Energy Management Systems (EMS) Introduction

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Abstract

This talk deals with the role of an Energy Management System (EMS) in the overall Smart Grid. Why an EMS is needed will be discussed and its importance to the overall reliability and efficiency of the electric grid. The NERC operating regions will be explain as well as the NERC requirements placed on electric operating authorities. We will look at key operating functions such as monitoring and control, generation control, load forecasting, load balancing and the economic factors in generation and transmission of electricity. We will also discuss key security and reliability factors which must be maintained during normal and dynamic system operations. How operators are trained for all emergency events will also be discussed. Finally we will look at the future of EMS's and where the technology is going.

Why Do We need an EMS

What happens when you turn that light switch on?

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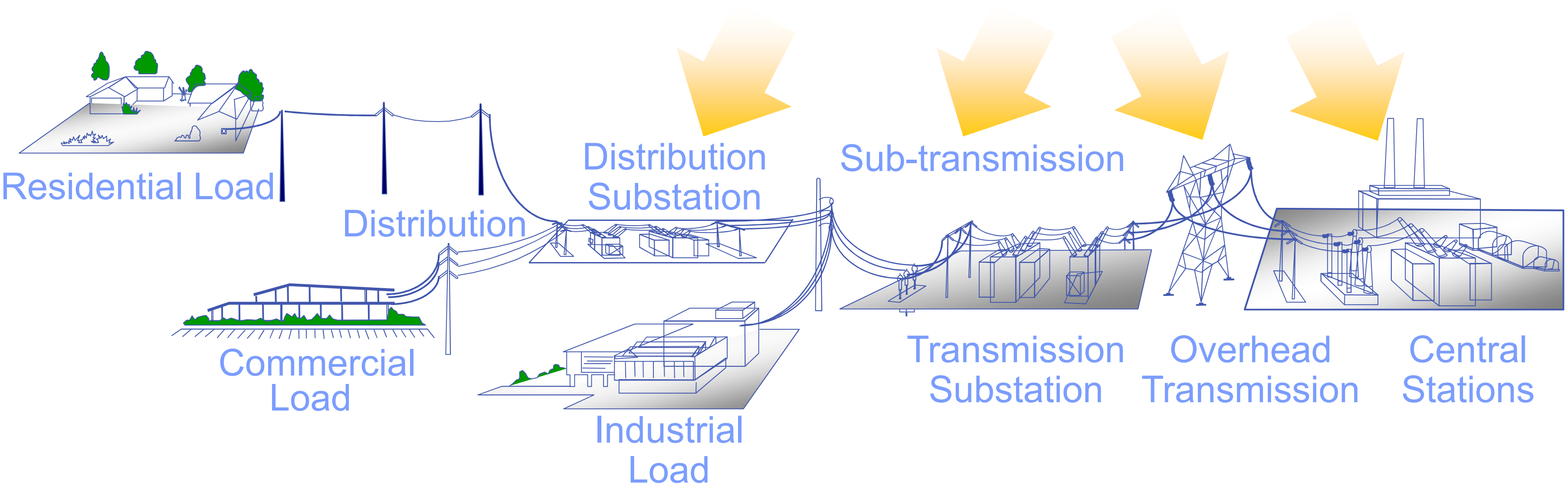
Where does an EMS fit in the network?

