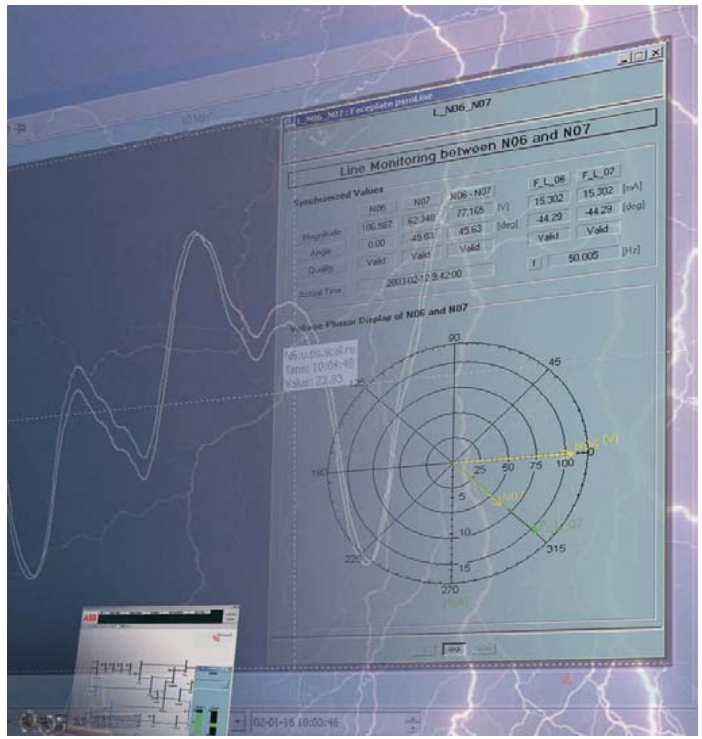
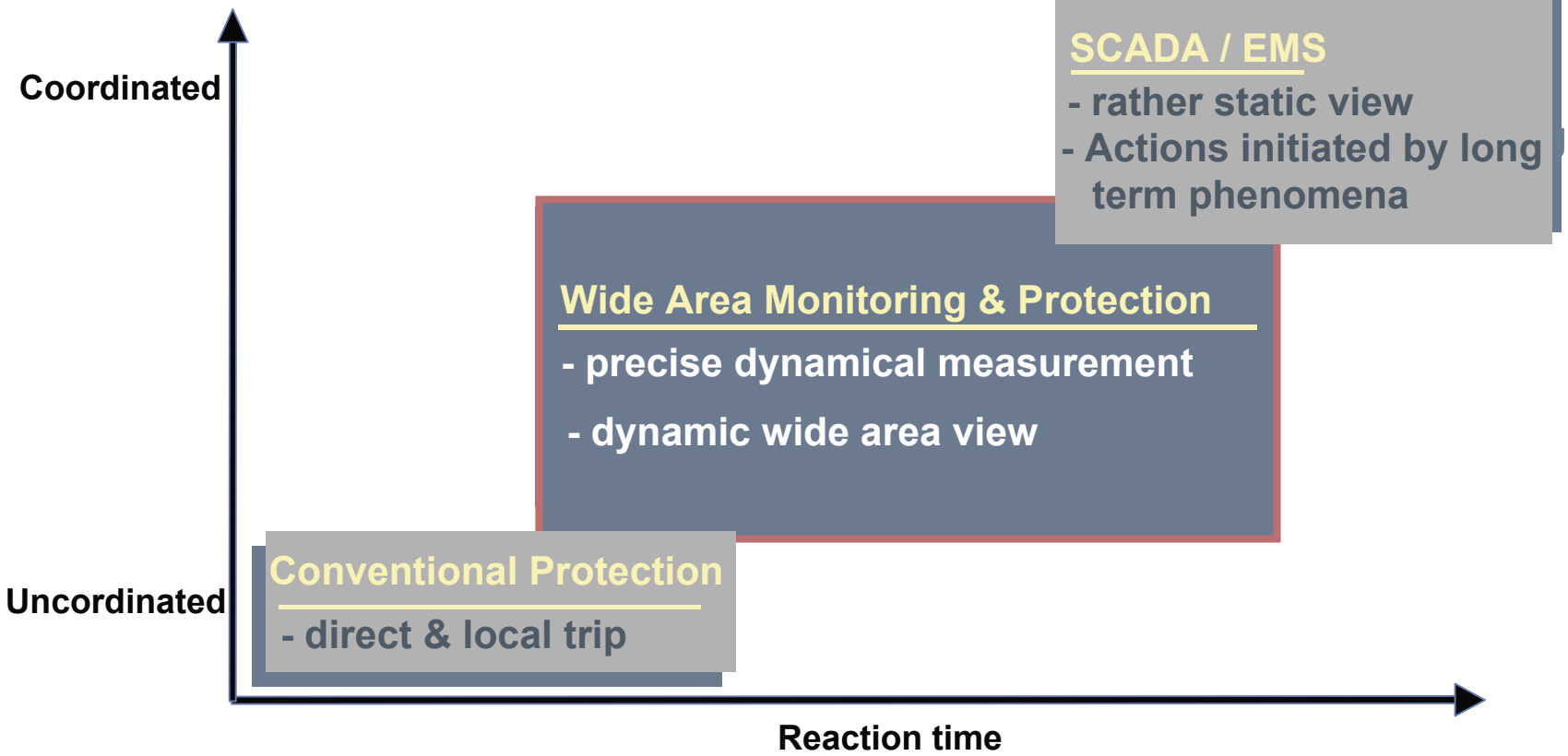
PSGuard - Wide Area Monitoring, Control & Protection System

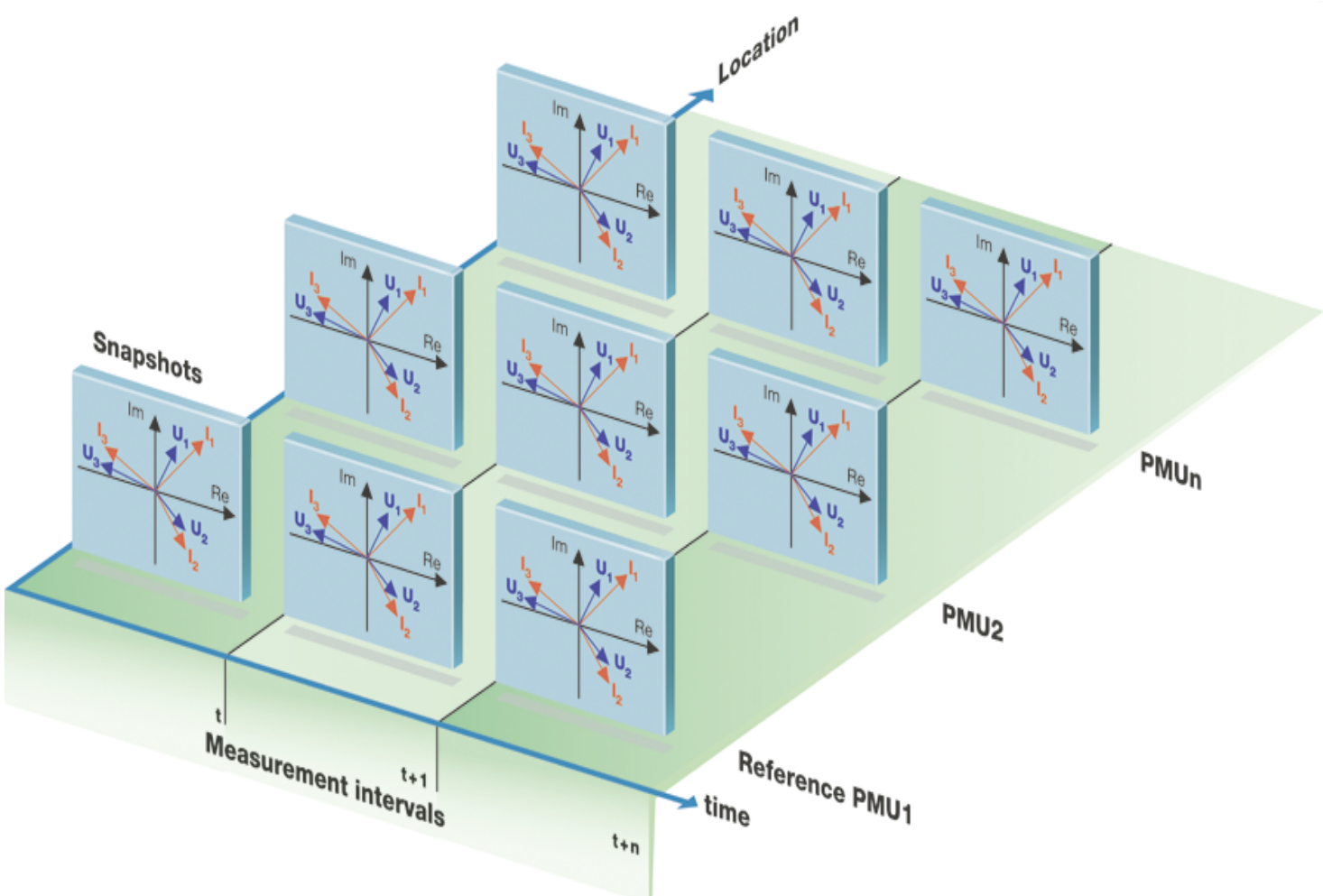


PSGuard

Positioning PSGuard / WAMP against SCADA & local Protection



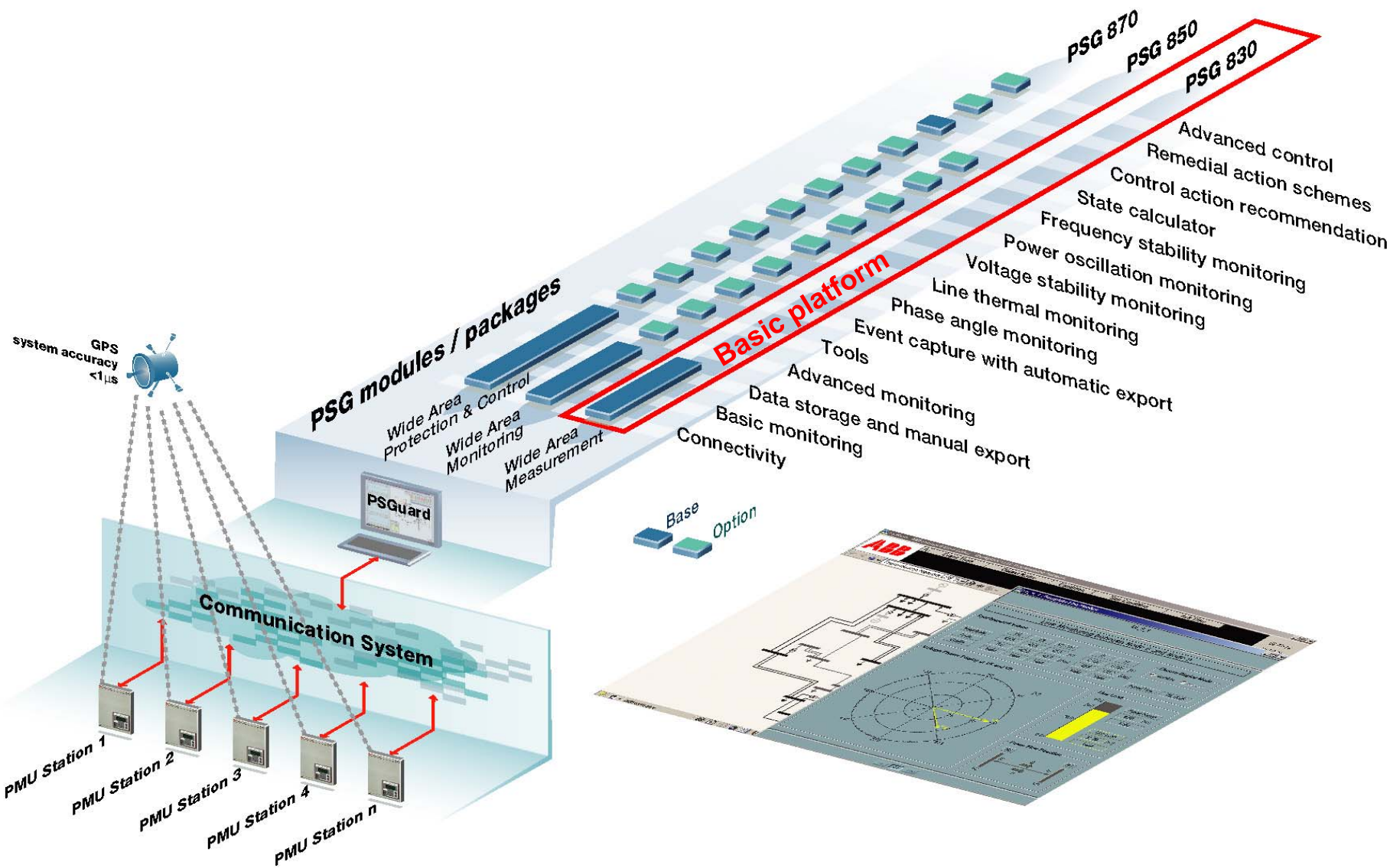
Dynamic & synchronized Information from substation to network control



