Cyber Attack Resilient Control Systems

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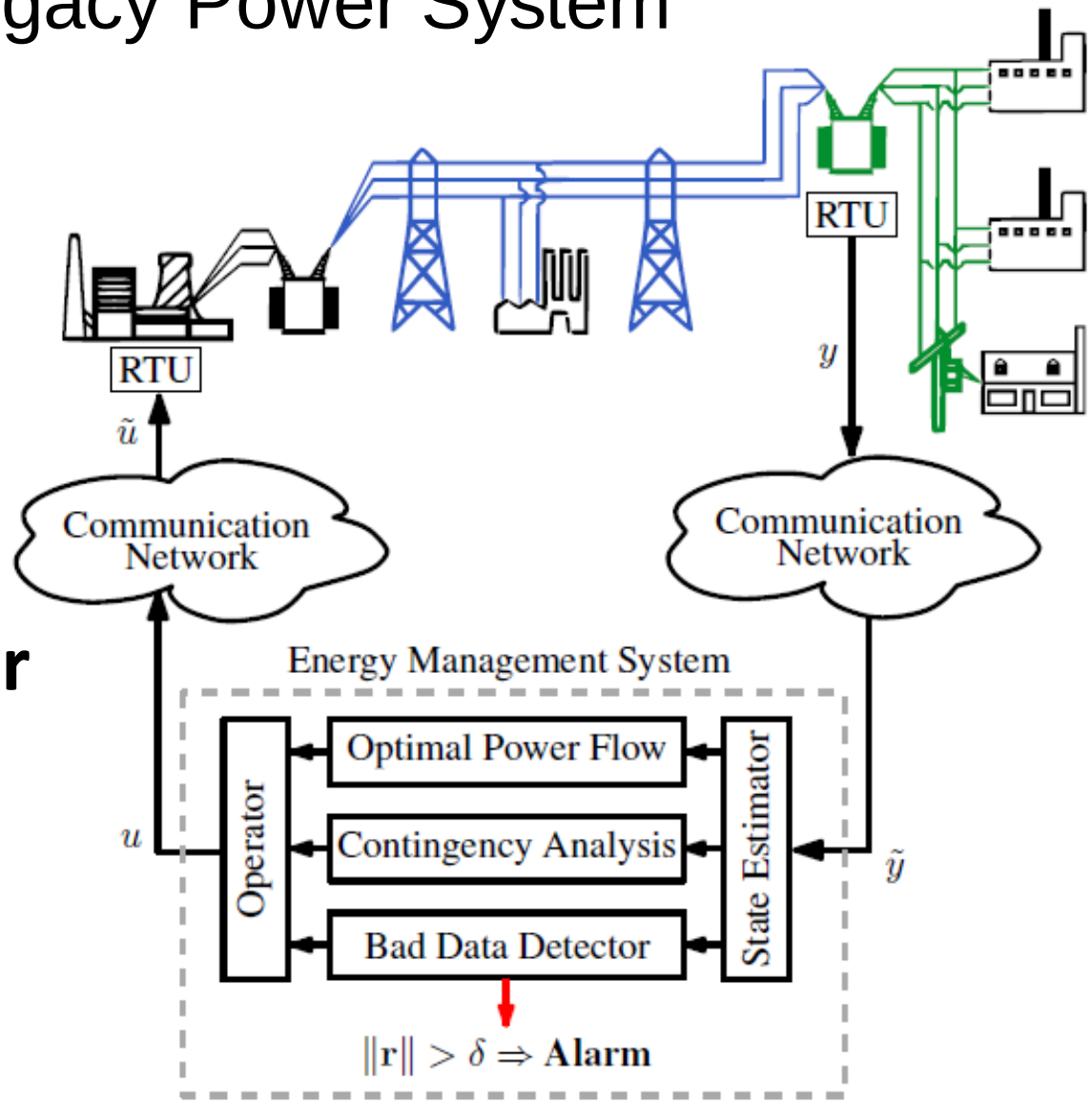
Motivation: Legacy Power System