Transmission, Distribution, & Generation Customers

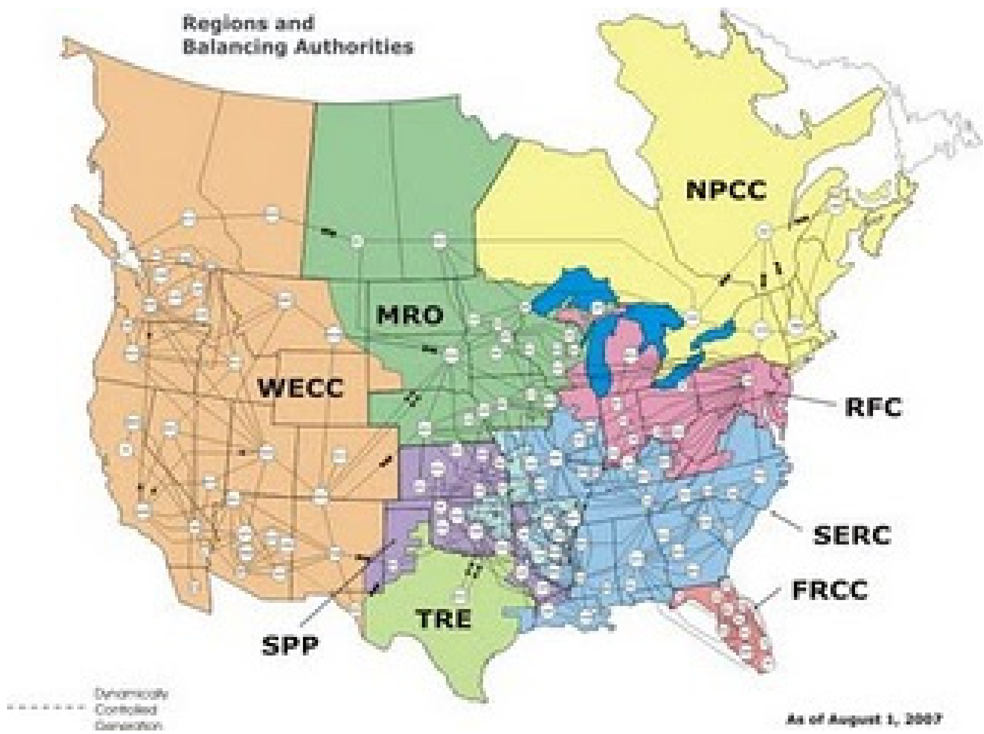
Distribution SCADA Systems

Generation Management Systems

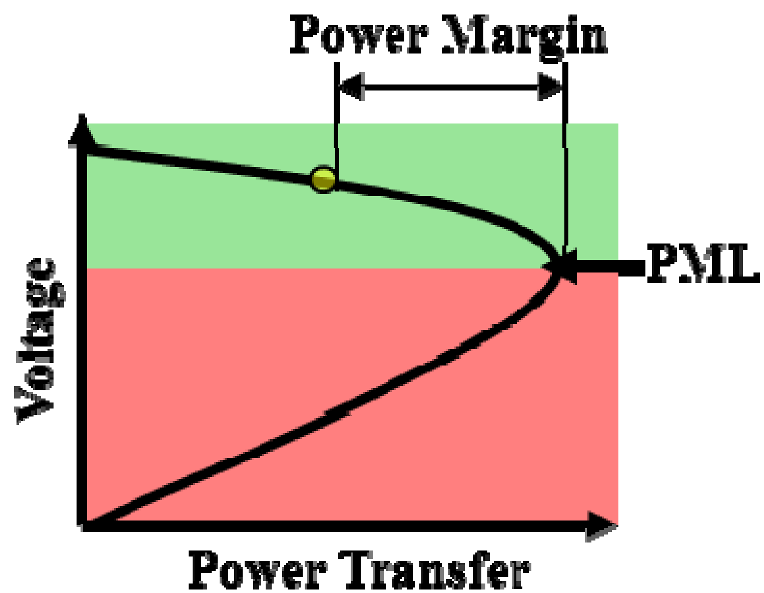
Energy Management Systems



NERC Region



Regions and Balancing Authorities
NPCC
MRO
WECC
RFC
SERC
FRCC
TRE
SPP
As of August 1, 2007



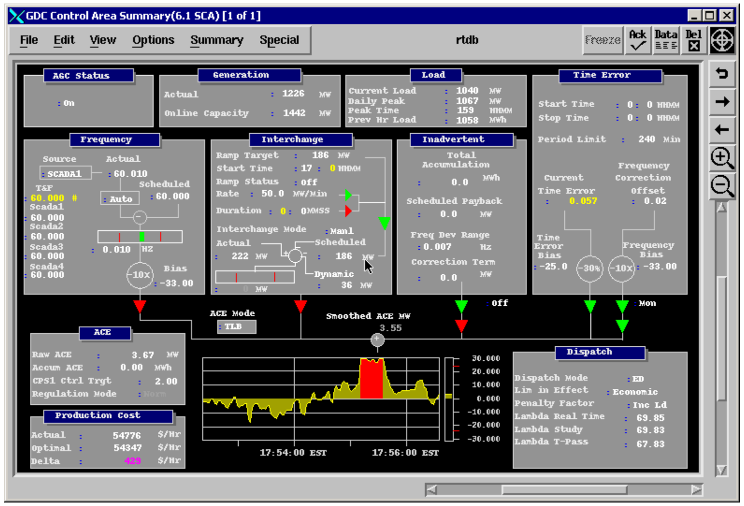
Power Margin
PML
Voltage
Power Transfer

Energy Management Overview

High performance, distributed, mission critical, control

Capability to monitor, control, and optimize the operation of geographically dispersed transmission and generation assets in real-time.

- Real-time SCADA Applications
- Generation Dispatch and Control
- Energy Scheduling and Accounting
- Transmission Security Management



EMS Application Description

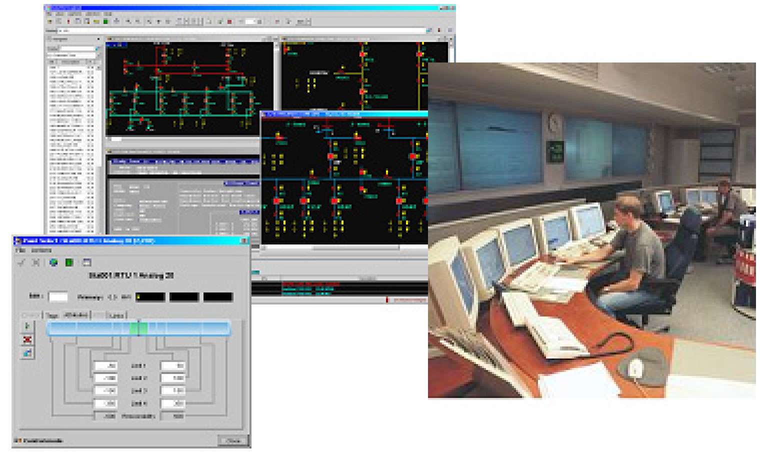
- **Real-time SCADA Applications –** Providing Supervisory Control and Data Acquisition including alarm/events, tagging, data historians, data links, control sequences, and load shed applications used to monitor/operate the network.
- **Generation Dispatch and Control -** GDC provides the functions required for dispatch and closed loop digital control of multiple generators in an economic fashion while adhering to NERC operating guides at the same time considering interchange schedules, dynamic schedules (load or generation in an out of the area), inadvertent interchange payback, time error correction, reserve requirements, and security constraints of the transmission network.
- **Energy Scheduling and Accounting –** ESA provides applications to monitor NERC reporting criteria, production costs, interchange scheduling, inadvertent interchange accounting, and weather adaptive demand forecasting.
- **Transmission Security Management –** TSM provides sophisticated applications to analyze and optimize the use of the transmission network in a reliable and secure manner.

