"Synthetic Power Grid Models: What They Are, How They're Made, and Why They Matter

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Motivation

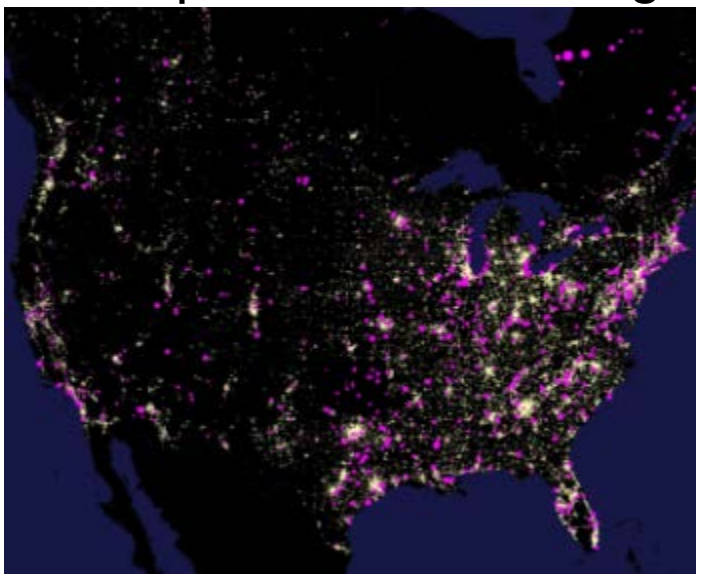
- Access to data about the actual power grid is often restricted because of requirements for data confidentiality (e.g., critical energy infrastructure)
  - Focus here is on high voltage power flow, optimal power flow, transient stability models, SCADA, PMUs
  - Some data is public, some is available by NDAs, and some is essentially unavailable to those outside of power system control centers
- In order for power system community to engage in research that adheres to the scientific principle of reproducibility of results we need common access to models that mimic the complexity of the actual grid

Overview

- There is a need for the creation and dissemination of synthetic (fictional) models and scenarios associated with the high voltage transmission grid
  - The models should be of varying size and complexity, ranging from about 200 buses up to 100,000 buses; the models should also include contingencies and extra parameters for transient stability and GMD analysis
  - All models should have geographic coordinates
  - Model requirements and validation should also considered
- We are developing such models in an ARPA-E Grid Data project
  - Have made 200, 500 and 2000 buses models, with a 10,000 bus model under development

Geography is Key!

- Actual power grids are geographically consistent
  - This is an inherent characteristic that has profound modeling implications
  - Examples include line impedance, and constraints such as lakes, rivers, and mountains



- Traditionally power system planning models did not include geographic coordinates
- This is now changing, partially because of growing GMD studies that require geography, and that require the buses be mapped to substations

