Power Grid Monitoring and Controlling

Xianping HONG

East China Power Grid
East China Electric Consulting Co., Ltd

September 6, 2007
NASPI Meeting in Montreal Canada
Introduction – China Power Industrial

Why WAMAP

WAMAP System Requirements

WAMAP System Specifications

WAMAP Features & Comparisons

Conclusion
China power industrial has the fastest growth in the world.

By the year 2010, the total installed generating capacity will reach 862GW;

By the year 2020, it will be 1,324GW.

*Took over 100 years, China got its first 100GW generate capacity.*

Just took one year, in 2006, China gained 110GW installed capacity.
new development

The world first 1,000kV AC and 653km transmission line was operated since Aug, 2006 in China. It includes three substations and a double transmission line with 5 million kVA power capacity.

It connects North China Grid to Central China Grid. The cost was over 6 billion RMB.
-- New development

By the end of 2010, China State Grid will add 1,000kV transmission lines with 4,200 km and 9 substations with total capacity at 39 million kVA.

By the year 2020, China will install interstate, super high voltage power transmission line with load capacity over 200 GW. It will be 15% of the nation’s total Installed units.
**New development**

The model ±800kV DC transmission line project was launched by China State Grid in May 2007. It brings the power over 2,000km and cross 8 provinces from Sichuan in south-west of China to Shanghai in east China. It is projected to be done in the year 2012.

The maximum transmission capacity is 7,000MW. It costs over 18 billion RMB.
WAMAP -- Wide Area Monitoring Analysis Protection and controlling system

What WAMAP does:

- To meet today’s high standards of power safety requirements
- Total solution for large scale power grid
- 3-state data acquisition platform
- Dynamic database design
- System analysis and online decision-making
- Online fault-simulations
How it was built:

A large scale R&D project -- WAMAP

Five years of research and development (2002 – 2007)

Hundreds of engineers were involved in WAMAP

- 9-2002 to 9-2003 System define and Study
- 10-2003 to 9-2004 Initial design and detail design
- 6-2004 to 7-2005 Phase-1 developing and FAT
- 8-2005 to 3-2006 Past RTDS test
- 11-2004 to 12-2005 PMU installation
- 4-2006 to 9-2006 Phase-1 field setup and SAT
- 1-2006 to 10-2006 Phase-2 development and FAT
- 10-2006 to 3-2007 Final phase-2 installation and SAT
- 6-2007 Phase-3 finalizing in Jiangsu, a sub grid of ECG
People who was involved in WAMAP Project

East China Gird Company (ECG)
East China Electric Consulting Co., Ltd. (ECEC)
Nanjing Automation Research Institute (NARI)
East China Electric Information Engineering Co., Ltd.
NARI Technology Development Co., Ltd. (NARI TECH)
China Electric Power Research Institute (EPRI)
Beijing Sifang Automation Co., Ltd
East China Electric Power Test & Research Institute
Shanghai Jiao-Tong University

And

ABB, Alston, SEL, WESCON (involved in WAMAP RTDS test)
1 Introduction – China Power Industrial

2 Why WAMAP

3 WAMAP System Requirements

4 WAMAP System Specifications

5 WAMAP Features & Comparisons

6 Conclusion
The **tremendous growth** of China’s power system requires a high reliable power system which has become a major challenge for the power engineers of China.

The East China power Grid (ECG) covers four provinces and Shanghai city which are the **most developed regions** in the country. In this region of 471,400km², the land is only 4.8% of the nation’s total, it creates over 30% of the GDP of the country.
• Since 2006, ECG has become the world 2nd largest wide area power grid with maximum power load of over 100,000 MW after US PJM Company. In this summer ECG’s peak load has reached over 120,000 MW.

• By the end of 2006, ECG boosted 500kV transmission lines with 15,600km, and 60 substations of 500kV with total capacity of 95 million kVA.

• In an increasingly complex power system as well as the ever greater demands in a market-driven environment in East China, power blackout prevention has become a major concern by the power companies and the government.
By the end of 2006, the total installed capacity of power generation units in ECG has achieved 152GW.