Energy Management Systems (EMS) XA/21™

Need

Optimally manage transmission grid and energy generation in a reliable and secure manner:

- Increase overall transmission grid reliability proactively minimizing blackouts
- Meet stringent security requirements



Solution

- Comprehensive, Integrated, Secure Sys.
- "State of the Art" Generation Control and Transmission Security Applications
- Platform Independent User Interface
- Flexible Backup Control Center Options
- Dispatcher/Operator Training Simulator
- Long-Term "Evergreen" Solution

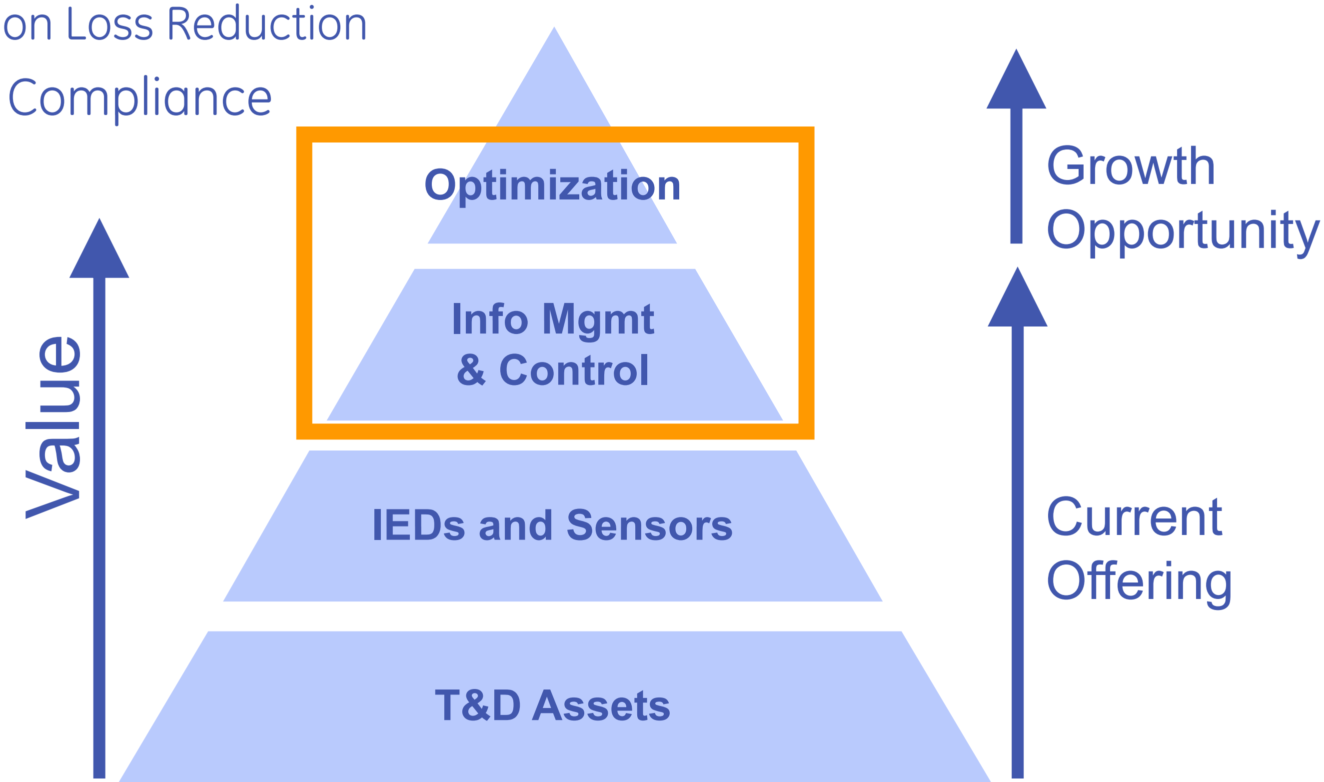
Benefits

- Improved Operational Security
- Improved Service Reliability
- Fuel & O&M Cost Reduction
- Transmission Loss Reduction
- Regulatory Compliance
- Deferred Capital Expenditure

EMS Vision

Optimise our customers' network performance by:

- Improved G&T Operational Security / Service Reliability
- Improving Operating Efficiency
  - Fuel & O&M Cost Reduction
  - Transmission Loss Reduction
- Regulatory Compliance



Transmission Security Management

State-of-the-Art Analytic Engines from Nexant/PCA

Network Topology Analysis

Load Flow

- Complete Study Capability Isolated From RT

Orthogonal Transformation-based State Estimator

- Status/parameter estimation, Plausibility Checks

Contingency Analysis

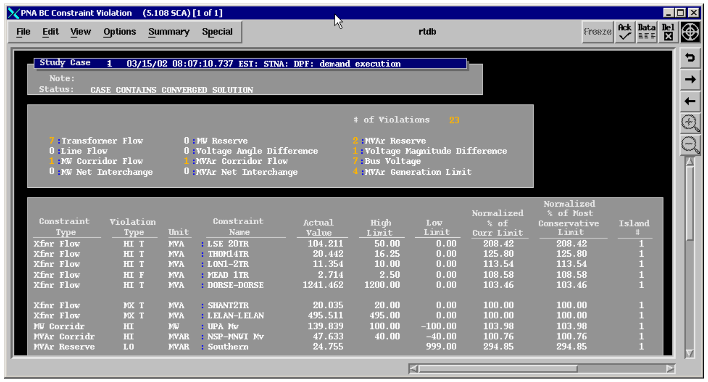
- Analyzes The Impact Of Possible Events

