The Trend of Power Quality Management

by ABB Power Management System (PMS)

by Wai Tai Yeap

Power & productivity for a better world

ABB Leader in power and automation technologies
Background

- **Wai Tai Yeap** –
  - Manager, PMS / ABB Industry Pte. Ltd. Singapore
    - SGIND is part of the global PMS application execution centre.
  - Six years experience in power and energy management solution
  - Industry experience including commercial power plant, petrochemical plant including fertilizer plant, refineries and LNG plant
Terminology for Power Management System

- **PMS** – Power Management System
- **LMS** – Load Management System
- **PDCS** – Power Distributed Control System
- **ECS** – Electrical Control System
- **ECSS** – Electrical Control & Supervisory System
- **ENMC** – Electrical Network Monitoring & Control System
- **ELICS** – Electrical Integrated Control System
- **IPCS** – Integrated Protection & Control System
Power Management – Introduction (1)

What ? Why?
- The control of electrical switchgear and equipment
- To optimise electricity generation and usage and to prevent major disturbances & plant outages (blackouts)

Where is it required?
- In plants with a substantial electrical load
- In plants with major electricity generation facilities
- In cases where there is no or a poor grid supply or the need to limit imported power
- In the context of
  - a green-field installation
  - a major extension or modification of a brown-field plant
In which industries?

- Oil and Gas – Onshore & Offshore
  - Onshore Production
  - Offshore Platforms and FPSO (Floating Production Storage & Offloading)
  - Refineries
  - LNG Complexes

- Petrochemical plants

- Large Industrial Complexes
  - Pulp & Paper Plants
  - Cement Plants
  - Metal & Mining Plants
Business Drivers for PMS

- Prevention of Blackouts
- Reduction of Energy Costs
- Reduction of Investment Costs
- Reduction of Operational Costs
- Environmental, Health & Safety (EH&S) Risk Management
Operational Drivers for PMS

- Critical loads
- Limited in-plant generation
- Insufficient reliability of grid supply
- Several generators
- Power-sharing with other plants/sites
- Different electrical operational configurations possible
- Generation & distribution networks
- “Local only” control facilities

Load Shedding
Power Control
Mode Control
SCADA
Main Application Areas in O&G Supply Chain
Typical Integrated Electrical System
Typical Electrical Network Monitoring System

- 22 kV
- 6.6 kV
- 400 V
Fast Functions are performed by Controllers:

- Load Shedding / Re-Acceleration / Re-Starting
- Power Control
- Mode Control

Substation N

S800 I/O

Serial links to AVR
Serial links to Governor
Serial Links to Emergency Diesel Generator

VFD

Control Network
TCP/IP Network

Server
Operator Station
Engineering Station

Remote Users
Plant & Enterprise Management Systems

Substation 1
Substation 2
Substation N
Substation Z
Power Management Functionality

- Load Shedding
- Active and Reactive Power Control
- Mode Control
- SCADA & Integration
- Re-Acceleration / Re-Starting
- Synchronisation
ABB’s Starting-point for Load Shedding

- Secure electrical power to critical loads
- Minimal disturbance to plant operation
- No spurious operation

Diagram:

- Secure electrical power to critical loads
- Minimal disturbance to plant operation
- No spurious operation
Load Shedding – The types

- Load shedding on loss of power resources
- Load shedding on frequency drop
- Load shedding on components overload
- Load shedding on peak shaving
Load Shedding – How should it work?

- Monitor available power generation in relation to consumption
- Monitor power flow in relation to capability of the components
- Shed load to avoid
  - Black-outs
  - Damage to the equipment
Fast Load Shedding – How should it work?