The power that was supplied by the outside of region through 500kV DC transmission lines was accumulated up to 34.5 billions kWh in 2006.

Fossil power, 80.0%
Hydro power, 10.1%
Gas turbine, 4.8%
Nuclear, 2.7%
Pump storage, 2.1%
Wind mill, 0.3%
1 Introduction – China Power Industrial
2 Why WAMAP
3 **WAMAP System Requirements**
4 WAMAP System Specifications
5 WAMAP Features & Comparisons
6 Conclusion
The WAMAP system requirements are:

1. To monitor and acquire steady state data as well as dynamic and transient states data.
2. To analyze the dynamics of a power system so that it can provide a decision-making assistance as well as prevention control assistance.
3. To generate a fast fault-analysis report and support an online decision making assistance.
4. To monitor the quantity and quality of the add-on services of power market.
1 Introduction – China Power Industrial
2 Why WAMAP
3 WAMAP System Requirements
4 WAMAP System Specifications
5 WAMAP Features & Comparisons
6 Conclusion
WAMAP System Configuration

WAMAP

- Dynamic system applications support
- Human-machine interface and control network
- Triple states data management platform
- Hardware interface and platform

Stability and control equipments
EMS/SCADA
Protect device
fault recorder

DDN Network
PMU
PMU
PMU
PMU
WAMAP System Software Configuration
WAMAP System Key Technical Specification

- System Processing Capacity: 5,000 bus points and 200 cases in 3 minutes per cycle.
- CPU power: Parallel processing method with 32 CPUs.
- SCADA/EMS Sampling Rate: 12,500 points, 2 min per cycle.
- CIM file communication format between ABB-EMS and WAMAP system.
- PMU transmission speed: 25 to 100 frame per second.
- PMU data memory storage capacity: 14 days.
Three phases in system development

• **Phase I**, the main focus is on building the system’s platform, the distribution of the PMUs, and the acquisition of the dynamic real-time data of the power system.

• **Phase II**, is based on the acquired dynamic real-time data, an algorithm is designed to analyze rotor angle, voltage, and frequency stability of the power system.

• **Phase III**, is an online safety evaluation and control are executed.
In Phase I,

*The main focus is on the data acquisition, offline analysis and simulation.*

2. Fast real-time fault analysis and intelligent alarm system based on the PMU information.
3. Detailed fault analysis based on the integrated power grid information.
4. Add-on service for power quality monitoring.
5. Low Frequency Oscillation (LFO) online monitoring.
6. Simulation modeling and parameter validation.
In Phase II,

1. Integration of the State Estimation method (SE) with the PMU data
2. LFO analysis.
3. Online analysis and projections for rotor-angle, voltage, frequency, safety, and stability.
4. Online monitoring for power transmission.
5. Modeling and parameter checking.

• In addition to the monitoring of the dynamics, the safety, and the stability of a power system, the WAMAP system provides prevention and alarm controls for a power system.
In Phase III,

The main focus is on the implementation of the control functions.

1. To make an online dispatching adjustment by using the “Real-Time Prevention and Control Strategy Table”. The order is sent to the related generators via the AGC system and to the security control equipment.

2. To control the rotor angle of the local Power System Stabilizer’s (PSS) in order to eliminate LFO.

3. To provide a wide area protection control.

4. To provide some assistance for post-contingency decision-making.
ECG PMU Installation Status

- 40 sets PMU have been installed in power plants & substations of ECG.
- The information over 150 PMU’s from four provinces will be integrated into ECG’s WAMAP system in the near future.
GUI-1, WAMAP User Interface (App. Layer)

Power Plant Wiring Map
Geography Flow
System Config. Map
PMU Map
Data Acquisition
Dynamic Monitoring
Fast Fault Analysis
Detail Fault Analysis
Turbulence Recognition
Tri-state Database management
Quality Evaluation
LFO Monitoring
Safety & Stability Decision Maker
State Analysis
V/F Dynamic Evaluation
System Order Monitor
East-China Grid WAMAP System Application Man – Dynamic Monitoring

