Mainstreaming Environmental Forecast Information into Management Decision Tools in the Power Industry

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- ***Business Process Reengineering***

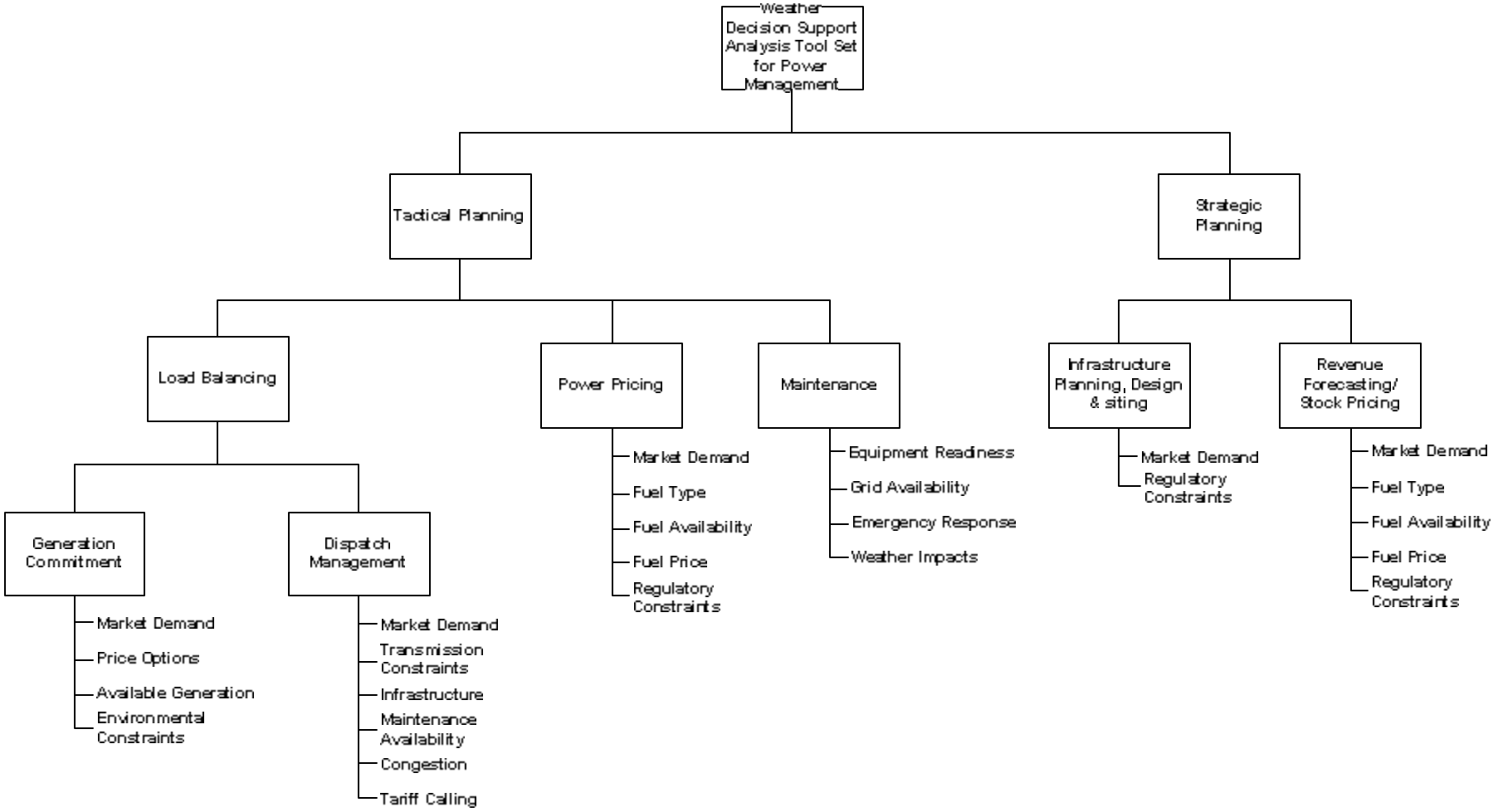
Weather Management Benefits

- Managing weather/climate impacts on the infrastructure and operations
  - Weather Forecast Error Can Be Costly and Better Planning for Weather Events Can Render Significant Benefits

Weather affects the electric utility industry by an estimated $300-500 million/year.