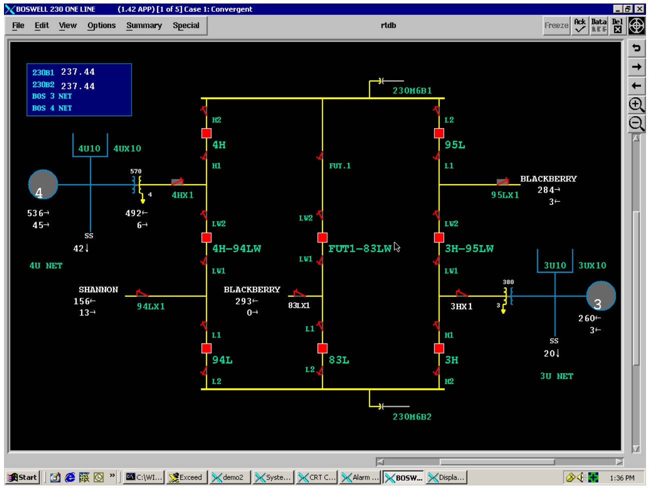
Successive LP-based Optimization

- Provides both active and reactive control movement strategies to relieve violations
- Contingency & Control Action Time Constraints

Real Time and Study Mode Suites

Multi-User Support - 10 cases (configurable)





Analyze and Optimize Utilization of Transmission Assets

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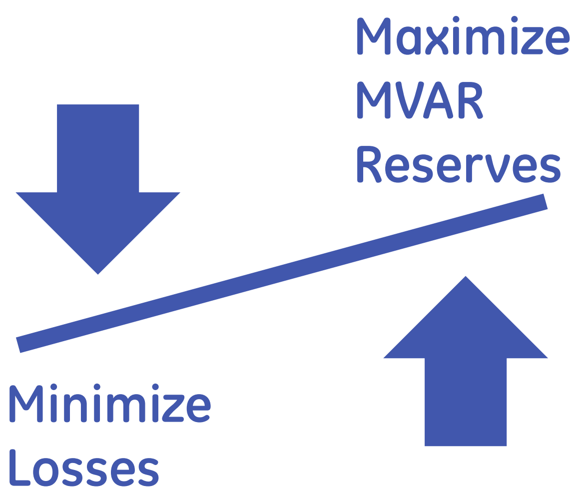
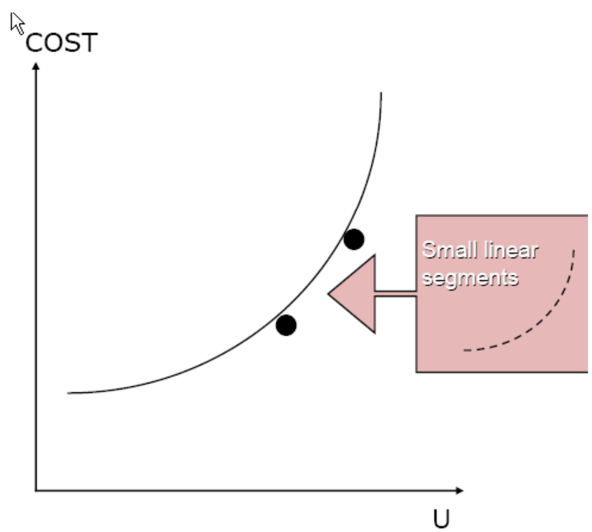
Security Constrained Optimal Power Flow

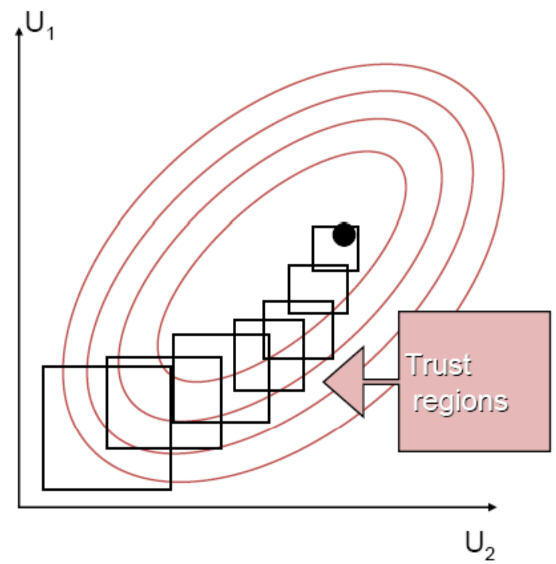
Objective function
Minimize
MW and MVAr losses
MVArs supplied/absorbed by generating units (i.e. maximize reactive reserves)
MVArs through network interfaces
Subject to
Power Flow Constraints

Algorithm

- MW and MVAr losses are non-separable and quite nonlinear
- Apply "cost curves" to gen MVArs, discouraging operation near limits
- Use **Successive LP** with special efficient piecewiselinearization techniques, iterated with accurate AC power flow







SCOPF (2)

SCOPF initial state (at ISO/RTOs) typically comes from the Day-Ahead "SCUC" (Security Constrained Unit Commitment) - optimal gen. schedules within grid thermal limits.

