



# Fort Future Virtual Installation

## Electrical Simulation Capability

*Modeling Power*

*Capacity, Vulnerability, and Impacts*

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17 August 2004



# Terror, Sabotage, Failure

**CNN.com/U.S.**

**U.S.**



## The Terror Question

### No Signs of Deliberate Attack in Blackout, But Possibility Not Ruled Out

**abcNEWS**

**Aug. 15**—  
contrary, o  
vulnerable  
massive b

Traffic leaving Manhattan moves across the Brooklyn Bridge in New York Aug. 14, 2003, after a blackout hit the city. The blackout stranded thousands of commuters, trapped subway riders underground and evoked fearful memories of the Sept. 11 attacks. (Peter Morgan/Reuters)

The Web  CNN.com

## Power outage leaves Motor City low on fuel

Friday, August 15, 2003 Posted: 7:32 PM EDT (2332 GMT)

**DETROIT, Michigan (CNN) --** With most service stations in Detroit closed because of the power blackout, even tow



**U.S.**



## Nuclear Power Plant Alert

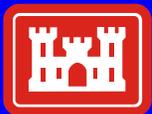
### FBI Warns Law Enforcement About Terror Activity at Power Plants

*By Pierre Thomas and Jason Ryan*

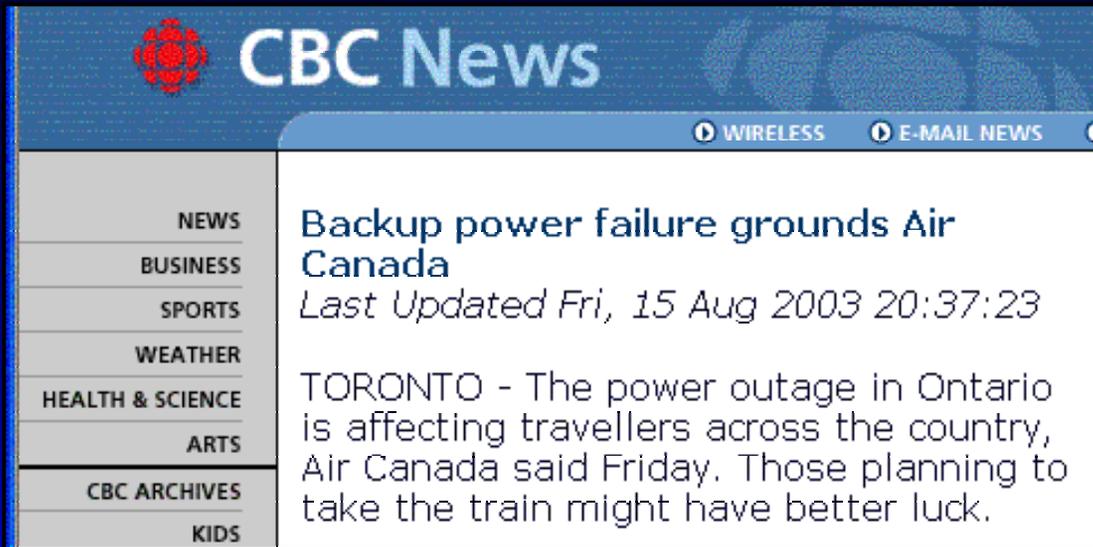
**abcNEWS**

**April 30**— The FBI is warning law enforcement officials around the country to be on the lookout for potential terrorist activity around nuclear power plants.

The cooling stacks for the Unit 2 reactor, foreground, at the Three Mile Island Nuclear Facility in Pennsylvania are dormant. (Paul Vathis/AP Photo)



# Loss of Service



**CBC News**

WIRELESS E-MAIL NEWS

NEWS  
 BUSINESS  
 SPORTS  
 WEATHER  
 HEALTH & SCIENCE  
 ARTS  
 CBC ARCHIVES  
 KIDS

**Backup power failure grounds Air Canada**  
*Last Updated Fri, 15 Aug 2003 20:37:23*

TORONTO - The power outage in Ontario is affecting travellers across the country, Air Canada said Friday. Those planning to take the train might have better luck.

## WATER & WASTES DIGEST

### Cities Still Testing Water Due to Power Outages

August 18, 2003

Businesses and homes are still adhering to a boil water order that was issued by the Detroit Water and Sewerage Department amidst the nation's power outages last week. Power failure across multiple states including New York, Ohio and Michigan shut down many water treatment plants forcing residents to boil their water and, in some cases, purchase bottled water when the municipal water was completely shut off.

### Michigan governor declares state of emergency; Cleveland sending out water tankers

By SARAH FREEMAN  
 Associated Press

DETROIT (AP) - Michigan's governor urged residents to stay indoors as he declared a state of emergency amid the continuing blackout. In Cleveland, workers filled "water buffalo" tanker trucks to ease the worst water crisis in history.