- Key benefits of weather management include:
  - Improved scheduling and load balancing
  - Improved asset management and replacement
  - Improved enterprise wide contingency and financial planning
  - Improved use of demand reduction and price responsive loads
  - Improved reliability
  - Better environmental dispatch
  - Improved congestion management
  - Improved tariff day accuracy

Potential Decision Aid Architecture



Meteorological Parameters in Decision Aid Architecture

- **Uncaptured WIND Events**
  - **Delta Breeze- Cal ISO**
  - **Lake effects- Salt Lake City- Pacificorp, Great Lakes- SUNY Buffalo**
  - **Seabreeze- NE ISO**
  - **Frontal passage- 2-4 day**
- **Uncaptured PRECIPITATION Events**
  - **Rain vs. snow/ice**
  - **Regional day ahead error in precipitation- Pacificorp**
  - **Afternoon thunderstorms**
  - **Marine Layer, fog- SDG&E**
  - **Drought and flood, flash flood**
- **Uncaptured CLIMATE Events**
  - **Climate outlooks –weather events frequency**
  - **El Nino and seasonal events**
  - **Decadal oscillations- NAO**
- **RESOLUTION- Spatial, temporal**
  - **Grid and Sub grid level**
  - **Targeted watershed level, Nodal, congestion and population**
  - **Topographic Effects- micro zones**
  - **Hourly changes during events**
- **Load Model Error**
  - **50% load error at certain event periods**
  - **Can't incorporate probabilities/ ensembles**
- **Sub-optimal Use**
  - **At all levels of the energy management process*****

Framework for Problem Solving

Translating Weather/Climate Data into Business Solutions

A Framework for Using Environmental Information for Operational Advantage

I. Introduction:

- ***Driving principles for managing with environmental information***
- ***Weather/climate impacts on global market segments***

II. Framework

A. Framework for Problem Identification

Role of weather on business processes-

Use of environmental information in the business value chain ,

B. Framework for Problem Solving

Translating weather data into business solutions

III. Deriving a Business Solution

A. From Data to Information

Converting data to knowledge process

Global Observing Systems
Statistical measurements, pattern analysis

B. From Information to Knowledge (of risks and impacts on business performance)

Actions to outcomes to impacts to solutions

Economic valuation of weather risk
Assessing vulnerability to risk
Diagnostic approach to assessing vulnerability
Managing information to hedge risk

