What is a Control Area: Historically and Today?

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Why Care About Control Areas?

- The functions performed by control areas impact competitive markets
- The definition of a control area is changing
- As the system evolves, we need to understand
  - how the term is used by different players (which functions are included and why)
  - which functions must be performed by an independent entity to ensure non-discriminatory transmission service

Overview

- Transmission system hierarchy
- Definition of control area
- Control area functions
- Impacts of restructuring
- Current events
- Hierarchical control
- Conclusion

Transmission System Hierarchy

- Electrical Interconnections
  - The US and Canada are divided into four AC electrical interconnections. These interconnections are connected by DC links only
- Regional Reliability Councils
  - The US, Canada and parts of Mexico form the international reliability club, NERC (North American Electric Reliability Council). Regional reliability councils are units within NERC
- Control Areas
  - About 150 control areas (the number changes often) are voluntary members of the regional reliability councils
The Electrical Interconnections

Power System Operation

Historical categories of control area responsibility (NERC manuals, FERC orders)
- Generation operation and control
- Transmission operation and control
- Ancillary service provision
- Security coordination
- Transmission planning and expansion
- Tariff administration / OASIS operation

New Level in the Hierarchy

Regional System Operators
- RTG: Regional transmission group
- ISO: Independent system operators
- RTO: Regional transmission organization
- _: ?

Where do control areas fit into the emerging industry structure? What is their role?

Definition of a Control Area

An electrical system bounded by interconnection metering and telemetry, capable of controlling generation to
- Balance supply and demand
- Maintain interchange schedules with other control areas
- Contribute to the frequency regulation of the Interconnection
Traditional Control Areas

Historically, control areas have had
☐ Strong transmission connections within their service territory
☐ Relatively weak interconnections between areas

Today, control areas have
☐ Strong interconnections with their neighbors
☐ Boundaries that tend to be corporate rather than electrical

Today’s Control Areas

Balance Supply and Demand

Historically, control areas have had
☐ Strong transmission connections within their service territory
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Today, control areas have
☐ Strong interconnections with their neighbors
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Imbalances and frequency regulation
☐ If supply is greater than demand, frequency will increase (too much energy put into the power system acts like an accelerator, so turbines spin faster)
☐ If demand is greater than supply, frequency will decrease (too much energy drained from system acts like brakes on the turbines)
Maintain Interchange Schedules

* Maintain the scheduled power flow on interconnections between companies
* The information required to maintain interchange schedules is commercially valuable information
  - Control area interconnections are typically the contract paths for commercial transactions
  - Is there unequal access to information?

Frequency Regulation

* Each Interconnection is essentially a single machine operating at 60 Hz
* All control areas contribute to the maintenance of the Interconnection frequency
* All actions potentially affect the system frequency, which affects all players
* If the frequency deviates from 60Hz, there may be instability and blackout

Frequency and Generation

* Area Control Error (ACE)
  - The area control error measures the deviation of system frequency, and interchange power flows from their scheduled values
* Non-zero ACE
  - Good if the error is such that the local imbalance helps the Interconnection frequency
  - Bad if the error means that a local imbalance is causing a frequency deviation on the Interconnect

A control area meets its responsibilities through the control of generation
- Generation determines frequency
- Generation maintains supply/demand balance
- Generation is being deregulated, so why do we care about control areas?
- Most ancillary services are supplied from generators → Transmission and generation cannot be fully separated
Control Areas & Transmission Service

Control Area Responsibilities
- Balance supply and demand
- Maintain schedules
- Contribute to frequency regulation

Ancillary Services
- Scheduling, system control and dispatch
- Regulation and frequency response
- Energy imbalance
- Operating reserves

Control Areas & Information

Basic Control Area Responsibilities
- Balancing
  - Knowledge of all loads and resources
  - Perform load following
  - Meter internal competitors for balancing
  - Impose penalties if out of balance
- Interchange Schedules
  - Knowledge of all scheduled and planned transactions
  - Perform transfer capability studies and calculate ATC
  - Meter tie-line flows and maintain inadvertent flow accounts
  - Request TLR (transmission loading relief) from security coordinator
- System Frequency
  - Perform AGC
  - Authority to declare emergencies
  - Receive SCADA information (real-time monitoring of the power system)

Control Areas & Transmission Service

- Ancillary services are supplied by the transmission provider
- Control area functions are performed by control area operators
- Ancillary services are the basic control area functions
- Therefore, should an RTO, as a transmission provider, be the control area operator?

