IOWA STATE UNIVERSITY

CPS: Medium: Cyber Attack-Defense Modeling, Risk & Contingency Analysis for Power Grid using Game Theory

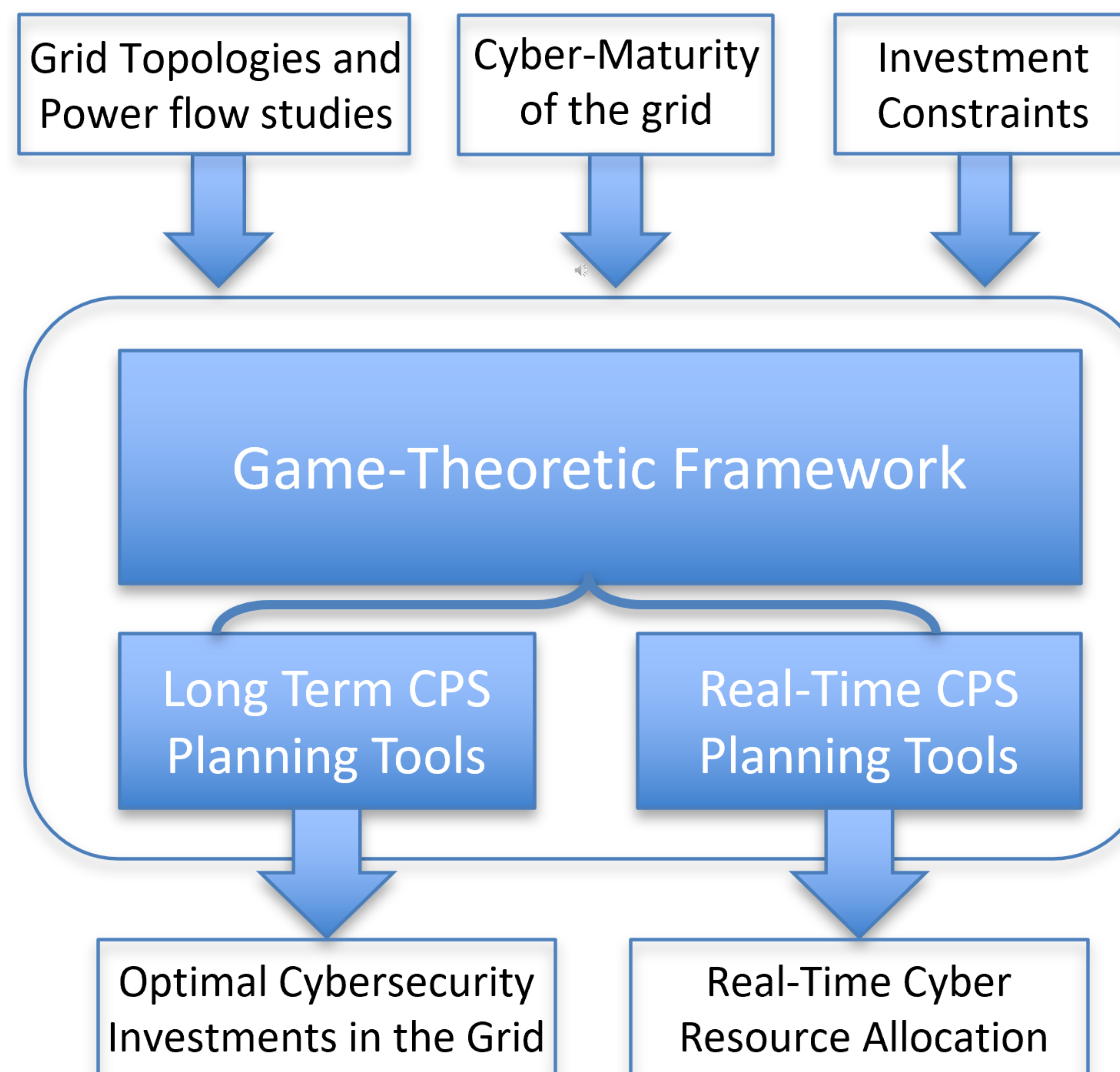**PIs:** Manimaran Govindarasu and Sourabh Bhattacharya

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Objectives

- To develop **cyber risk assessment tools and methodologies** to optimize security investments to defend the grid against attacks
- To develop **real-time operational planning strategies** to handle multiple contingencies due to coordinated attacks
- To **evaluate the effectiveness** of the proposed game-theoretic models and defense algorithms

Solutions

- **Risk assessment-based** cybersecurity investment optimization using game-theoretic approach (zero-sum games)
- **Real-time** resiliency-based **cyber resource allocation** using game theoretic framework (non-zero-sum games)
- **Computational complexity reduction** from exponential to linear time for N-k contingency analysis using special properties of zero-sum games in power grids

Grid Topologies and Power flow studies

Cyber-Maturity of the grid

Investment Constraints

Game-Theoretic Framework

Long Term CPS Planning Tools

Real-Time CPS Planning Tools

Optimal Cybersecurity Investments in the Grid

Real-Time Cyber Resource Allocation

Broader Impacts

- Cyber Risk Assessment Tool that helps to systematically quantify cyber risks and helps to make cost-optimal security investment decisions.

- CPS contingency analysis methodology, metrics, and proof-of-concept studies showing their benefit and efficacy in smart grid's energy management system (EMS).

- Broader applicability of the game-theoretic models, metrics, and methodology to model cyber risk, investment analysis, and CPS contingency analysis in other CPS critical infrastructure systems.

- Workforce development: Graduate education (course work and thesis research) and undergraduate senior design project(s).