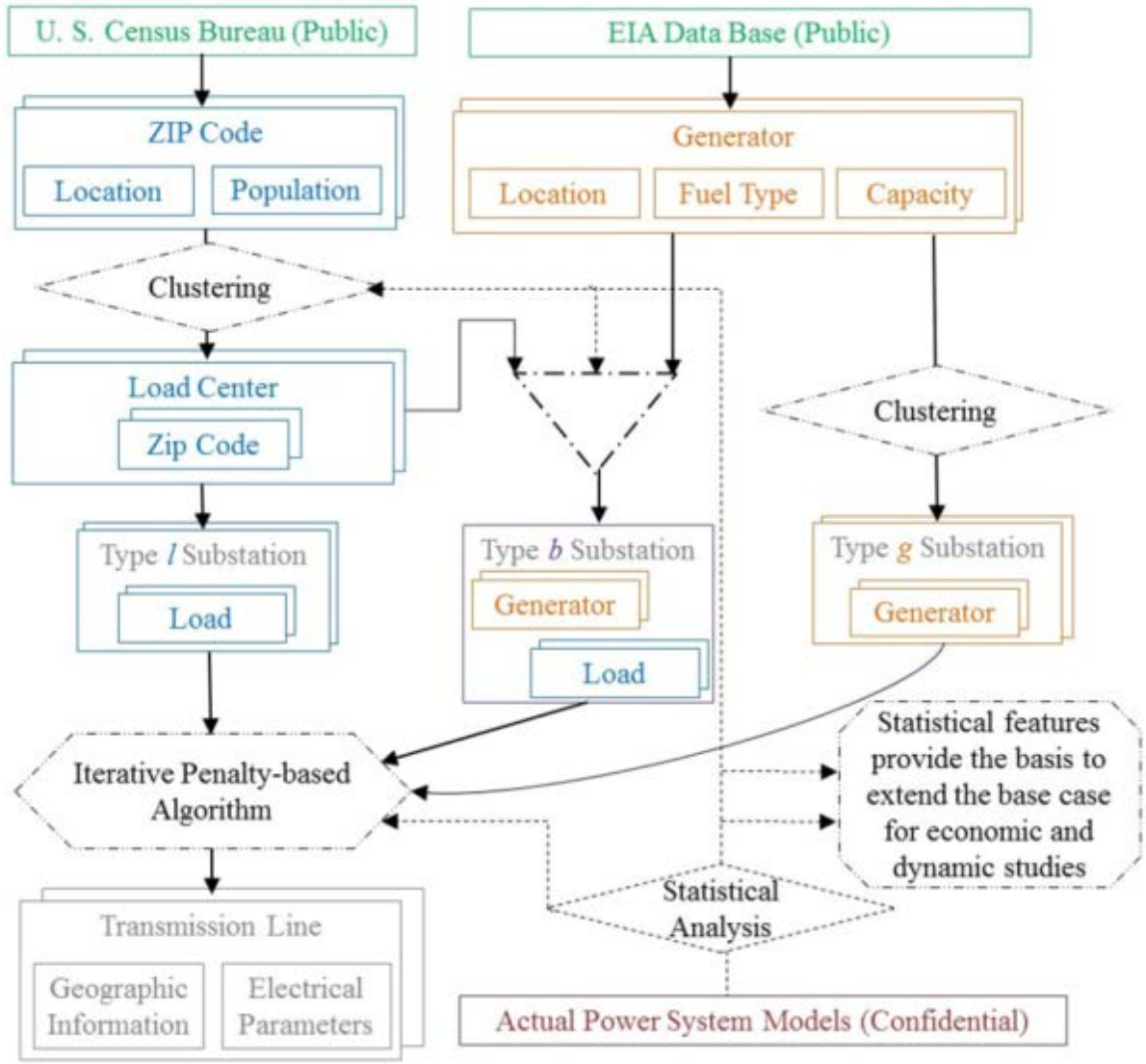
Our Approach

- Our approach is to make models that look real and familiar by siting these synthetic models in North America, and serving a population density the mimics that of North America
  - The transmission grid is, however, totally fictitious
- This approach is predicated on gathering statistics associated with actual grids, and then using those statistics as appropriate
  - Actual grids have idiosyncratic characteristics that need to be considered, some of which are dictated by geography

