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

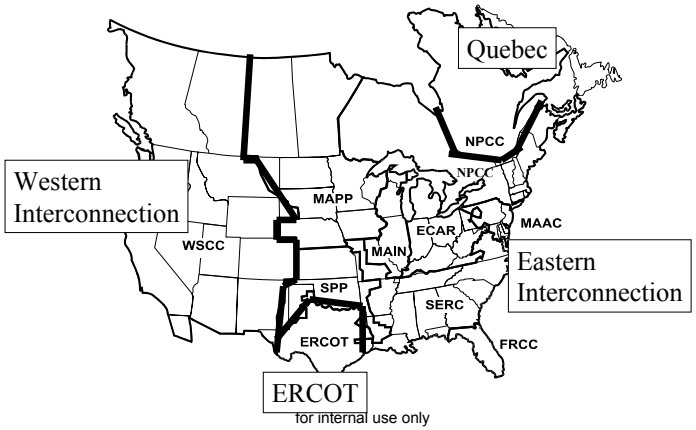
Overview

- 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

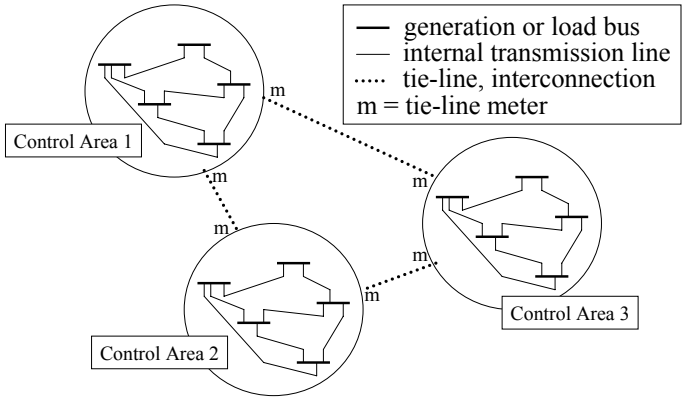
- Regional System Operators
  - RTG: Regional transmission group
  - ISO: Independent system operators
  - RTO: Regional transmission organization
  - _ _ _: ?

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

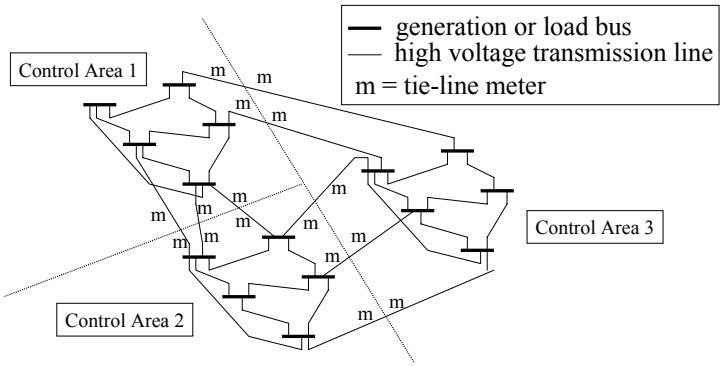
Definition of a Control Area

- 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



Today's Control Areas



Today's 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

Balance Supply and Demand

- 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 Regulation

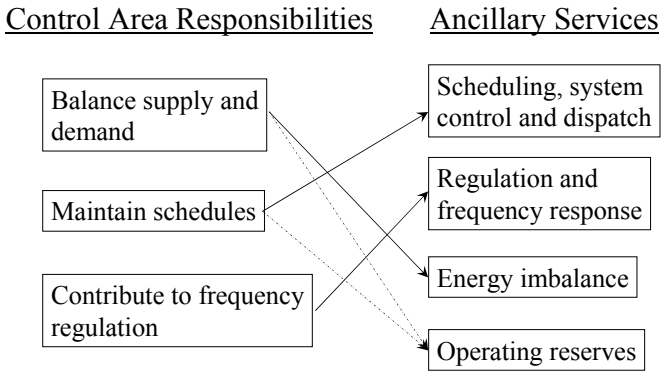
- Area Control Error (ACE)
  - The area control error measures the deviation of
    - system frequency, and
    - interchange power flows