Power system control and monitoring over networks



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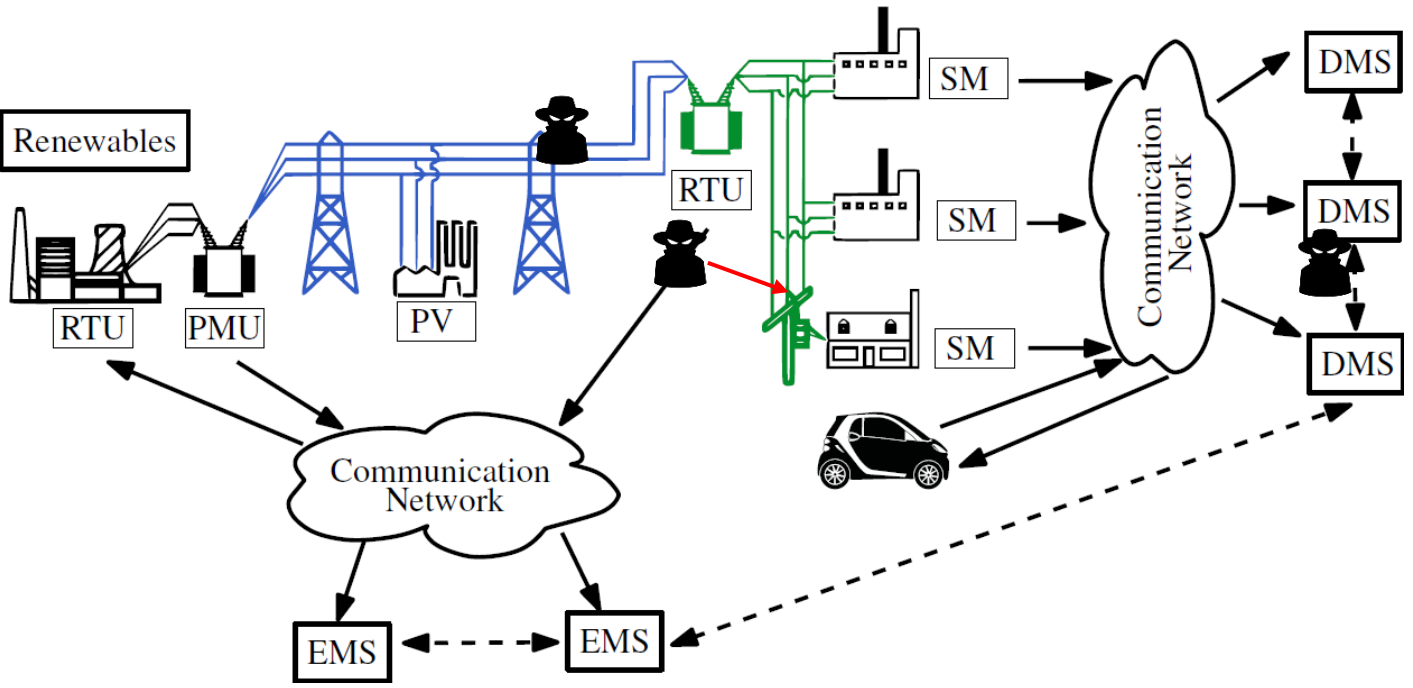
Motivation: Smart Grid

SMART GRID PROTECTION AGAINST CYBER ATTACKS

Smart Grid

- More
  contro
- Large
  comm
- Leads
  vulner
  threat
  points of attacks



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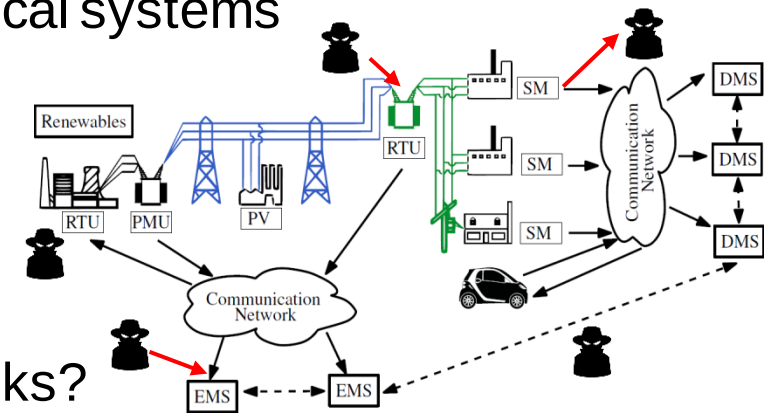
Motivation

