1 Introduction

2 Roadmap

- Exploratory Inventory Location Problem for Newsvendor pre-allocation
- contrived grid/contrived geography no-routing power grid repair scheduling with 1 crew
- contrived grid/contrived geography perfect information road repair with 1 crew
- inclusion of routing into power grid
- formulation of real geography and transition to GIS data
- transition from pipeflow power to DC grid model
- consult electrical engineers RE: power grid analysis
- generate real hurricane scenarios
- 1-2 response style interactions
- 1-2-1 revision style interactions
- joint solution
- incomplete information in roads

3 Exploratary ILP

4 Power Grid Models

4.1 NonInteracting/NonRouting

4.2 NonInteracting/Routing

4.2.1 Variable Glossary

- C_{FlowIJ} is steady state flow on the grid before the hurricane
- C_{lineIJ} is the capacity limit for the power line going from IJ
- $C_{RepairTimeI}$ is the time to repair node I
- $C_{RepairTimeIJ}$ is the time to repair line IJ
- $C_{TravelIJ}$ is the travel time between nodes I and J
- C_{broken} is a coefficient of "broken-ness" representing the average slowdown from debris on the road and minor flooding

- $C_{demandI}$ is the power demand at location I in the pre-disaster steady state
- $C_{GeneratorCapacityK}$ is the maximum power generation for generator K

4.2.2 Variables

- X_{ij}^t is the flow from i to j at time t
- G_k^t is the production from generator k at time t
- Y_i^t is 1 if node i is functioning at time t
- W_{ij}^t is 1 if line ij is functioning at time t
- S_{ij}^t is 1 if line ij is serviced at time t
- K_{ij}^t is 1 if node j follows node i in the tour at time t
- F_i^t is 1 is node i is serviced at time t t

4.2.3 Sets

- L is the set of nodes
- P is the set of power lines
- R is the set of roads
- T is the planning horizon
- J is the set of Generators

4.2.4 Model

$$Minimize \sum_{i \in L} \sum_{t \in T} C_{FlowIJ} - X_{ij}^t$$

Subject to:

(1) $\sum_{i \in L} X_{ik} + G_k^t = \sum_{j \in L} X_{kj} + C_{demandK} \ \forall t \in T \ \forall k \in L$

(2) $\sum_{i \in L} C_{DemandI} Y_I^t = \sum_{k \in J} G_k^t \ \forall t \in T$

(3) $G_k^t \leq C_{GeneratorCapacityK} \ \forall t \in T \ \forall k \in J$

(4) $X_{ij}^t \leq C_{lineIJ} W_{ij}^t \ \forall t \in T \ \forall i, j \in P$

(5) $\sum_{i \in L} C_{RepairTimeI} F_i^t + \sum_{i,j \in P} C_{RepairTimeIJ} S_{ij}^t + \sum_{i \in L} \sum_{j < i \in L} K_{ij}^t C_{TravelIJ} C_{broken} \leq 8 \ \forall t \in T$

(6) $Y_i \leq \sum_0^t F_i^t$

(7) $W_{ij} \leq \sum_0^t S_{ij}^t$

(8) $\sum_{j \in L} K_{0j}^t \geq 1$

(9) $\sum_{j \in L} K_{ij}^t - \sum_{j \in L} K_{ji}^t = 0 \ \forall t \in T \ \forall i \in L$

(10) A subtour elimination constraint

4.2.5 Explanation of Constraint Systems

- Constraint (1) defines flow balance equations for each node
- Constraint (2) defines input/output network balance. This is assuming Generator ramp time can be ignored, but that's fine since excess power can always be dropped to ground.
- Constraint (3) constrains power generation to be in the realm of feasible production
- Constraint (4) constrains line flow to be inside line capacity
- Constraint (5) constrains/decides what gets done during a shift
- Constraints (6) and (7) handle defining operations
- Constraints (8)-(10) handle the routing side of the problem

4.2.6 Comments

- I'm assuming that we're staying in the region of safe production for generators, a later thing to think about is "pushed" generators where they can be run in overdrive for short periods of time