Market Systems in North America

- Major electricity markets in North America:
  - Nodal markets
    - New York ISO – Day ahead and Real time market – ABB delivered Market System and AGC for both ISO and one market participant NYSEG (Binghamton, NY)
    - California ISO – Real time market (Day ahead will be implemented by 2009) – ABB delivered Market System and AGC for CAISO (Folsom, California)
    - PJM – ABB delivered Participant AGC for EXCELO Power ((Kenneth Square, PA), Reliant Energy (Houston, TX) and PEPCO (Washington, D.C.)
    - MISO – ABB delivered Market Participant AGC to Indianapolis Power & Light (Indianapolis, IN), Vectren (Evansville, IN), DTE Energy (Detroit, MI)
  - Zonal market
    - ERCOT (will become a nodal market in 2009) – ABB is delivering Market system and has delivered Market Participant AGC to Reliant Energy (Houston, TX), Austin Energy (Austin, TX), Lower Colorado River Authority (Austin, TX), Suez Energy (formerly Tractebel, Houston, TX), Exelon Power Team (Kennett Square, PA), NRG Texas (Houston, TX), CPS Energy (San Antonio, TX)
Network Manager System

- Deregulation in US created need for GMS systems
- Companies like Exelon and Reliant Energy have generation assets that participate in multiple markets
- Each market is similar but with some unique requirements
- This created new requirements
  - AGC, ED, Performance/Ancillary Service Monitoring,
  - Market System Interface
  - Energy Scheduling and Accounting
  - Resource scheduling to determine plans for submittal to ISOs
NYISO AGC – Input Data

- ADI Value
- ADI Time Stamp
- Generator Static Response Rate Data
- Frequency Measurements
- Generating Unit MW Measurements and Connectivity Statuses
- Tie Line Primary and Alternate MW Measurements
- Interruption Load Reserve Contributions
- RTD Unit Base Points, Limits and Statuses
- Security Constraint Flags
- 60-Minute DNI Profiles
- Export-As-Reserve Contribution
- Net Interfaces
- SAR MW Offsets
- Global ADI Enable/Disable Flag
- Control Area ADI Enable/Disable Flag for NYISO
- Display and Control Inputs
- Unit Islanding Data
- Calculated TIE Line Flows
- State Estimator
- Network Analysis
- AGC Operator
- MIS
NYISO – Participant AGC overview

- Unit Desired Generation
- Unit Telemetry
- ICCP
- ACE Calculation
- Unit Control Mode
- Unit Basepoint
- Unit Ramp Schedules

UDG Pass-through Mode

- Setpoint/Pulse Control Commands
- Unit Connection Status
- Unit Control Status
- Unit Output
- Unit Limits
- Unit Ramp Rates

NYISO

Participant AGC
AGC to Participant Interfaces

- **Real-time data transfers**
  - Market Participants assets to CAISO:
    - Unit MW and MVAR
    - Unit Breaker and Switch Status
    - Unit Operating Limits from plants
  - CAISO to Market Participants:
    - Unit Set point and Raise/Lower Controls sent using DNP with security
- **Secure communication**
  - Hardware certificates for authentication
  - Data transmitted using encryption
MISO Day 2 -- Overview
MISO Day 2 – Data Exchange

- The real-time data exchange with MISO is implemented via ICCP.
- The bidirectional XML Communication with MISO is managed by the Market Operation System (MOS).
- Most of the data exchange between the MOS and the Network Manager Applications functions is implemented via the Oracle-based Market System Interface (MSI) subsystem.
- The only exception to the above is the transfer of real-time data to MISO via the MOS:
  - Resource Energy Loading
  - Resource Ancillary Loading
AGC overview with interface to MISO

- Unit Basepoints (Backup source)
- Unit Economic Participation Factors

**Economic Dispatch**
- Island Data

**State Estimator**
- Tie Line MW Flow

**Control Area / MP AGC**
- Setpoint/Pulse Control Commands
- Unit Connection Status
- Unit Control Status
- Unit Output
- Unit Limits
- Unit Ramp Rates