- The Smart Grid is a cyber-physical system
  - **Power system** and **IT infrastructure** tightly coupled through SCADA and control systems
  - integrated with data analytics environments etc.

- Traditional IT security provides necessary tools
  - but not sufficient to secure cyber-physical systems

- Need for tools and strategies to understand and mitigate attacks:
  - Which threats should we care about?
  - What impact can we expect from attacks?
  - Which resources should we protect (more)?



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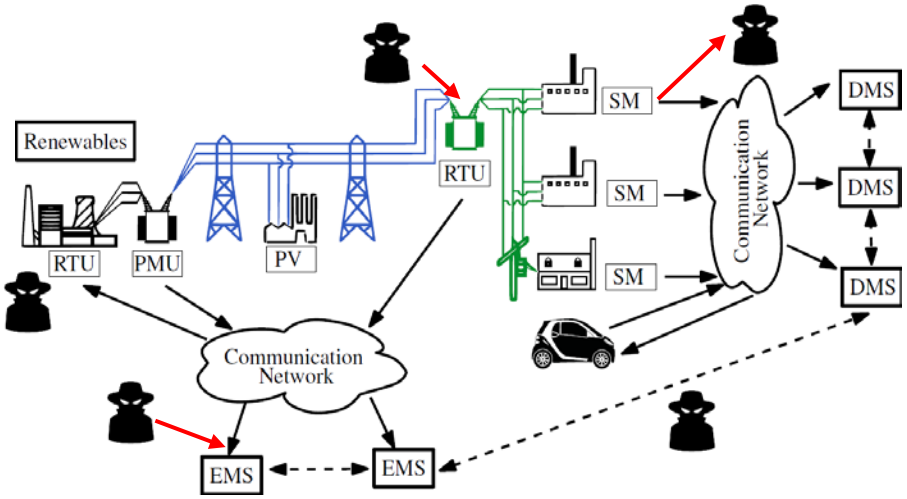
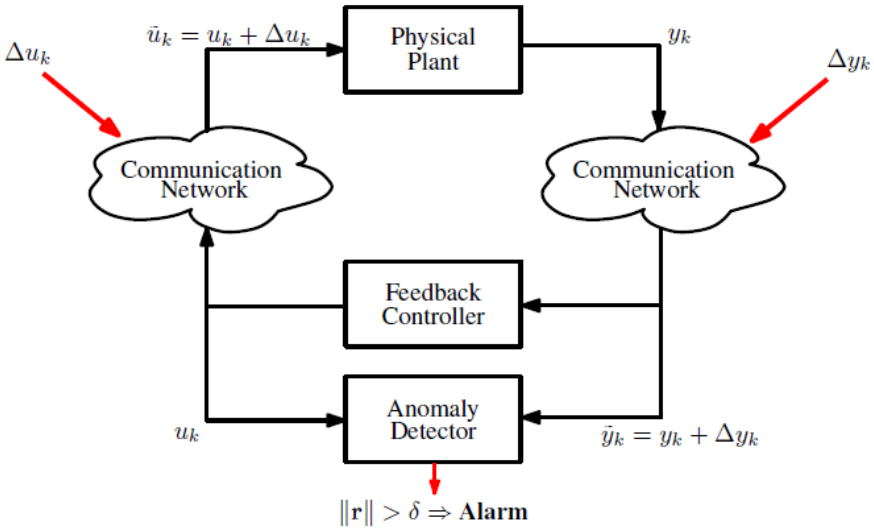
Resilient Control Systems