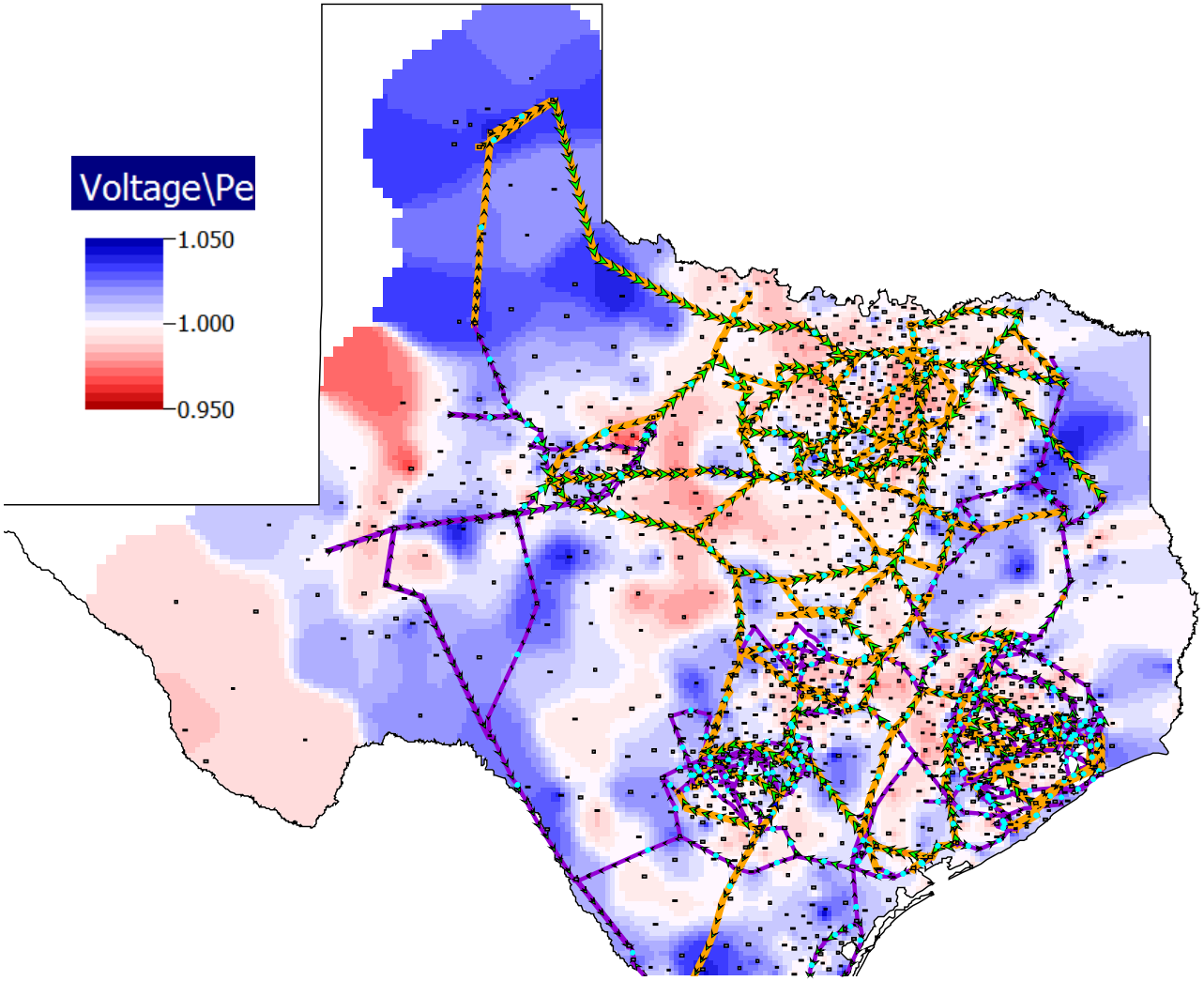
Our Approach, continued

- Approach leverages widely available public data:
  - Geography
  - Population density (easily available by post office)
  - Load by utility (FERC 714) and state-wide averages
  - Existing and planned generation: Form EIA-860 contains information about generators 1 MW and larger; data includes location, capacity and fuel type
- Statistically driven algorithms are used to group buses into substations, place transformers, and include a transmission grid

Overall Synthetic Model Design Process



2000 Bus Synthetic Texas Footprint Model



Model has 2000 buses, 545 generators, and four transmission voltage levels (500, 230, 161, 115 kV). Statistically it is quite similar to actual North American grid modesl

2000 Bus Synthetic Texas Footprint Model: Zoomed View