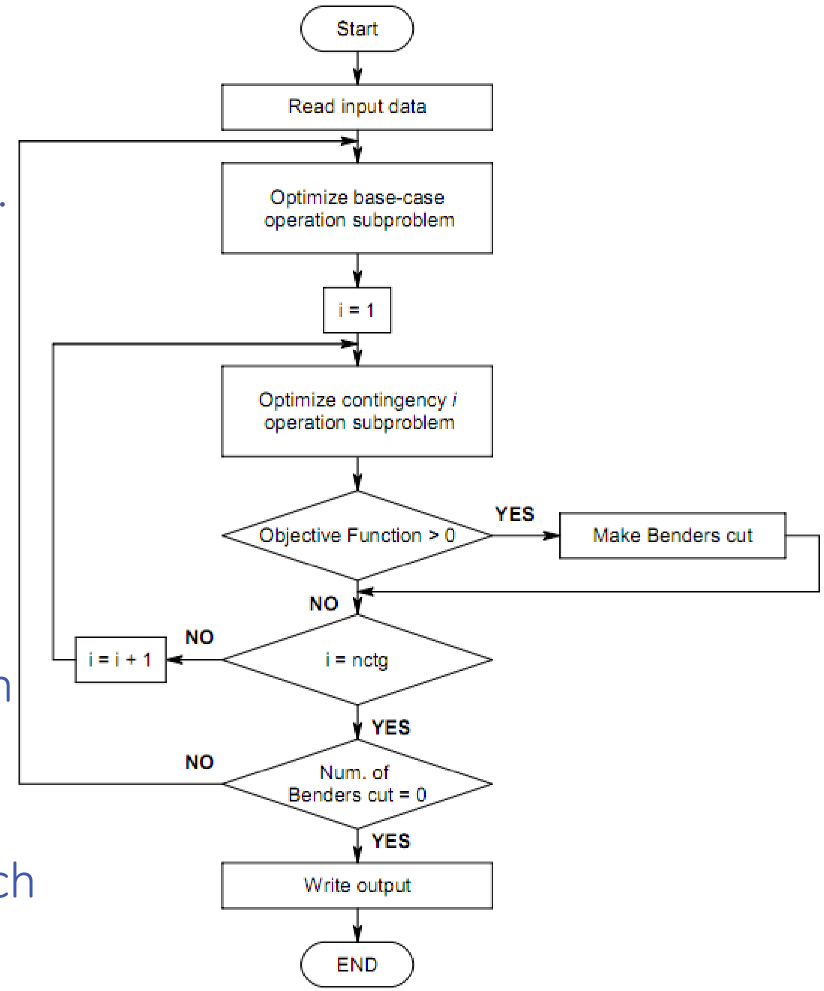
Inputs: SCADA measurements, load forecast, possible use of phasor data, contingency list

Control variables include:

- Regulated bus voltages
- Xfmr taps
- Switching for Cap banks
- Settings for phase-shifting devices

SCOPF is run in real-time (<10 minutes to solve) in "predictive mode" - suggests schedules for control variables to operators.

It is not run in an automatic post-contingency "corrective mode" - yet. Nexant doing research in this area.



Generation Dispatch & Control

Closed Loop Monitoring & Control of Generating Assets

Automatic Generation Control (AGC)

> ATE, TLB, CNI and CF Ace Modes

> CPS1 & CPS2 Control Criteria

> Multi-Area Support

> Jointly Owned Units

Generation Dispatch (GD)

> Economic

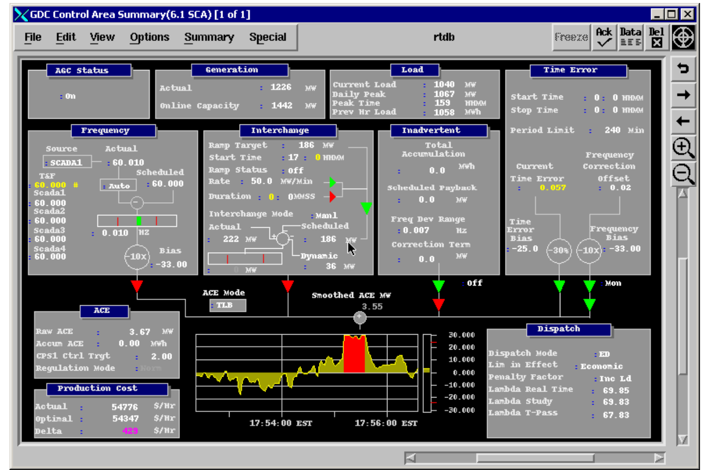
> Security Constrained (w/TSM)

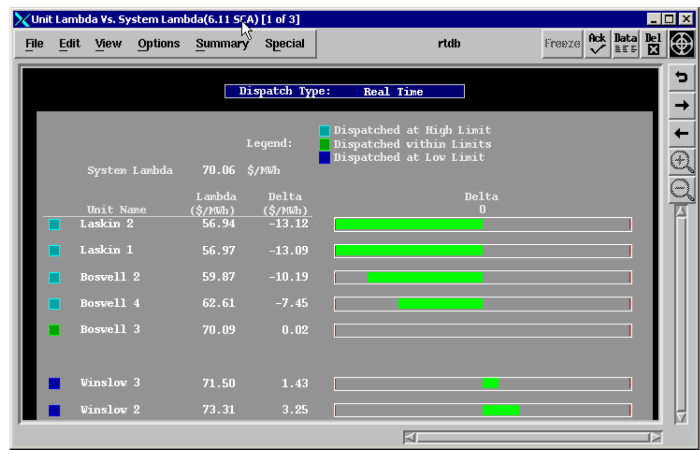
Reserve Monitoring (RMON)

> Time Limited

> Considers Role of Quick Start Assets

> Notifies Operator of Deficiencies





Meet Frequency and Interchange Obligations, Minimize Fuel-Related O&M

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Energy Scheduling & Accounting