IEEE 1344: Timestamp accuracy : 1 Microsecond

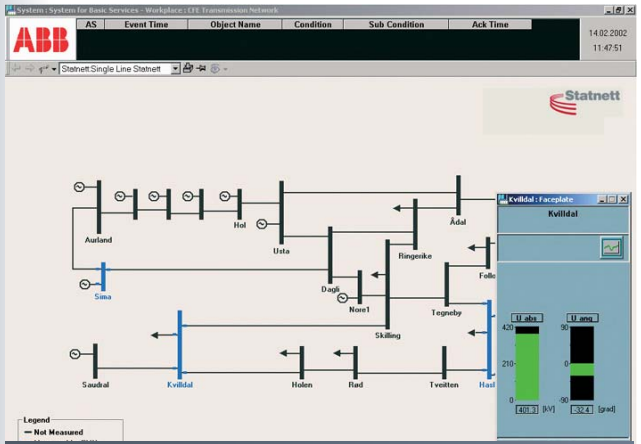
Angle accuracy error: < 0.1 degree

PSGuard offers Modular Scaleable System Structure

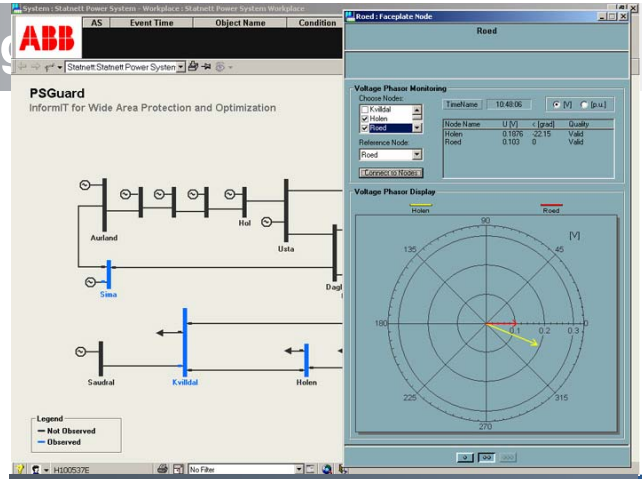


Preconfigured views ready for implementation

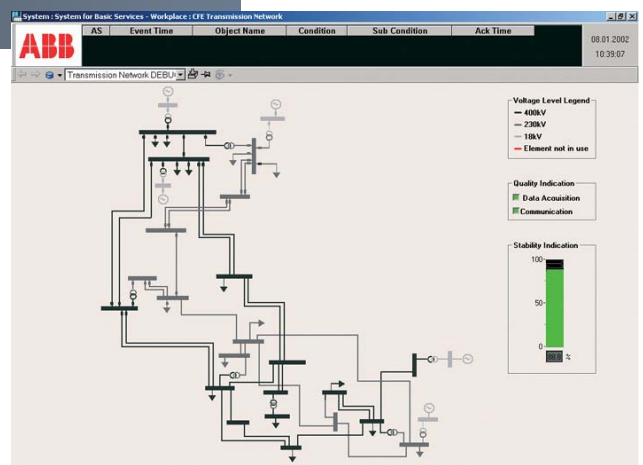
provided views for monitoring



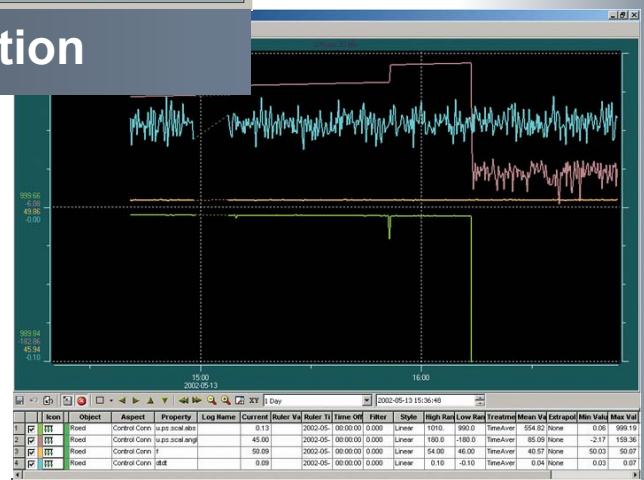
Easy navigation



Phasor information

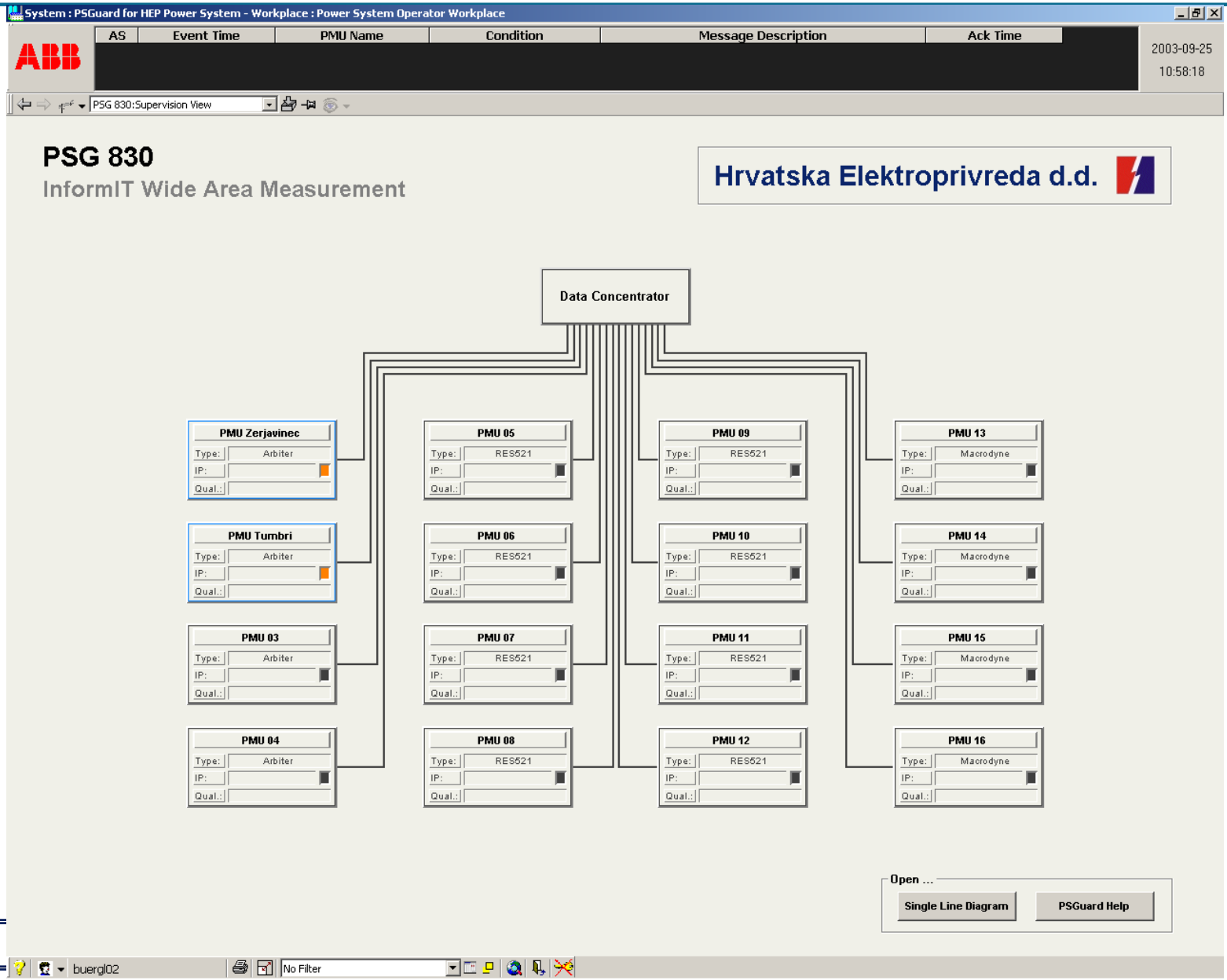


View on critical nodes

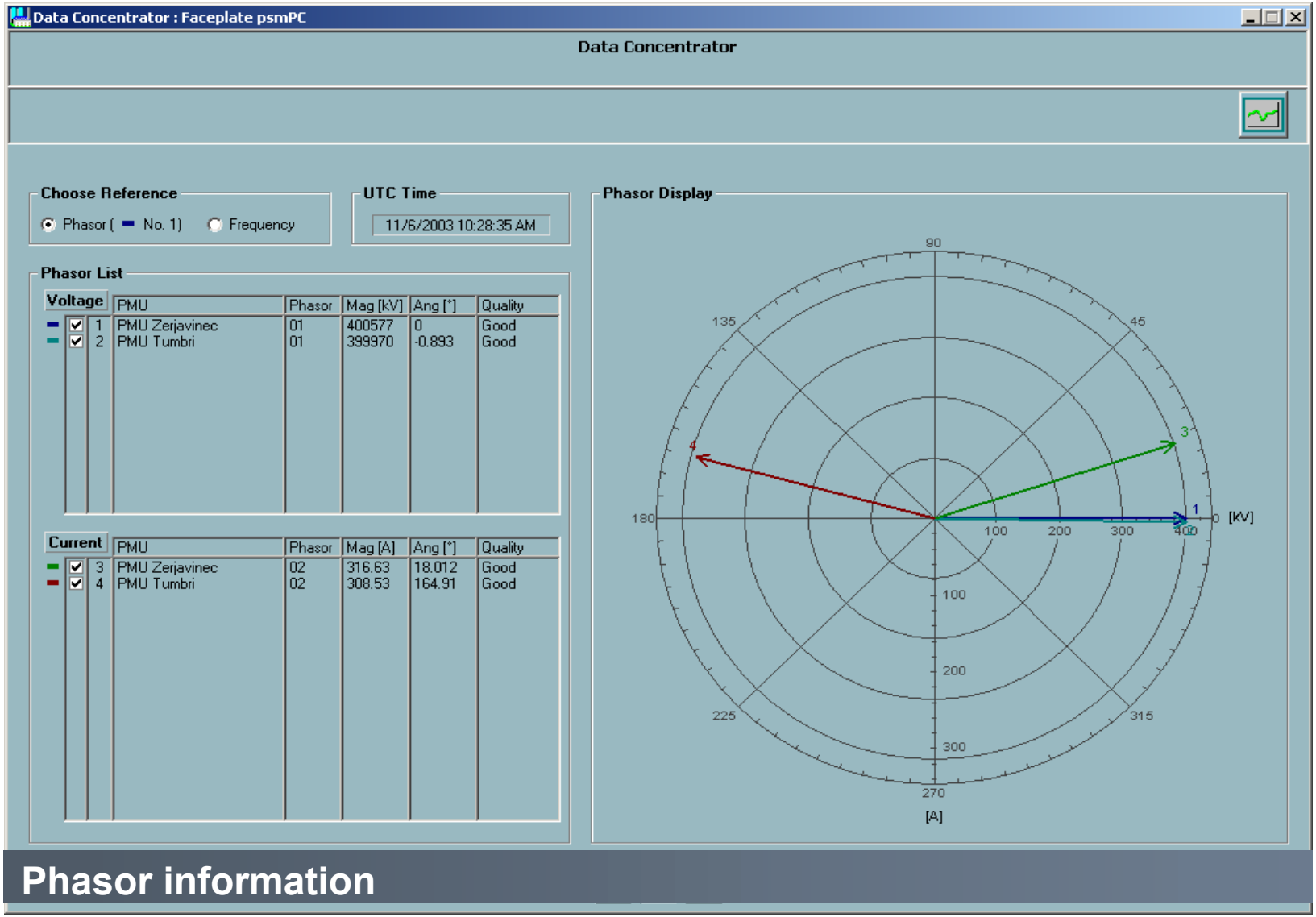


History view

PSGuard - PMU Supervision View - Implementation at HEP &TVA

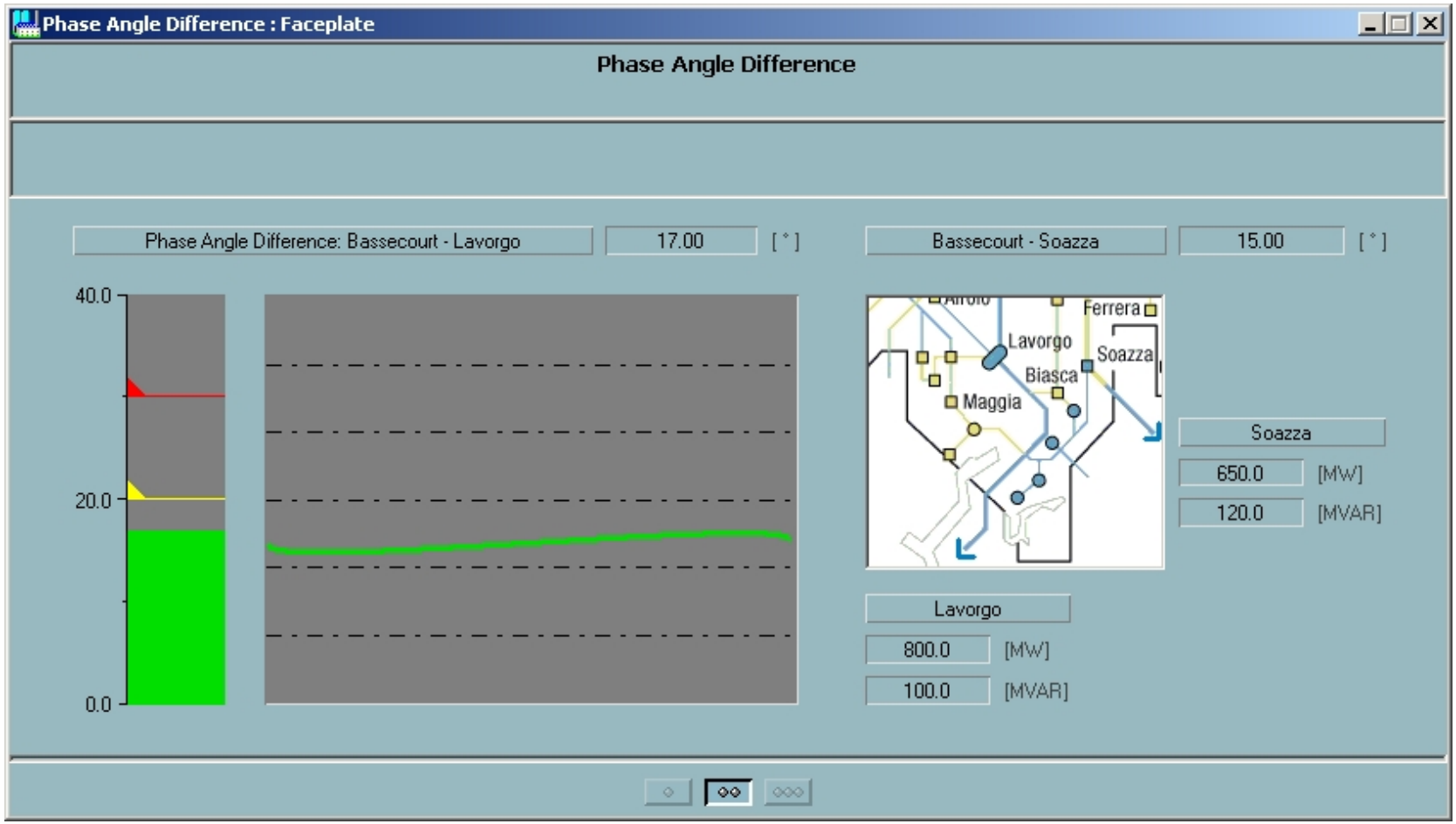


PSGuard - Wide Area Measurement - Implementation at HEP & TVA



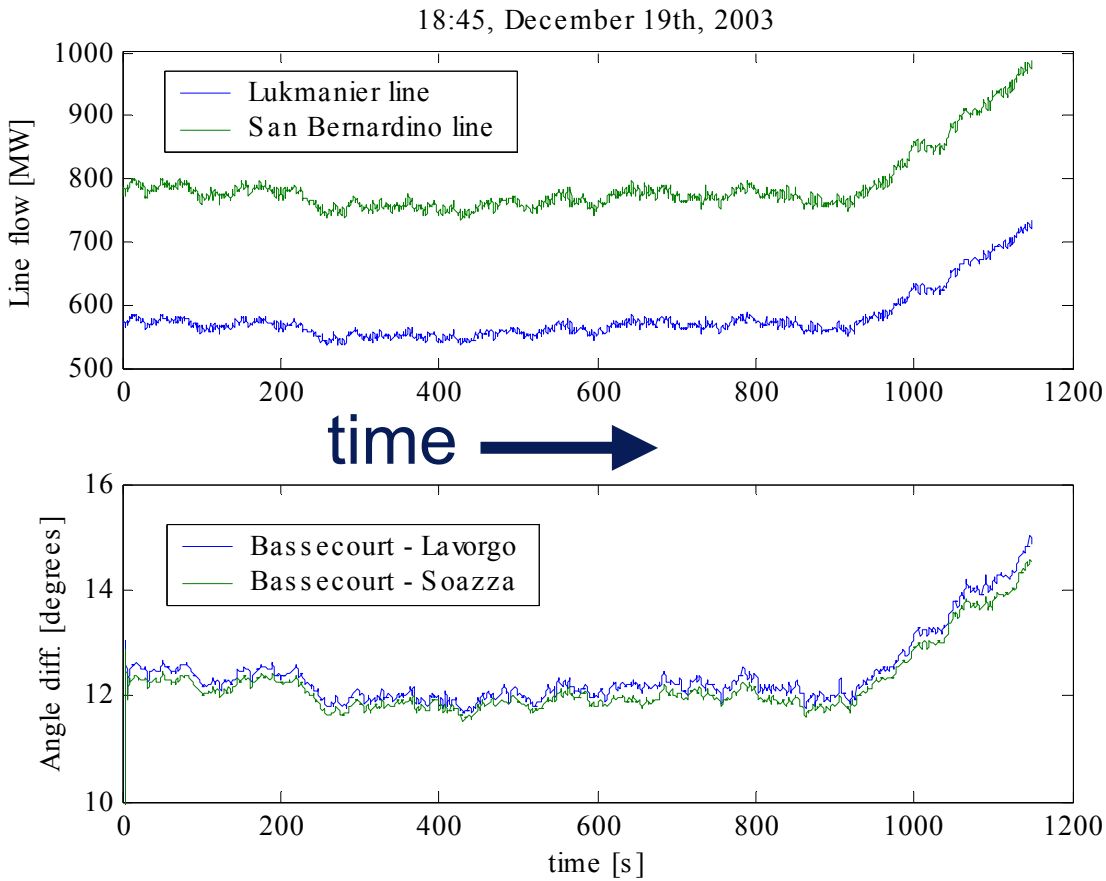
Phasor information