**MISO**
- Schedules (CSV)

**ESA/TIM**
- NSI
- Unit Basepoints
- Unit LMPs (info only)

**ICCP/XML**

**Setpoint**
- ACE Calculation
- Unit Control Modes
- Unit Basepoints
- Unit Ramp Schedules
PJM -- Market Participant Overview

- Regulation MW
- Unit MW basepoints
- Prices $/MWh (info only)
- Measurements

RTDB
AGC
HIS
GMS

Oracle
Price Curves
Reserve Data

XML
Reserves
Schedule Offers

Oracle
MSI
AGC overview with interface to PJM

- Regulation MW
- Unit MW Basepoints
- Unit LMP ($/MWh) – for info only

Backup Mode, only when UDS signal is not available.

- Unit Telemetry
- Unit telemetry

Lambda Dispatch
- Unit Basepoints

Participant AGC
- Unit Connection Status
- Unit Control Status
- Unit Output
- Unit Limits
- Unit Ramp Rates

Setpoint/Pulse Control Commands

ACE Calculation
- Unit Control Modes
- Unit Basepoints
- Unit Ramp Schedules
PJM Data Exchange

Real-time data transfers (via ICCP):

- **PJM Data Sent to AGC**
  - AR Signal
  - Unit Base point (UDS Signal)
  - Unit Lambda Signal ($/MWH, for display only)
  - PJM Unit Mode
  - UDS On/Off Signal
  - Assigned Regulation per Unit
  - Zone Load
  - Zone Lambda (for backup price dispatch using unit price curves)
  - PJM ACE

- **AGC Data Sent to PJM**
  - Unit MW and MVAR
  - System Frequency
  - Unit Breaker and Switch Status
  - Calculated (TREG) Total Regulation on AGC control
  - Calculated (CREG) Current Regulation
PJM Data Exchange

- Market Participant-to-PJM data transfers (via Oracle and XML):
  - Reserve data
    - Operating Reserve
    - Normal Regulating Reserve
    - Spinning Regulating Reserve
    - Spinning Non-Regulating Reserve
    - Quick-Start Hydro Reserve
    - Quick-Start non-Hydro Reserve
    - Secondary Reserve
    - Beyond 30-min Reserve

- PJM-to- Market Participant data transfers (via Oracle and XML):
  - Unit Schedule Offers
    - Unit Price Curves
ERCOT Zonal -- Market Overview

SCADA

AGC / ED

Other GMS Apps

GMS

Balanced Schedules

Bids

A/S Awards

MOS

SQL/XML

Resource Plan

A/S Deployment

(Unit BES/DBES, NSRS, OOM)

Unit Actuals

HIS

Balanced Schedules

Bids & Queries

Awards & Mkt Info

DNP 3.0 + ICCP

DNP 3.0 + ICCP

Measurements

R-T A/S Deployment

(RGS+RRS)
ERCOT Zonal -- QSE Data Exchange

- Real-time data exchange with ERCOT is implemented via DNP 3.0 and ICCP
- Bi-directional XML Communication with ERCOT is managed by the Market Operation System (MOS)
- Most of the data exchange between the MOS and the Network Manager GMS Applications is implemented via the Oracle-based Market System Interface (MSI)
- An MSI program running on the MOS parses incoming XML files and copies their content to the Oracle DB on the GMS
The following tables are imported from the MOS:
- Ancillary Service Bids
- Balancing Bids
- A/S Obligations
- Balanced Schedules
- Deployments
- Resource Plan

Optional transfer mechanisms:
- Oracle-to-Oracle
- XML files
ERCOT Nodal -- QSE Data Exchange