Oracle Resident, Temporal Data Store

AGC Performance Monitoring (APM)

> Meets All NERC Reporting Criteria

Production Costing (PC)

> Complete Fuel, Maintenance and Transition Cost Accounting

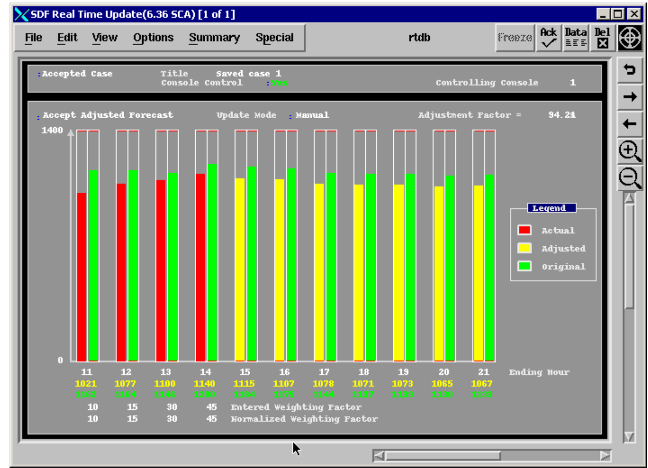
All GDC displays DCR driven

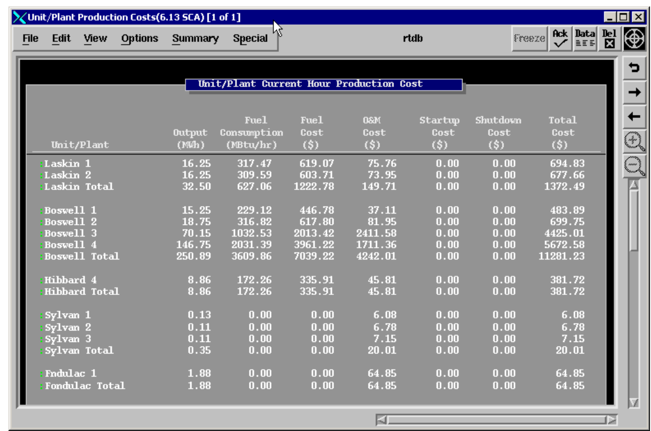
> Devices automatically added

External ISO interfaces

> Net Schedule interchange

> Generation Basepoints





Unit/Plant	Output (MWh)	Fuel Consumption (MBtu/hr)	Fuel Cost ($)	O&M Cost ($)	Startup Cost ($)	Shutdown Cost ($)	Total Cost ($)
Laskin 1	16.25	317.47	619.07	75.76	0.00	0.00	694.83
Laskin 2	16.25	309.59	603.71	73.95	0.00	0.00	677.66
Laskin Total	32.50	627.06	1222.78	149.71	0.00	0.00	1372.49
Boswell 1	15.25	229.12	446.78	37.11	0.00	0.00	483.89
Boswell 2	18.75	316.82	617.80	81.95	0.00	0.00	699.75
Boswell 3	70.15	1032.53	2013.42	2411.58	0.00	0.00	4425.01
Boswell 4	146.75	2031.39	3961.22	1711.36	0.00	0.00	5672.58
Boswell Total	250.89	3609.86	7039.22	4242.01	0.00	0.00	11281.23
Hibbard 4	8.86	172.26	335.91	45.81	0.00	0.00	381.72
Hibbard Total	8.86	172.26	335.91	45.81	0.00	0.00	381.72
Sylvan 1	0.13	0.00	0.00	6.08	0.00	0.00	6.08
Sylvan 2	0.11	0.00	0.00	6.78	0.00	0.00	6.78
Sylvan 3	0.11	0.00	0.00	7.15	0.00	0.00	7.15
Sylvan Total	0.35	0.00	0.00	20.01	0.00	0.00	20.01
Fndulac 1	1.88	0.00	0.00	64.85	0.00	0.00	64.85
Fondulac Total	1.88	0.00	0.00	64.85	0.00	0.00	64.85

Develop and Track Performance Against Short Term Operating Plan

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Operator/Dispatcher Training Simulator

Realistic, Steady State Simulation of the Electrical Network from the Perspective of the Operator

Same Application Software as Online System

> Database / Display Checkout

> Software Test Bed

Detailed Models

> Generation

> Load

> Frequency

> Network

> Relays

Instructor Interface

> Model Selection & Setup

> Pre-Scheduling of Events (including conditional)