- Resiliency to disturbances and malicious threats
  - Maintain state awareness
  - Accepted level of performance





- Obtained through
  - automated fault detection
  - controller reconfiguration (islanding, for example)

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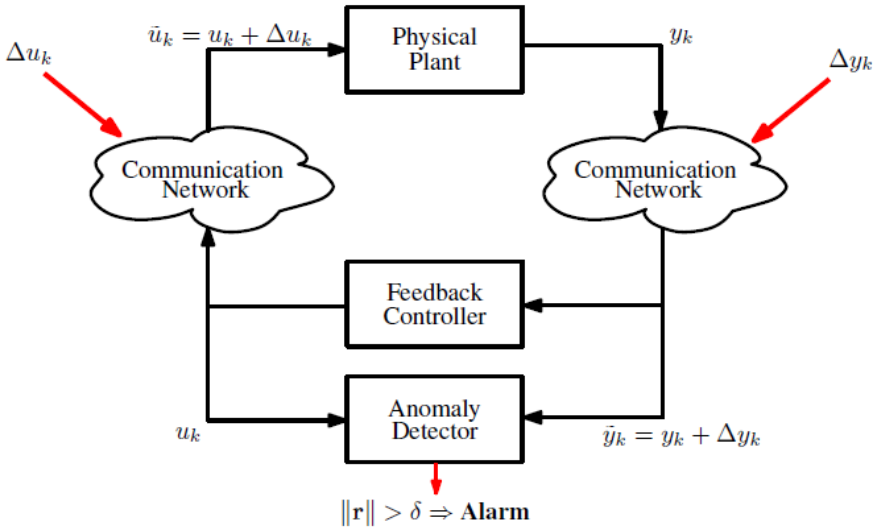
Objectives and Desired Outcomes

- New methods for cyber-secure networked control



- Quantifying system performance under malicious attacks
- Rigorous theory and practice for resilient feedback controllers and anomaly detectors