PSGuard - Phase Angle monitoring - Implementation at Etrans



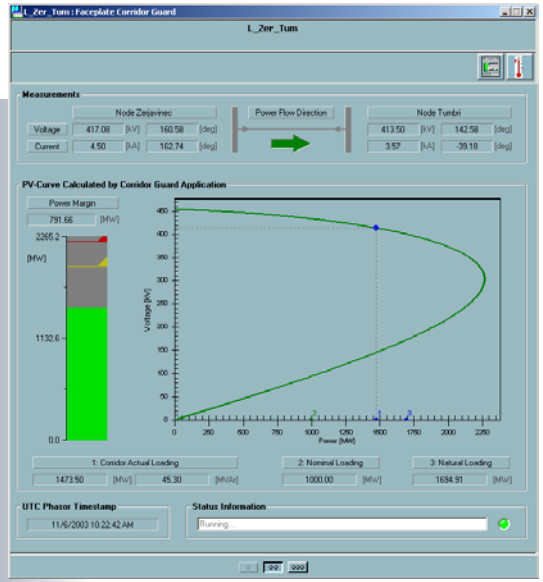
ETRANS - Phase Angle Monitoring - Results

Line flow

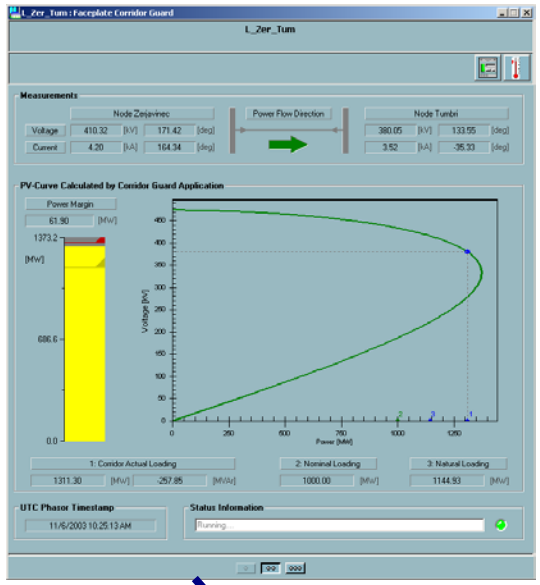


- Strong relation of line-loading and phase angle difference of voltages on both sides of corridor
- **100 MW** approximately corresponds to **1 degree**
- **Supervision of n-1 criteria**

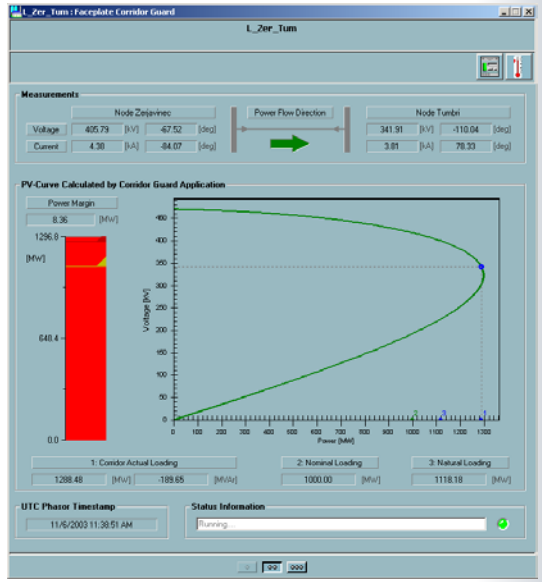
Voltage Stability Monitoring – Implementation for HEP



Early warning



Emergency alarm

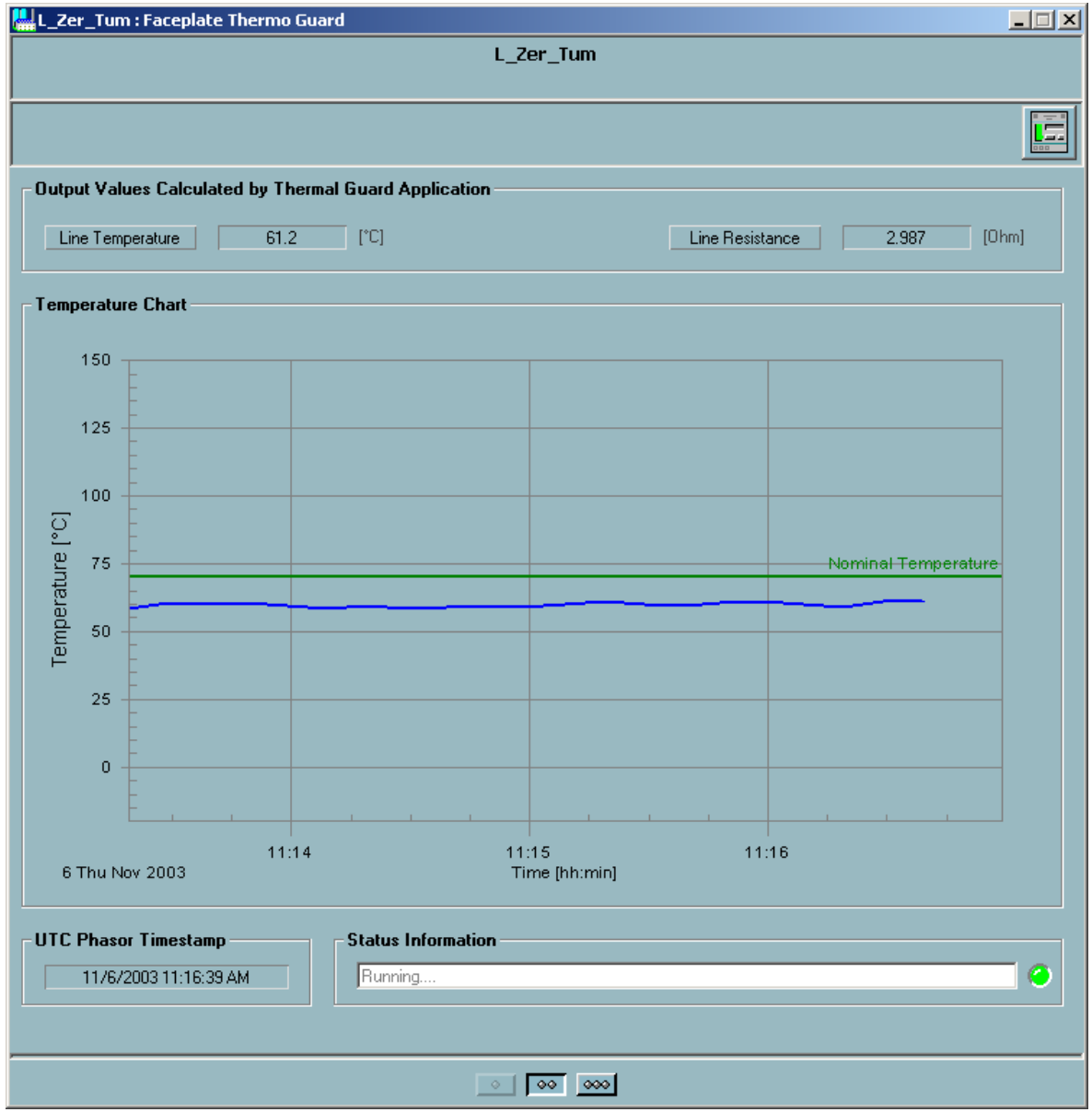


AS	Event Time	Object Name	Condition	Message Description
☐	04-03-27 18:02:48:238	L_LocC_F	Voltage Stability Monitoring Warning	Observed corridor is heavily loaded
☐	04-03-27 18:01:17:387	Items	Phase Angle Monitoring Warning	The angle difference is in dangerous state