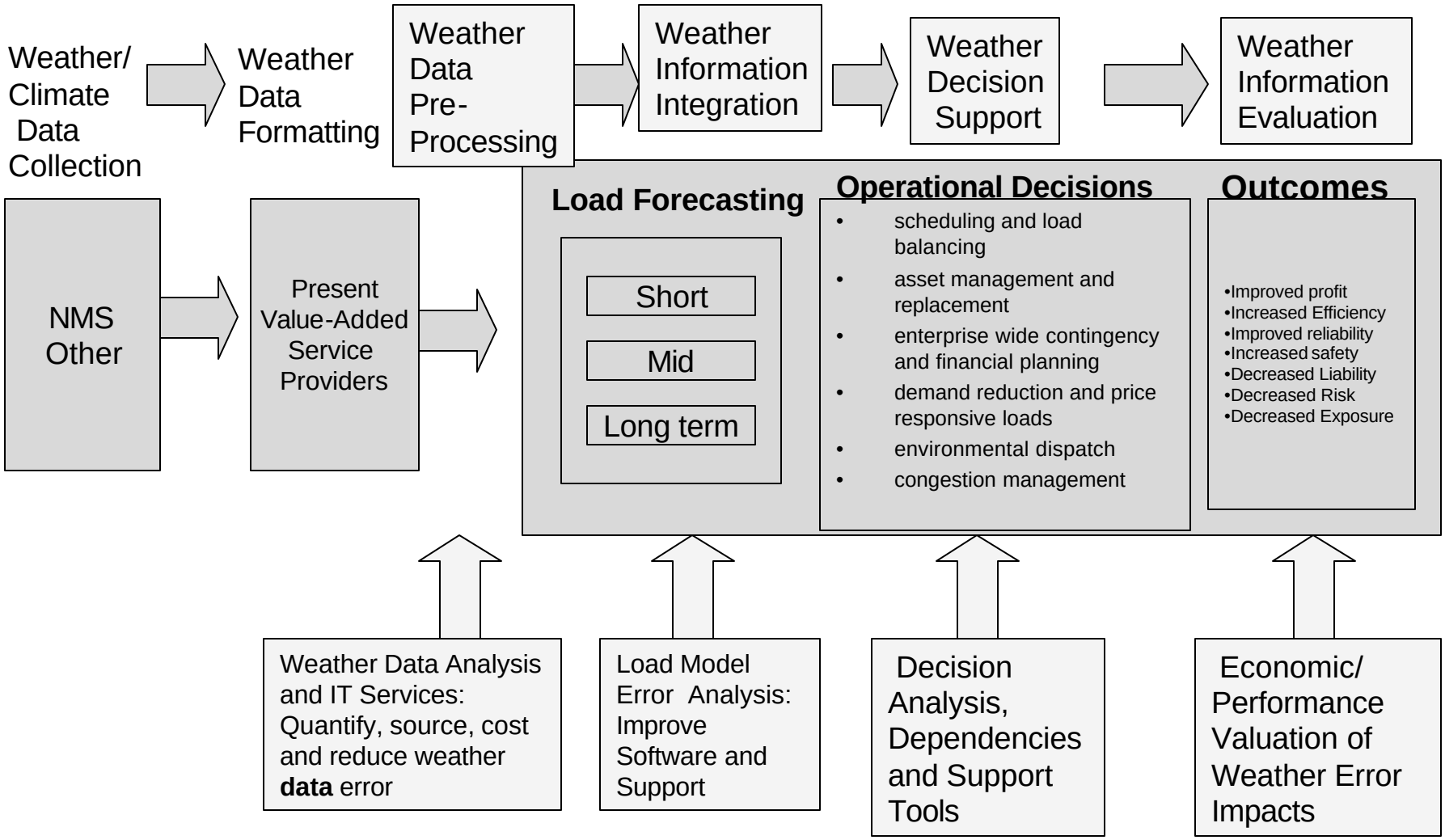
C. From Knowledge to Action/Decision

- ***Strategic decisions***
  - ***Re-engineering business processes for managing with environmental information***
    Leadership issues
- ***Planning decisions***
  - ***Risk hedging financial/insurance decisions***
- ***Tactical Decisions***
  - ***Selecting decision tools*** (was "producing a decision tool")
  - ***Scenario analysis***--Academic reading: Decision trees
- ***Linking decision tools to get a solution***

- **D. Implementation and Evaluation**
  - ***The audit process***
  - ***Satisficing/ scrutiny***

Weather Information "Flow" on the Operational Decision Process: Risk Reduction Areas

DATA — INFORMATION — KNOWLEDGE — ACTION — OUTCOMES — IMPACTS

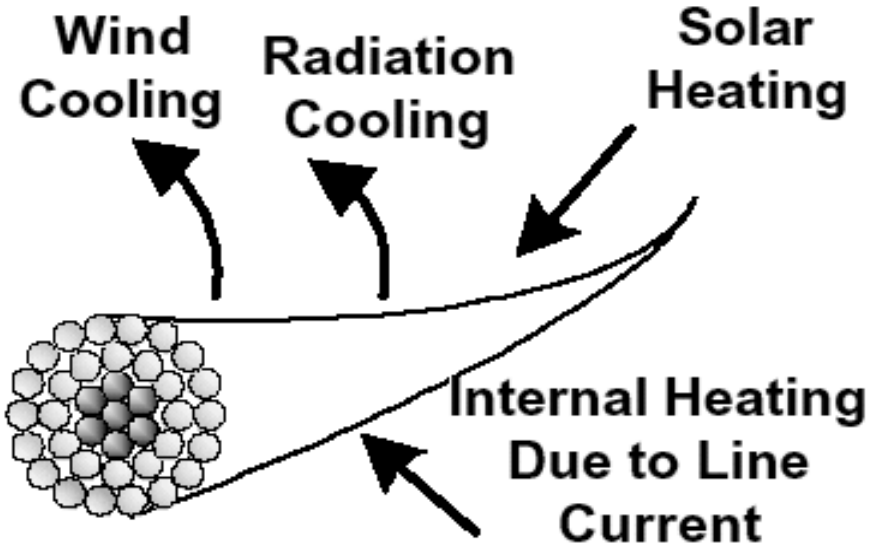


Case Study in Dispatch Management: Real Time Weather and Line Loading Policy Determination

What Physical Parameters Affect the Transmission Line Thermal Rating?