Volume 12, No. 34 August 20, 2003

*Highlight story from the current issue of WaterWeek*

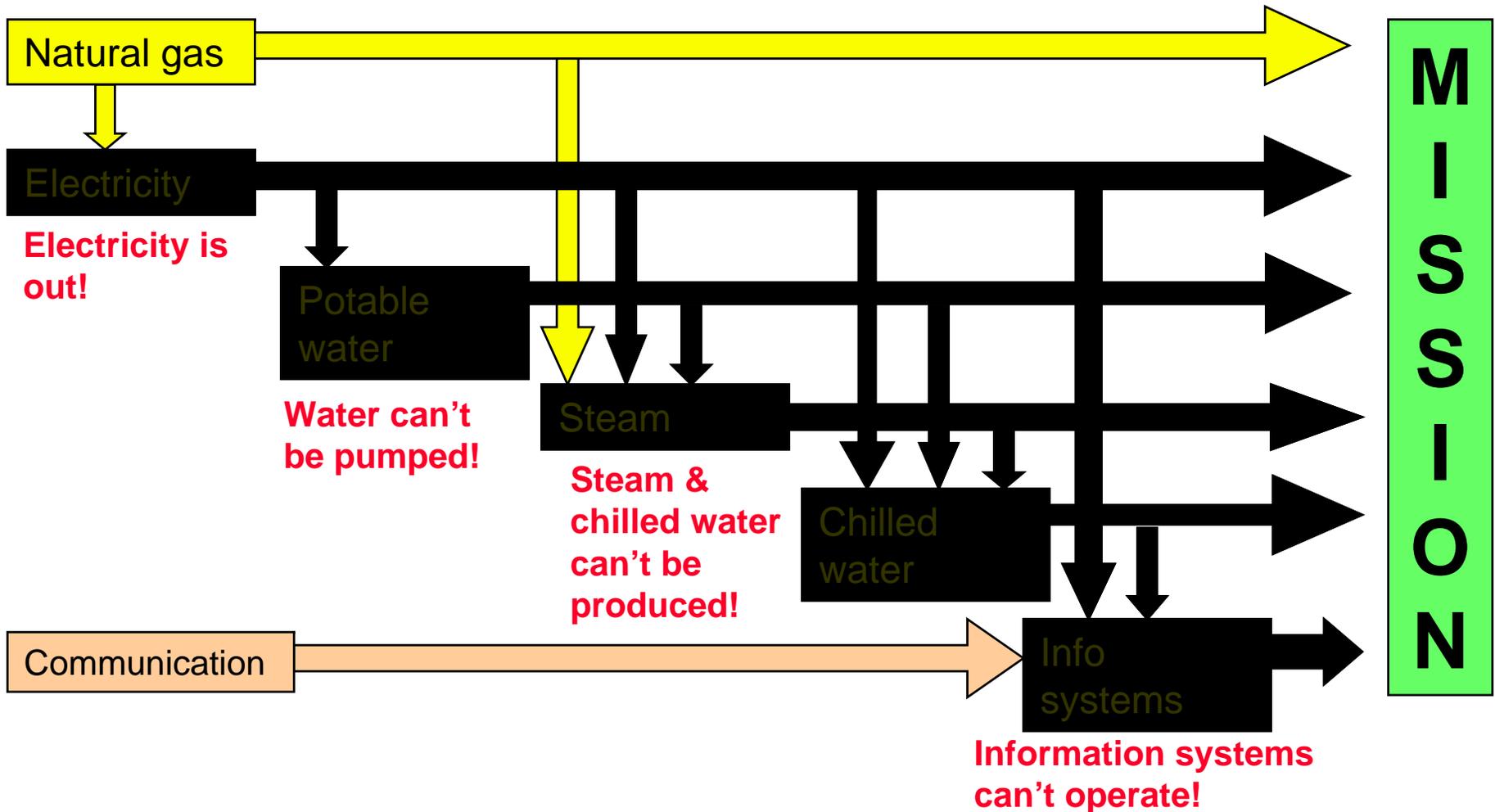
### Water fully restored after US/Canada blackout

Full water service to major eastern US and Canadian cities hit by a massive power outage late last week was restored as of Monday. Particularly hard hit with water disruptions were Detroit and Cleveland, while New York, Toronto and other smaller cities and towns in the region were affected to a lesser degree.



# Utility Systems are Highly Interdependent

Disruption of one utility service often causes disruption of the others.



# Utility Systems

## Enable Key Installation Functions



**Force Projection**



**Training**



**Daily activities**



# “Mission” of Utility Systems

## The system must be:



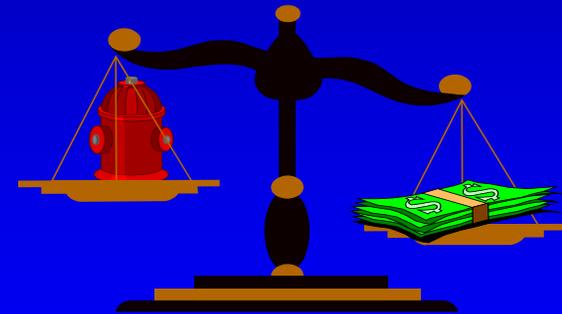
**Sufficient** to meet demand – both normal and “surge”



**Reliable** – always there when it’s needed



**Safe** – does not cause harm



**Affordable** – a balance between cost & service



# Problem

**With the increased threat to military installations and emerging transformation**

**Installations must be able to:  
forecast utility requirements, capabilities,  
and vulnerabilities to ensure mission  
support is provided.**



# Technology Needed

- Installations do not have the resources, knowledge, or tools to protect everything from everything.
- Currently-used risk assessment methods have shortcomings when applied to utility systems:
  - Do not relate *directly* to the mission
  - Primarily based on subjective judgments and knowledge of system owners/operators
  - Physical security is the main focus
  - Semi-quantitative at best
  - Labor-intensive



# Criteria for Solution

- **Energy Security is Essential**  
*(DEFENSE ENERGY PROGRAM POLICY MEMORANDUM DEPPM 92-1)*
- **Capable of modeling and testing**
- **Connects utilities with Missions**
- **Integrated with other utility modeling systems**
- **Embeds expert knowledge**
- **Cannot require new data or extensive data collection**



# Types of Utility System Models



## Steady State Model

“Snapshot” at one point in time

## On-line Dynamic Model

Data is obtained from SCADA and model is updated once a day.



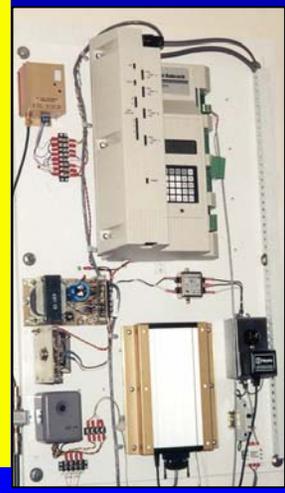
## CAD Diagrams, Static Data

“Seat of the pants” methods for dealing with new situations & problems



## Off-line Dynamic Model

Time-varying processes can be modeled but data input is not automated



## ‘Real-Time’ Dynamic Model

Model updated with SCADA data at intervals of 15 minutes or less.