- Generator Monitoring
  - Rotor-angle Monitoring
  - Rotor-angle Over Limit Monitoring
- Power Monitoring
  - Power for line with PMU
  - Line Power Monitoring
- Frequency Monitoring
  - Frequency Monitoring
  - Sub System Frequency Monitoring
- Line Monitoring
  - Line-angle Monitoring
  - Line Power Over Limit Monitoring
  - Line Voltage Monitoring
  - Related Angle Over Limit Monitoring
- Bus Monitoring
  - Bus Voltage Monitoring
  - Voltage Over Limit Monitoring

All Angle Display
GUI–3, Fast On-Line Fault Analysis

Progressing control
Enable Fault Analysis
Pause Fault Analysis

Fast On-Line Fault Analysis Flowchart

Front Devices
Get SOE data
Recall PMU
Collecting PMU
Real-time Data
High Speed Data Buffer

Analysis App.
Alarm App.
Fault Report
Waveform Access
SOE Data Access
Fault Event Logging

Enable Reporting
Result
Save
Fault Report,
Storage Device
Sequencing Files

Detail Analysis
Modeling simulation

Fast On-line fault analysis in progress...
500KV Line Fault due to “SONWEI” Typhoon in FuJian, June 2006

GUI – 4A, Example of Fault Analysis

**PMU COMM. Statistic**

**Peak Report**
GUI – 4B, Example of Grid Turbulence Identification
GUI -5，Add-on Services for Power Quality Monitoring

East-China Grid WAMAP System Application Maun – Add-on Services for Power Quality Analysis

1st F-Turning
- Generator Operation status online monitoring
  - 机组运行状态在线监视
  - 机组一次调频动作情况
  - 机组一次调频后计算
- One time F-Turning Monitoring
  - F-Turning History Data

2nd F-Turning
- Generator AGC Monitoring
  - 机组AGC调节性能在线监视
  - 机组AGC调节性能事后计算
  - 机组AGC调节性能历史查询
- AGC Post Calculation
  - AGC History Data

After F-Turning Recalculation
- Grid Frequency Characteristic
  - Grid Frequency Characteristic Monitoring
    - 电网自然频率特性在线监视
    - 电网自然频率特性事后计算
    - 电网自然频率特性历史查询
  - Grid Natural Frequency Characteristic Post Analysis
    - 电网自然频率特性历史查询
  - Grid Natural Frequency Characteristic History Data Access

Frequency Point Monitoring
- Grid Frequency Turbulence
  - History Data Access
GUI – 6A, Example of Frequency Monitoring of a Power Plant

**Name of Power Plant**

(ZQNGJ) 强蛟电厂 ZQNGJ2002FGEN

<table>
<thead>
<tr>
<th>Start Time</th>
<th>End Time</th>
<th>Frequency Error</th>
<th>Delay Time</th>
<th>Frequency Deviation</th>
<th>Total Time</th>
<th>Frequency Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007/08/19 10:14:25</td>
<td>2007/08/19 10:15:15</td>
<td>6.9%</td>
<td>0.0 s</td>
<td>0.049 Hz</td>
<td>0.0 s</td>
<td>0.033 Hz</td>
</tr>
</tbody>
</table>

**Recent Data Log**

<table>
<thead>
<tr>
<th>Start Point</th>
<th>Frequency Value</th>
<th>Output Value</th>
<th>Frequency Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>49.992 Hz</td>
<td>502.5 kVA</td>
<td>-0.037 Hz</td>
</tr>
<tr>
<td>32</td>
<td>49.944 Hz</td>
<td>508.5 kVA</td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>49.947 Hz</td>
<td>509.7 kVA</td>
<td></td>
</tr>
<tr>
<td>44</td>
<td>49.955 Hz</td>
<td>509.0 kVA</td>
<td></td>
</tr>
</tbody>
</table>

**Graph**

- **Frequency Reading**
- **1st Frequency Turning Data Log**
Location: Luo-He power plant in Anhui
Event Log: 600MW 4# generator was shut down.
WAMAP Monitors the responses of the regulation of excitation system of generators.
GUI–7,  Frequency Quality Monitoring

