

Coupled Cascading Failure in Energy CPS: Modeling and Prevention

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Cascading failures in Energy CPS have caused **Blackouts**. The project introduces **dynamic cascading failure model and centralized optimal preventive control** for power grids consisting of **interdependent** physical and cyber layers with fiber-optic/wireless communication systems supported by **battery backup**.

Key Challenges

Modeling cascading failure:

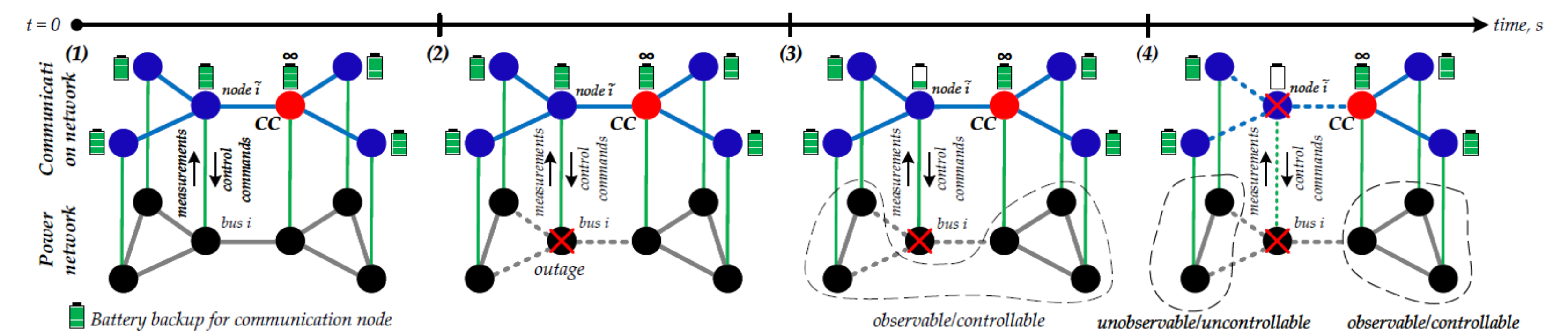
- Striking a balance between accuracy vs complexity – Fast dynamic cascade model
- Modeling interdependent failures in cyber and physical layers and battery backup

Prevention of cascading failure:

- Mitigating cascade by generation rescheduling considering AC OPF while addressing uncertainty in controllability and observability
- Integrating the proposed preventive controls with CPS model

