

# Smart Grid Testbeds

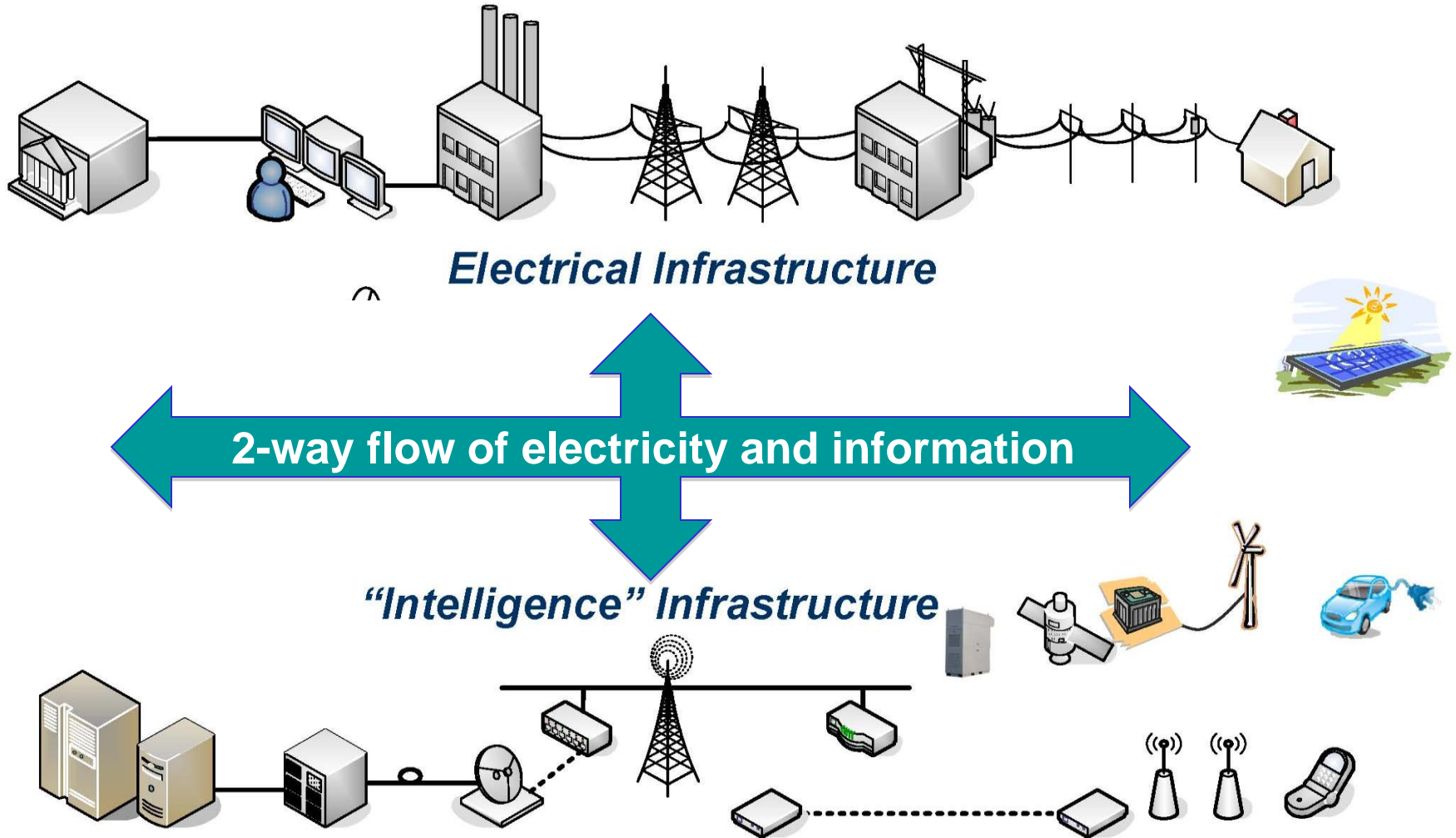
## Characteristics And Thoughts

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# Smart Grid = Electrical Grid + Intelligence ←



# General Frameworks for Testbeds

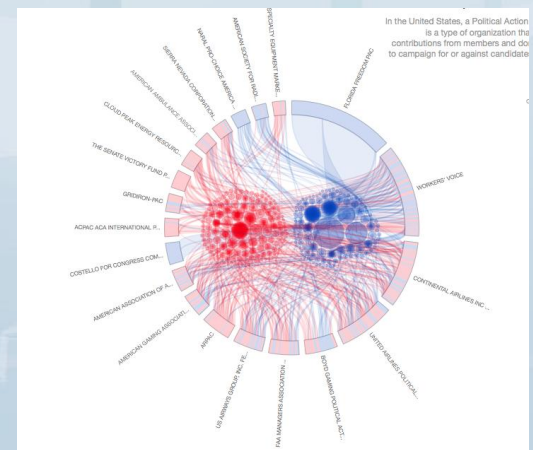
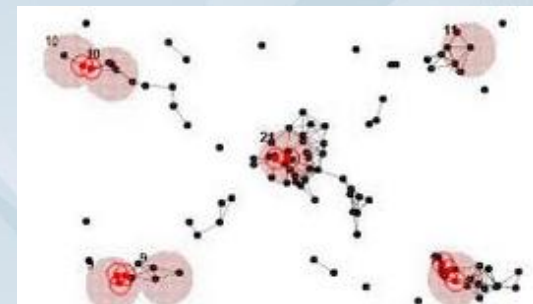
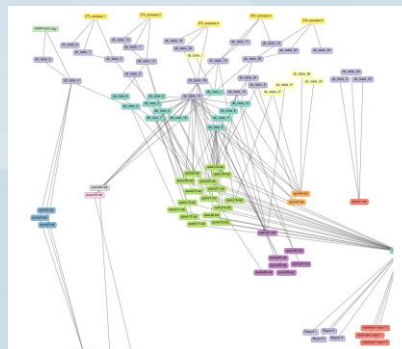
- Physical Testbeds
  - Standards for Physical Interconnection
  - Experiments: Agile/Mutable/Dynamic
  - Scalability
- Logical Testbeds
  - Component/Element Simulations
  - System Simulations
- Modular Testbeds
  - Experiment Specific
  - Evolutionary
- Localized.vs.Distributed
- Homogeneous.vs.Heterogeneous



# Data is Readily Available

## → But Information is Critical

- Floods of Data
  - PSUs – Major sampling points
  - PSU in Every Substation
  - PSU in Every Switch
- Analytic Engines
  - Move the data to the engine?
  - Move the engine to the Data?
- Timeliness of Information Extraction
  - Responsive Control Strategies
  - Forecasting and Capacity Planning
- Visualization for Understanding



# Characterizing A Testbed Framework

- **Modular**
  - Hot swappable real and simulated components/elements
  - Integrated Metering of performance and resilience
- **Distributed**
  - Experiments on loosely and tightly coupled control strategies
  - Information Interoperability as a essential characteristic
- **Heterogeneous**
  - Black Box interconnection strategies
  - Forecasting and Capacity Planning
- **Modular Strategy for Analytic Testbed Evolution**



# Testbeds For Innovation

**Engineering: Identify and leverage agility in experimentation**

**Operations: Dynamical and Responsive Simulation and Control**

**Analytics: Understand the Unexpected Through Big Data**

**Policy: Scenario Development and Simulation**

**Deployment: Plug & Play of the Successes**