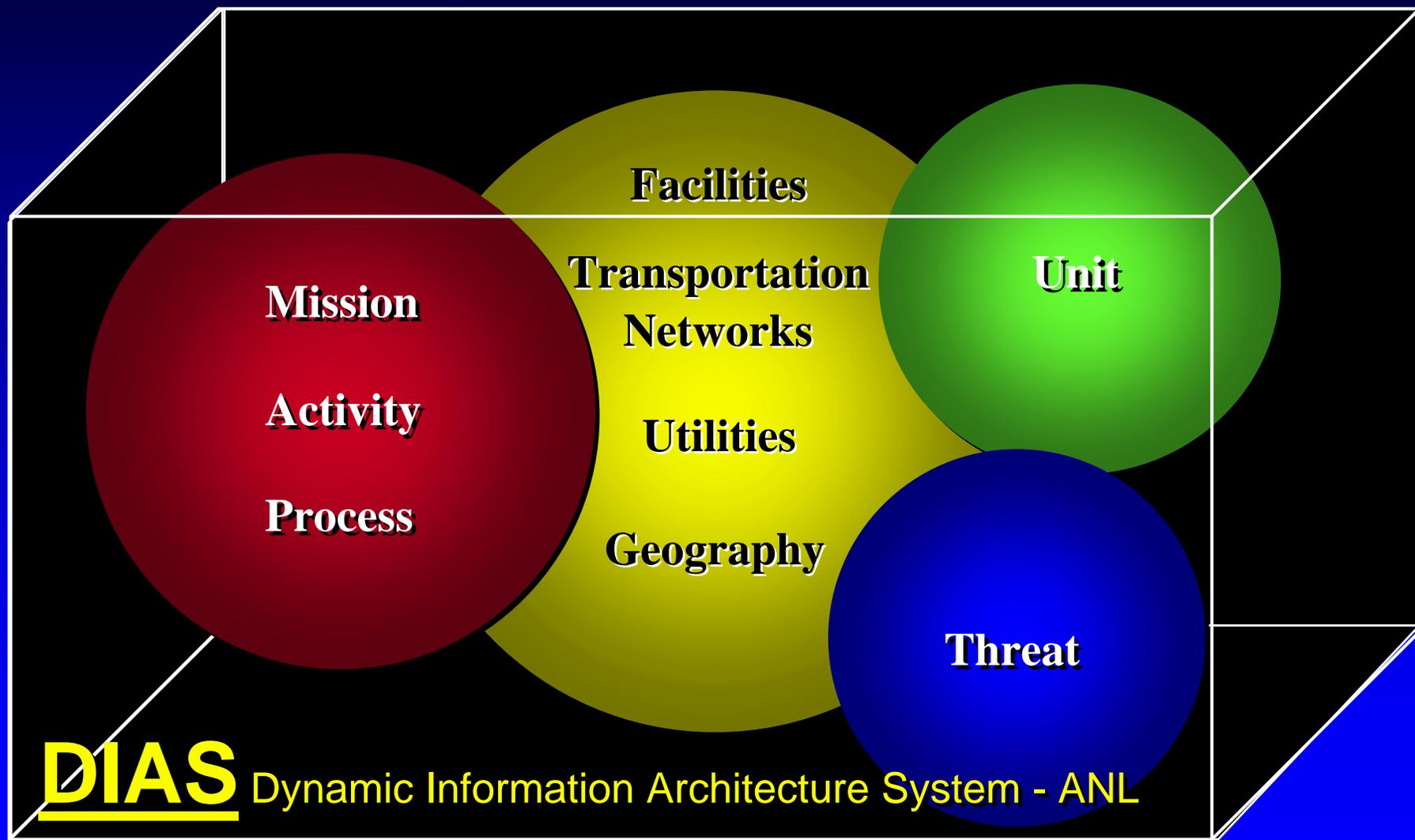
# Capabilities

- **Capacity analysis to determine if utility systems are sized adequately for scenarios like these:**
  - **New facilities**
  - **Upgrade of existing facilities**
  - **Change of mission**
  - **Facility decommissioning**
- **Analysis of utility service interruptions / denial of service including vulnerability assessment and options for response and recovery**



# How It Works

## Object Interactions



# How It Works

## Data Requirements



**Build Installation's Deployment Process and Capabilities**



**GIS Layers, Utility System Data and existing databases**



**Unit Specific Deployment Data (Personnel/Logistics/Training)**



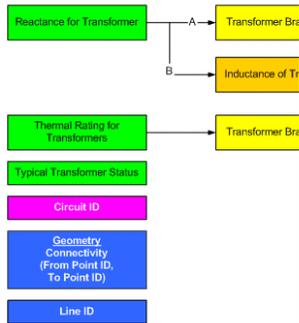
# Challenges

- **Collected and assembled data**
  - **Incomplete data**
  - **Needed significant work**
  - **Demands**
  - **Assumptions required**
- **Defined data schema**