> Run Time Changes to Scenario

Much More than a Tool for Training Operators

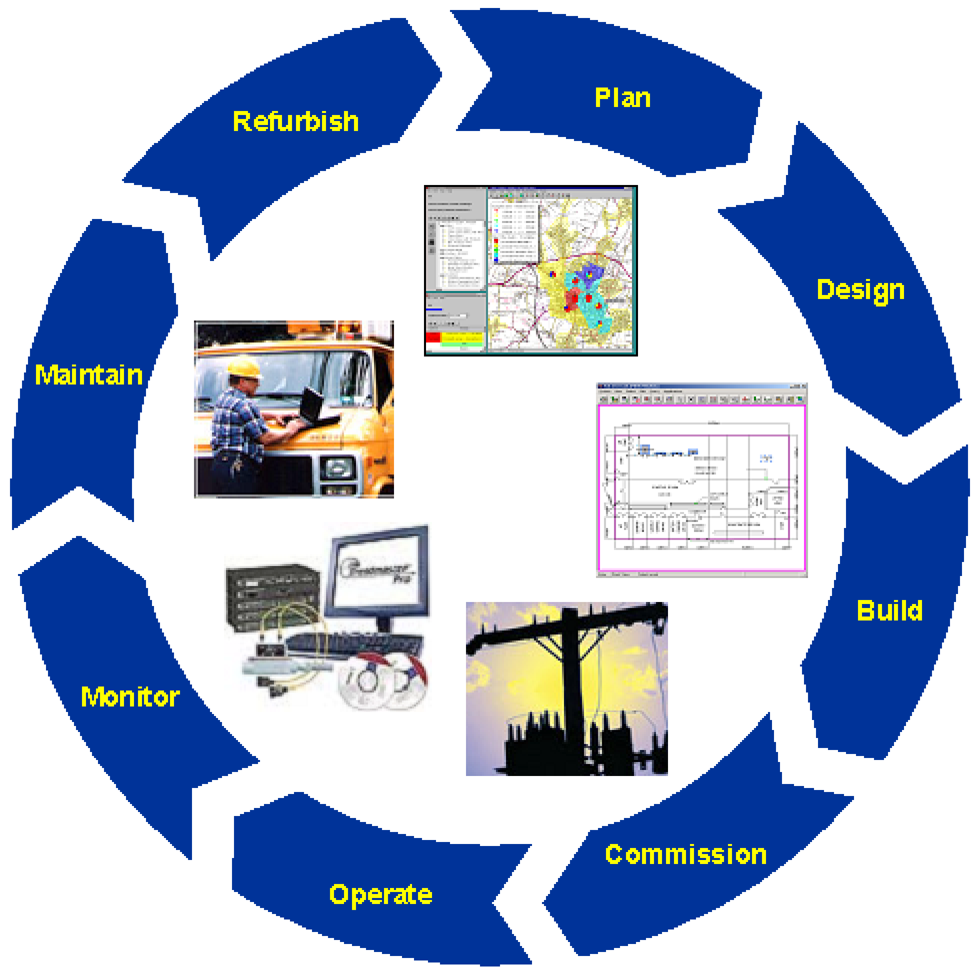
Where does the EMS fit in the network lifecycle?

Monitor: XA/21 SCADA and applications monitor the entire network.

Operate: Along with SCADA, transmission security management applications and closed-loop generation dispatch and control software help operate the network.

Maintain: Transmission switching applications coordinate maintenance activities with the control room operations.

Plan: XA/21 applications plan equipment outages and help determine optimal future asset placement for optimal network reliability.



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EMS Customer Value

- Improved Operational Security / Service Reliability
  - "State of the Art" Generation Control and Transmission Applications
- Fuel & O&M Cost Reduction
  - Economic and Security Constrained Dispatch
  - Unit Commitment / Transaction Evaluation
- Transmission Loss Reduction
  - Voltage/Var Scheduling
  - Transmission Loss Penalty Factors
- Regulatory Compliance
  - AGC Performance Monitoring
  - Energy Accounting
- Deferred Capital Expenditure
  - Optimal Use of Existing Assets