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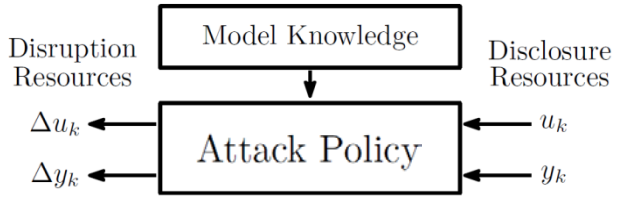
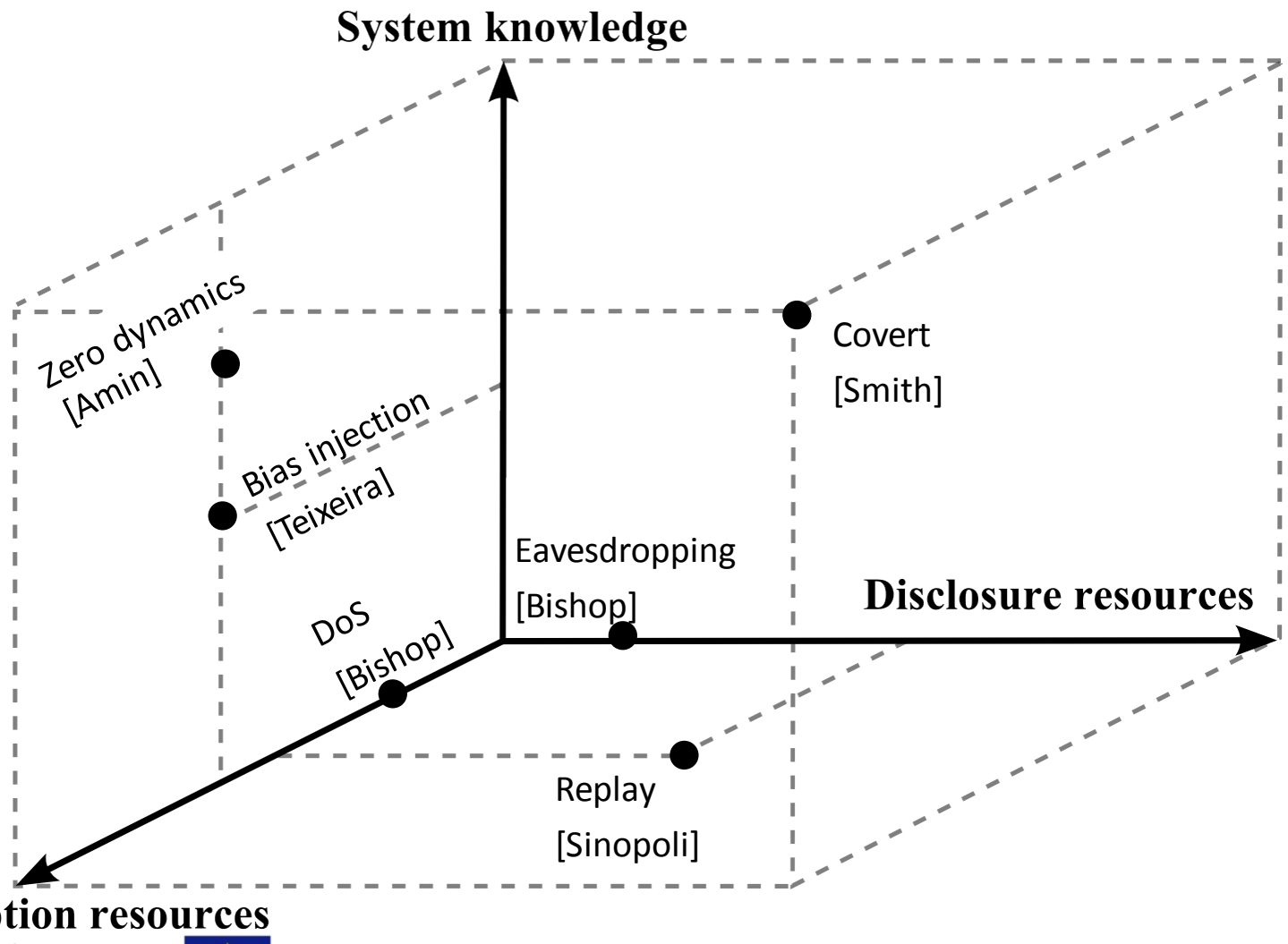
