1. Vision Narrative:

a. Technology Description

Smart grid monitoring and control systems (MCS) must interface with a large number of diverse components undergoing complex interactions under a wide range of circumstances. In the absence of actual hardware, MCS modeling and simulation (M&S) is a computational approach to testing how MCS will behave under various scenarios.

b. Current State of the Technology(ies)

MCS M&S tools are developed and used on an *ad hoc* basis. Tools cannot take advantage of the capabilities of the others. Proprietary tools do not promote common understanding and interoperability while much of the open literature has not matured to practical application.

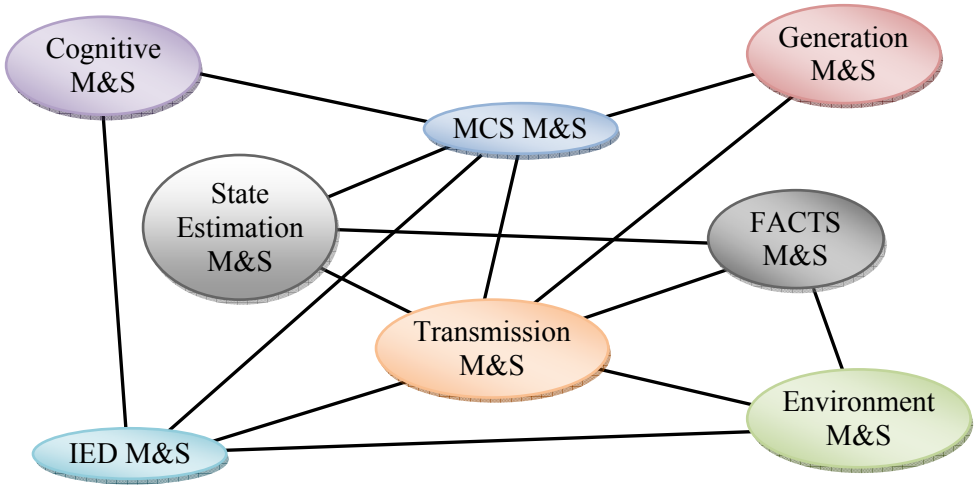
c. Anticipated Future State of the technology(ies)

Standardized MCS M&S tools will be readily available from multiple vendors. Data formats will be also be standardized. Tools will be able to follow arbitrary, well-specified business rules. Tools will scale their input and CPU needs and output capabilities as desired from simple approximations to high fidelity depending on the available data, hardware, and time. Tools will be able to take advantage of computing services wherever they exist from smart phones to HPC to cloud services. Standard interfaces to these tools will accommodate various third-party software components including state estimation M&S. Other software components will be able to simulate human performance and behavior. Vendors of products such as intelligent electronic devices (IEDs) will supply MCS M&S-compatible software component models of their products while others will provide interfaces for real-time hardware in the loop simulations.

d. Concepts for Innovative applications of the technology(ies) within Smart Grid

MCS M&S could be applied to any grid-connected product or service. Vendors would use it for conception and design of smart grid components while owners could use them during planning and operations. MCS M&S components could provide tireless advice, overwatch, and/or backup for grid operators.

e. Model describing the concept – behavioral and architectural



2. Tier 2 use cases that this Technology Vision applied to:

- **a. UC01, Transmission planning**
- **b. UC03, Bulk Power/Transmission Dynamic Operations**
- **c. UC05, Transient operations**
- **d. UC06, Asset Management**
- **e. UC10, Ad hoc configuration due to extensive use plug-and-play sources and loads**
- **f. UC13, Real time load and generation matching control**
- **g. UC21, Fast adaptive protection and quality of service drive design and planning**

3. Revolutionary or disruptive advancements in computer science key words:

- **a. Modeling methodologies**
- **b. Automatic Programming**
- **c. Modules and interfaces**
- **d. Interoperability**
- **e. Cognitive simulation**
- **f. Types of Simulation**

4. **Anticipated technology evolution and barriers to evolution:**

- **a. Assumptions**
  - i. (Just list)
  - **ii.**
  - **iii.**
- **b. Sequence of Events**
  - i. (Just list)
  - **ii.**
  - **iii.**
- **c. Tech Challenges, Issues, and barriers**
  - i. (Just list)
  - **ii.**
  - **iii.**
- **d. Areas that need research and development**
  - i. Multi-fidelity M&S
  - ii. Heterogeneous M&S integration
  - iii. Automatic scenario generation
- **e. Training and education needed**
  - i. (Just list)
  - **ii.**
  - **iii.**
- **f. Standards Needed**
  - i. Smart grid data formats
  - ii. MCS M&S tool definitions
  - iii. MCS M&S interface definitions
- **g. Other Needs**

i. (Just list)

ii.