Scientific Impact

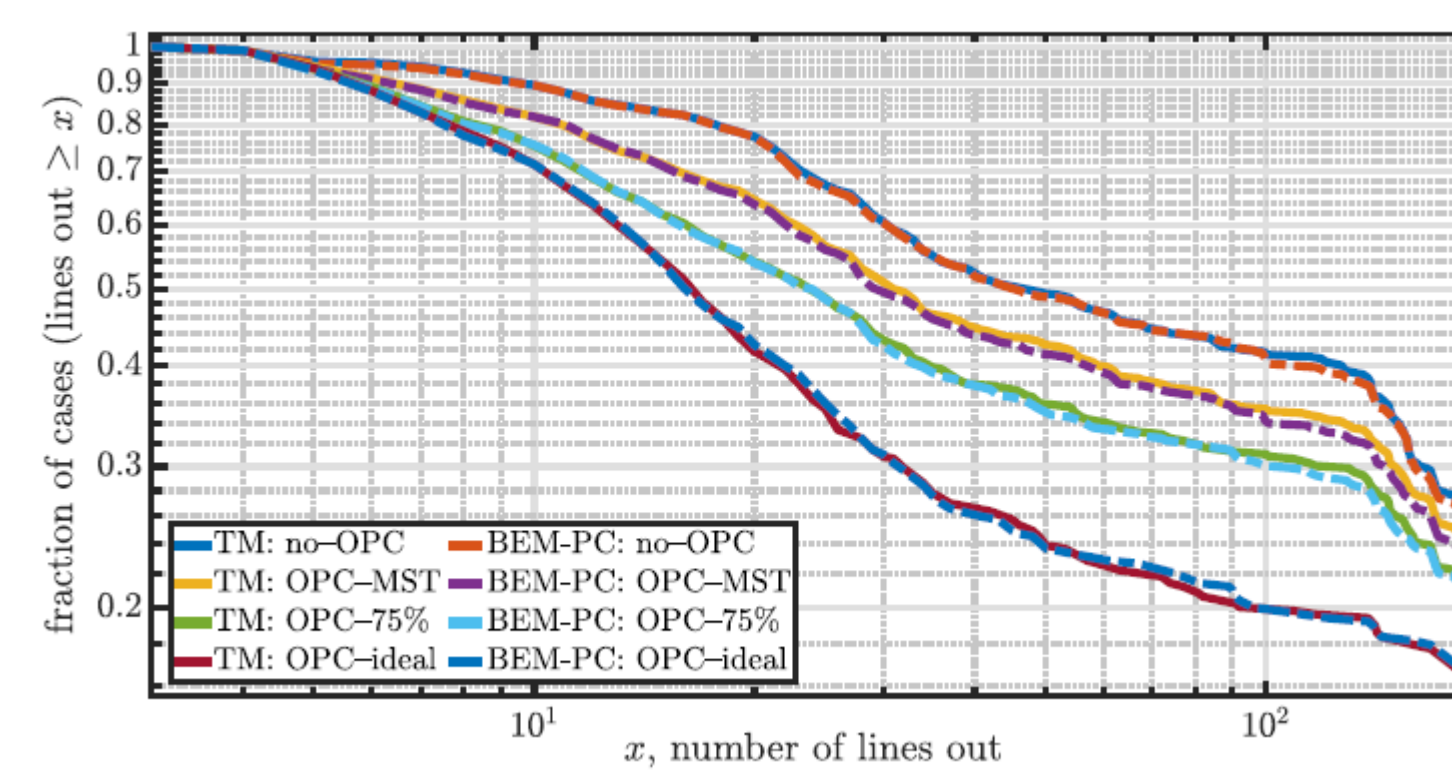
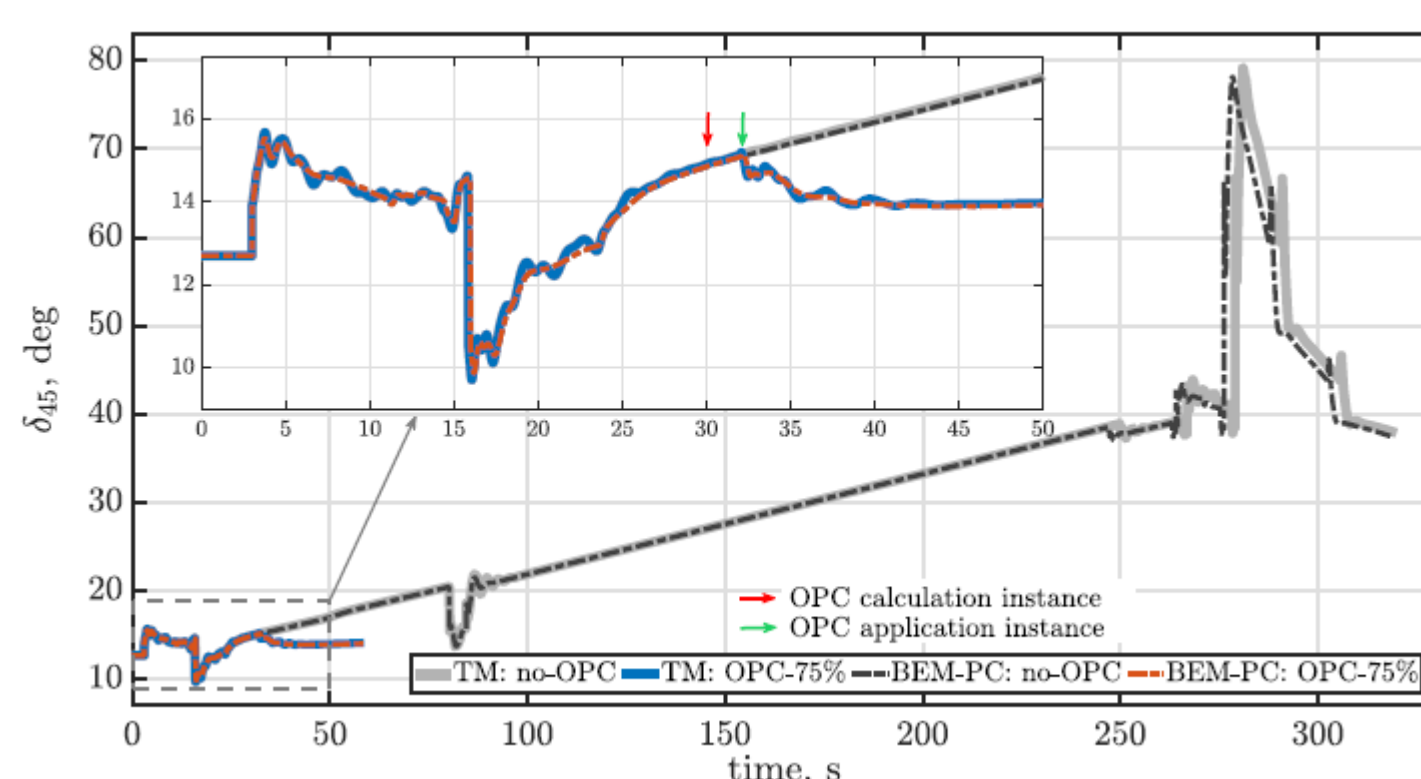
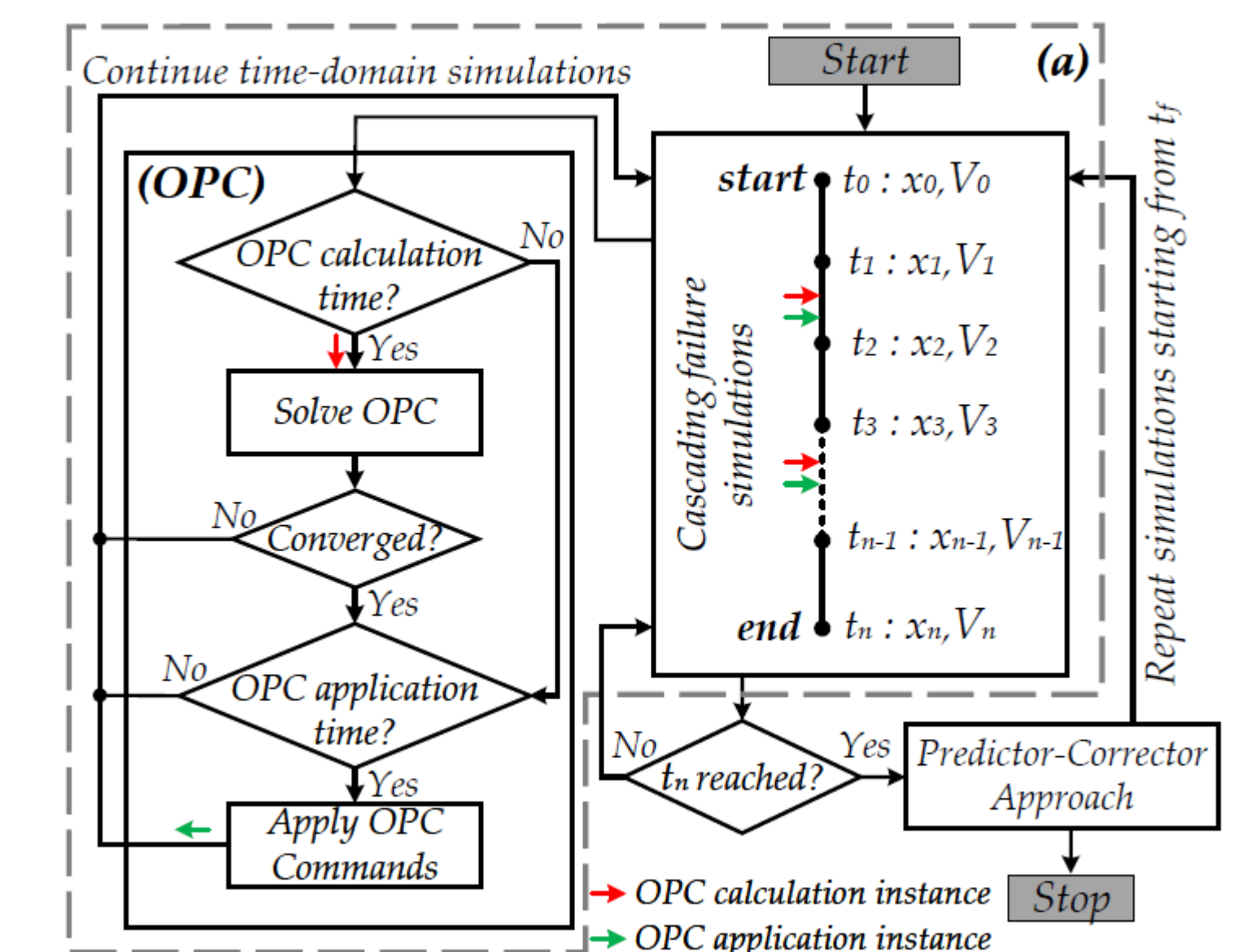
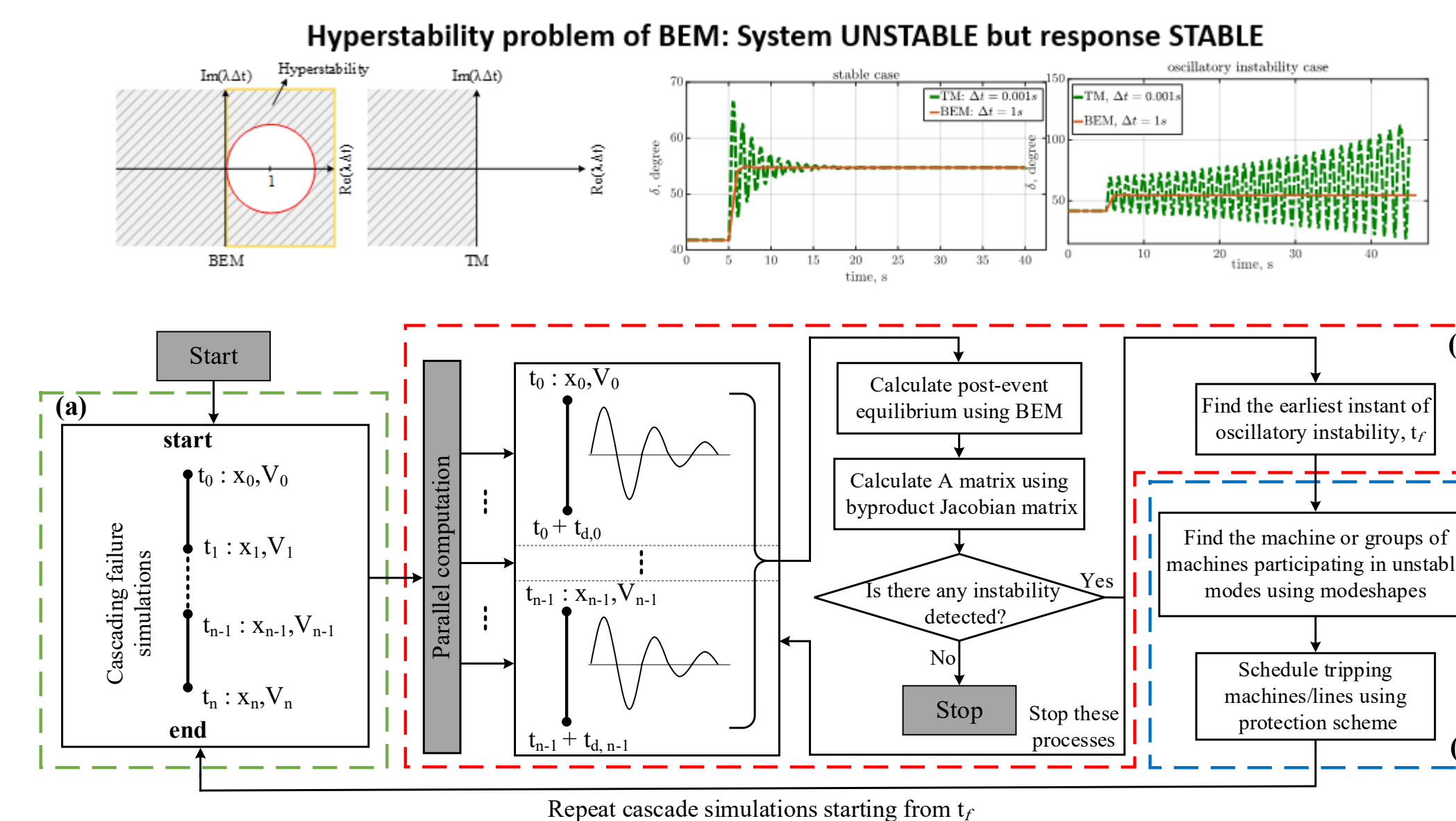
Any CPS where failure propagates in a coupled manner among the cyber and physical layer will benefit from our research.



Examples -- Aviation Control Towers, EV-dominated Transportation

Proposed Solution

Attributes	Performance of the State-of-art Cascading Failure Models			
	QSS Models		Phasor-based Dynamic Models	
	DC-QSS	AC-QSS	Conventional (TM/R-K)	Proposed (BEM-PC)
Accuracy	Very poor	Poor	Ground truth	~Ground truth
Speed	Extremely fast	Very fast	Extremely slow	At least 9X speed
Statistical analysis	Feasible	Feasible	Not Feasible	Feasible



Broader Impacts: Multiple Summer Camps in EE and CSE Departments



Scientific & Societal Broader Impacts

- Introduces computationally manageable dynamic CPS cascading failure model **for the first time**.
- Proposed preventive control strategy can stem large-scale blackouts and save billions of dollars. **Has direct impact on human society and economy**.
- **1 Patent app, 6 Journals, 7 Conferences, 3 Ph. Ds, 1 MS**