Control Areas & Information

- A company may have an incentive to exploit the commercial advantage in being responsible for frequency regulation and ACE
  - Unequal access to commercially sensitive information
  - Unequal authority for controlling events (power flows) on the system
  - Conflict of interest between reliability, non-discriminatory service and profit maximization
Impacts of Restructuring

The role and definition of a control area are changing
- ISOs, RTOs ... are assuming some traditional functions
- Other new participants are trying to become control areas (e.g., Enron)
- Control areas want to share responsibility for some functions (scheduling, balancing the system)
- Is this practical? Non-discriminatory?

Impacts of Restructuring

NERC rules state that control areas are responsible for power system operation and reliability
Deregulation and restructuring does not change this, even if ISOs, RTOs or Security Coordinators perform (share) some control area functions

So, What is a Control Area?

Is a control area simply the entity that maintains ACE? (Is this really ‘simple’)
Can the functions of
  - balancing supply and demand
  - maintaining interchange schedules, and
  - maintaining system frequency
be cleanly separated among different market participants (ISOs and transmission owners)?

This brings us to today
Current Events: Enron

Enron files complaints of abuse of control area authority
NERC says claims are unfounded
FERC ignores the exchange
REPEAT ABOVE for many years, until
Enron plays the NERC game and establishes 3 control areas in the TVA region of SERC
All heck breaks loose at NERC

Current Events: NERC

NERC creates a new task force, the Control Area Criteria Task Force (CACTF)
This new task force is empowered to define control area functions and obligations
SERC has meetings with Enron
TVA changes the rules as to how one becomes a control area, and what rights a control area can enjoy (e.g., decreases Enron’s ATC)

Current Events: NERC

NERC admits (September 1999) that there are incentives to being a control area (CA)
- CAs can “park” transactions (Enron’s original complaint)
- CAs can directly schedule with other CAs and use themselves as a sink on tagging (transaction) forms
- CAs can avoid imbalance charges, and use inadvertent energy to balance load and generation
- CAs have closer contact with security coordinators and receive interregional security network (ISN) information
- CAs are notified first if a schedule is about to be cut (TLR)

Current Events: RTOs

Issue: Should FERC require RTOs to be the control area operator?
Options:
(1) Yes
(2) No (NOPR approach)
(3) Ask the question differently
Option 3: Hierarchical Control

Hierarchical control is an emerging (decades old) form of power system control that relies on a master-satellite control structure *rather than* consolidation of control area operations into a single control room.

There can be a single *control area* without the high cost and technical limitations of constructing a single *control room*.

Multiple Control Areas

- Control area boundary
- • Control center

Single Control Area

- ★ New master control center

Hierarchical Control

- Retain existing control centers
  - Make them independent from market participants
  - Avoid excessive costs from replacing existing infrastructure
- Make new security center dual purpose as master control center and security center
- *There is no single method to implement hierarchical control*
Hierarchical Control

- New master control center
- Region boundary
- Satellite boundary
- Satellite center

Master-Satellite structure
- A hierarchical control structure has one master and multiple satellite control centers (PJM, NEPOOL)
- The satellite control centers could be the current utility control centers
- The master control center might need to be newly constructed (equal to security center)

There is no single method to implement hierarchical control

Hierarchical Control

Satellite centers
- Become independent of energy market participants
- Avoid excessive costs by maintaining these centers
- Retain most engineering, hardware tasks at the existing control centers
  - Receive SCADA for medium, lower voltage levels
  - Pulse generators on a ~5 minute cycle
  - Receive commands from the master control center
  - Make suggestions to master control center
  - Dispatch repair crews

Master control center
- Independent from energy market participants
- Oversees and directs actions of satellite centers
- Receives SCADA for high voltage system
- Receives commercially sensitive information
- Performs security coordinator functions
- Maintains regional energy balance
- Determines ACE for region and sends information to satellite centers
Hierarchical Comparisons

**PJM, NEPOOL**
- Developed over time into tight power pools, with a hierarchical control structure
- Relatively easy to evolve into ISOs, continuing the hierarchical control, and only changing flows of information so that commercially sensitive information is less available to transmission owners

**California**
- Built entirely new infrastructure. Did not adapt existing hardware and software
- Very expensive

**Midwest ISO**
- Building new security center
- Maintaining individual control centers
- Risky for competitive markets
- Could easily develop a hierarchical structure

Conclusion

**The definition of a control area is changing.**
**The basic control area responsibilities convey extensive and unexpected authority into other realms of the emerging energy markets.**
**The best solution is to put the basic control area functions & frequency regulation and related functions & exclusively into the hands of an independent entity.**