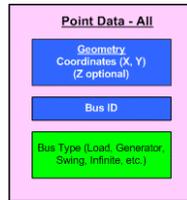


# Data Schema

## Line Data - Transformers

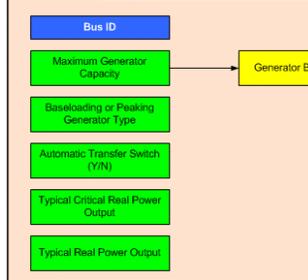


## Point Data

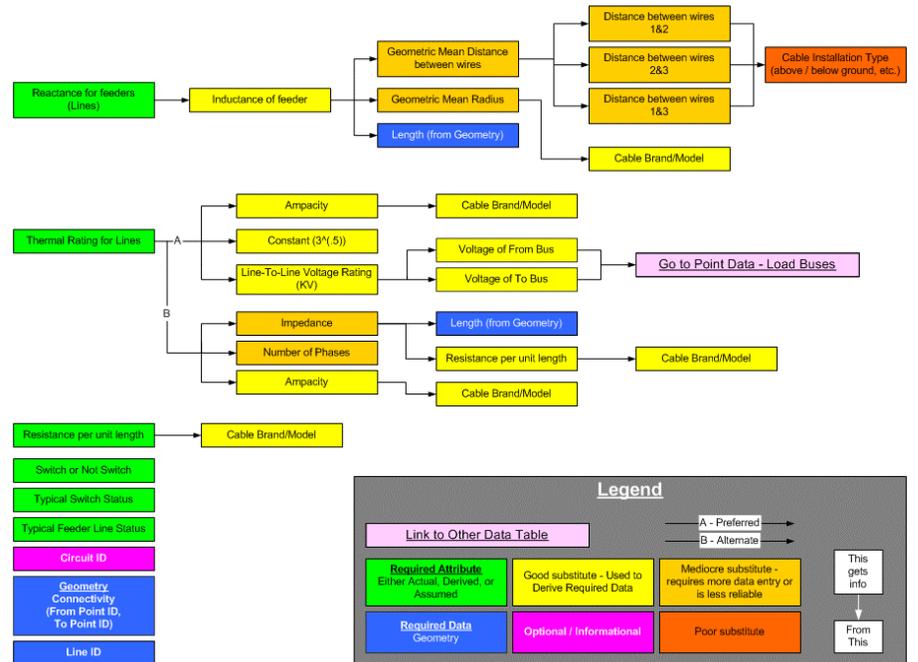


## Tabular Data

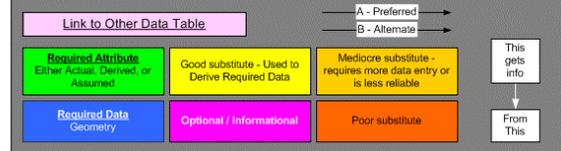
### Point or Tabular Data - Generators



## Line Data - Feeders



### Legend



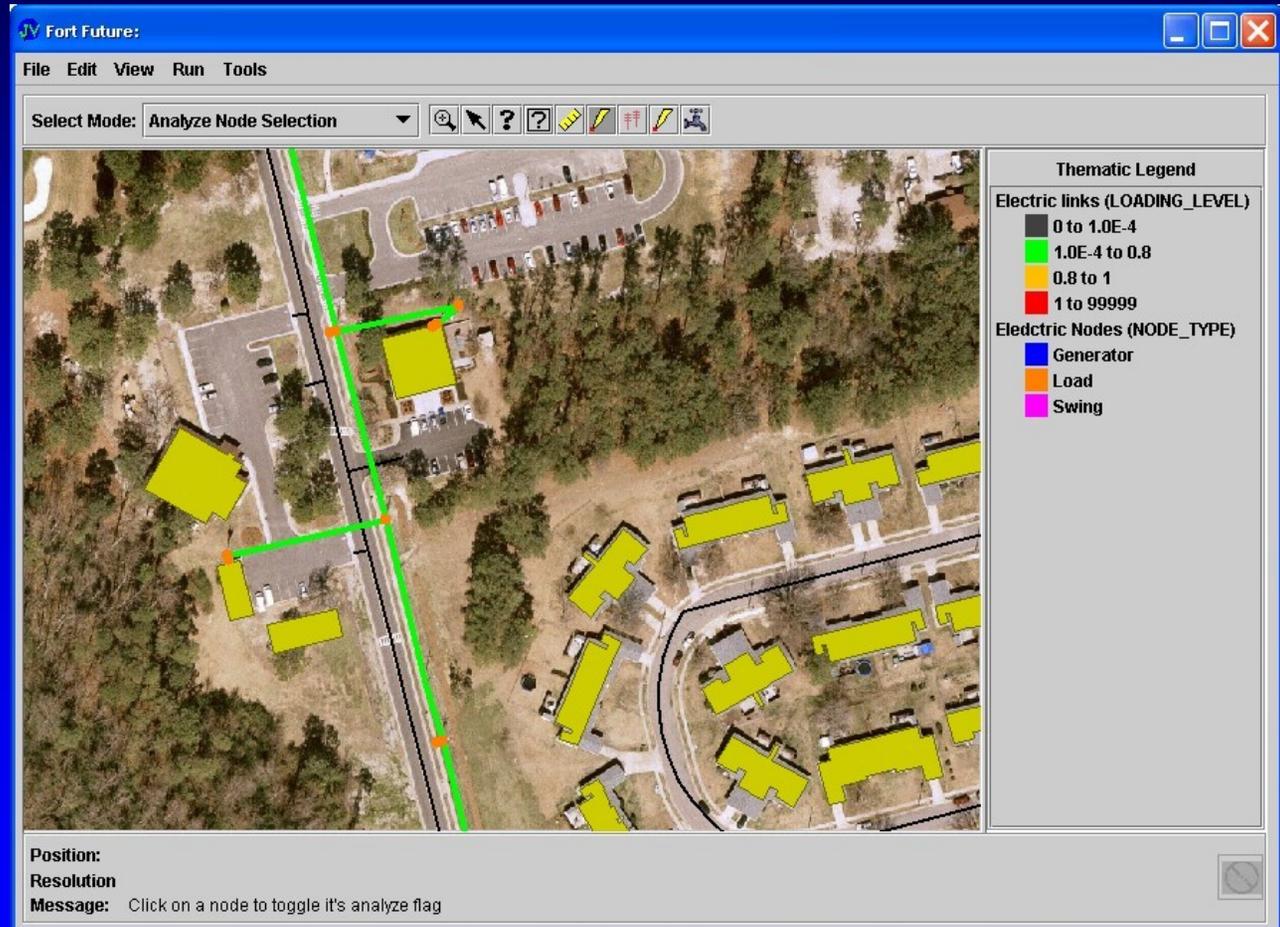
# How It Works

- **DC Load Flow algorithms integrated into DIAS**
- **DC Load Flow algorithm computes simplified Fast Decouple Power Flow (FDPF) for capacity availability analysis [Stott 1974]**
  - **Pure resistive analysis of current flows from substation to customer loads**
  - **Conductor (resistive) loss estimated along a system of discrete feeder segments and nodes**
- **Automated vulnerability assessment is iterative, cycling through potential points of failure**



# Capabilities

Capacity  
Vulnerability



# Capacity

A new simulation center is proposed and will have a peak requirement of 800 kW.

Bus Info: 6508

Name	6508
<b>Node Type</b>	<b>Load</b>
Base Load (MW)	0.0262
Additional Load (MW)	0.0449
Total Load (MW)	0.0711
Theta (rad)	-0.0003
Delta Theta (rad)	0.0000

Apply Undo

Future:

Edit View Run Tools

Mode: Analyze Node Selection

Thematic Legend

Electric links (LOADING\_LEVEL)

- 0 to 1.0E-4
- 1.0E-4 to 0.8
- 0.8 to 1
- 1 to 99999

Electric Nodes (NODE\_TYPE)

- Generator
- Load
- Swing

Position:  
Resolution:  
Message: Click on a node to toggle it's analyze flag

Analysis of the nearest node indicates 44.9 KW additional load can be supported by the node.



# Capacity

Enter peak  
800 kW  
requirement and  
apply to test  
impact.

Test for Power Outages indicates that the load  
will lead to a power outage along the feeder.

**Bus Info: 6508**

Name	6508
Node Type	Load
Base Load (MW)	0.0262
Additional Load (MW)	0.8000
Total Load (MW)	0.8262
Theta (rad)	-0.0003
Delta Theta (rad)	0.0000

Apply    Undo

The screenshot shows the Fort Future software interface. A menu is open with the following options: Run DC Load Flow Model, Determine Power Outages, and Run EPANET Model. The main window displays an aerial map of a residential area with yellow buildings and green power lines. A legend on the right side is titled 'Thematic Legend' and includes the following categories:

- Electric links (STATUS)**
  - Heavy Load (Orange)
  - NoFlow (Grey)
  - Normal (Green)
  - Overloaded (Red)
  - Removed (Dark Grey)
- Electric Nodes (NODE\_POWER\_)**
  - Generating (Blue)
  - NotGenerating (Grey)
  - Powered (Green)
  - Unpowered (Black)