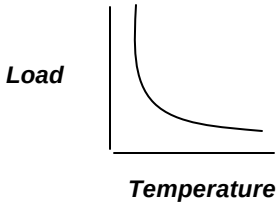
Heat in = Heat out (steady-state)

$$Q_{solar} + I^2R = Q_{convection} + Q_{radiation}$$

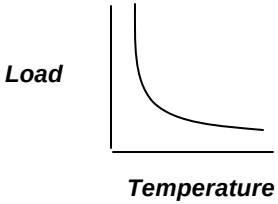


Temperature and Line Loading

Line Ratings Change as a function of loading and temperature



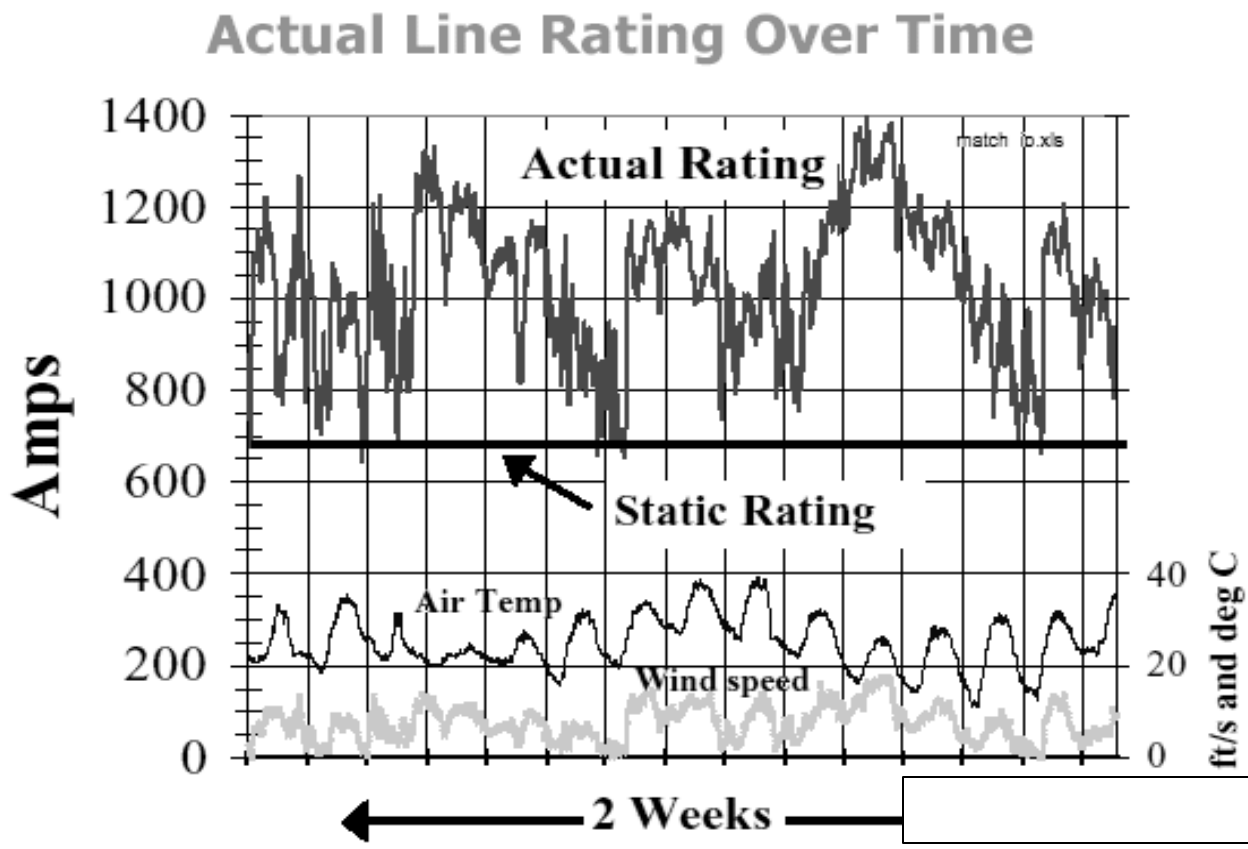
Line temperature is affected by ambient temperature and airflow



In order to know how close to design limits the line is operating, you must know temperature, wind speed and direction IN REAL-TIME

If you know the line specs and the load the line temperature can be calculated

Establishing the dependencies



Impacts on Policy Decisions

The State of California strapped for power, with huge reliability issues and with large environment concerns looked for ways to increase the transfer capacity of the existing grid. The report titled "Dynamic Thermal Line Rating" developed for the California Energy Commission had the following conclusions:

"[The] Project successfully demonstrated the feasibility and reliability of providing real-time transmission line ratings to the system operator. Real-time line ratings for the transmission Lines monitored in this study had ***40 to 80 percent more power transfer capacity than the Static transmission line ratings presently applied***."

