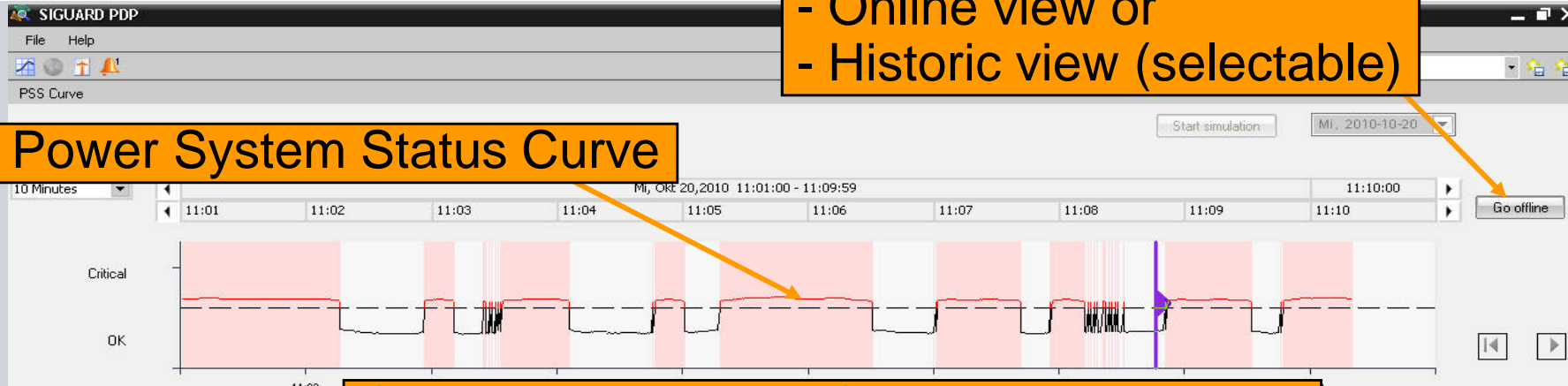
Interfaces of a Wide Area Phasor Measurement System



SIGUARD PDP Overview Userinterface

Monitoring of
- Online view or
- Historic view (selectable)

Power System Status Curve



Geographical View (Google Earth based)

Time charts

Event List

Phasor diagrams

Application of Wide Area Monitoring

- Support analysis of critical system status by control center experts
 - During disturbance: Fast and precise measurement display
 - After disturbance: Use PMU measurements to understand the dynamic behaviour of the system to be able to improve it; create report.
- Load monitoring (stress) of lines based on angle differences
 - Synchrophasors give a clear picture without the need of using system topology data
 - Reference Phasor provides the view for the relevant difference
- Clear indication of system separation
 - Example disturbance Nov 4th 2006, Europe: System separation was not recognised by all TSOs immediately
- Optimal loading of transmission corridors with Voltage-Power-Curve
 - Gives an actual picture of load situation and reserves
- Use phasor measurements for enhancing state estimation

Future applications

- Synchrophasors as base for Wide Area **Control** System
 - Control of HVDC, FACTS as fast reaction to power swings based on synchrophasor measurement
 - Algorithms will have a strong project specific component
- Synchrophasors as base for Wide Area **Protection** System
 - Direct transmission of phasors between protection devices
 - Could improve reaction of protection device

Status of Wide Area Monitoring in selected countries

Some installations already in operation, for example::

- Europe: Switzerland, Germany, Denmark
- USA: NASPI-Project (North American Synchro-Phasor Initiative) generating the first tenders
- China: PMUs in more than 400 substations
- India: Tender under preparation
- Thailand: Two Systems in operation
- Brasil: Tender under preparation

Trend: Increasing interest worldwide.

Drivers: Higher grid load, energy trade, increasing decentral generation (renewables), highly loaded transmission corridors,

References

Wide Area Monitoring System

TenneT Germany (Former E.on Netz), Bayreuth

- 7 PMUs on 400 kV, one SIGUARD PDP
- In operation since 03/2009

ewz Zurich/Switzerland

- 18 SIMEAS-R PMUs on 20kV and 110kV, one SIGUARD PDP
- In operation since 05/2009

MISO / USA

- In evaluation since 08/2010

EGAT / Bangkok (Thailand)

- 14 PMUs on 230 kV and below, one SIGUARD PDP
- In operation since 12/2010

Ďakujem Vám za pozornosť .