- Initiate on trip of a critical signal
  - Generator breaker
  - Bus coupler
  - Inter tie-line breaker
  - Lock out protection

- Based on power balance calculation
  - \[ \text{Total } P_{\text{generation}} + P_{\text{spinning reserve}} \geq \text{Total } P_{\text{load}} + P_{\text{inhibit}} \]
Power Management Functionality

- Load Shedding
- Active and Reactive Power Control
- Mode Control
- SCADA & Integration
- Re-Acceleration / Re-Starting
- Synchronisation
Active and Reactive Power Control

- Coordinated Control of Power Generation
- In island operation:
  - Maintain system frequency
  - Maintain system voltage
- Connected to grid:
  - Control active power exchange
  - Control reactive power exchange
- Share active & reactive power among the machines:
  - Participation factors
  - Efficient power generation optimization
  - Spinning reserve optimization
  - Stand by optimization
Power Management Functionality

- Load Shedding
- Active and Reactive Power Control
- Mode Control
- SCADA & Integration
- Re-Acceleration / Re-Starting
- Synchronisation
Mode Control

- for Generators
- for Turbines
- for Transformers
- for Switchboards
Power Management Functionality

- Load Shedding
- Active and Reactive Power Control
- Mode Control
- SCADA & Integration
- Re-Acceleration / Re-Starting
- Synchronisation
Supervision, Control and Data Acquisition

- Clearly Structured Presentation
- Controls - Select Before Execute
- Status Indications
- Consistency Analysis
- Time Tagged Events (1 ms resolution)
- Alarm handling, Reports, Trends
- Supervision and Self Diagnostics
- Single Window concept
Integration with Supervisory Systems

- Plant Information Systems - MIS
- Regional Dispatch Centres
- Power Generation Co-ordination Centres
- Energy Trading
- Utility Management Systems
- Process DCS
Integration with Subordinated Systems

- Satellite Time Receiver (GPS)
- Alarm annunciations
- SF-6 Density Monitoring Units
- Motor Control Centres
- Battery Chargers
- Meteorological Stations
- Diesel Generators
- Generator- and turbine controller
- Protection and Control Units
Integrated Protection & Control Units

- Protection
- Measuring of U,I,E,
calculation of P & Q
- Monitoring & Control
- Interlockings
- Alarm annunciation
- SOE Recording
- Disturbance Recording
- Protection Parameterization
- Power Quality and Transient Analysis
Power Management Functionality

- Load Shedding
- Active and Reactive Power Control
- Mode Control
- SCADA & Integration
- Re-Acceleration / Re-Starting
- Synchronisation
Re-Acceleration / Re-Starting

- Triggered by Load Shedding or Under-voltage
- Individual motors
- Priority per motor
- Max. allowed time delay per motor
- Network configuration check
- Network restoration
Power Management Functionality

- Load Shedding
- Active and Reactive Power Control
- Mode Control
- SCADA & Integration
- Re-Acceleration / Re-Starting
- Synchronisation
Synchronisation

- Synchronization for closing:
  - Bus tie breakers
  - Generator main breaker
  - Grid incomer breaker
  - Network breaker

- Operator interface to select of variables, U-Var side for matching the voltage and frequency phase with reference U-Ref side
ABB Industrial IT PMS allows you to:

- **Avoid black-outs (up to 500 kUSD / hour)**
  - Power control including voltage control, frequency control, sharing power among generators and tie-line(s).
  - High Speed Consistency Load Shedding (< 100 ms.)

- **Reduce electricity costs**
  - Peak-shaving
  - Re-active Power Control & Sharing

- **Minimize maintenance costs**
  - Optimize resource utilization
  - Event driven maintenance
  - Single Window concept

- **Reduce investment costs**
  - Minimized cabling and engineering
  - Optimized network design
Differentiators

- In-depth knowledge of the electrical process
- 20 years experience in PMS implementations across the world since 1986
- Standard software, well documented, tested,
- Global support through various Main Execution Centers
- Based on state-of-the-art Industrial IT System 800xA technology
- Advanced technical features, including:
  - Fast Response Time for Load Shedding, Mode Control, Power Control, Re-acceleration
  - High Resolution and Accuracy of Sequence of Event recording
  - Compliance to class 3 EMC immunity
- Single responsibility: One supplier for PMS integrated with: protection, governor, excitation, tap-changer, Motor Control Centre, Variable Speed Drive, etc.
Industrial\textsuperscript{IT} PMS Application Areas