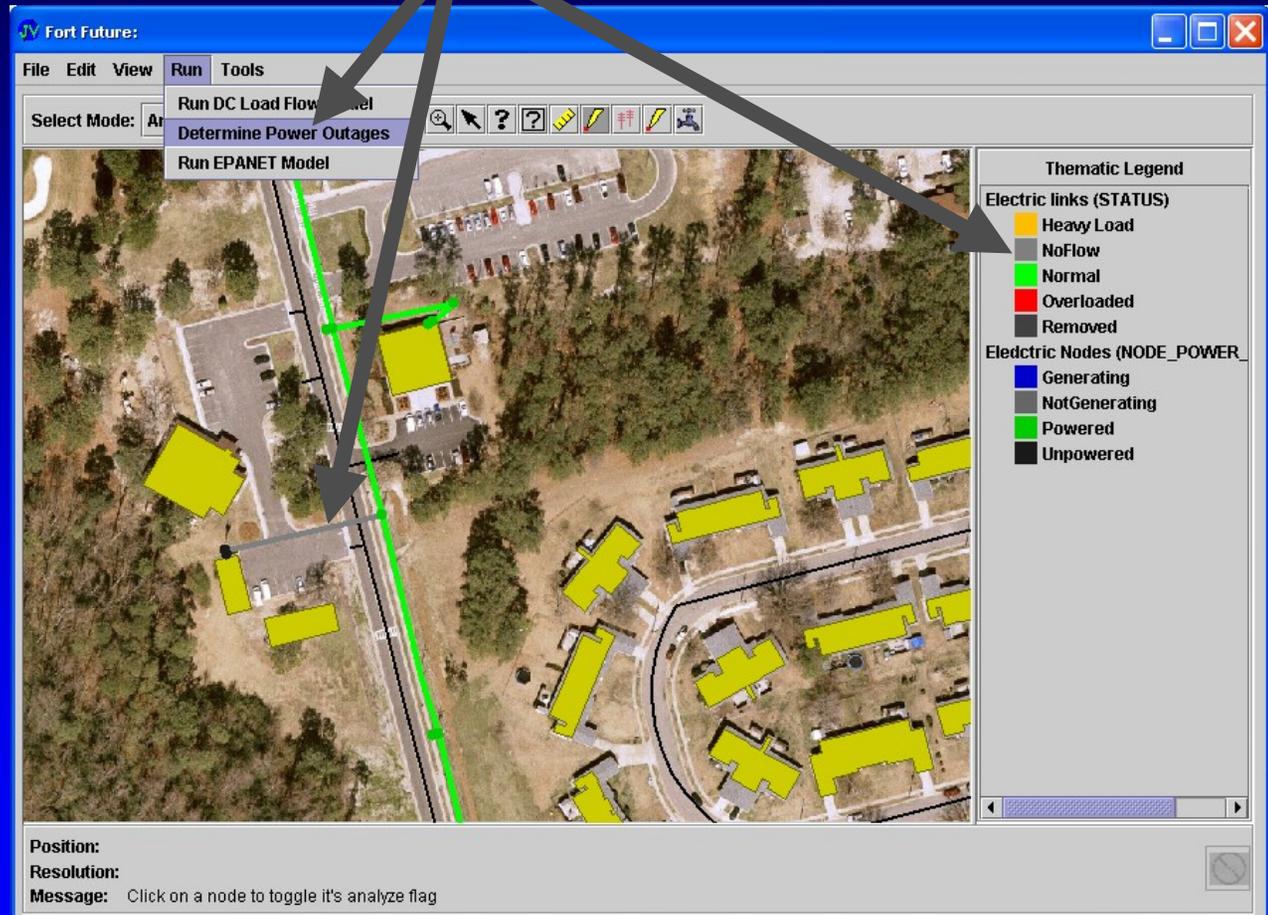
At the bottom of the window, there is a 'Position:' field, a 'Resolution:' field, and a 'Message:' field with the text 'Click on a node to toggle it's analyze flag'.



# Capacity

Test for Power Outages indicates that the load will lead to a power outage along the feeder.

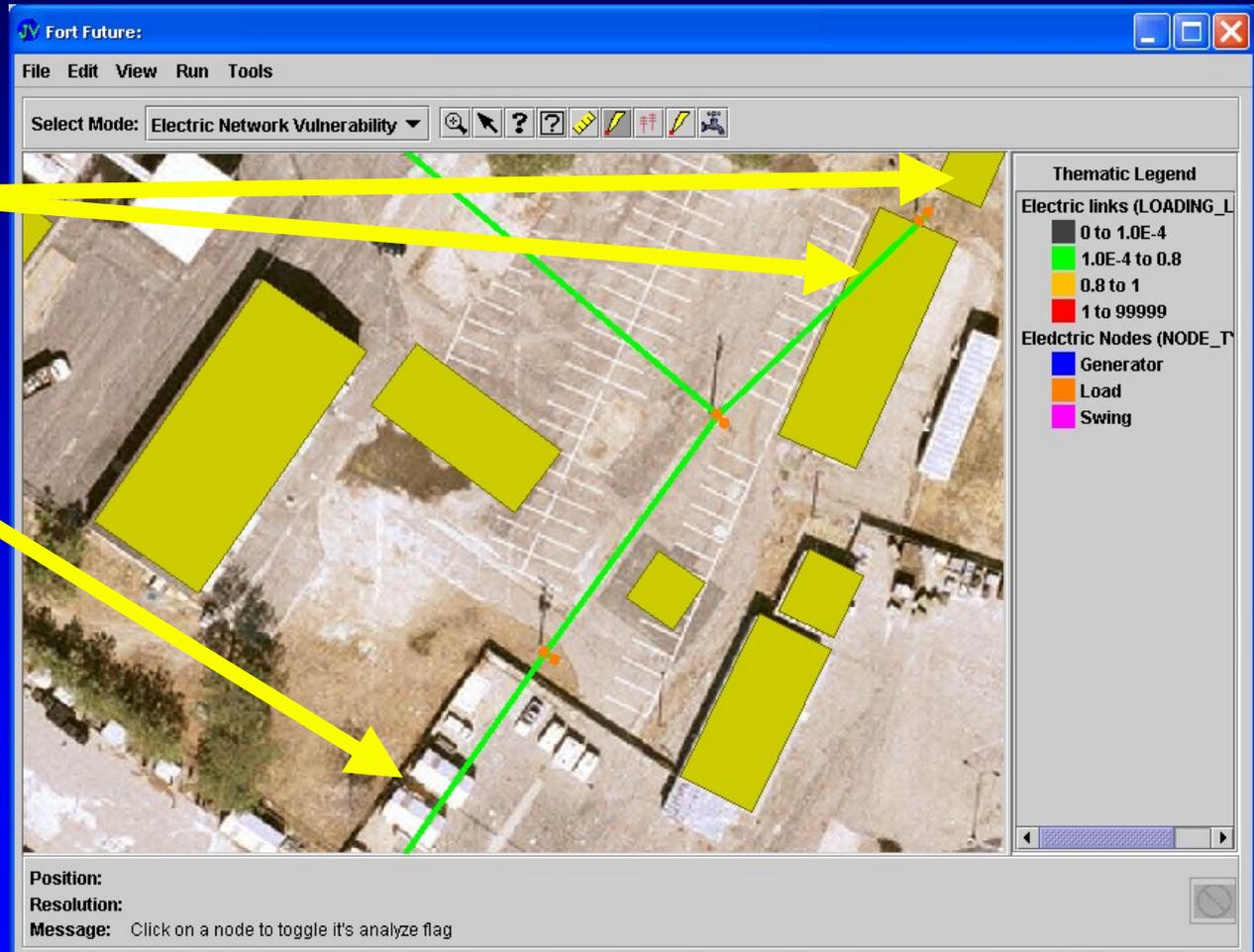
Alternate sites, or other feeder connection configurations in this location can be tested.



