

UQ, UPSCALING & COUPLED SYSTEMS

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Outline

- SmartGrid Specific Challenges
- Challenges and Opportunities Enabled by SmartGrid

Math Challenges Specific to SmartGrid

Coupled Dynamics/Hybrid Systems

- Coupled networks together with human behavior
- Distributed generation (PVC) coupled to concentrated intermittent generation (wind)
- Random eigenvalue problem

Control through pricing

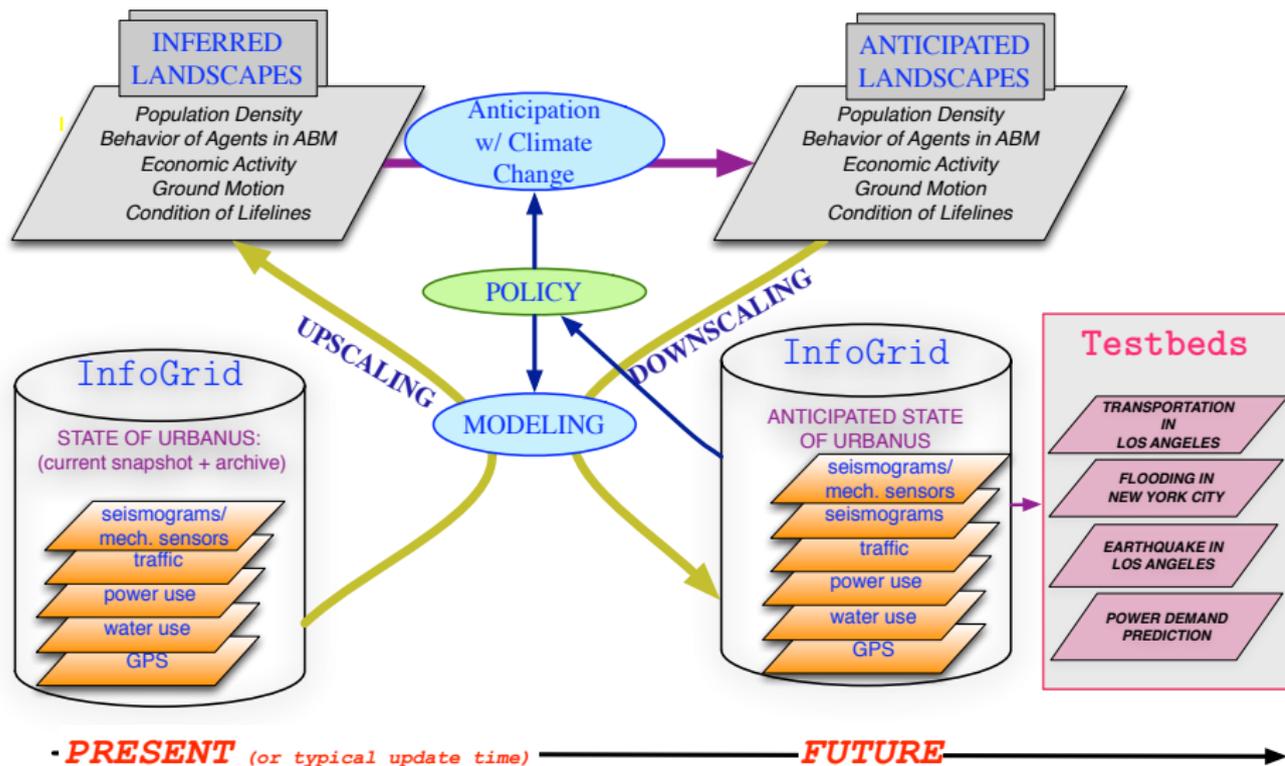
- validated models for interacting agents and actors (humans, organizations, etc...)
- game-theoretic approaches

Coupled networks

- Coupling of information and power networks.

Sustainability by Design

SENSING / COMMUNICATING / MODELING / DECISION



- Use information technology and modeling to enable the engineering of policies and decisions with managed consequences.