自然频率特性事后计算

<table>
<thead>
<tr>
<th>联结点</th>
<th>F reading Power Exchange</th>
<th>F reading Power Exchange</th>
<th>F reading Power Exchange</th>
</tr>
</thead>
<tbody>
<tr>
<td>浙江–江苏</td>
<td>214.9</td>
<td>-191.7</td>
<td>23.1</td>
</tr>
<tr>
<td>浙江–福建</td>
<td>341.4</td>
<td>-401.0</td>
<td>-53.1</td>
</tr>
<tr>
<td>浙江–安徽</td>
<td>182.6</td>
<td>-53.5</td>
<td>129.2</td>
</tr>
<tr>
<td>上海–江苏</td>
<td>115.6</td>
<td>-132.4</td>
<td>16.8</td>
</tr>
<tr>
<td>上海–福建</td>
<td>228.7</td>
<td>-196.5</td>
<td>32.2</td>
</tr>
<tr>
<td>上海–安徽</td>
<td>100.6</td>
<td>-151.6</td>
<td>50.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Zhejiang-Shanghai</th>
<th>Initial Power Exchange</th>
<th>Final Power Exchange</th>
<th>Diff.</th>
</tr>
</thead>
<tbody>
<tr>
<td>浙江–上海</td>
<td>-115.6</td>
<td>-132.4</td>
<td>16.8</td>
</tr>
<tr>
<td>浙江–江苏</td>
<td>-214.9</td>
<td>-191.7</td>
<td>23.1</td>
</tr>
<tr>
<td>浙江–福建</td>
<td>-341.4</td>
<td>-401.0</td>
<td>-53.1</td>
</tr>
<tr>
<td>浙江–安徽</td>
<td>-182.6</td>
<td>-53.5</td>
<td>129.2</td>
</tr>
</tbody>
</table>

总换功率

TaiHua Power

总换功率变化

TaiHua Power

功率损失

TaiHua Power

江苏

安微

浙江

上海

福建

直属

ECG's plant

F ULian

54.4

4.2

2007/03/04 (20:53:23)

监测时间

21.0 s
GUI–9，Low Frequency Oscillation (LFO) Analysis

LFO Event Analysis 低频振荡案例分析

LFO Event View LFO Event Select 低频振荡事件选择

Current LFO Event Data 本事件高频振荡主要信息

- 起始时刻: 2007/03/02 11:01:00
- 终止时刻: 2007/03/02 11:03:00
- 持续时间: 2分40秒
- 最大值: 0.0, 0.0
- 最小值: 0.0, 0.0

Main Frequency in LFO 主频率在低频振荡

Main oscillation model trend 主模型趋势

Time Start Time Finish Time Interval +Peak -Peak
Ex. Report: Integration of the State Estimation (SE) with PMU data

<table>
<thead>
<tr>
<th>Load flow</th>
<th>5905 line active power</th>
<th>5905 line reactive power</th>
<th>5915 line active power</th>
<th>5915 line reactive power</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCADA (Normal)</td>
<td>-143.2</td>
<td>-84.1</td>
<td>-241.6</td>
<td>-53.0</td>
</tr>
<tr>
<td>SE (Normal)</td>
<td>-136.3</td>
<td>-90.0</td>
<td>-239.0</td>
<td>-43.0</td>
</tr>
<tr>
<td>SCADA (Err. Introduce)</td>
<td>-200</td>
<td>-120</td>
<td>-320</td>
<td>-80</td>
</tr>
<tr>
<td>SE (Err. Introduce)</td>
<td>-169.2</td>
<td>-95.0</td>
<td>-268.5</td>
<td>-47.0</td>
</tr>
<tr>
<td>SE with PMU (weight factor = 0.01)</td>
<td>-157.0</td>
<td>-93.0</td>
<td>-260.2</td>
<td>-44.2</td>
</tr>
<tr>
<td>SE with PMU (weight factor = 1.00)</td>
<td>-138.7</td>
<td>-93.2</td>
<td>-241.0</td>
<td>-47.0</td>
</tr>
</tbody>
</table>
GUI–10, Turbulence Online Identify – Cut off test on 600MW Generator

Turbulence Info.