3/27/2004
6:03:02 PM

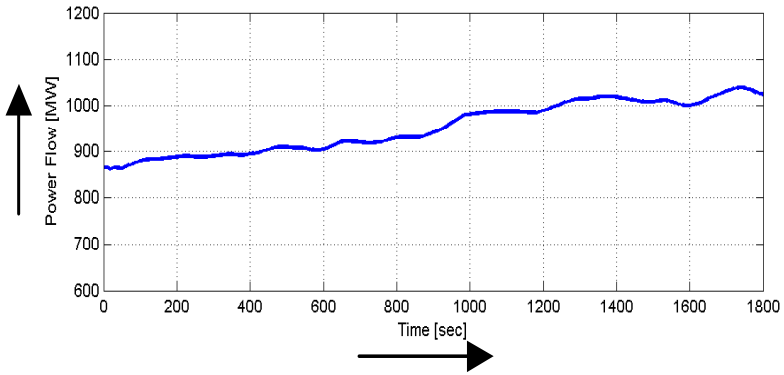
PSG Power System:Single Line Diagra

PSGuard - Line Thermal Monitoring - Implementation at HEP & Etrans

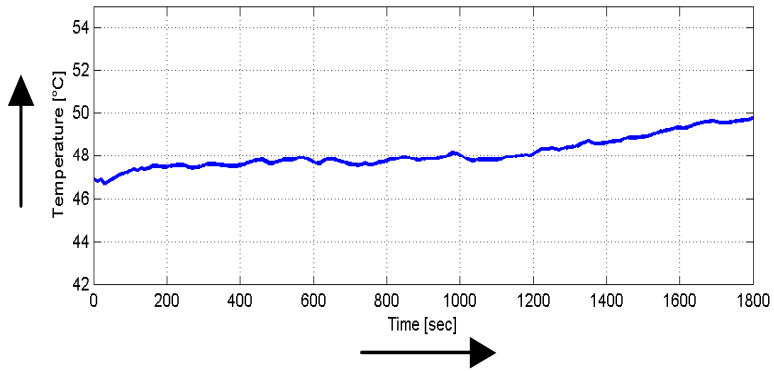


ETRANS Switzerland - Line Thermal Monitoring - Results

Power flow



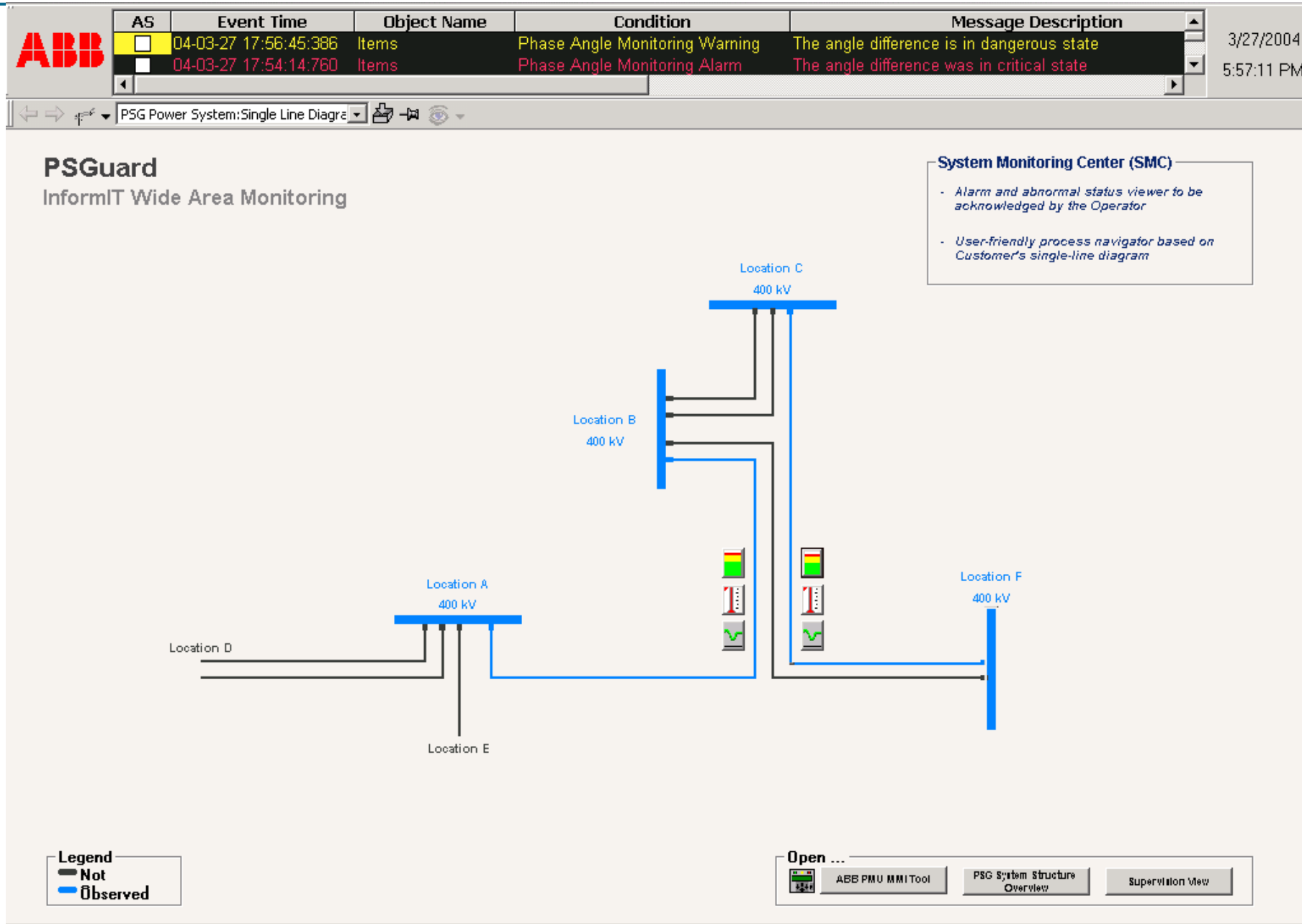
Temperature



time

- Resistance and average line temperature monitored using only PMU data
- Increase of power flow on line from 950 MW to 1150 MW -> temperature increase from 46 degrees to 49 degrees in 30 min

PSGuard Small Trial System Available for Fast Implementation



MIT: 10 EMERGING TECHNOLOGIES THAT WILL CHANGE YOUR WORLD

OTHER LEADERS
In Power Grid Control

JOHN HAUER
Pacific Northwest National Laboratory (Richland, WA)
Monitoring and analyzing U.S. power flows

INNOCENT KAMWA
Hydro-Québec Research Institute (Varennes, Québec)
Securing power flows in Canada

CARSON TAYLOR
Bonneville Power Administration (Portland, OR)
Wide-area measurement systems to stabilize west-coast power lines

VIJAY VITTAL
Iowa State University (Ames, IA)
Simulation of large-scale power systems

CHRISTIAN REHTANZ

Power Grid Control

Power grids carry the seeds of their own destruction: massive flows of electricity that can race out of control in just seconds, threatening to melt the very lines that carry them. Built in the days before quick-reacting microprocessors and fiber optics, these networks were never designed to detect and squelch systemwide disturbances. Instead, each transmission line and power plant must fend for itself, shutting down when power flows spike or sag. The shortcomings of this system are all too familiar to the 50 million North Americans from Michigan to Ontario whose lights went out last August: as individual components sense trouble and shut down, the remaining power flows become even more disturbed, and neighboring lines and plants fall like multimillion-dollar dominoes. Often needless shutdowns result, costing billions, and the problem is only expected to get worse as expanding economies push more power onto grids.

Christian Rehtanz thinks the time has come for modern control technology to take back the grid. Rehtanz, group assistant vice president for power systems technology with Zürich, Switzerland–based engineering giant ABB, is one of a growing number of researchers seeking to build new smarts into grid control rooms. These engineers are developing hardware and software to track electric flows across continent-wide grids several times a second, identify disturbances, and take immediate action. While such "wide area" control systems remain largely theoretical, Rehtanz and his ABB colleagues have fashioned one that is ready for installation today. If their design works as advertised, it will make power outages 100 times less likely, protecting grids against everything from consumption-inducing heat waves to terrorism. "We can push more power through the grid while, at the same time, making the system more predictable and more reliable," says Rehtanz.

Real-time control systems are a natural outgrowth of a detection system pioneered in the 1990s by the U.S. government-operated Bonneville Power Administration, which controls grids in the Pacific Northwest. In this system, measurements from sensors hundreds to thousands of kilometers apart are coded with Global Positioning System time stamps, enabling a central computer to synchronize data and provide an accurate snapshot of the entire grid 30 times per second—fast enough to glimpse the tiny power spikes, sags, and oscillations that mark the first signs of instability. An earlier version of Bonneville's system helped explain the dynamics of the 1996 blackout that crippled 11 western U.S. states, Alberta, British Columbia, and Baja California; western utilities subsequently rejiggered their operations and have thus far avoided a repeat. "I know the people back east sure wish they had one right now," says Carson Taylor, Bonneville's principal engineer for transmission and an architect of its wide-area system.

But Rehtanz is eager to take the next step, transforming these investigative tools into real-time controls that detect and squelch impending blackouts. The technical challenge: designing a system that can respond quickly enough. "You have half a minute, a minute, maybe two minutes to take action," says Rehtanz. That requires spartan calculations that can crunch the synchronized sensor data, generate a model of the system to detect impending disaster, and select an appropriate response, such as turning on an extra power plant. Control algorithms designed by Rehtanz and his colleagues employ a highly simplified model of how a grid works, but one that they believe is nevertheless capable of instantly identifying serious problems brewing—and on a standard desktop computer. ABB engineers are now studying how such algorithms could protect a critical power corridor linking Switzerland and Italy that failed last September, blacking out most of Italy.

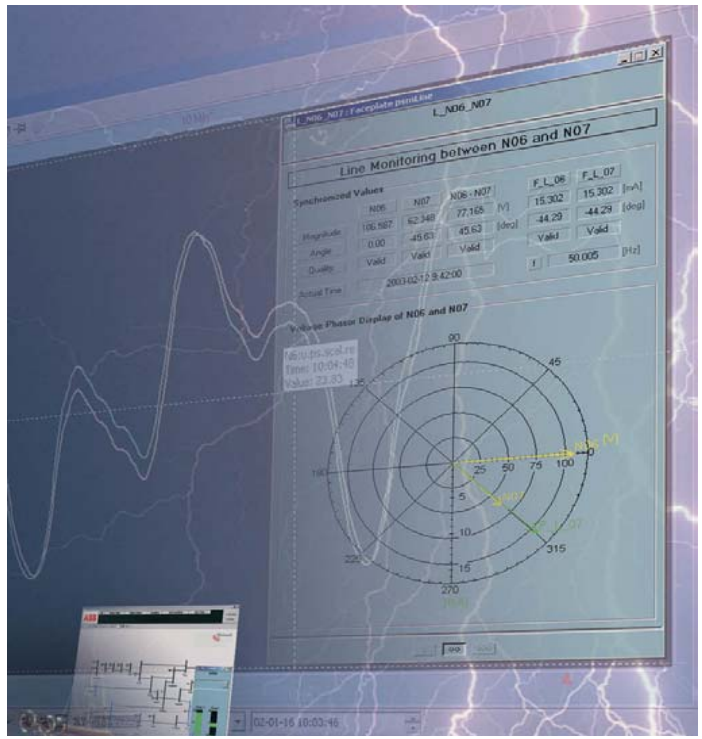
Many utilities are already implementing elements of real-time grid control—for example, installing digital network controllers that can literally push power from one line to another or suppress local spikes and sags (*see "Power Gridlock," TR July/August 2001*). Tied into a wide-area control scheme, these network controllers could perform more intelligently. Still, it may be years before a utility takes the plunge and fully commits to Rehtanz's algorithms. It's not just that utilities are conservative about tinkering with untried technologies; cash for transmission upgrades is thin in today's deregulated markets, where it's unclear which market players—power producers, transmission operators, or government regulators—should pay for reliability. What is clear, however, is that the evolution toward real-time, wide-area sensing and control has begun.