EMS…What Does The Future Hold

Demand Response & EMS integration

Renewables … forecasting & variability management

Integration of EMS with DMS

Growth of phasor analysis & Visualization

- Small Signal Analysis
- CRAS

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Backup Slides

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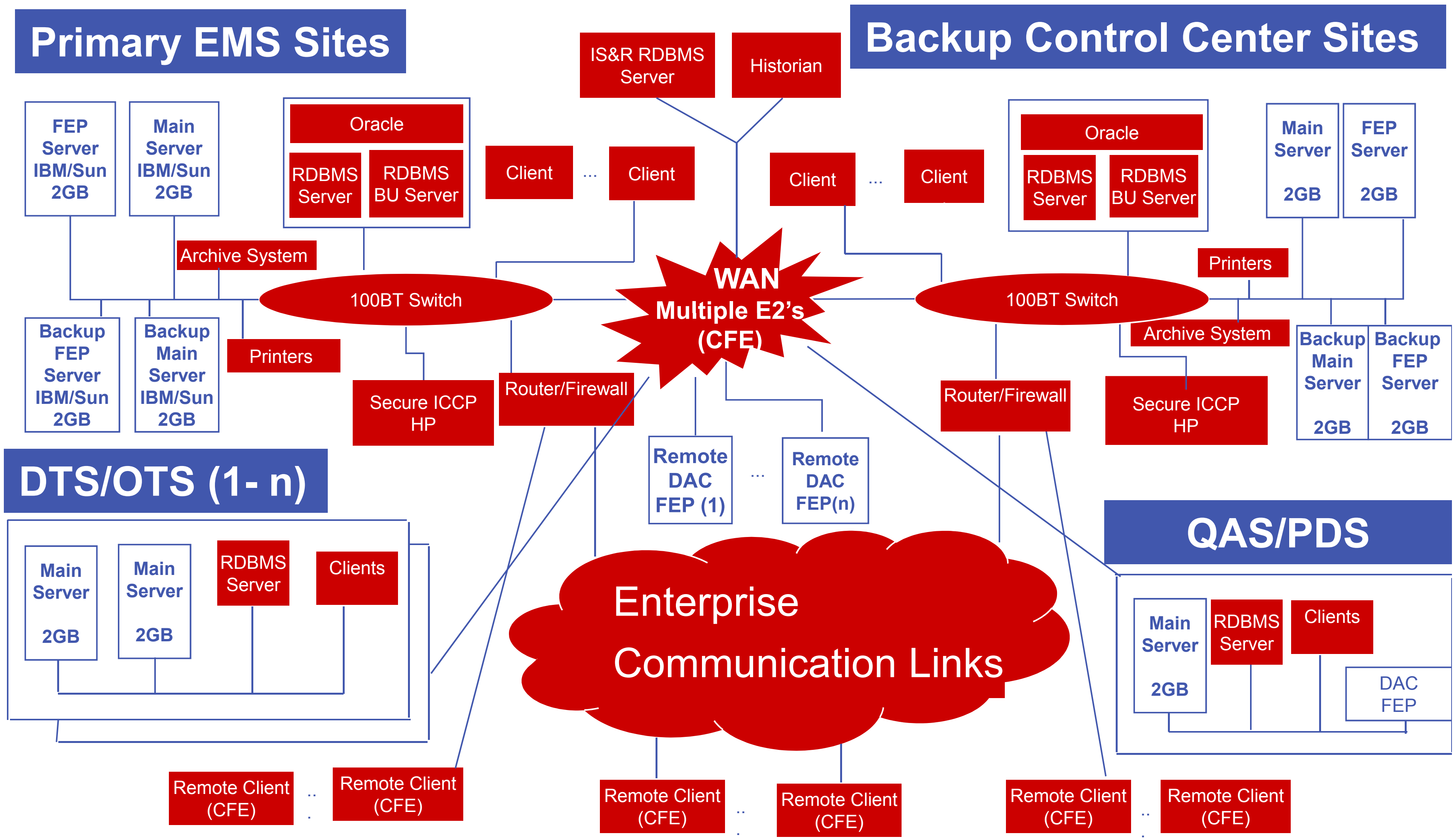
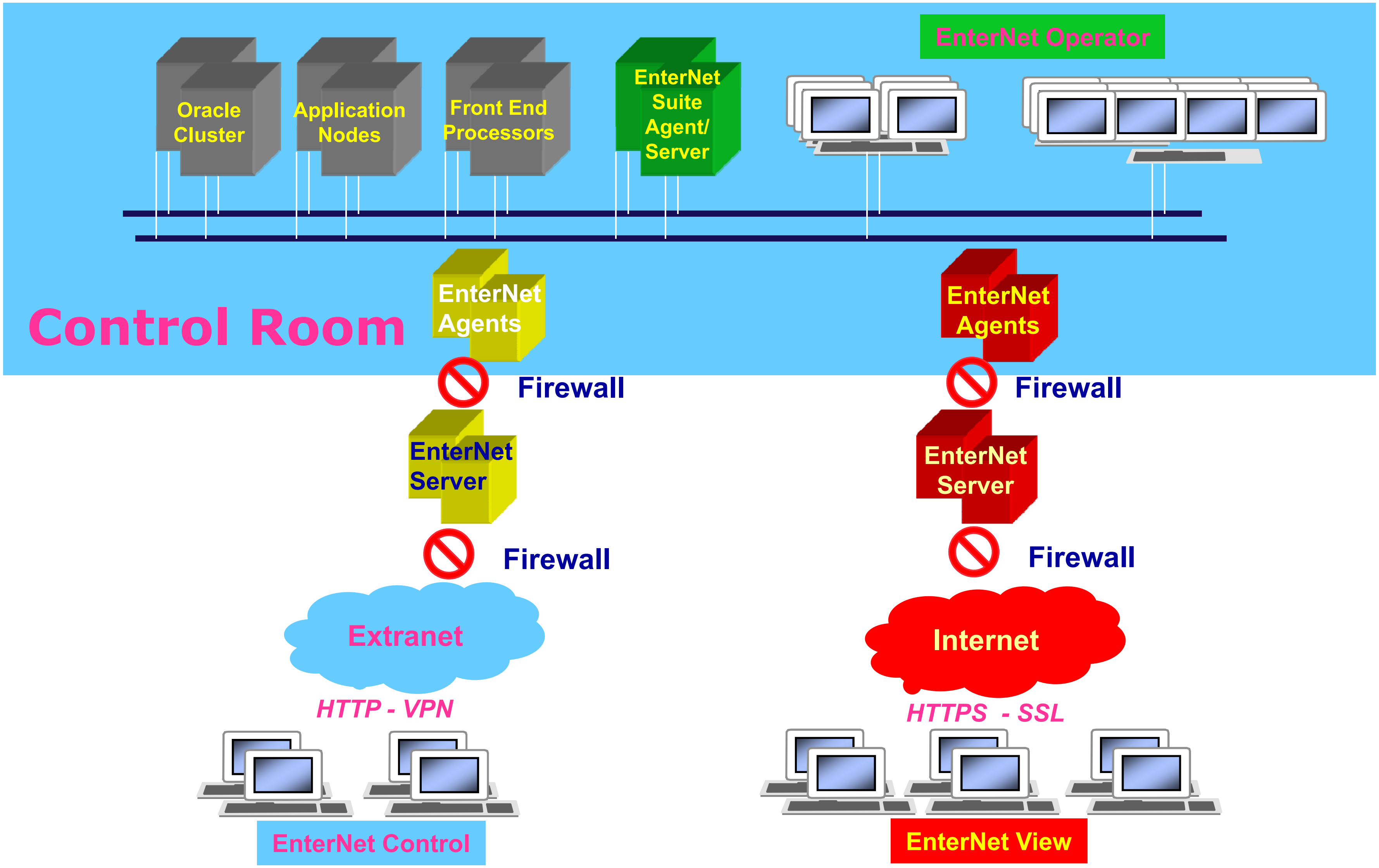
Potential Overview Block Diagram



Graphical User Interface - EnterNet Suite



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