# Vulnerability

**Power-dependent missions have moved into facilities.**

**Primary feeder crosses a fenceline, beyond which has reduced security.**





# Vulnerability

Determine the resulting power outages.

The screenshot shows the Fort Future software interface. A yellow arrow points to the 'Determine Power Outages' option in the 'Tools' menu. The main window displays an aerial map of a facility with several buildings highlighted in yellow. A network of green lines represents electric links, with orange dots indicating load locations. A 'Thematic Legend' on the right side of the window provides the following information:

- Electric links (LOADING\_L)**
  - 0 to 1.0E-4 (Black)
  - 1.0E-4 to 0.8 (Green)
  - 0.8 to 1 (Yellow)
  - 1 to 99999 (Red)
- Electric Nodes (NODE\_T)**
  - Generator (Blue)
  - Load (Orange)
  - Swing (Pink)

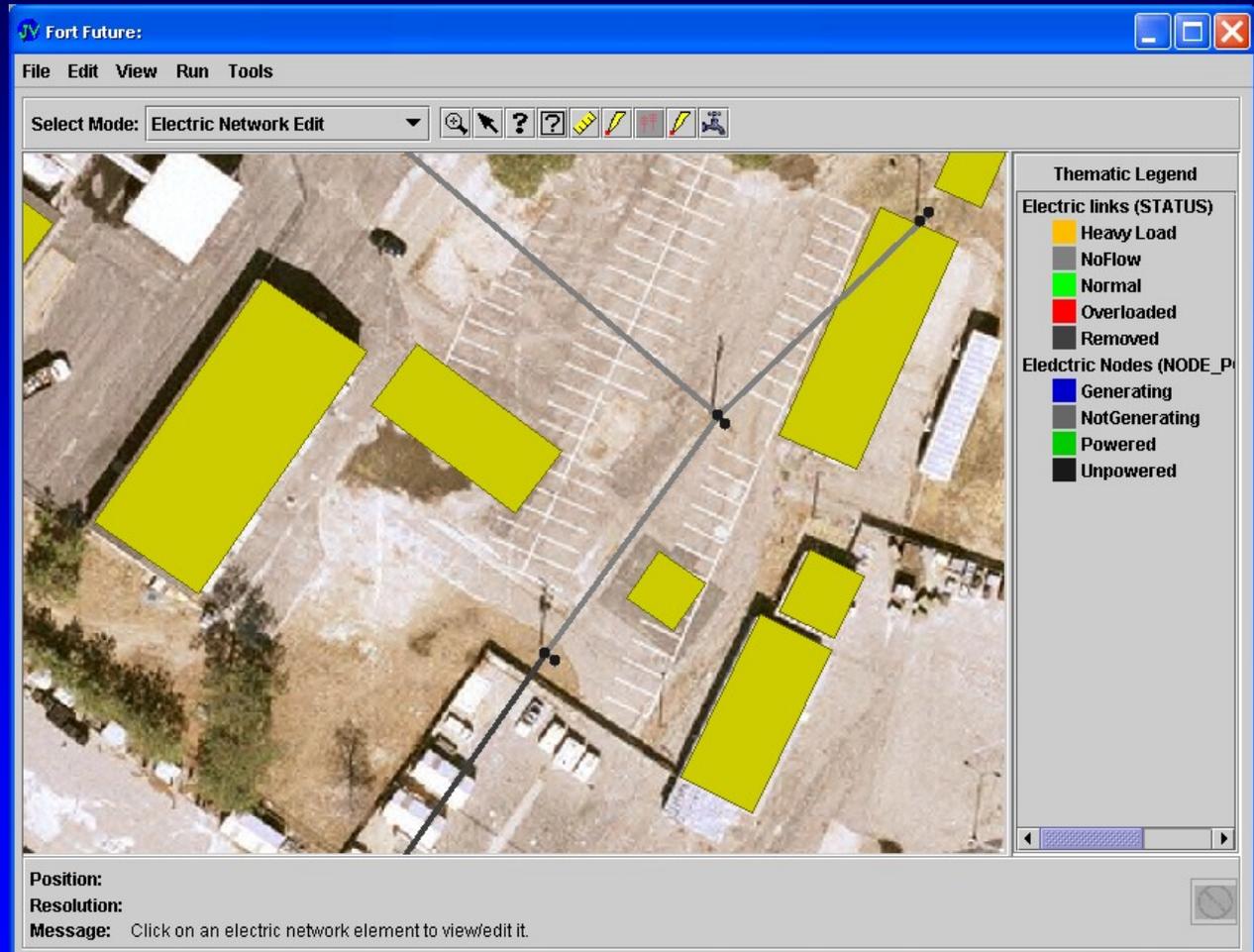
At the bottom of the window, there is a status bar with the following text: 'Position:', 'Resolution:', and 'Message: Click on an electric network element to view/edit it.'



# Vulnerability

The resulting power outages eliminate power to the facilities.

Additional backup generators or redundant power feeds should be tested and implemented.



# Vulnerability

Compare vulnerability across complete installation, selected feeders, or selected geographic area.