    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

Frequency and Generation

- 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***

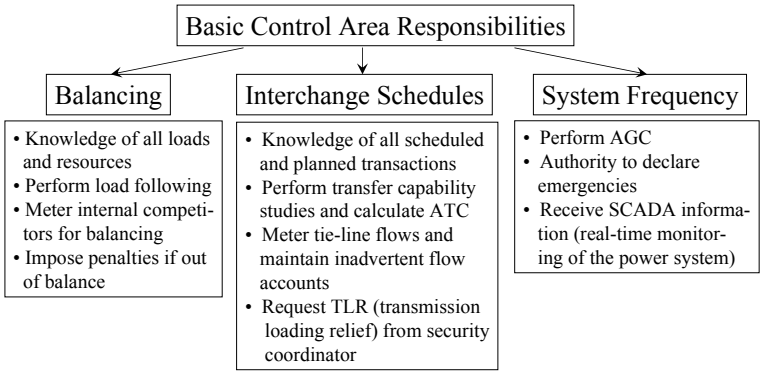
Control Areas & Transmission Service



Control 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



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

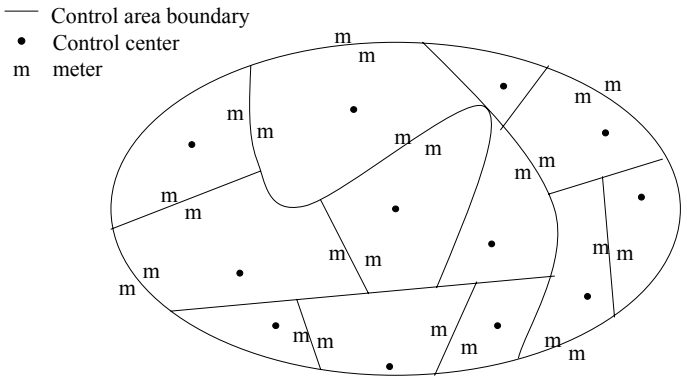
Option 3: Hierarchical Control

- 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*.

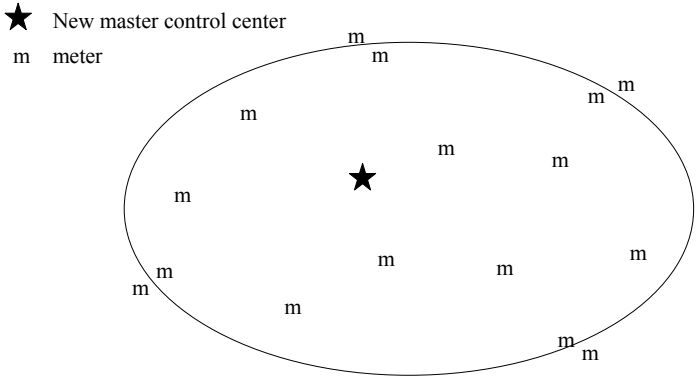
Hierarchical Control

- 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*

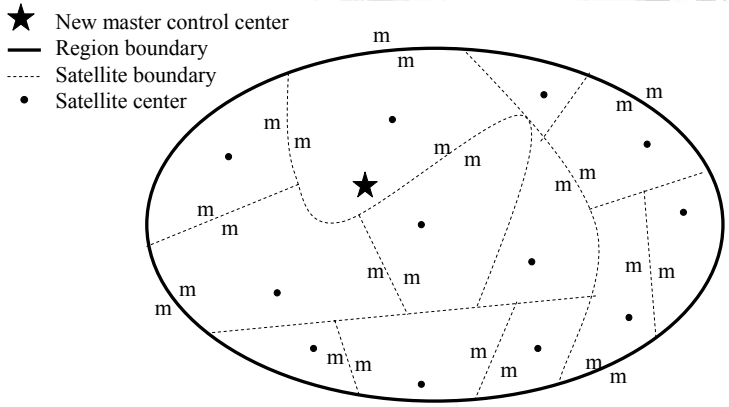
Multiple Control Areas



Single Control Area



Hierarchical Control



Hierarchical Control

- 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

Hierarchical Control

- 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

Hierarchical Comparisons

- 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.