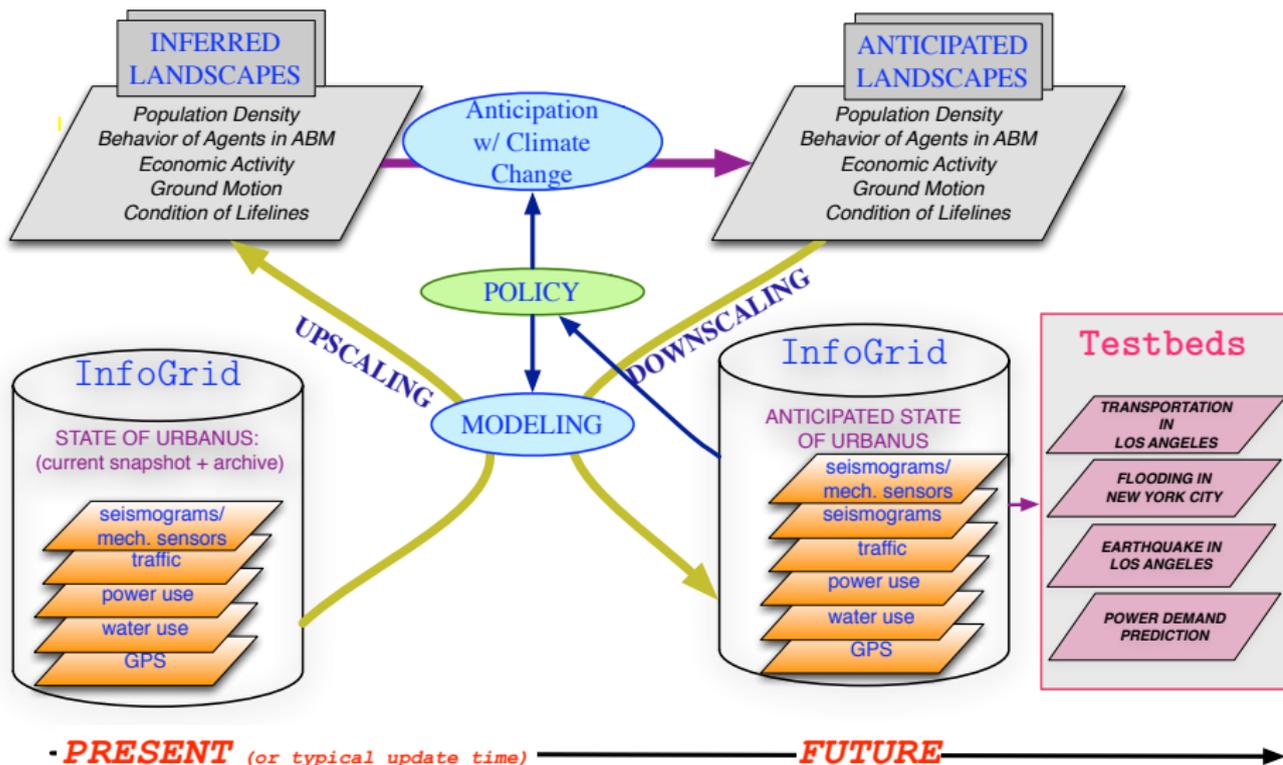
- Enable data-driven prediction science for complex coupled infrastructure systems accounting for human dynamics.

Approach and Methodology

- Create information immersion through a hierarchy of area networks.
- Develop requisite IT infrastructure.
- Develop validated models of population dynamics and model response of humans to policies and environmental drivers.
- Develop models for coupling humans and infrastructure systems.
- Fold predictive models into decision-making environments.

Integrated Solution

SENSING / COMMUNICATING / MODELING / DECISION



CONSTRUCTION OF COARSE-SCALE DYNAMICS:

Identify and synthesize dynamics for coarse-scale variables.

- **Approach:** Nonlinear filtering and stochastic marked processes on multiple scales.
- **Impact:** Permit two-way transitions between InfoGrid and Coarse Landscapes.

VALIDATION OF HYBRID MODELS:

Develop procedures and algorithms for validating agent-based models of human behavior.

- **Approach:** Rely on random matrix theory to describe transition probabilities as statistics.
- **Impact:** Permit more confident reliance on ABM for projecting future of urban environment and response to policies.

DATA INTEGRATION:

Develop methodology and algorithms for coupling data collected with different instruments and at different nodes in the network hierarchy.

- **Approach:** Hierarchical statistical models and stochastic upscaling techniques.
- **Impact:** Efficient use of communication and computational resources.

Rapid condition assessment and emergency response following an extreme event.

- **Approach:** Reduced order models assimilated from observations used for Bayesian update of coupled prior models.
- **Impact:** Reduce human and economic loss; expedite recovery.