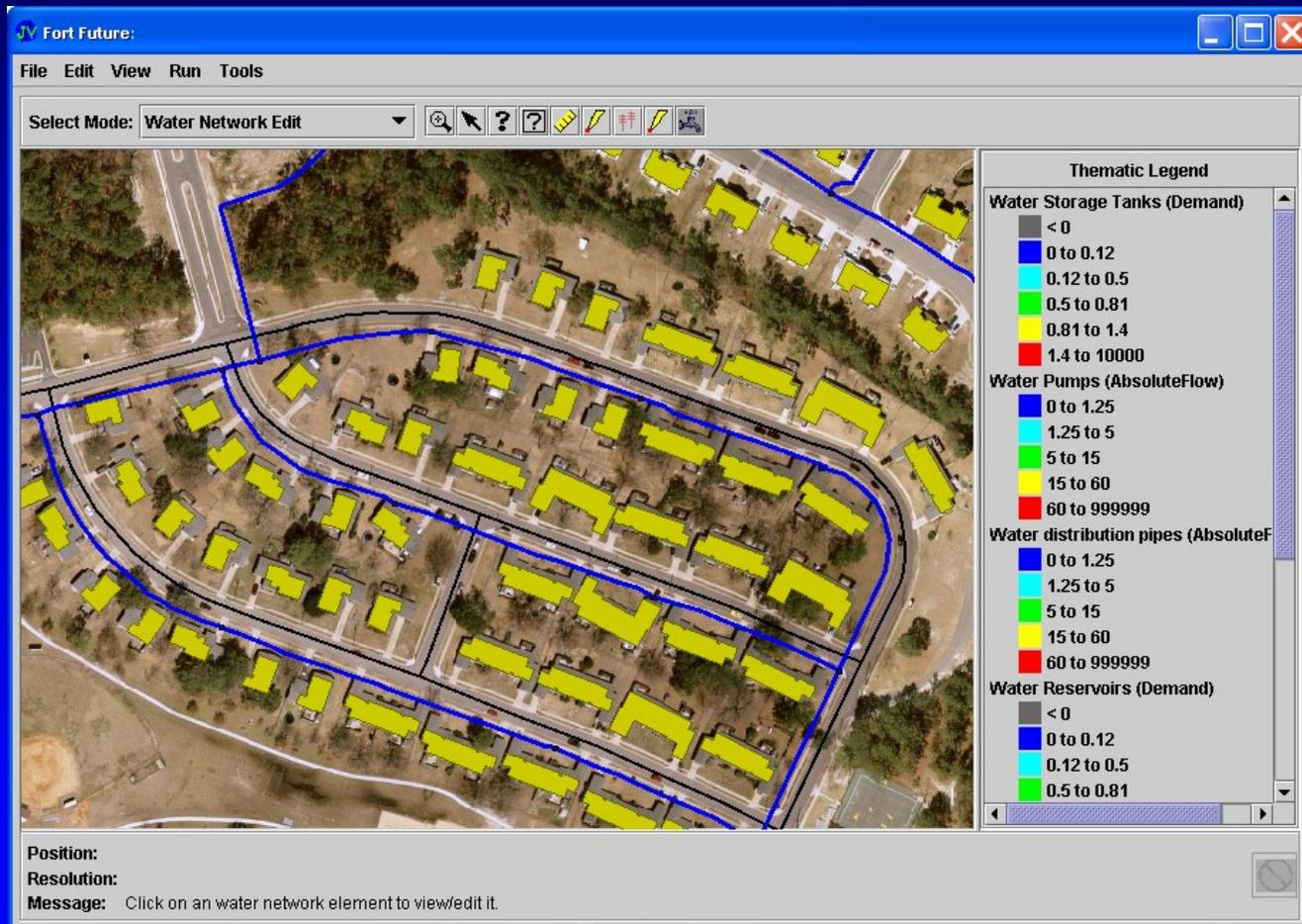
Map or Rank vulnerability by number of affected:  
Critical facilities, total facilities, links, nodes, generators, etc.

Vulnerability Analysis										
Analysis	Component	Vulnerability	...	...	Unpowered Non-critical	Powered Non-critical	Used gener...	Unused ge...	Links w/ No Flow	Links w/ Normal
Run	Link [451...	Medium	0	0	11	360	2	4	12	365
Results	Link [178...	Medium	0	0	11	360	2	4	11	366
Component	Link [445...	Medium	0	0	11	360	2	4	11	366
Highlight	Link [453...	Medium	0	0	11	360	2	4	12	365
Zoom To	Link [191...	Medium	0	0	11	360	2	4	12	365
Outages	Link [453...	Medium	0	0	11	360	2	4	11	366
	Link [438...	Medium	0	0	11	360	2	4	12	365
	Link [454...	Medium	0	0	11	360	2	4	12	365
	Link [192...	Medium	0	0	11	360	2	4	12	365
	Link [186...	Medium	0	0	11	360	2	4	12	365
	Link [192...	Medium	0	0	11	360	2	4	12	365



