

Hierarchical Coordinated Protection of the Smart Grid with High Penetration of Renewable Resources



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Research objectives

Goal:

- Design of a hierarchically coordinated protection paradigm
- Integration of decentralized component protection and centralized wide area protection

Three hierarchically coordinated layers:

- Predictive protection
- Inherently adaptive protection
- Corrective protection

Importance for the future grid

Answering critical questions of future grid protection:

- How the legacy relaying works under overloads, cascades and high penetration of renewable resources
- Why it fails to offer satisfactory solution for complex network conditions expected in the future
- What are the expectations for skills of the future protection engineers

Avoiding unsatisfactory results from today's protection caused by:

- New system conditions
- Pre-calculated relay settings
- Fixed measurement algorithms

Research deliverables

First year:

- A concept of the overall hierarchical coordination scheme
- A white paper describing the framework for hierarchical coordinated protection

Final:

- A report with the full details of the new concept and experimental results

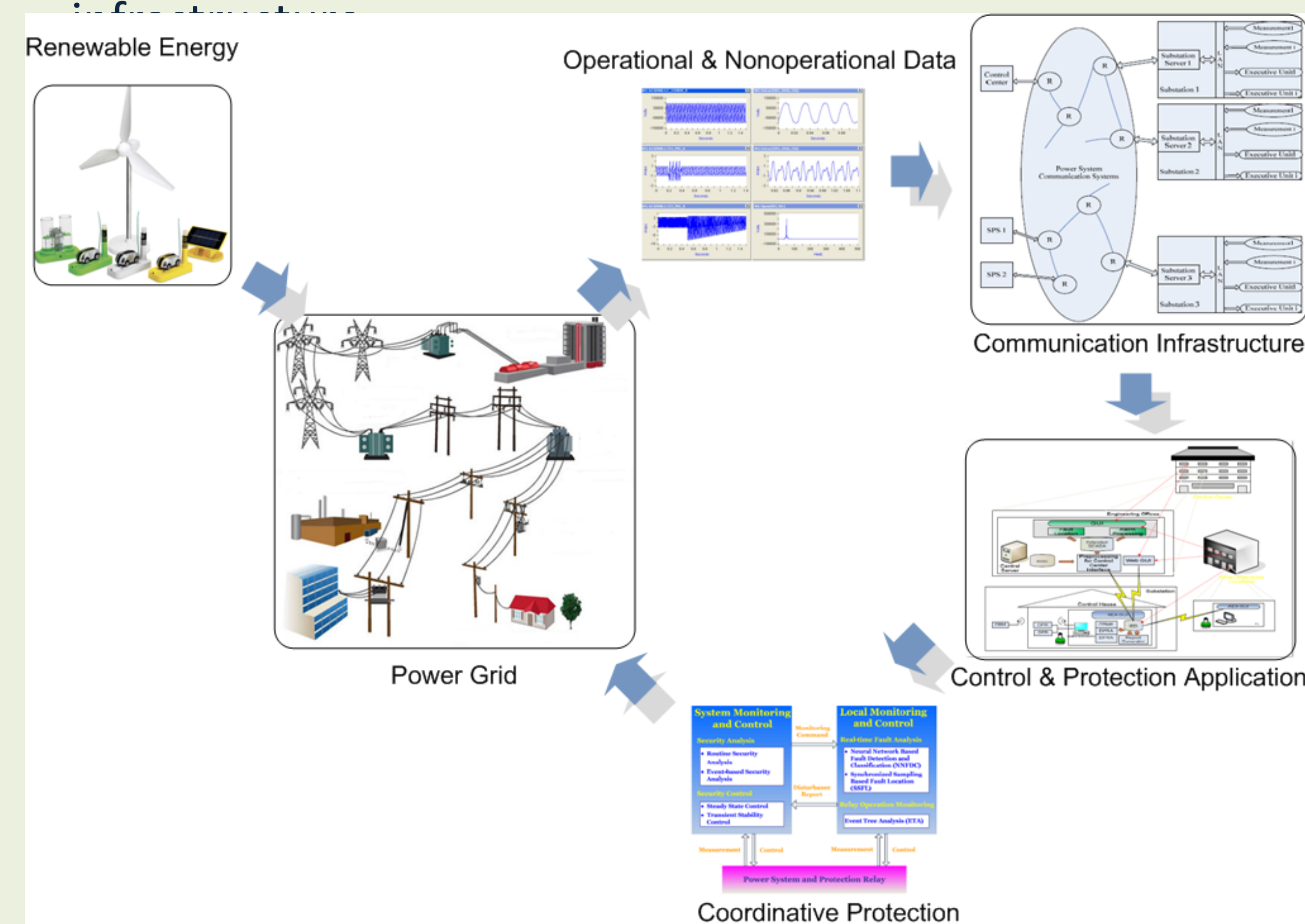
Research approach

Subtasks:

- Define protection issues and network conditions that current solutions cannot handle well
- Specify new protection requirements associated with high penetration of renewable resources
- Outline criteria for the design of new protection solution that can improve efficiency and reliability
- Propose conceptual solution for the hierarchically coordinated protection scheme
- Describe each of the three protection layers and explain how they may be implemented
- Present overall solution using some modeling and simulation, as well as real-life examples
- Assess major benefits of the new coordinative protection approaches

Methodology:

- Time simulation of the power grid
- Time simulation of individual protection device
- Time simulation of communication and computation infrastructure

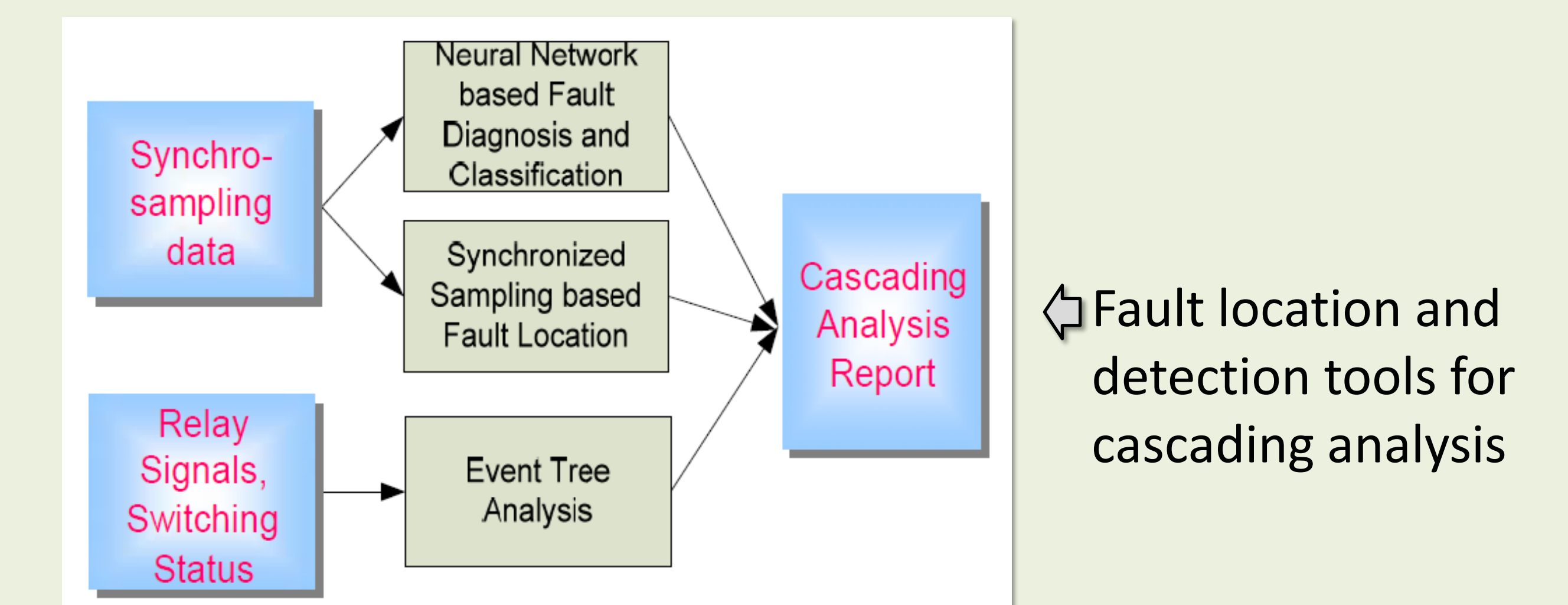


🏠 Concept of Coordinative Protection

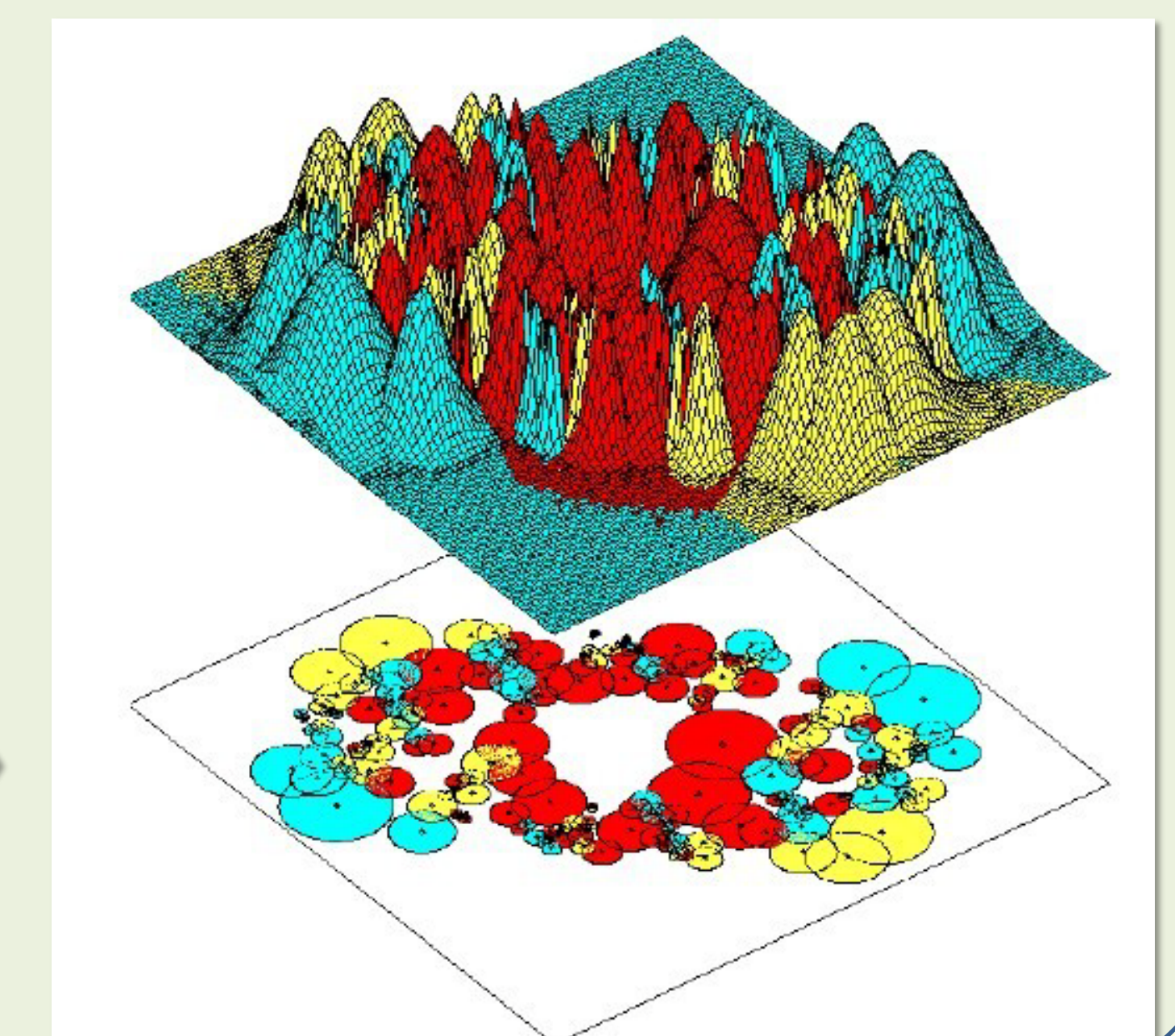
Accomplishments to date

Focus of current study is the new protection methods for predictive, adaptive and corrective protection and the requirements on sampling, synchronizing, transmitting and processing of data.

- Predictive protection for mitigation of cascading events
- Application of Neural Network algorithm to achieve inherently adaptive relaying
- Two-ended fault location for corrective relaying



Fuzzy ART Neural Network algorithm for fault classification



Potential uses of this research

- Retrofit and redesign of future communication system for system protection
- Training of system engineers
- Solutions that are inherently adaptive and have optimality in dependability and security
- Application of such solutions in solving future challenges:
 - High penetration of renewable resources
 - Detection, classification and mitigation of cascades
 - Malicious attacks
 - Line overloads and severe voltage conditions
 - Simultaneous events of faults and out-of-step condition