Quantifying the Attack Space





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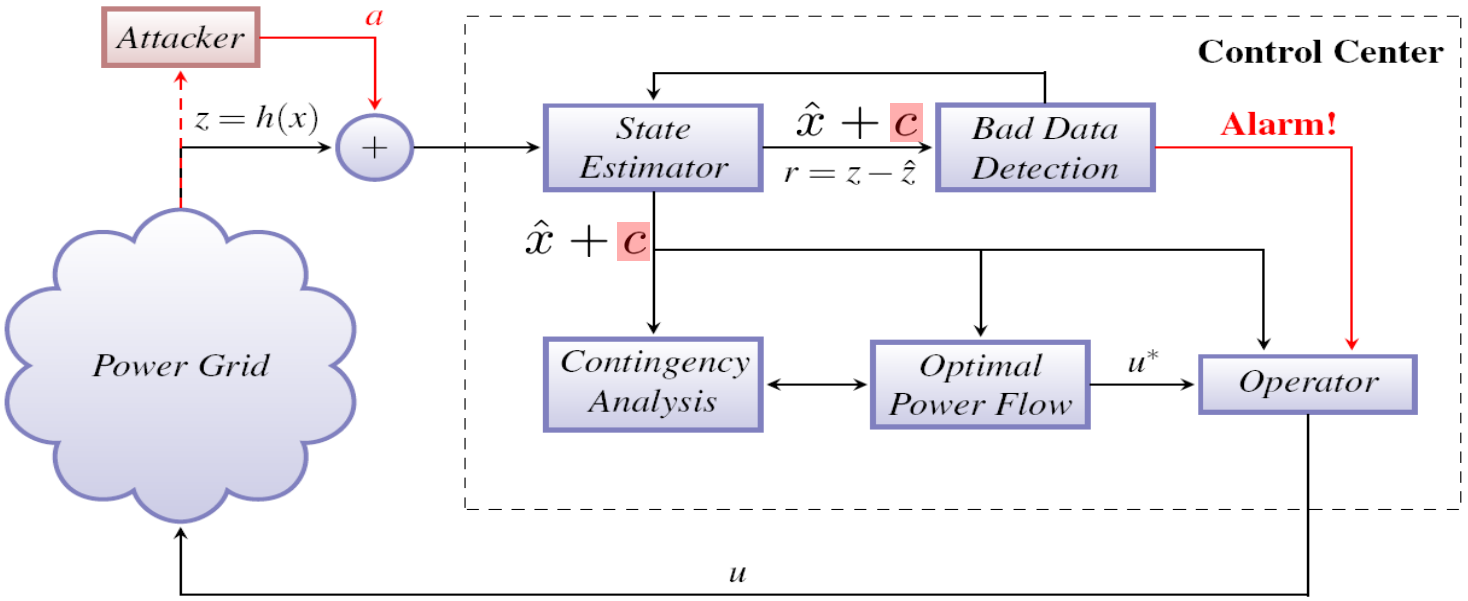
Example: False-data injection on EMS



