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Power System Reliability & Security

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Washington State University

Electricity Security and Survivability Workshop
November 28-29, 2001
Carnegie Mellon University

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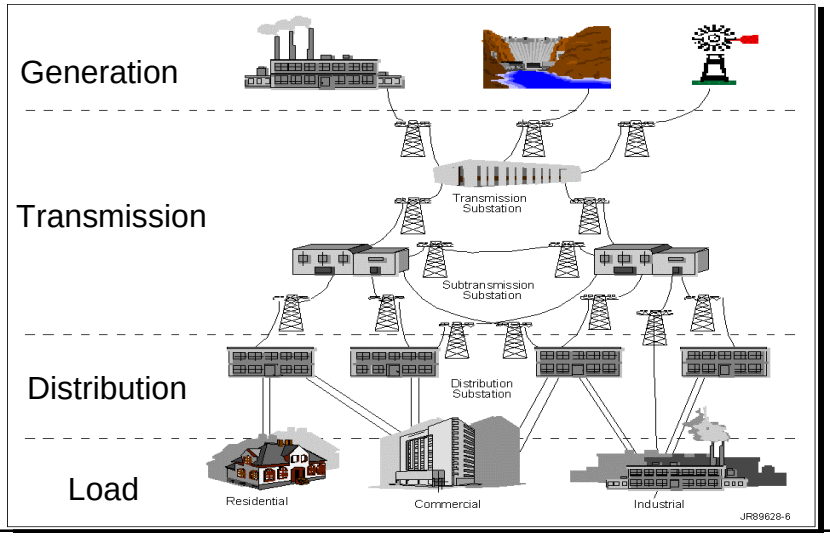
Major Power Grid Components



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North American Power Grid

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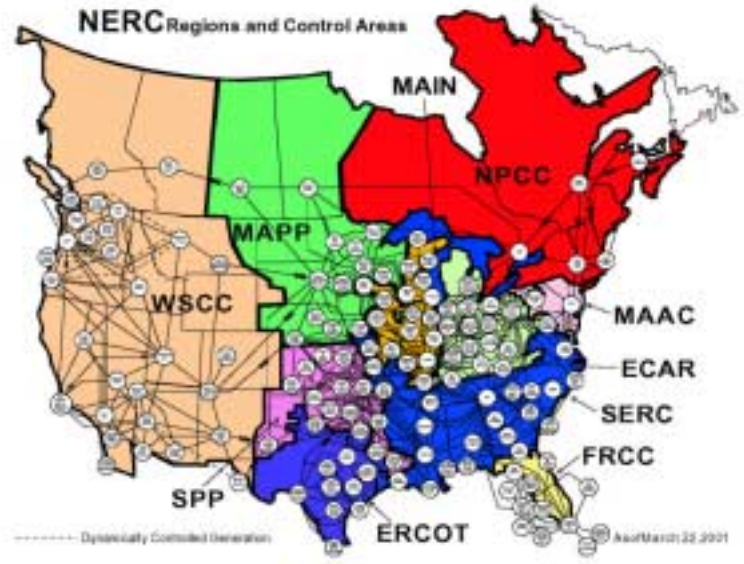
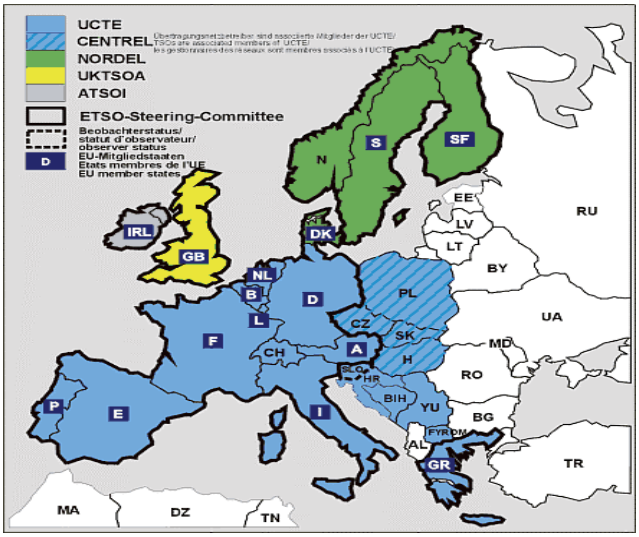