PETER FAIRLEY

Source: MIT

> While such "wide area" control systems remain largely theoretical, Rehtanz and his ABB colleagues have fashioned one that is ready for installation today.

> "We can push more power through the grid while, at the same time, making the system more predictable and more reliable," says Rehtanz.



PSGuard References

PSGuard References

Tennessee Valley Authority (TVA), US 16 PMUs

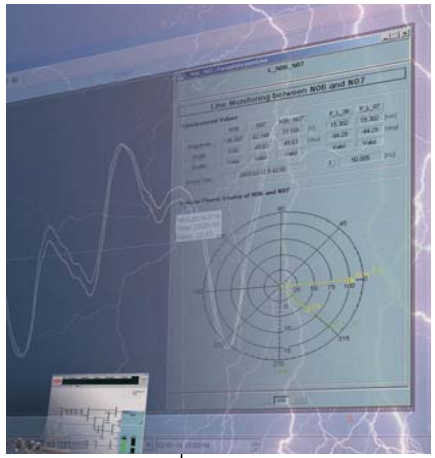
HEP Croatia, 2 PMUs, extension foreseen

ETRANS Switzerland, 4 PMUs, extension foreseen

Fribourg University Switzerland, 4 PMUs

Statnett, Norway, 3 PMUs

PSG830 – Successfull FAT with TVA in 2003



PSG830

Data concentrator

FAT, TVA April 2003


Wide Area Monitoring System: P. S. G. Wide Area Monitoring System

Final client / Endkunde: TVA

Project / Projekt: TVA PSG830 Pilot Project

Purchaser / Auftraggeber: TVA

ABB Order-No./ ABB Bestell-Nr.: 501195

Place of testing / Ort der Tests: ABB Switzerland Ltd / Baden / Switzerland

End of the test / Ende der Tests:

Standard Solution / Standard Lösung: PSG830

Abnahme / Factory acceptance test

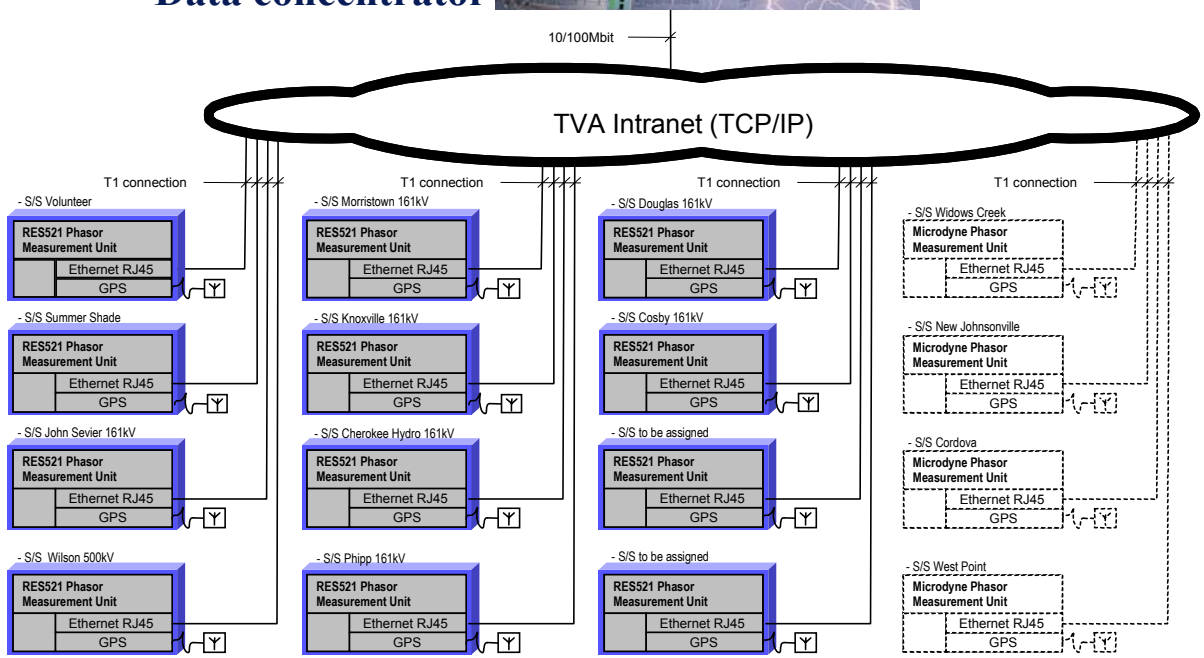
Factory acceptance test

Abnahme

Factory Acceptance Certificate

Übergabe-Zertifikat

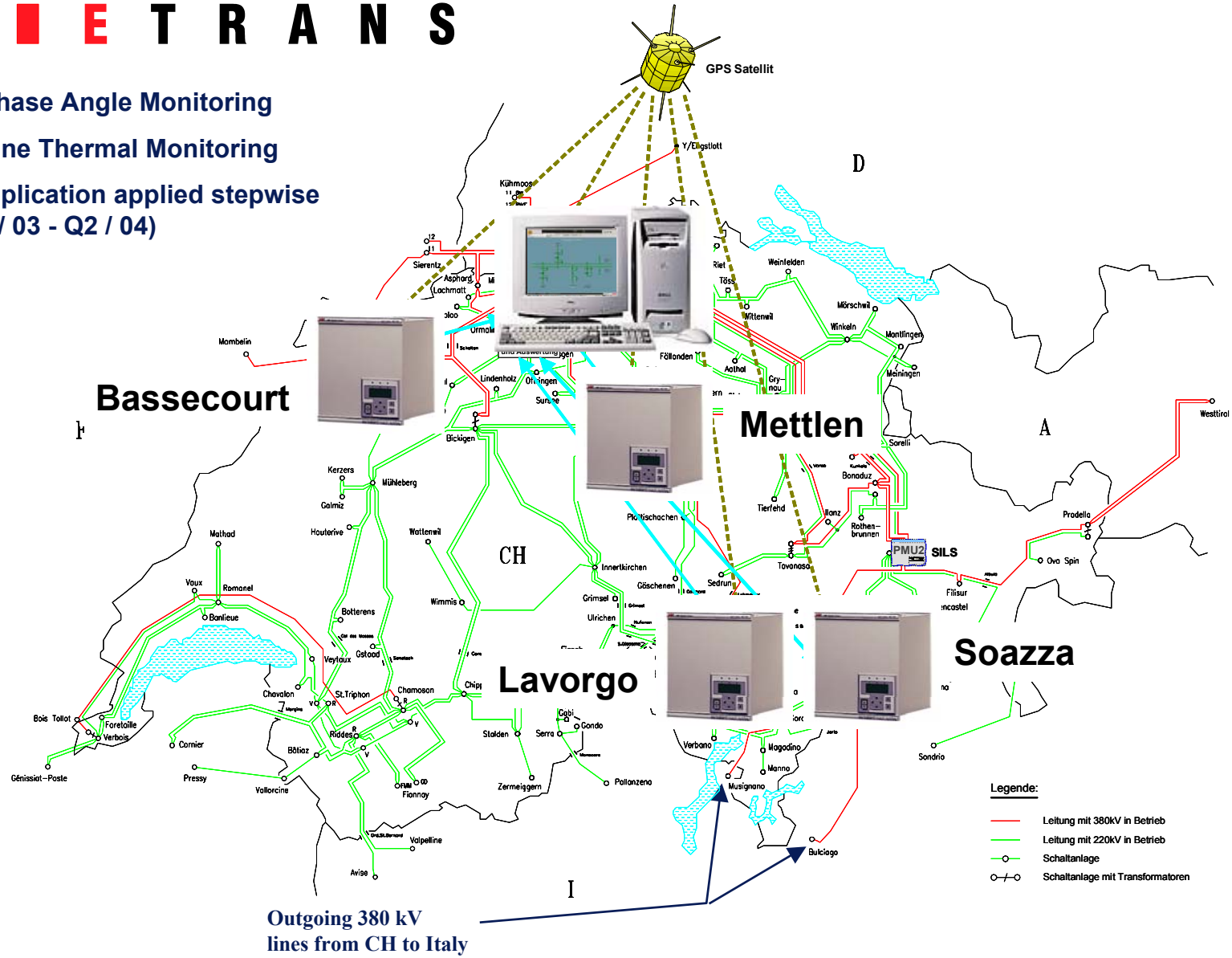
ABB Switzerland Ltd



Etrans Switzerland - PSGuard system structure

ETRANS

- Phase Angle Monitoring
- Line Thermal Monitoring
- application applied stepwise (Q4 / 03 - Q2 / 04)



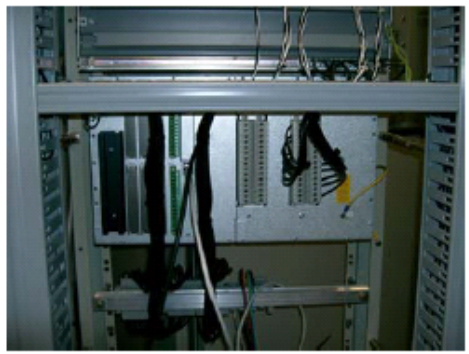
Outgoing 380 kV lines from CH to Italy

Etrans Switzerland - SMC located in Laufenburg

Etrans Switzerland - PMU RES521 locations on site

PMUs:

Bassecourt



Lavorgo

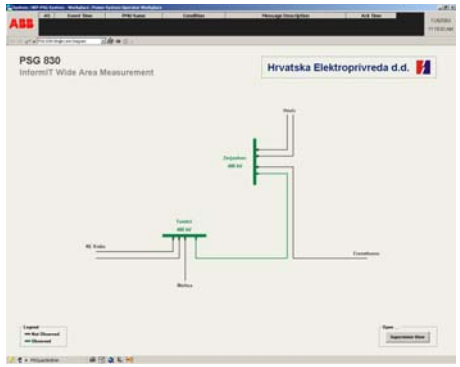
Mettlen

Soazza

ETRANS

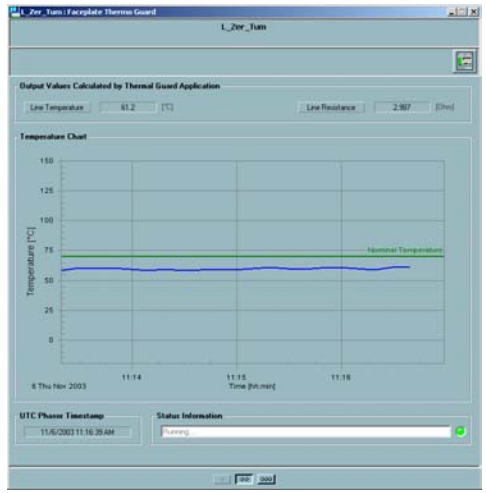
ABB

PSG830 with applications – Successfull FAT with HEP

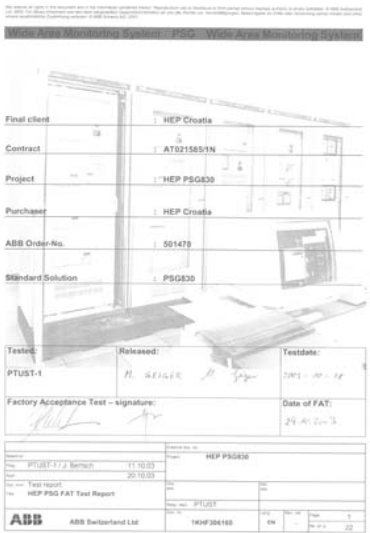


Single line diagram

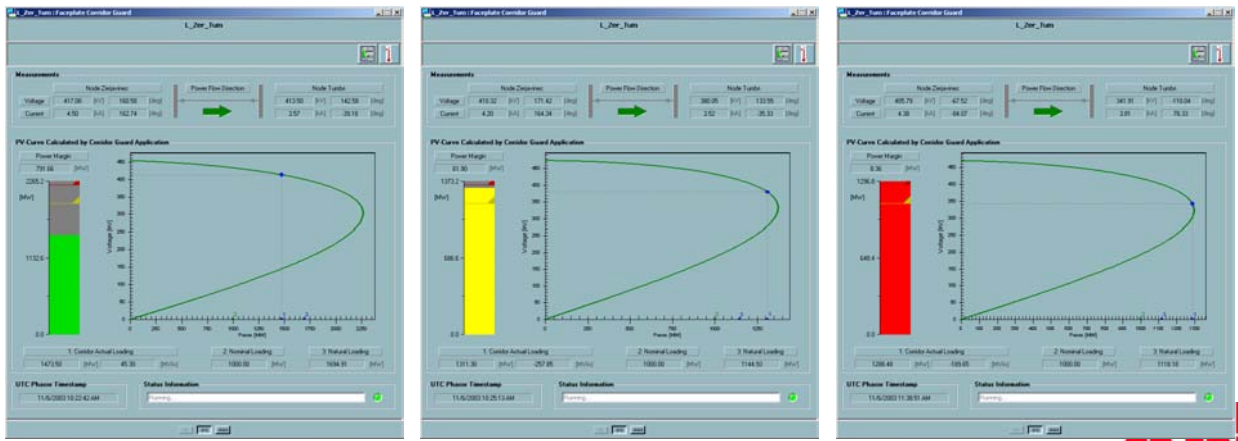
Line thermal monitoring



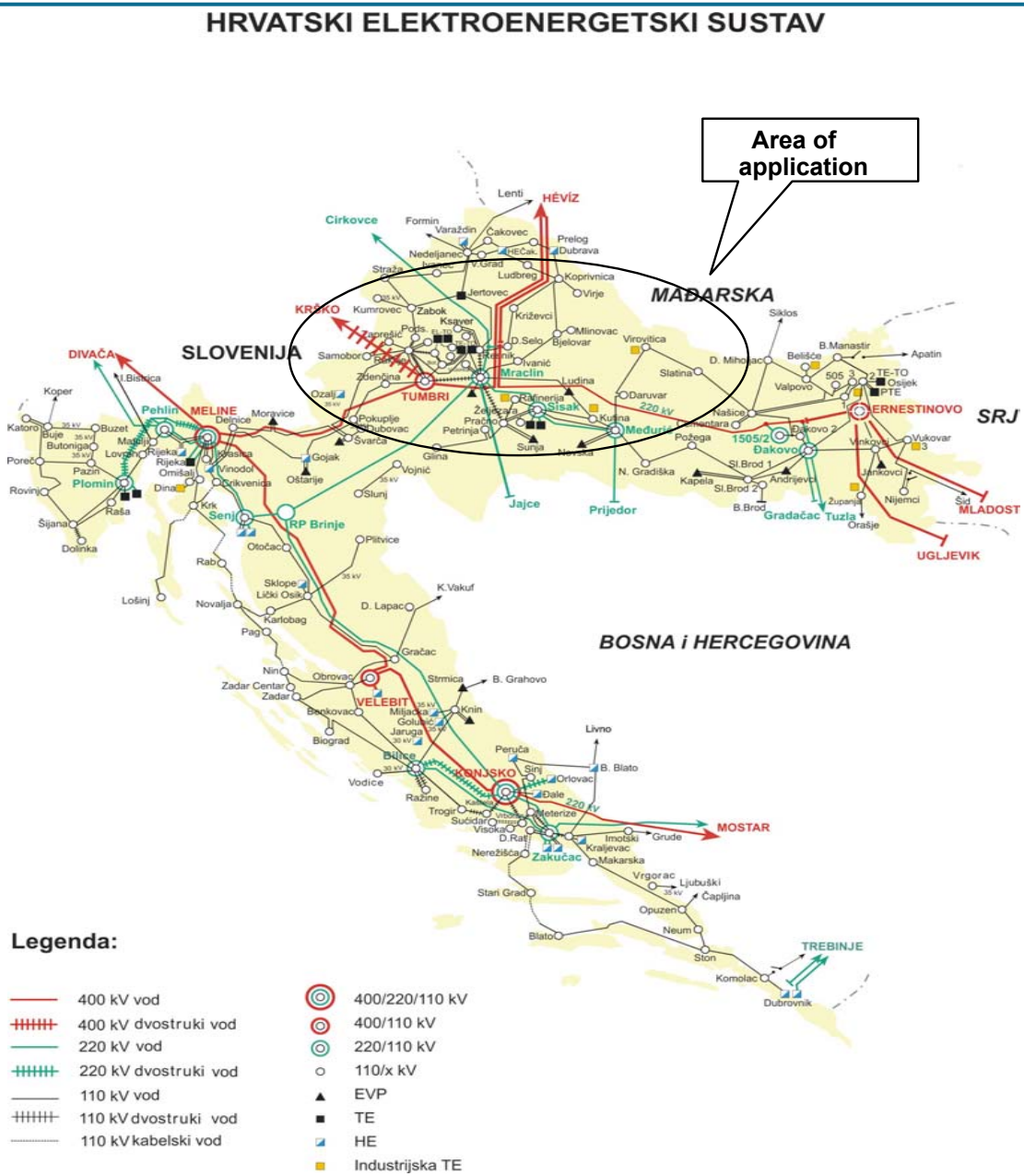
FAT, HEP October 2003



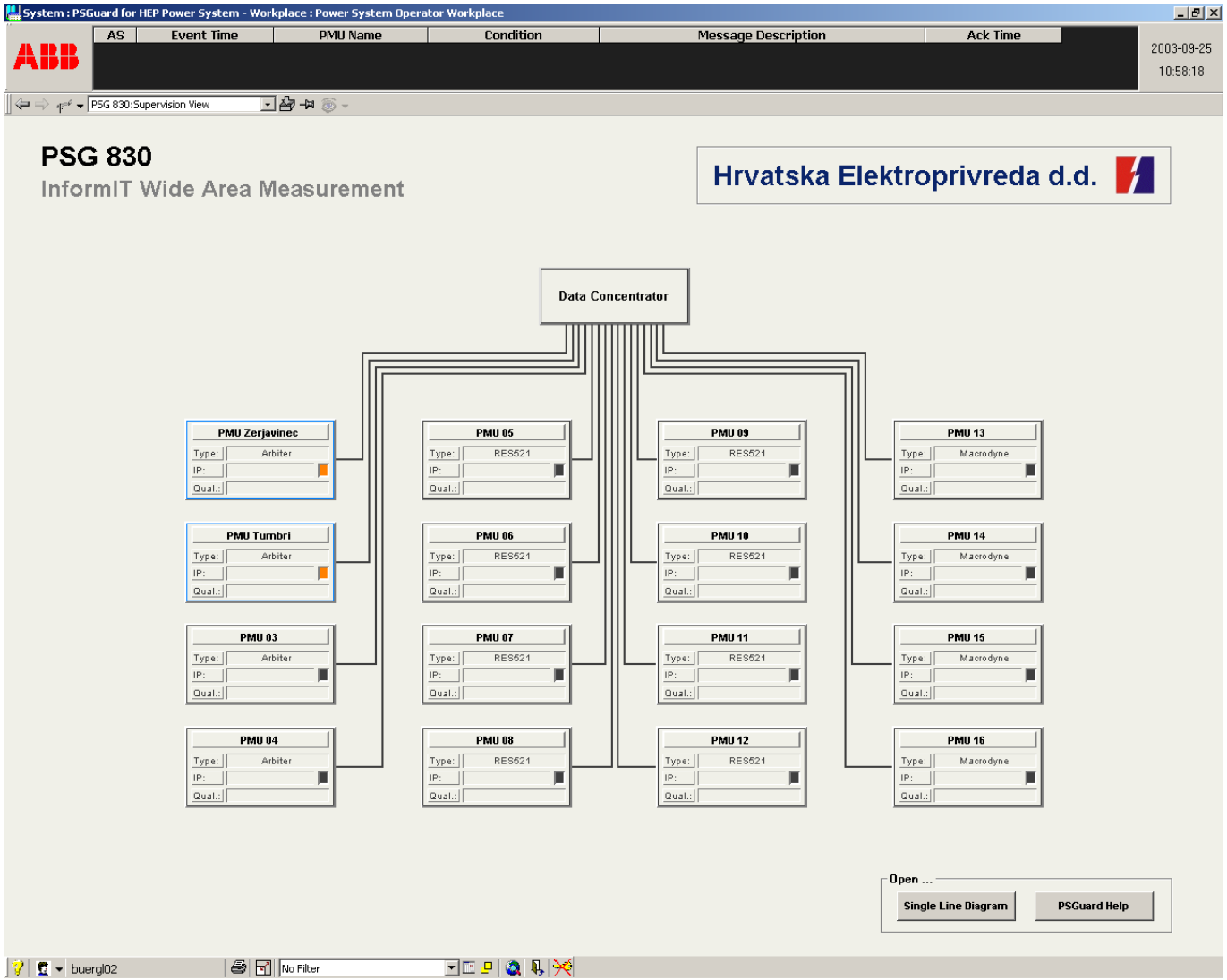
Voltage stability monitoring