- **Scenario:** Attacker injects **undetectable malicious data** *a* to induce bias *c* in state estimate
  - Which threats should we care about?
  - Which resources should we protect (more)?

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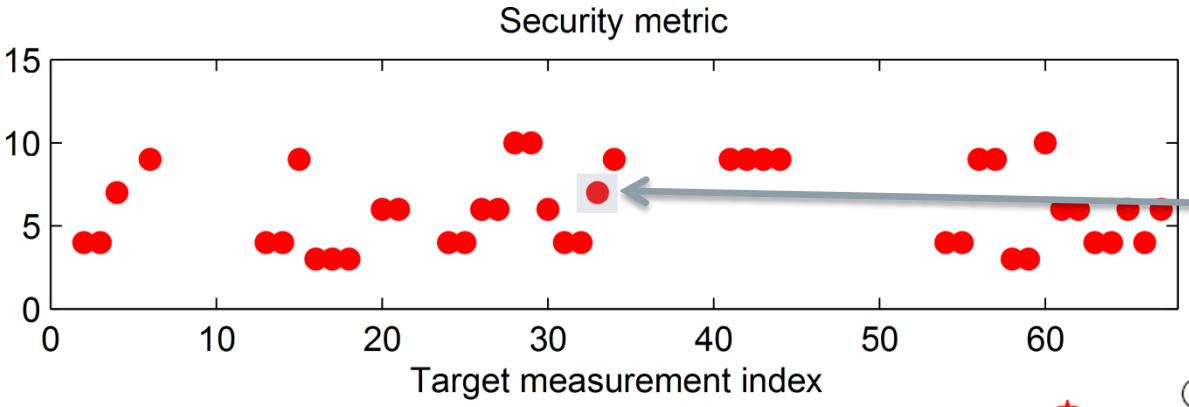
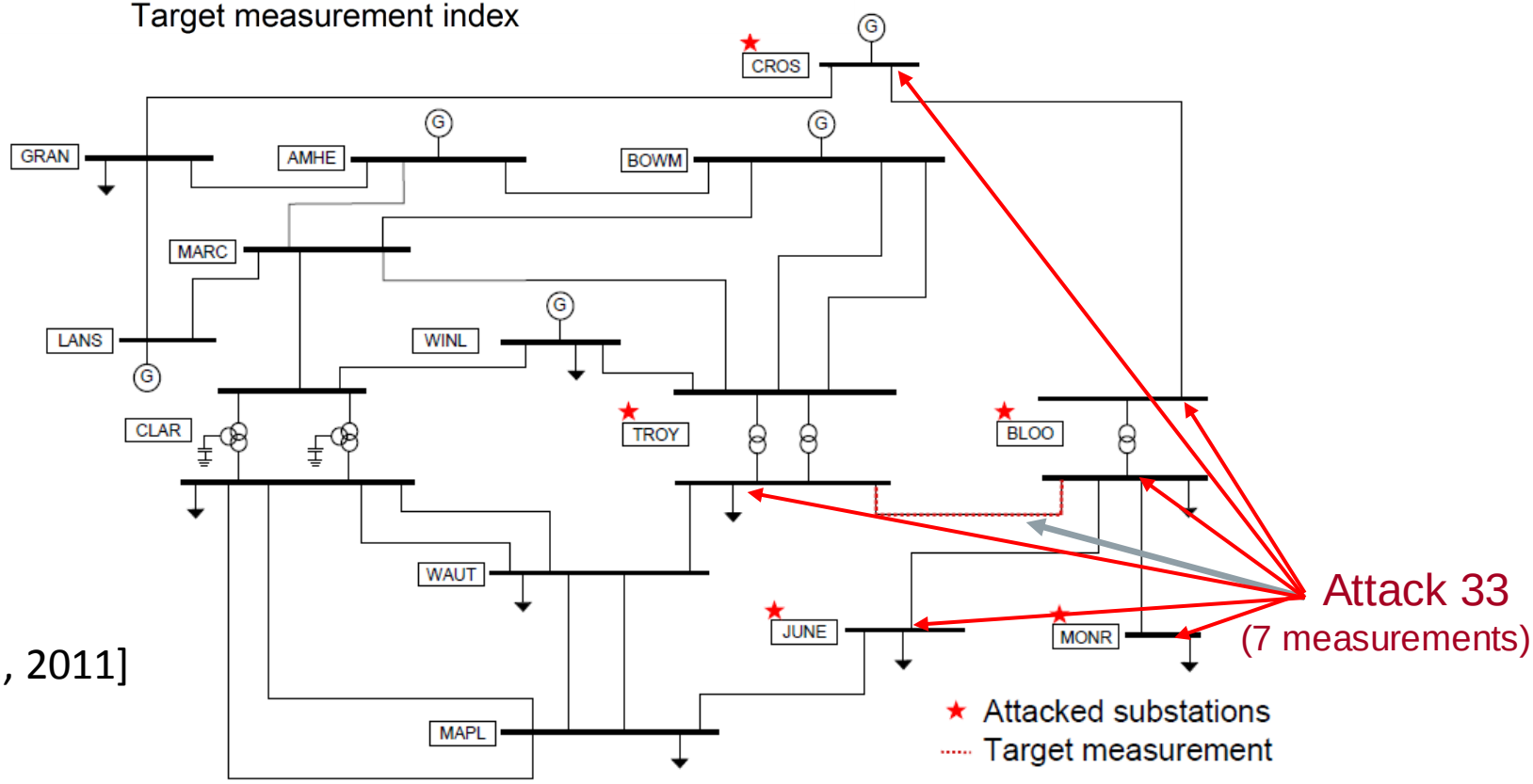
Security Metric for VIKING Network



At least 7 measurement readings involved in an *undetectable* attack against measurement 33



[Teixeira *et al.*, 2011]