Selecting or Building a Decision Tool

- Concept: How Decision aids influence the decision process and how they are formed
- Business Concepts: Decision Support Tools
- Scenario analysis
- Case Study: Nuclear Power Plant emissions release strategies

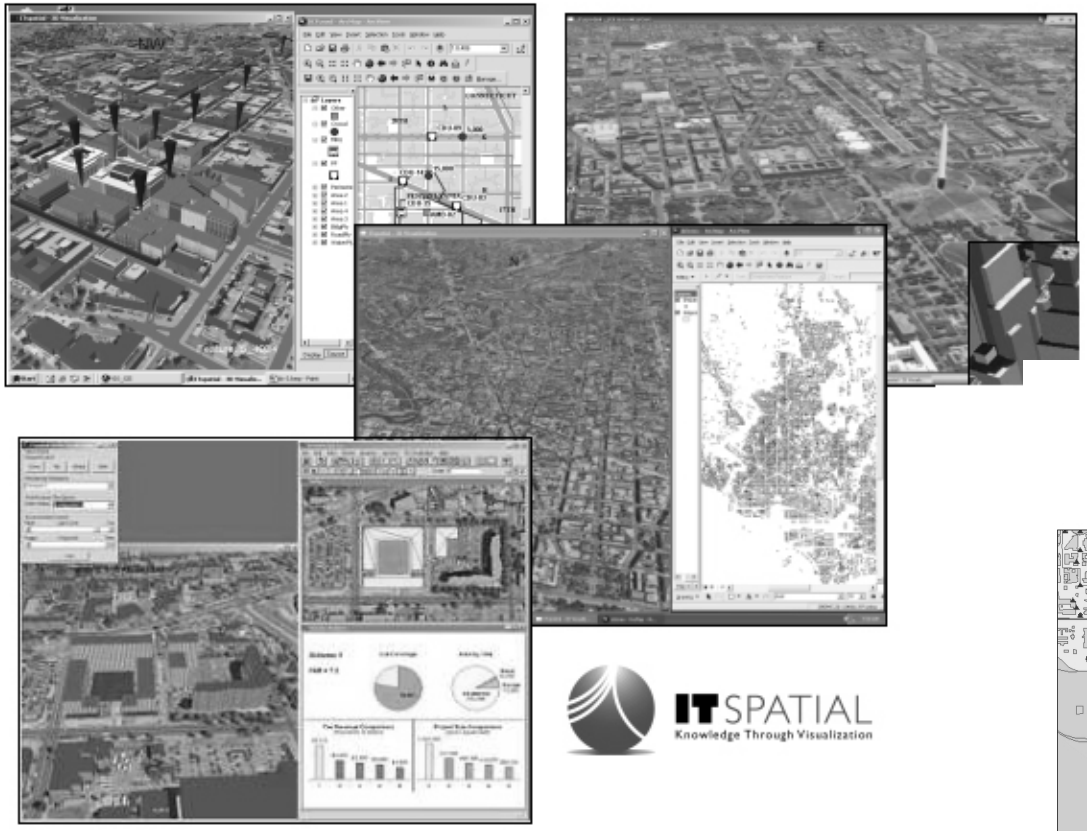
Example Wind Speed Algorithm

- For both levels
- If neither wind speed reading is obtained from front-end processor
- set valid value to the bad wind speed value and set flag to 9
- If both wind speeds were “off” or “out of range”
- set valid value to the bad wind speed value and set flag to 9
- If one wind speed was “off” or “out of range”
- set valid value to good measurement and set flag to
- 5 if using Train A or 6 if using Train B
- If both wind speeds are a “stuck” value for last 12 15-minute periods
- set valid value to the bad wind speed value and set flag to 8
- If only one current wind speed is a “stuck” value for last 12 15-minute periods
- set valid value to the other train and set flag to 7
- If flag is less than 5
- If the difference in wind speeds is £ allowable and not blowing through the tower
- set valid value to Train A wind speed and set flag to 0.
- If the difference in wind speeds at level is £ allowable and blowing through the tower
- If both wind directions are blowing through the tower
- set valid value to Train A wind speed and flag to 4
- If one wind direction is through the tower
- set valid value to system sensor not in tower and set flag to 1 or 2 depending on which system sensor was used
- If the difference in wind speeds at level is greater than allowable