Device ID # Date / Time

Turbulence Type

Cut off Turbulence

V (Phase-A)
- A相电压
- B相电压
- C相电压

V (Phase-B)
- A相电压
- B相电压
- C相电压

V (Phase-C)
- A相电压
- B相电压
- C相电压

I (Phase-A)
- A相电流
- B相电流
- C相电流

I (Phase-B)
- A相电流
- B相电流
- C相电流

I (Phase-C)
- A相电流
- B相电流
- C相电流
GUI–11, Turbulence Online Identify -- Short Circuit in a 500kV Line

<table>
<thead>
<tr>
<th>Device ID #</th>
<th>Turbulence Info.</th>
<th>Turbulence Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>设备: 5115</td>
<td>时间: 2006/10/25 15/19/35:520</td>
<td>类型: 短路扰动</td>
</tr>
<tr>
<td>录波文件:</td>
<td>Date / Time</td>
<td>Short Circuit</td>
</tr>
</tbody>
</table>

- **V (Phase-A)**
- **V (Phase-C)**

- **I (Phase-A)**
- **I (Phase-B)**
- **I (Phase-C)**
GUI–12， Online Safety Analysis Based On V & F

V & F Dynamic Safety Estimation

Voltage and frequency dynamic safety estimation

Voltage and frequency minimum safety gap curve

Voltage Safety Limit

F Safety Limit

Copyright www.ecpgc.com
GUI-13, Online Safety Margin Analysis for Bus Voltage

BUS Voltage Safety Estimation

<table>
<thead>
<tr>
<th>Bus name</th>
<th>Area</th>
<th>Safety Status</th>
<th>Safety gap%</th>
<th>Threshold</th>
<th>Time Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>200201</td>
<td></td>
<td>电压安全</td>
<td>87.70</td>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>JJL102</td>
<td></td>
<td>电压安全</td>
<td>91.78</td>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>200201</td>
<td></td>
<td>电压安全</td>
<td>90.22</td>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>ZZL5001</td>
<td></td>
<td>电压安全</td>
<td>82.42</td>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>JJL102</td>
<td></td>
<td>电压安全</td>
<td>94.01</td>
<td>0.75</td>
<td>1.00</td>
</tr>
<tr>
<td>Z20020101</td>
<td></td>
<td>电压安全</td>
<td>94.08</td>
<td>0.75</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Copyright www.ecpgc.com
GUI-14, Online Safety Margin Analysis for Bus Frequency

BUS Frequency Safety Estimation

<table>
<thead>
<tr>
<th>Bus name</th>
<th>Area</th>
<th>Safety Status</th>
<th>Safety gap%</th>
<th>Threshold (Hz)</th>
<th>Time Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (ALH) 武汉电厂</td>
<td>安徽</td>
<td>频率安全</td>
<td>77.81</td>
<td>45.00</td>
<td>0.50</td>
</tr>
<tr>
<td>2 (JNH) 嘉兴变电站</td>
<td>江苏</td>
<td>频率安全</td>
<td>77.88</td>
<td>45.00</td>
<td>0.50</td>
</tr>
<tr>
<td>3 (JNJ) 浙江电力</td>
<td>浙江</td>
<td>频率安全</td>
<td>70.02</td>
<td>45.00</td>
<td>0.50</td>
</tr>
<tr>
<td>4 (FAG) 杭州变电站</td>
<td>浙江</td>
<td>频率安全</td>
<td>70.03</td>
<td>45.00</td>
<td>0.50</td>
</tr>
<tr>
<td>5 (QSY) 青海变电站</td>
<td>青海</td>
<td>频率安全</td>
<td>70.07</td>
<td>45.00</td>
<td>0.50</td>
</tr>
<tr>
<td>6 (JTV) 云南省电</td>
<td>云南</td>
<td>频率安全</td>
<td>70.11</td>
<td>45.00</td>
<td>0.50</td>
</tr>
</tbody>
</table>
GUI – 15, Real-time Alarm for Safety and Stability