- Real-time data transfers via ICCP:
  - ERCOT Data Sent to QSE *(per QSE)*
    - Regulation MW
    - RRS MW
    - NSRS off-line capacity deployment status
    - ERCOT Total Load
    - ERCOT Frequency
    - Participation Factor
    - Frequency Target
    - Governor Response
    - K Factor
    - $L_{10}$
ERCOT Nodal -- QSE Data Exchange

- Real-time data transfers via ICCP:
  - ERCOT Data Sent to QSE (per Unit)
    - Gen up block status (on/off)
    - Gen down block status (on/off)
    - Gen basepoint MW
    - Gen LMP
    - Gen BP above HASL due to AS deployment (on/off)
    - Gen BP above HASL due to congestion (on/off)
  - QSE Data Sent to ERCOT (per QSE)
    - Frequency (system)
ERCOT Nodal -- QSE Data Exchange

Real-time data transfers via ICCP:

QSE Data Sent to ERCOT (per Unit)

- Combined Cycle config no.
- Resource status
- Gen MW
- Gen MVAR
- Gen Breaker status
- Gen Hi Sustained Limit
- Gen Lo Sustained Limit
- Gen Hi Operating Limit
- Gen Lo Operating Limit
- Gen URS Schedule
- Gen DRS Schedule
- Gen RRS Schedule
- Gen NSRS Schedule
- Gen URS participation factor
- Gen DRS participation factor
- Gen RRS participation factor
- Gen Block URS status
- Gen Block DRS status
- Gen NRAMP
- Gen ERAMP
ERCOT Nodal -- QSE Data Exchange

- Real-time data transfers via ICCP:
  - QSE Data Sent to ERCOT (per Bus)
    - Gen DSR Basepoint
    - LAAR MW per bus
    - LAAR breaker status per bus
    - LAAR RRS schedule per bus
    - LAAR NSRS unavailable status per bus
    - Private network net interchange per bus
    - Private network net interchange Hi limit per bus
    - Private network net interchange Lo limit per bus
    - Status of devices affecting flow per bus
    - Unit Hi side bus KV per bus
1. Generation Control Functions
Multi-Markets / Multi-Areas / Multi-Time Zones

GMS

Centralized SCADA

GMS Applications:
- AGC, ED,
- Performance/Ancillary Service Monitoring,
- Market System Interface,
- Energy Scheduling and Accounting

Market A
- Area A1
- Area A2

Market B
- Area B1
- Area B2
- Area B3

Market Z
- Area Z1

Time Zone A

Time Zone B

Time Zone N

ISO/RTO’s

Market Operation System:
- Bidding and Settlement

Multi-Markets / Multi-Areas / Multi-Time Zones

Market Operation System:
- Bidding and Settlement

ISO/RTO’s
Multi-Area GMS Applications

- **Market A**
  - Area A1
    - AGC_A
    - ED_A
    - MSI_A
    - ESA_A
    - RS_A

- **Market B**
  - Area B1
    - Joint Dispatched w/ Zones B2&B3
  - Area B2
    - Joint Dispatched w/ Zones B1&B3
  - Area B3
    - Joint Dispatched w/ Zones B1&B2

- **NETWORK MANAGER DATABASE**
AGC for Multiple Markets / Control Areas

- One AGC task per market
- Fully customized to comply with the specific protocols of each market
- Each market has a separate data base
- Alarms/Displays must be separated for each market
- Each market resides in one time zone
- Functionality implemented on the following systems:
  - Reliant Energy
  - NRG LaGen
  - El Paso Electric
  - Suez Energy
  - Commonwealth Edison
  - PacifiCorp
  - DTE Energy
  - Exelon Power Team
  - NRG Texas
ED for Multiple Markets / Control Areas

- One ED task per market
- Each market has a separate data base
- Alarms/Displays must be separated for each market
- Each market resides in one time zone
- Each market may have multiple areas
- For multi-area dispatch, if the areas are physically connected, the transmission constraints (MW) and the associated price ($/MW) are considered in the optimization process