- If both wind directions are blowing through the tower
- set valid value to Train A wind speed and flag to 4
- If one wind direction is through the tower
- set valid value to system sensor not in tower and set flag to 1 or 2 depending on which system sensor was used
- If the wind direction is not through the tower
- If both sensors are “good” on the other level (flags are less than 5)
- Calculate the difference in values at other level
- Calculate the difference in values between levels.
- If the difference at other level is £ allowable, and the difference between one or both levels is £ allowable
- Compare each wind speed to the wind speed at other level. Select either Train A or Train B wind speed that is closer to the values at the other level. Set the flag to:
- 1 if Train A selected or 2 if Train B selected.

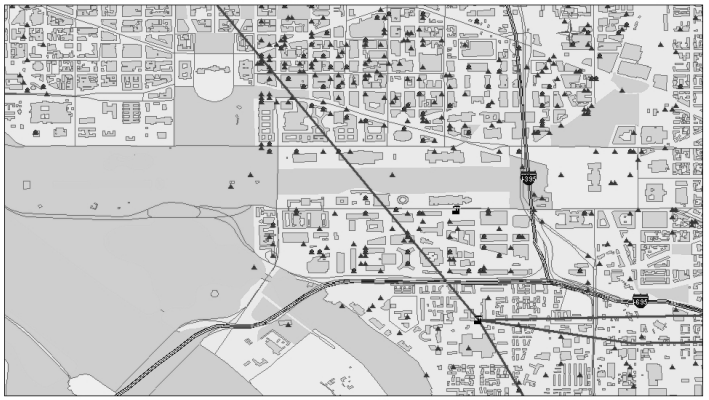
The Power of Linking Decision Tools to get a Solution

Severe Weather/Climate Event + Impact Assessment + Emergency Power Dispatch Management

Decision Support Tools Analyze and Inform

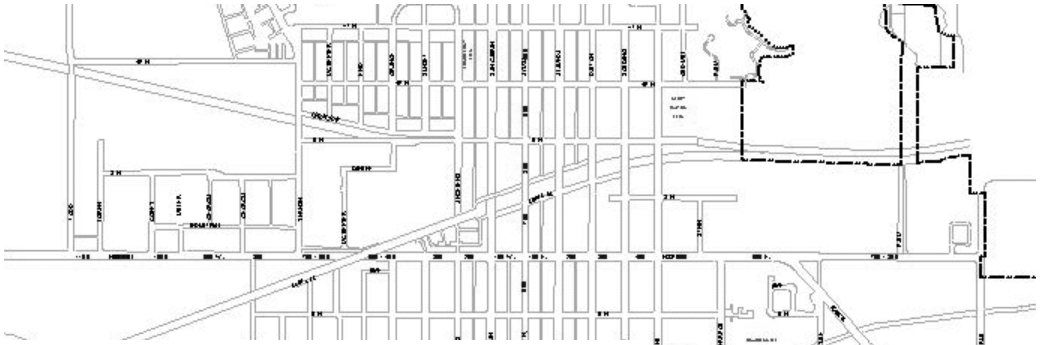


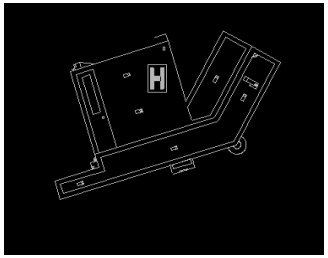
DC Electric Power and Telecommunications:
Transmission Lines from 121 kV; Electric Power Stations
Telephone Equipment Locations

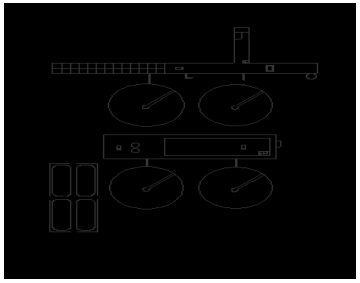


Electricity Visualization and Modeling at the Distribution Level is Essential

- Using the existing GIS from utilities and state & federal agencies
- Import Electrical Data
- Identify Critical Customers
- Assess Consequences
- Improve Mitigation Approaches