Steady state Safety

 transient state Safety

Transparent state Security

Sensitive results

Critical result

Steady state Security

Transient state Security

Sensitive results

Critical result

Steady state Security

Transient state Security

Sensitive results

Critical result
GUI – 16, Online Evaluation of Active Power Limitation on Steady State Voltage Stability

Steady State Safety Stable Limitation

System Status: Safe

Border Name | The current flow | Line Limit | High Line Limit | Descrip: High Line Limit | Line Limit Description
---|---|---|---|---|---
1 | 上| 887 | 1200 | 1200 | 上线正常，设置为高线限的1.05倍
2 | 1024 | 975 | 1024 | 0.975 | 1024
3 | 1024 | 975 | 1024 | 0.975 | 1024
4 | 1104 | 1950 | 1500 | 1950 | 1104
5 | 1950 | 1950 | 1950 | 1950 | 1950
6 | 2400 | 2400 | 2400 | 2400 | 2400
8 | 3000 | 3000 | 3000 | 3000 | 3000
1 Introduction – China Power Industrial
2 Why WAMAP
3 WAMAP System Requirements
4 WAMAP System Specifications
5 WAMAP Features & Comparisons
6 Conclusion
From the user perspective,

The WAMAP system provides:

• A Multi-States Data Management Platform which consists of dynamic data from PMUs, steady data from EMS, and transient state data from the reaction of protection devices.

• An online prevention strategy and an emergency control strategy by using a rapid data processing and analysis.

• An add-on system service tool package for the power market such as the monitoring of frequency, voltage, and the evaluation of power plant contract execution.

• A rapid safety margin analysis of a power system.

• An efficient utilization of the transmission capacity and the generation capacity of a power system in order to meet economic interest of power companies.
Overall, *WAMAP vs. WAMS*

- WAMS monitors system dynamics and logs data. In contrast to the SCADA system (in which only the steady state is monitored), WAMS made some improvement by the inclusion of system dynamics monitoring.
- WAMS analyzes only the transient states data provided by the independent protection device. As a result, the simulation of a power system is based only on a real local operation environment.
- The WAMAP system, however, advances its capability significantly over WAMS. Its goal is to achieve a power grid protection over a wide area. This is achieved by including all condition simulation of the power system, with its human-machine interface.
- WAMAP is a next generation system for power grid monitoring and controlling after WAMS.
<table>
<thead>
<tr>
<th>Function</th>
<th>WAMAP</th>
<th>WAMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Acquisition</td>
<td>3 States</td>
<td>Dynamic state only</td>
</tr>
<tr>
<td>Multiple States Data Management</td>
<td>Uniform timestamp and Management</td>
<td>NO</td>
</tr>
<tr>
<td>Characteristics of Online Analysis (Angle, frequency, voltage)</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Assistance for post-contingency decision-making</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>On-line fault prevention and emergency control strategy</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Fault finding and locating</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Offline power system simulation model and parameter checking</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Damping control and other process control</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Online check of power system modeling parameters</td>
<td>YES</td>
<td>NO</td>
</tr>
</tbody>
</table>
WAMAP’s Foundation: Triple state Data Platform

WAMAP uses all 3 kinds of information

- Transient information
- Steady information
- Dynamic information

WAMAP
The data platform of WAMAP
## The Triple-State Data Type

<table>
<thead>
<tr>
<th>Device</th>
<th>Type of Data Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>PMU</td>
<td>Vector, state and wave records</td>
</tr>
<tr>
<td>SCADA/EMS System</td>
<td>Remote data, tele-signalization data, network and component modeling parameters.</td>
</tr>
<tr>
<td>Integrated Protection Relay Management System</td>
<td>Protection configuration, On/Off status, operation data, operation current and voltage, wave records.</td>
</tr>
<tr>
<td>Stability Control Devices</td>
<td>Configuration and operation information.</td>
</tr>
<tr>
<td>Fault Waveform Recording Devices</td>
<td>Recording fault current and voltage waveform.</td>
</tr>
</tbody>
</table>
Data sharing issue is resolved by WAMAP data management platform

When a problem occurs, the PMU real-time data acquisition unit shall be invoked to collect data such as frequency, voltage, current, active power, reactive power and switch status. At the same time, all of the action information from fault protection device, recording devices, auto-protect switches, and other stable control devices will be recorded and transmitted to the analysis center.