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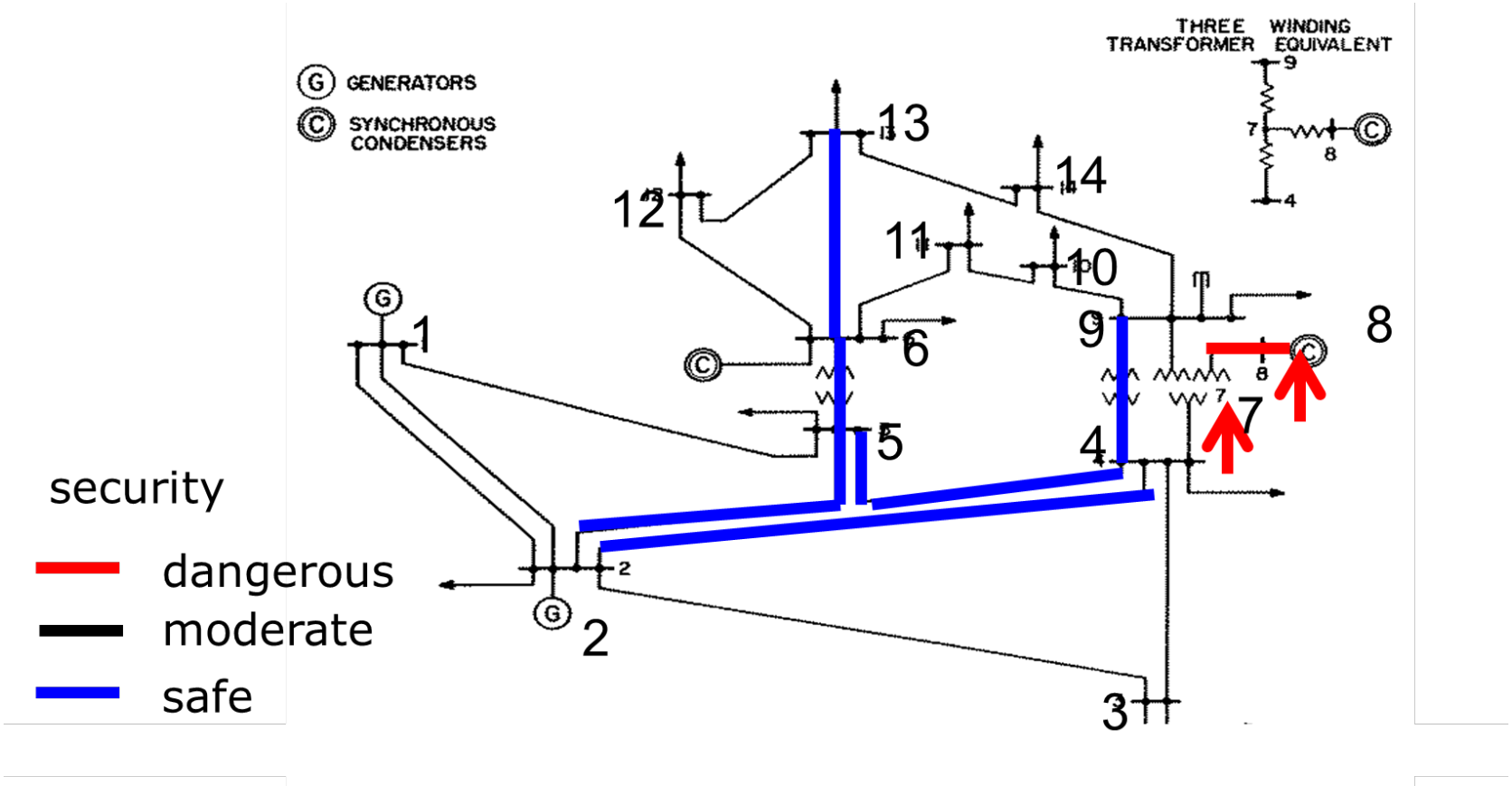
Example – Vulnerability Analysis

- A security metric from EU-project VIKING



- Used for allocation of new security measures

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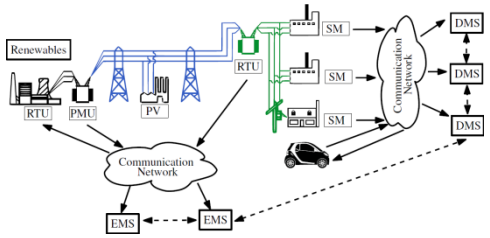
Discussion Session



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SMART GRID PROTECTION AGAINST CYBER ATTACKS

- What are the **key** control loops?
  - Critical control loops to ensure performance / safety?
  - Most cyber-vulnerable control loops?
- Desired input / output of "vulnerability analysis" algorithms for control systems
  - What should the input / output mean in terms of Smart Grid?
  - How should the output be presented?
  - Keywords or system features to keep in mind?
- Meaningful validation scenarios
  - What could be considered a good "proof of concept"?

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