West European Power Grid



Reliability of the Power Grid

- Generation Capacity must be greater than load
- Transmission must not be overloaded
- Voltages must be within limits
- Must be able to withstand loss of generator
- Must be able to withstand loss of transmission line
- Must not lose stability during short-circuit

Control of the Power Grid

- **Load Following – Frequency Control**
  - **Area-wise**
  - **Slow (secs)**
- **Voltage Control**
  - **Local**
  - **Slow to fast**
- **Protection**
  - **Local (but remote tripping possible)**
  - **Fast**
- **Stability Control**
  - **Local machine stabilizers**
  - **Remote special protection schemes**
  - **Fast**

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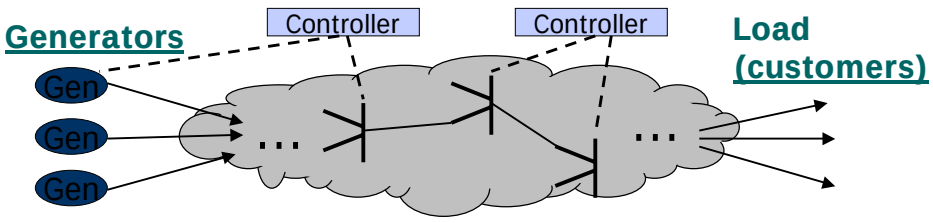

- Must monitor and control over wide range of time scales for control decisions (hybrid control)
  - Slow response (10s of seconds): Transformer, shunt switching, etc.
  - Medium response (seconds): load following, etc.
  - Fast response (milliseconds): protection, stabilizers, etc.

Status Information & the Power Grid

- Deregulation is adding <u>many more</u> participants to the grid!
- Resulting changes in status monitoring requirements
  - Many more devices
  - More general topology and connectivity
  - Much more heterogeneity involved
  - Existing hardwired, hierarchical structure does not suffice!
- New services require more quantity, timeliness, …
  - Local extreme today: substations tracks all its devices
  - Other extreme possible: adjacent grids track some of neighbors' internal status or derived (computed) values

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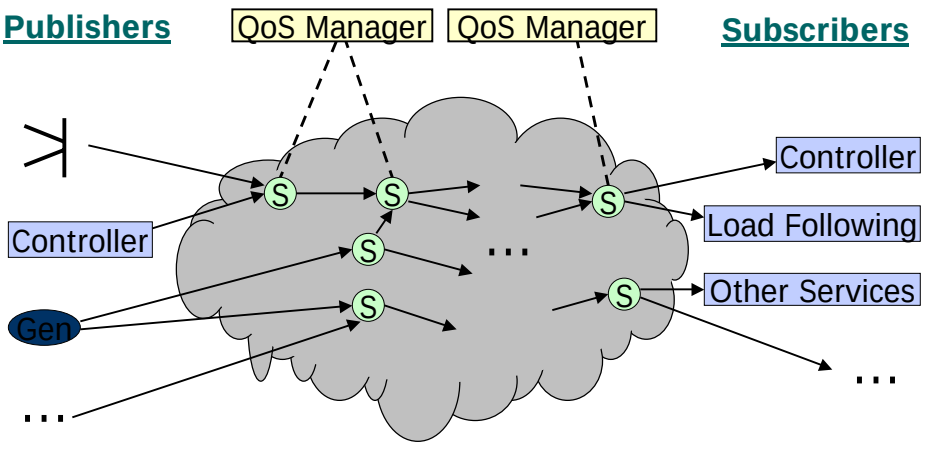
GridStat Architecture



Some Observations

- Deregulation dependent on increased movement of data (markets, metering, billing, etc.)
- Operational reliability dependent on better monitoring and control
- More communication and computer systems
- Information security becomes more important while physical security remains an issue

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Power System engineering research center (PSerc)

- NSF IUCRC, 11 universities (Cornell lead), 35 industry members
- Research in three broad areas: markets, systems, transmission and distribution
- Founder member of the USDOE CERTS program (Consortium for Electricity Reliability Technology Solutions)
- www.pserc.wisc.edu