To power system researchers, the sharing of information from different time, different devices, states and areas is always an important topic. An additional benefit of a WAMAP system is that it is built to resolve this “critical” data sharing issue by using a unique data management platform.
The main functionality of the WAMAP’s data management platform includes:

- Collecting,
- Logging,
- Sorting,
- Categorizing
- Real-time data Processing for all three states

Using these data, the WAMAP system will be able to perform system protection estimation, Sequence of Event (SOE), Post Disturbance Record (PDR), analysis of fault process, modeling and parameter checking as well as stability margin calculation
1 Introduction – China Power Industrial
2 Why WAMAP
3 WAMAP System Requirements
4 WAMAP System Specifications
5 WAMAP Features & Comparisons
6 Conclusion
How to do? what to do?

--- the most difficulties in five years of WAMAP development.

1, No idea, Thinking hard In the WAMAP beginning stage.
--- After 1 year WAMAP system study, we divided project to phase-1,2,3

2, Difficult to finalize WAMAP system requirements
--- After 2003 North America blackout, our goal is confirmed.

3, Big challenge in testing
--- Spent great effort to complete dynamic simulations, functional test, as well as the system level test. The same tests were repeated for multiple times.

4, The Interface issue was often a problem during integration
--- Issues are in the data sharing, communication within EMS, protection device, data acquisition and data logging devices.

5, Management challenges
--- “wide area grid” project needs “wide area” management method. A lot push, a lot patience and proper orders as well as rewards.
Conclusion - 2

ECG Control Center

Dynamic data from field

ECG Headquarter in Shanghai

Master station computer Room
Conclusion - 3

Design begin meeting >

< System Planning meeting

< Phase-1 Detail Design Meeting

< Problem Solving and Discussion

Final stage WAMAP Design Meeting

V
Conclusion - 4

Meeting for finalizing of system design phase

WAMAP Feasibility Discussion Meeting

Project Contract Meeting with suppliers
Engineers in WAMAP Project Development
WAMAP System Application Function
RTDS Test

2005.7.15--7.29
1st RTDS test
2005,10.8--10.22
2nd RTDS test
2006.3.8—3.28
3rd RTDS test
WAMAP System Developments in China Power Grid

The WAMAP system of East-China is operating and stepping ahead in the China

- 6 systems in progress
- 8 systems in beginning stage
WAMAP, National wide Recognition

- Prize Award, Advanced Science and Technology in Electric Power, Society of Electrical Engineering, China (CSEE)
- 1st Place Prize Award, Advanced Science and Technology, China State Grid (CSG)
- 1st Place Prize Award, Advanced Science and Technology, East China Grid (ECG)
Conclusion

• Without a system-level data platform and the capability to analyze the triple-state data, our power system is not a robust system.

• Based on its unique “Triple-State Data Management Platform”, the WAMAP system is capable of a wide area power grid monitoring and control. It uses today’s the most advanced technologies to gather steady-state, dynamic-state, and transient-state data in order to provide a complete protection of a power system.

• The WAMAP system is currently being developed by the power engineers of East China Power Grid Co. The first two phases have been completed and it is now in its third phase. The system was able to detect LFOs in its early stage. In many cases, its online fault-simulators have prevented wide area power outages with satisfactory preliminary results.
Ms. Xianping Hong

- East China WAMAP project Manager
- CEO, East China Electric Consulting Co., Ltd
- Member of IEEE
- Member of the standing council of Shanghai Society of Electrical Engineering (SSEE)
- Member of the standing council of Shanghai Electro-technical Society (SES)
- The council Member of Shanghai Women Engineers Association (SWEA)
- Graduated from the Electrical Engineering Department of Shanghai Jiao-tong University in 1982.
Welcome to ECG & Welcome to Shanghai, China

Thank You!

If any questions, please contact me at
hong_xp@ec.sp.com.cn

Xianping HONG, CEO

East China Electric Consulting Co., Ltd

http://www.ecec.sh.cn; www.ecpgc.com