- Offshore Platforms & FPSO
- Refineries
- LNG Complexes
- Large Industrial Complexes
ABB delivers Industrial IT solution to the Statoil Hammerfest, Norway LNG Plant

ABB Helps Statoil Set New Records with Europe’s First LNG Facility

A competitive multi-scope delivery by ABB that seamlessly integrates Automation and Safety system, Power Distribution Control system, Power Management system, Electrical Equipment, Field instruments, and Analyzers. ABB’s Industrial™ systems and equipment put Statoil operators and engineers in complete control of the new energy efficiency benchmark for LNG plants.

Client: Statoil
Location: Melkøya island, Norway
Scope of Work: Safety and Automation System, Power distribution control system, power management systems, operator and engineer stations, training simulator

Competitiveness is a matter of keeping your price at the most competitive level, but also demonstrating the capacity and skill set, competence, and solutions to provide us with a professional deliver. We felt comfortable with ABB’s ability.

Ole Hausken,
Senior Advisor for Statoil’s Hammerfest LNG plant
ABB delivers Industrial IT solution to the Sakhalin II LNG Plant, Russia

ABB Leads Telecom and Electrical Project for World’s Largest LNG Plant

The world’s largest LNG processing plant is being built in an extreme environment with a multicultural work force, under complex regulations. But ABB’s experts are used to such challenges. That’s why SEIC chose ABB to provide the telecommunications and electrical distribution systems.

Client: Sakhalin Energy Investment Company Ltd.
Location: Russia’s Far East – Sakhalin Island
Scope of Work: Telecommunication and Electrical distribution equipment, engineering, installation, testing

“ABB is responsible for all telecommunications equipment for the project on a turnkey basis... ABB has always remained focused and dealt with the challenges, and in the process has forged successful partnerships with Russian companies.”

Ian Johnston, Telecommunications Project Manager, SEIC “We were able to win the client’s confidence because we provided one window for them to all of ABB’s global abilities and responded with fast feedback on any inquiries they had.”

Hugh Clayton, Vice President of Process Automation at ABB K.K.
ABB’s Unified Integration Approach

- **Vertical Integration**
  - Faceplates
  - Asset Monitors
  - Historical Data Collection

- **Engineering / Commissioning**
  - Diagnostics

- **Application integration**
  - Peer-to-peer communication

---

IEC 61850

- AIS
- GIS
- HV

Profibus...

- MV Switchgear
- MV Drives
- Distribution transformer
- LV Switchgear
- Drives
- LV Products
- Remote I/O
- Proxies to other buses
- Profibus
- others
- Valves
- Instrumentation

Substation

- Power Distribution
- Low Voltage Distribution
- Process Control
- Instrumentation

© 2008 ABB
Background – What is IEC 61850?

- IEC 61850 is a global standard for “Communication Networks and Systems in Substations”
- “How to make different devices from different vendors work together (interoperability)“
IEC 61850 Functional Level

- Data in monitoring direction
- Commands in control Direction
- SNTP Time synchronization
- Parameters settings
- Disturbance recording
- Network redundancy
- Horizontal Communication (GOOSE)
GOOSE Messaging

GOOSE: Generic Object Oriented Substation Event
IEC61850 for Electrical Integration

IEC61850

Benefits:
- Standard protocol for medium and high voltage switchgear and protection
- Interoperability between IED’s (Intelligent Electrical Devices)
- High Performance
- Increased Diagnostics

Power Management Application

Benefits:
- Avoid black-outs
- Reduce energy costs
- Minimize operational costs
- Energy optimization
General System Topology

Client/Server network
- Aspect Server
- Controller Connectivity Server

Control network
- IEC61850 network
- Time server (GPS/SNTP)
- 61850 GOOSE

IEC61850 Connectivity Server
- 61850 MMS

Engineering tools

External Clients
- Firewall

Features:
- Generator Protection, Transformer Protection, MV / HV Switchyard, Excitation, Synchronization