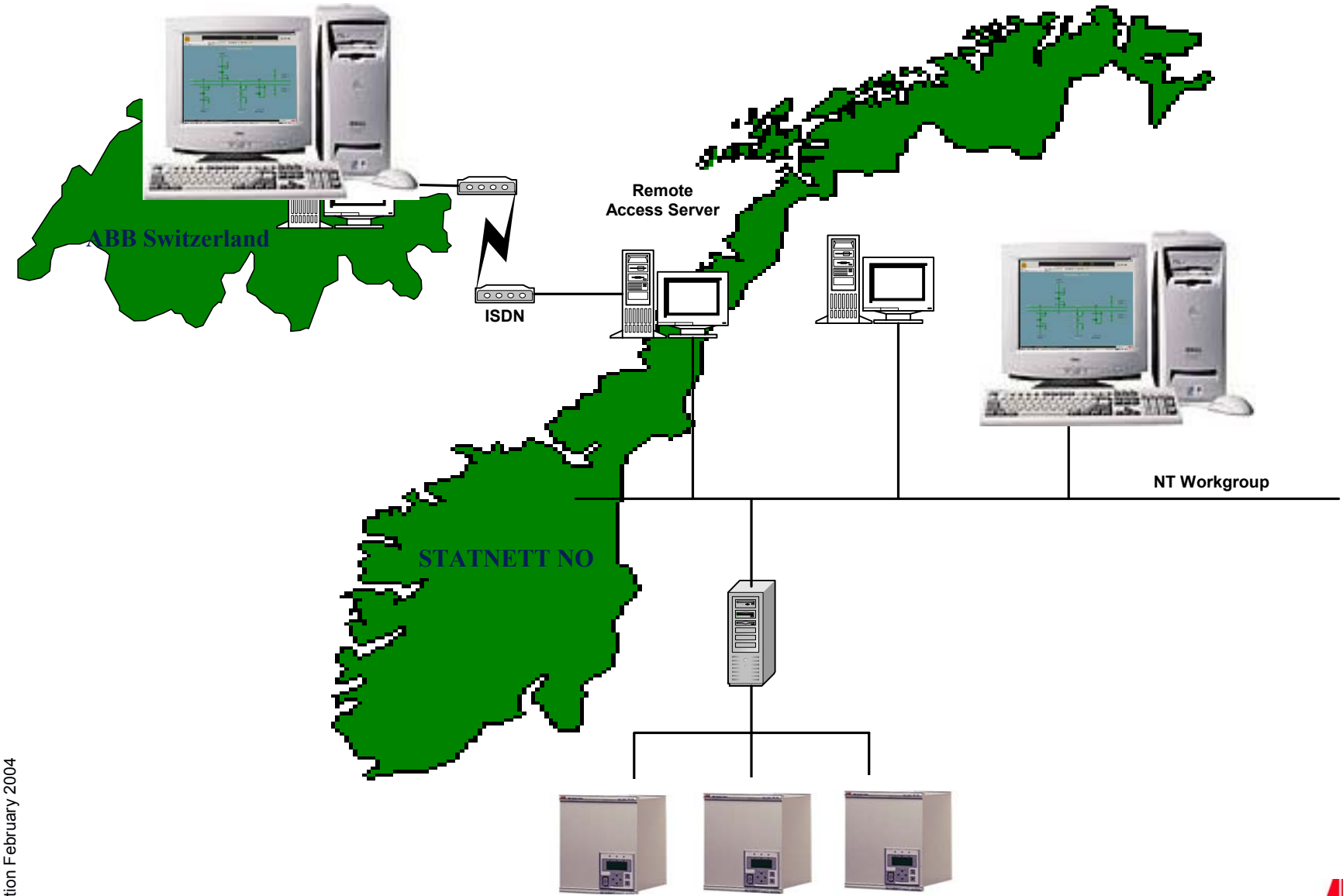
PSGuard Reference at HEP, Croatia



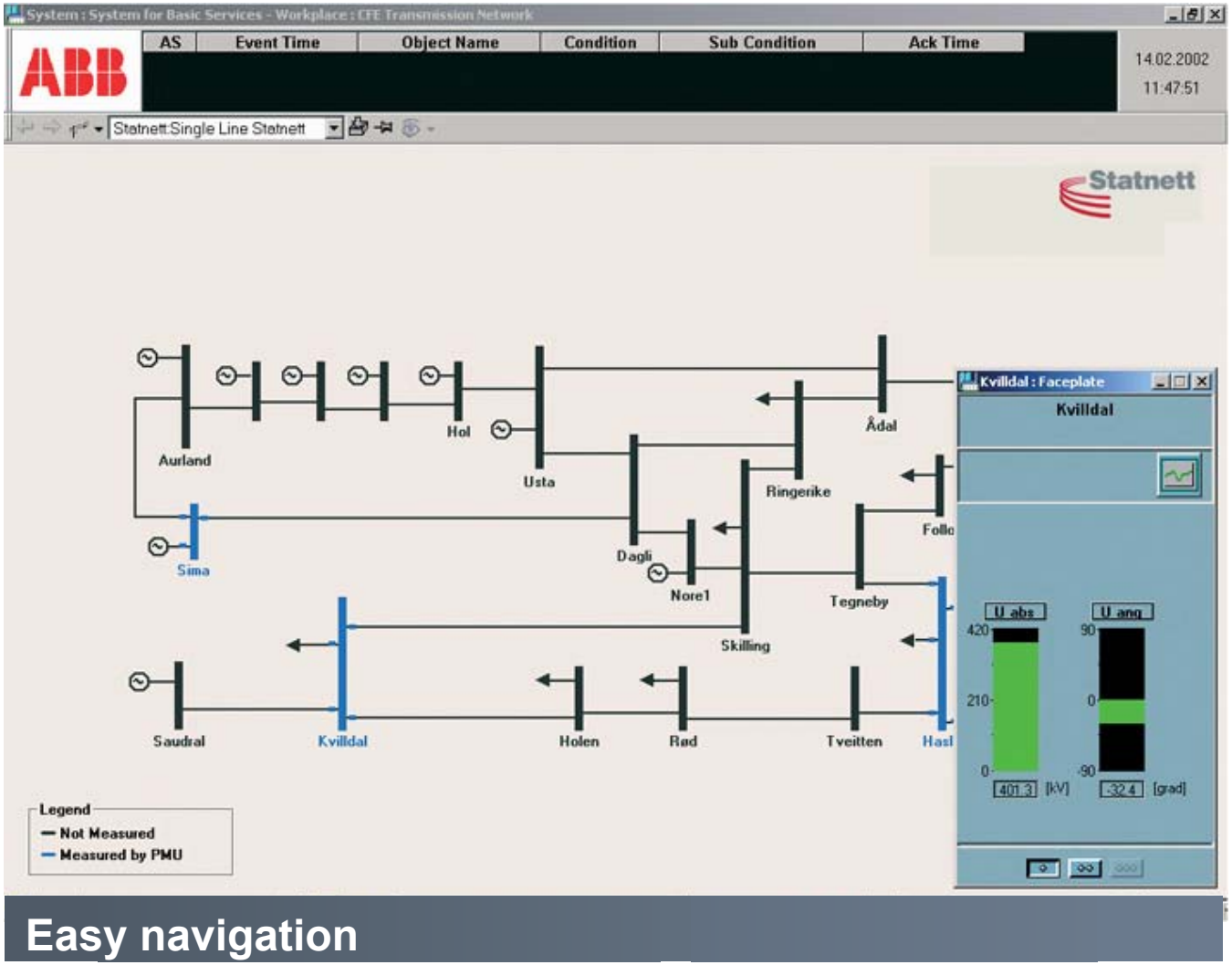
Basic monitoring: supervision view (HEP, Croatia)



PSGuard Reference: Stattnet / Norway

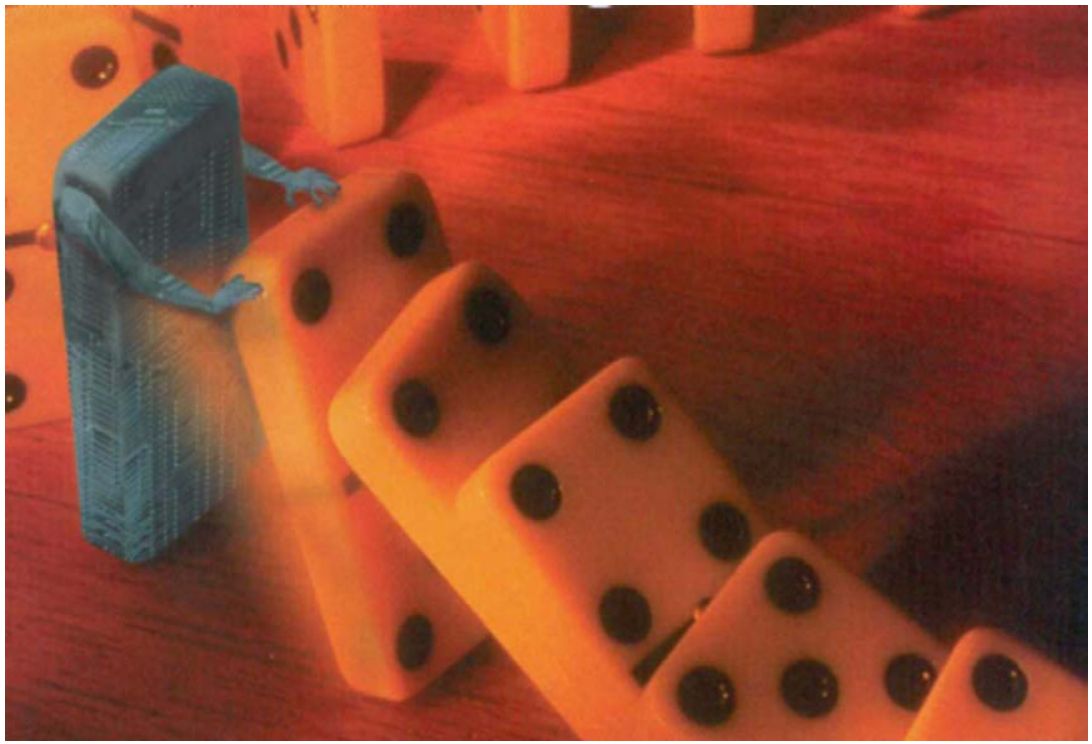


Basic monitoring: customer specific view (Statnett)



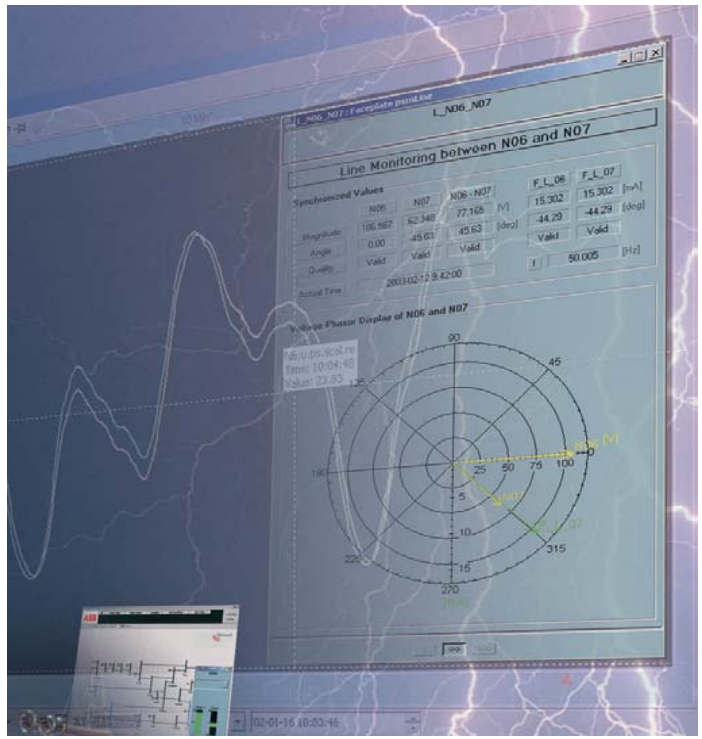
Easy navigation

PSGuard: Ready to protect your transmission capacity



Contact us for details:

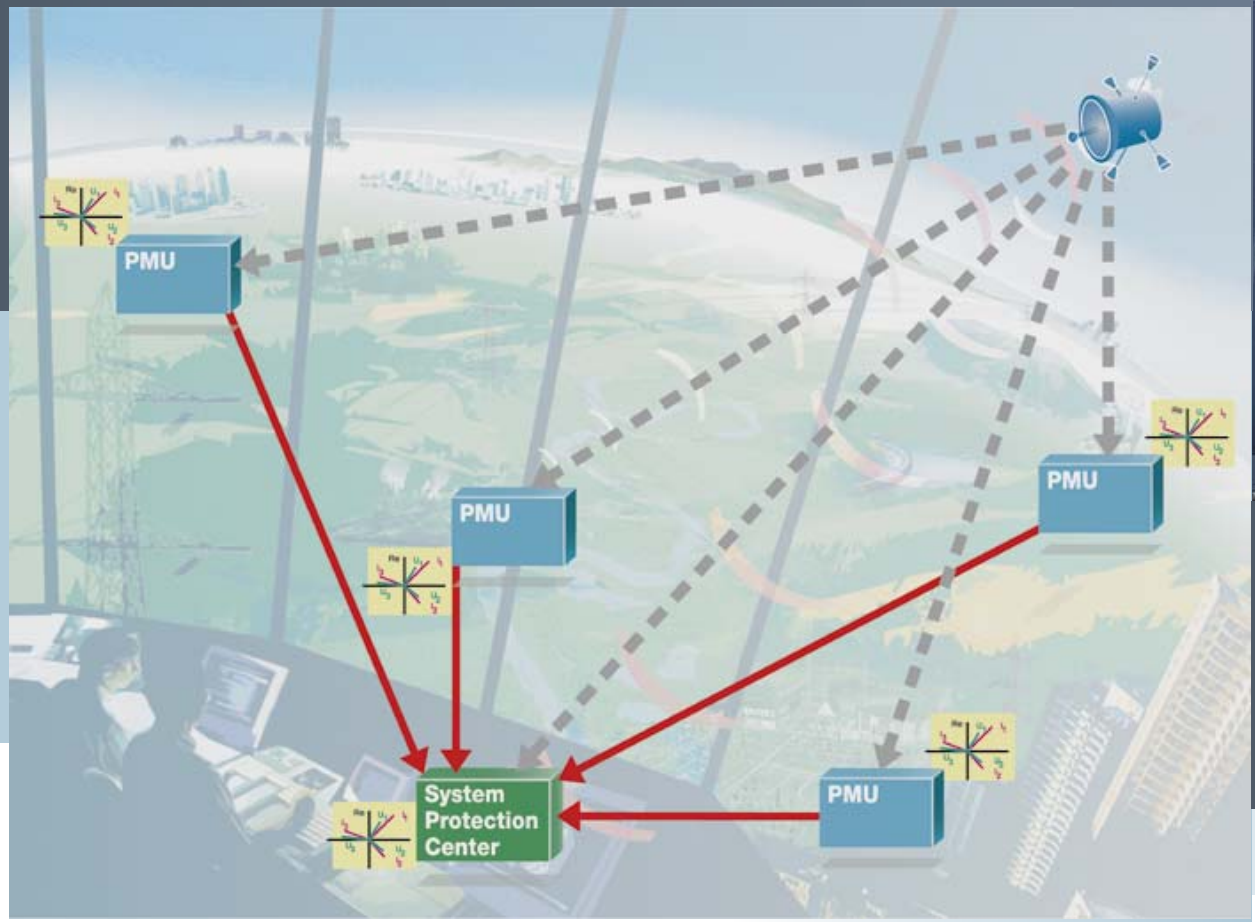
wide.area@ch.abb.com

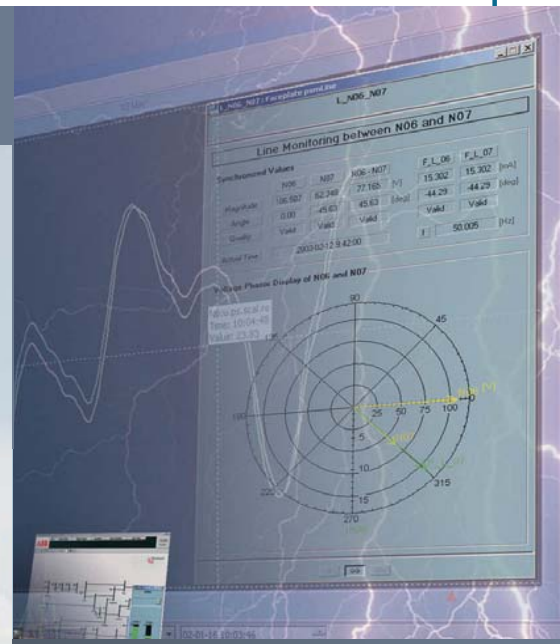


Backup Slides

Wide area protection and monitoring - PSGuard

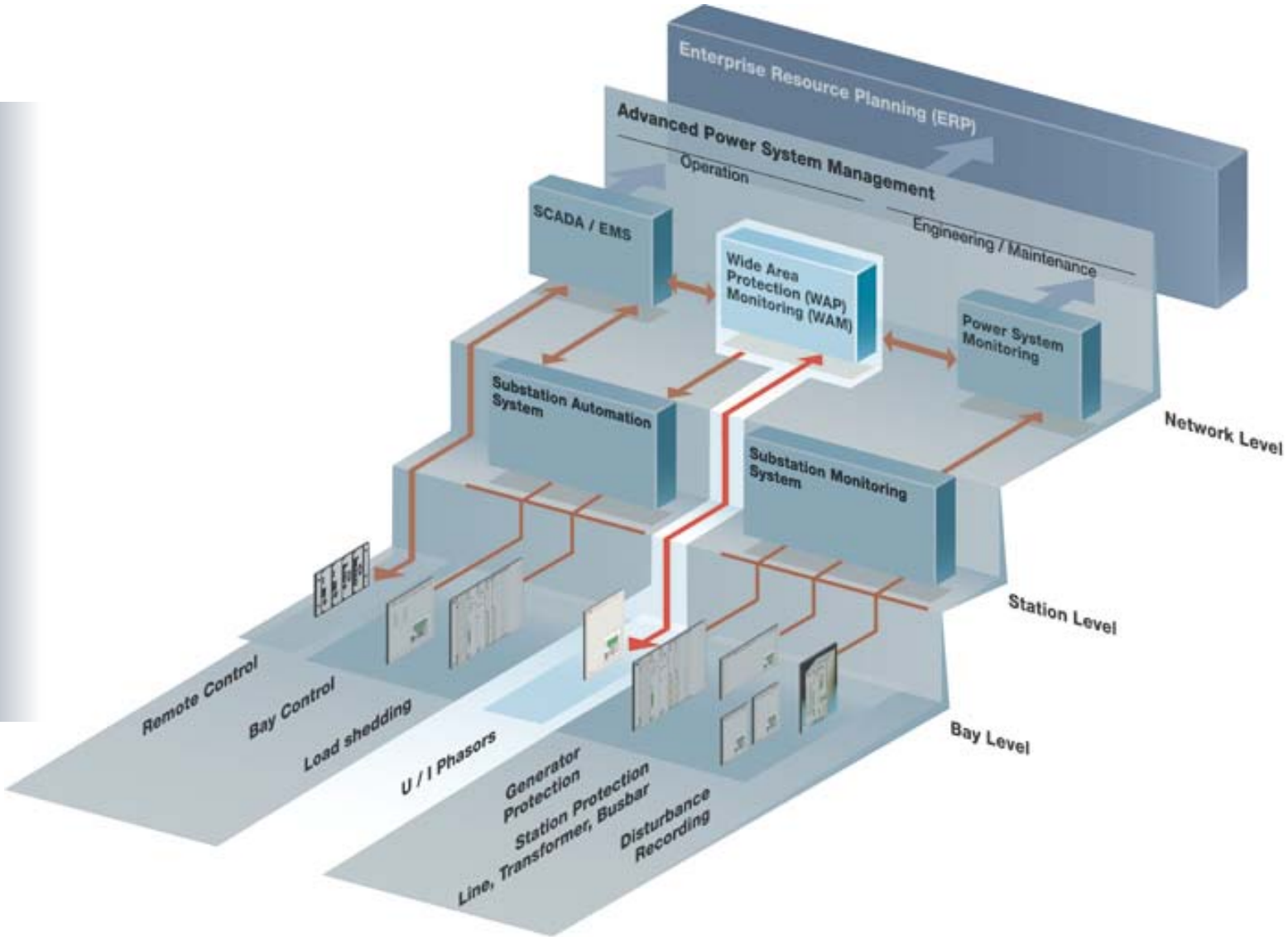
Dynamic monitoring of critical network nodes



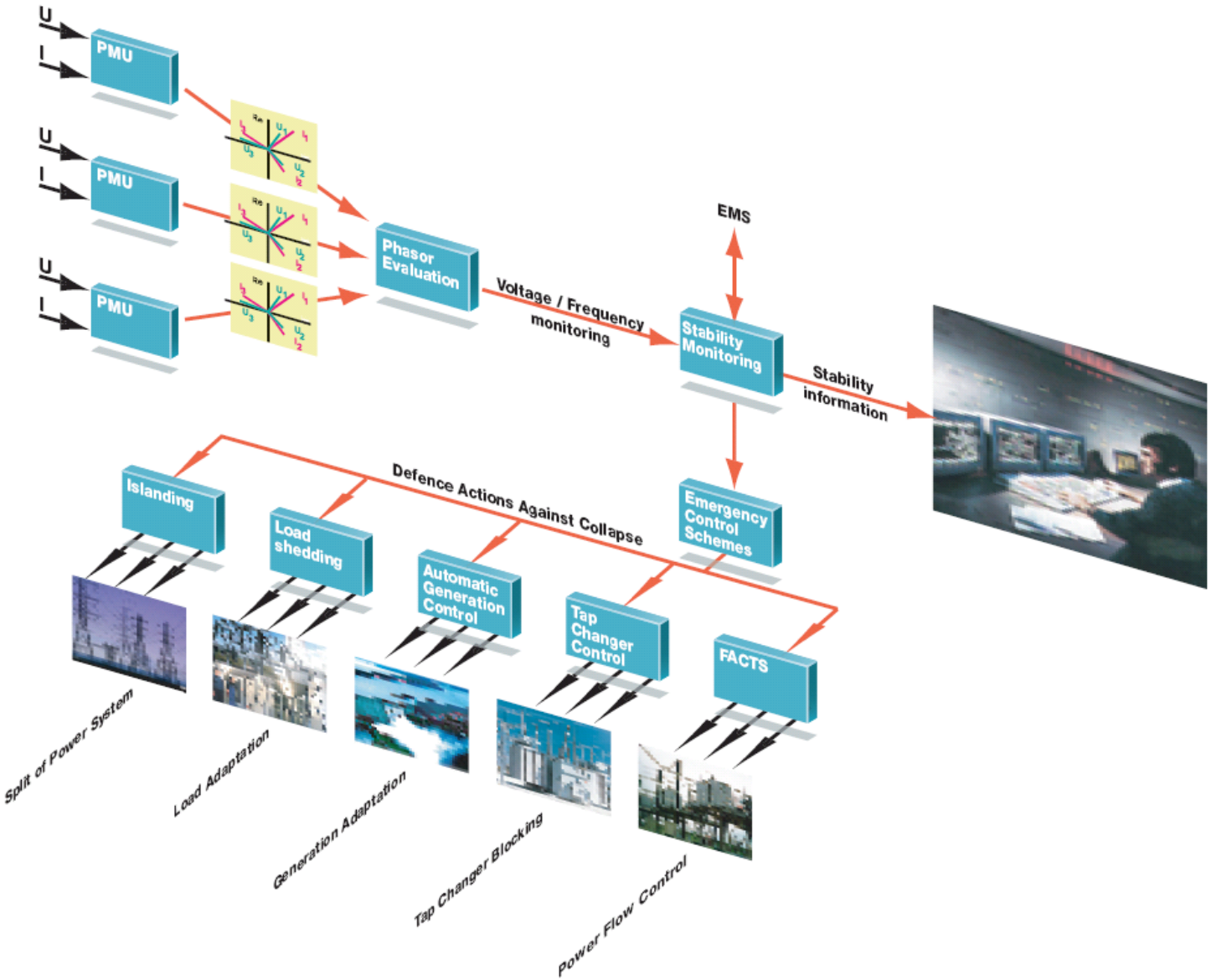


Take the right time to an dynamic approach to your power system

Synchronized Information from substation to network control



Emergency control schemes



PSGuard assists to prevent critical incidents

Source: US DOE / NERC

August 14th Blackout

By-The-Numbers

2 Canadian Provinces

3 deaths

8 U.S. states

12 airports closed

23 cases of looting in Ottawa

100 power plants

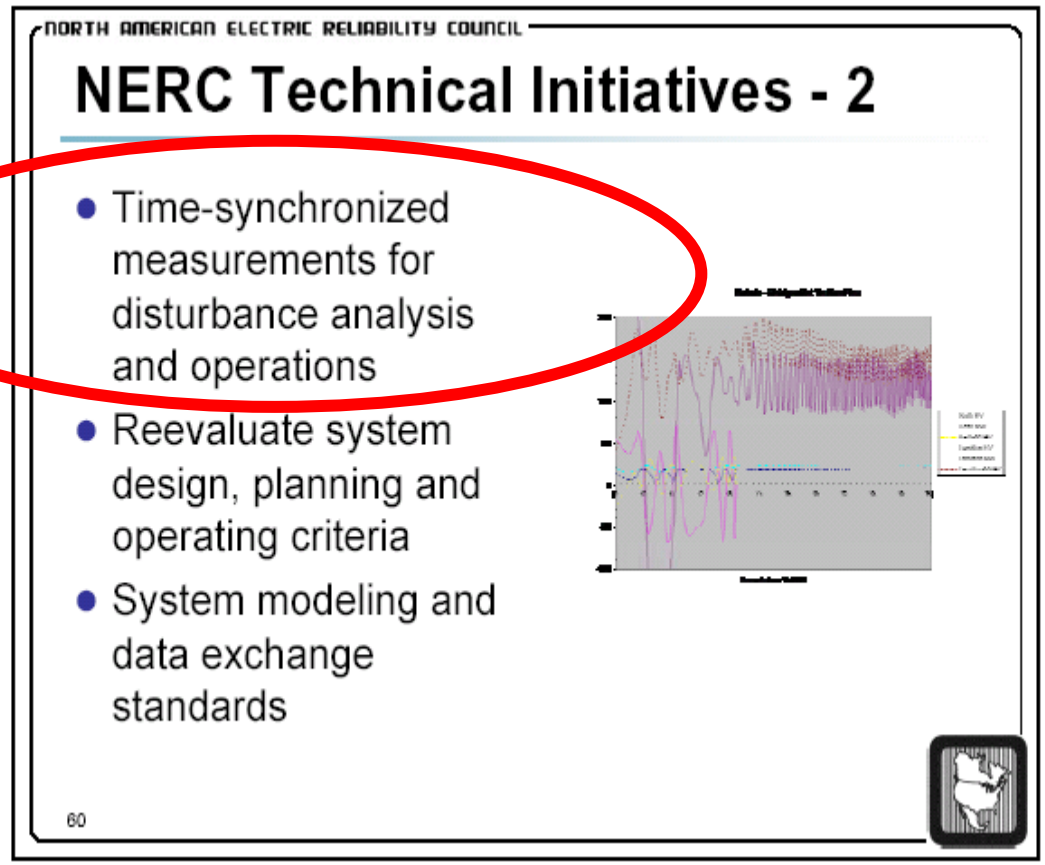
9,266 square miles

61,800 MW of power lost

1.5 million Cleveland residents without water

50 million people

$4-6 billion in economic activity lost



PSGuard: Risk Management System for the Transmission Grid

Target:
Early warning system against instabilities leading to blackouts

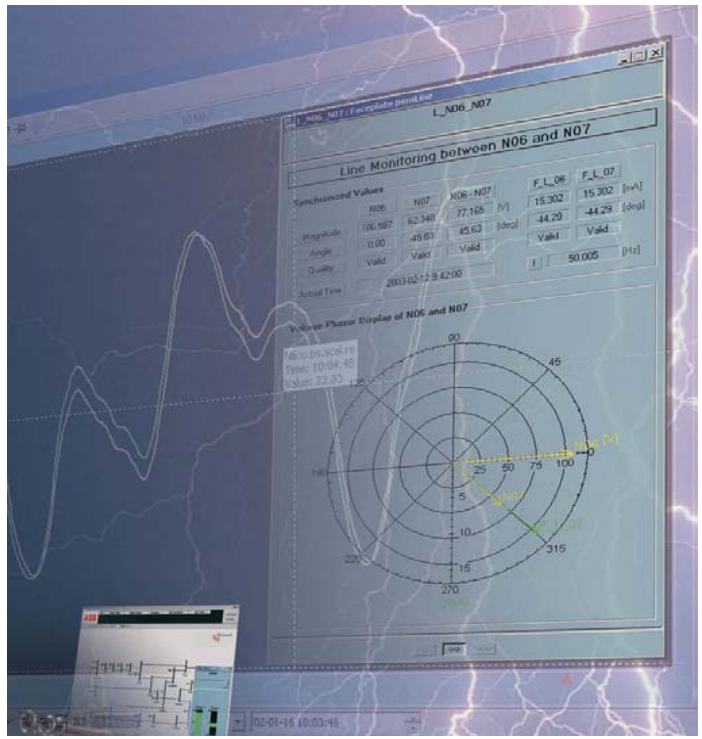
Function:
Dynamic monitoring of transient safety- and stability margins

Benefits:

- Safe temporal enhancement of line transmission capacity
- Detect uprising instabilities due to abnormal Voltage-, Frequency- or Thermal line conditions
- Enable to start effective countermeasures in time
- Stop cascading domino effects
- Avoid blackouts or spreading of failures

Blackout ?

PSGuard - Wide Area Monitoring, Control & Protection System



PSGuard