# Integrated Utility Models

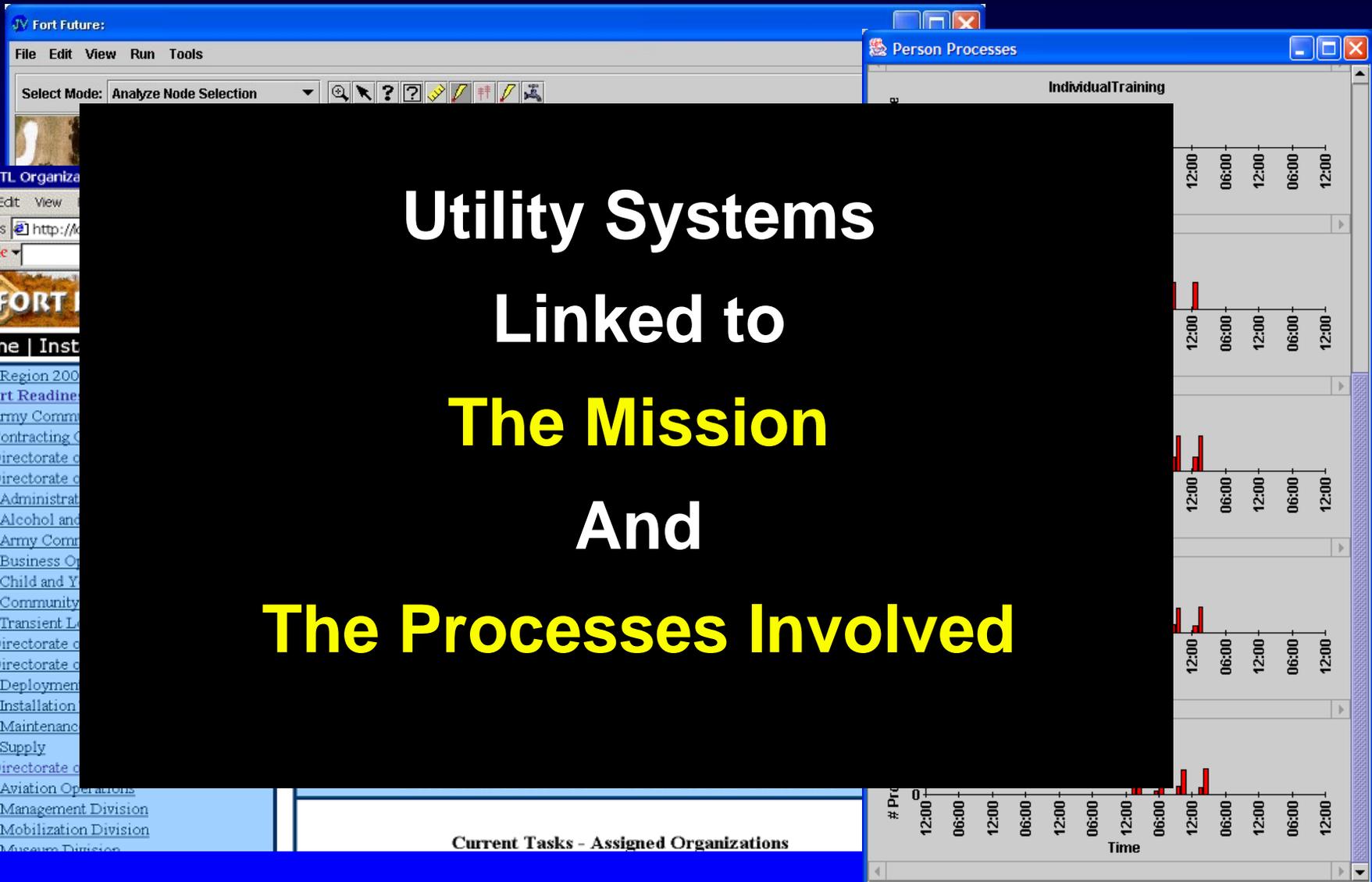
- Electrical and water models
- Models linked to buildings





# Integrated Utility Models

**Utility Systems  
Linked to  
The Mission  
And  
The Processes Involved**





# Integrated Utility Models

**Fort Future:**  
File Edit View Run Tools  
Select Mode: Analyze Node Selection

**METL Organization Page - Microsoft Internet Explorer**  
Address: http://localhost:8080/ffwb/controller?event=METL\_REPORT\_SUMMARY&orgid=3&instid=3

**FORT FUTURE**  
Home | Installation Planning | Force Projection | Facility Composer | Force Protection

**IMA Region 2008**  
Fort Readiness  
[Army Community Hospital](#)  
[Contracting Command](#)  
[Directorate of Civilian Personnel](#)  
[Directorate of Community Activities](#)  
[Administrative Support and Services](#)  
[Alcohol and Drug](#)  
[Army Community Services](#)  
[Business Operations](#)  
[Child and Youth Services](#)  
[Community and Family Recreation](#)  
[Transient Lodging](#)  
[Directorate of Information Management](#)  
[Directorate of Logistics](#)  
[Deployment Plans](#)  
[Installation Transportation Office](#)  
[Maintenance Management Office](#)  
[Supply](#)  
[Directorate of Plans, Training and Mobilization](#)  
[Aviation Operations](#)  
[Management Division](#)  
[Mobilization Division](#)  
[Museum Division](#)

**Fort Readiness Requirements Summary**

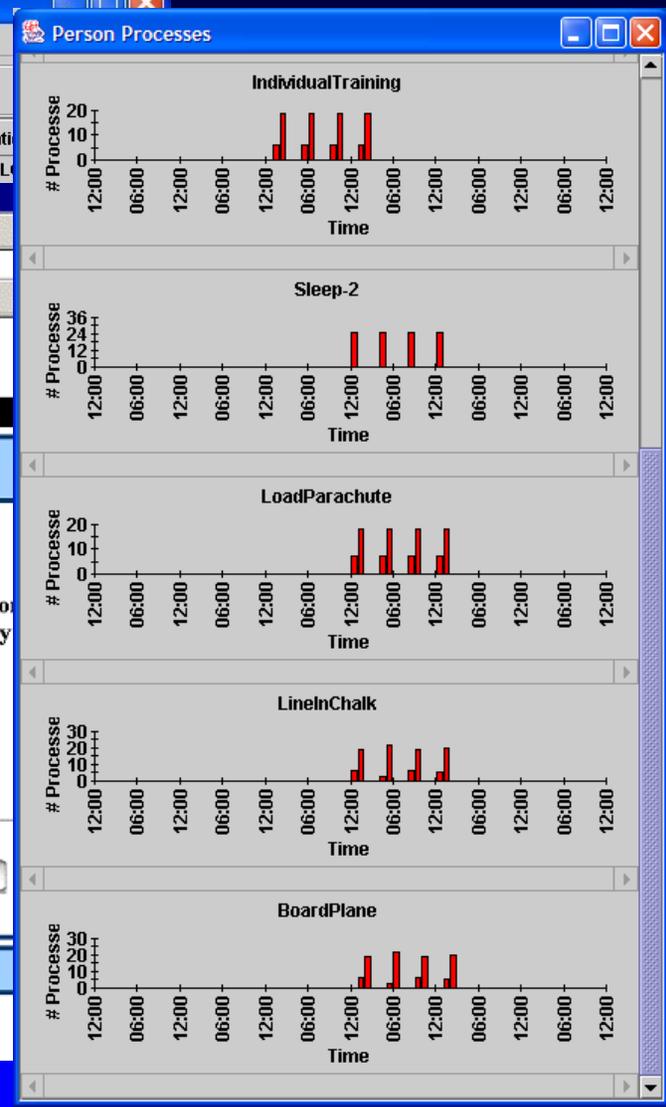
**Mission**  
Provide vital information, power projection, combat preparation, sustainment, force protection and community support to Army Joint Force tenants.

**Vision**  
Total support to train, sustain, and project.

[Edit Requirements Summary](#)   [View Installation Summary](#)

**Fort Readiness - Mission Essential Task List**

Current Tasks - Assigned Organizations



# Summary

- **Enhances energy security**  
*(DEFENSE ENERGY PROGRAM POLICY MEMORANDUM DEPPM 92-1)*
- **Capable of modeling and testing**
- **Connects utilities with Missions**
- **Integrates water and electrical models**
- **Embeds expert knowledge, and does not require an expert user**
- **Minimal data requirements**



# Fort Future Virtual Installation

## Electrical Simulation Capability

*Modeling Power*

*Capacity, Vulnerability, and Impacts*

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