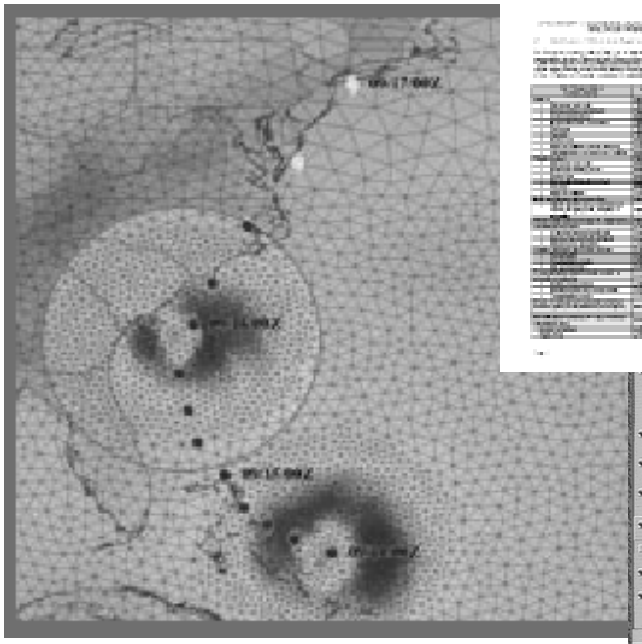


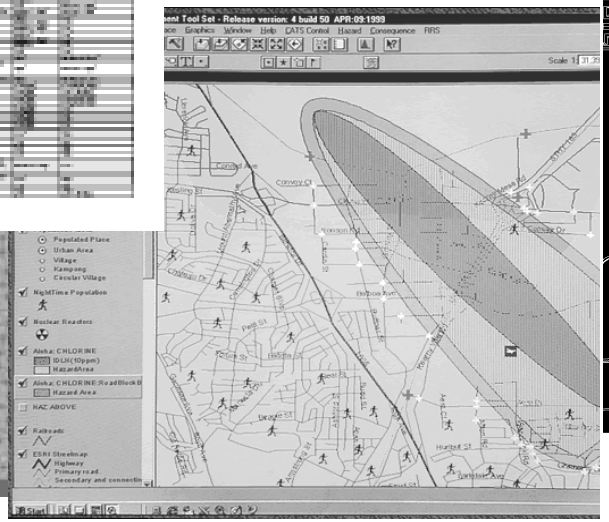
The Solution: Linking Weather Forecast Simulation Tools with Emergency Response Simulation Tools for Severe Weather Emergency Energy Management

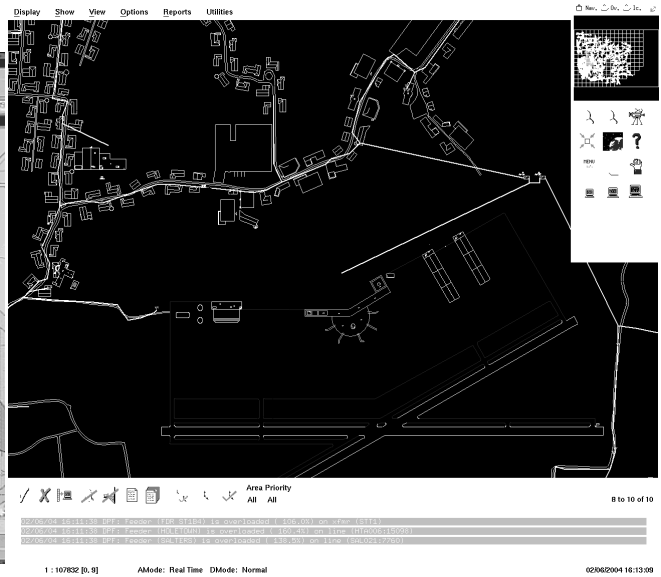
Storm Tracking with simulation tool- predict hurricane landfall

Emergency preparedness with "**CATS" (consequence assessment tool set)** Locate critical energy assets, estimate damage and position for relief

Expert "Grid" Management Situational Awareness and Power Restoration Management Tool







Data-Information

Knowledge

Action and Outcomes

Next Steps

Rethinking the structural organization of the business

Let the optimal flow of information organize the system

Business Process Reengineering for optimal communication- the major hurdle to using information is overcoming stove-piping

Models Forecast Hazards and