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Country-Wide Distributed Emergency Control Systems of the Transmission Network in the Republic of Georgia

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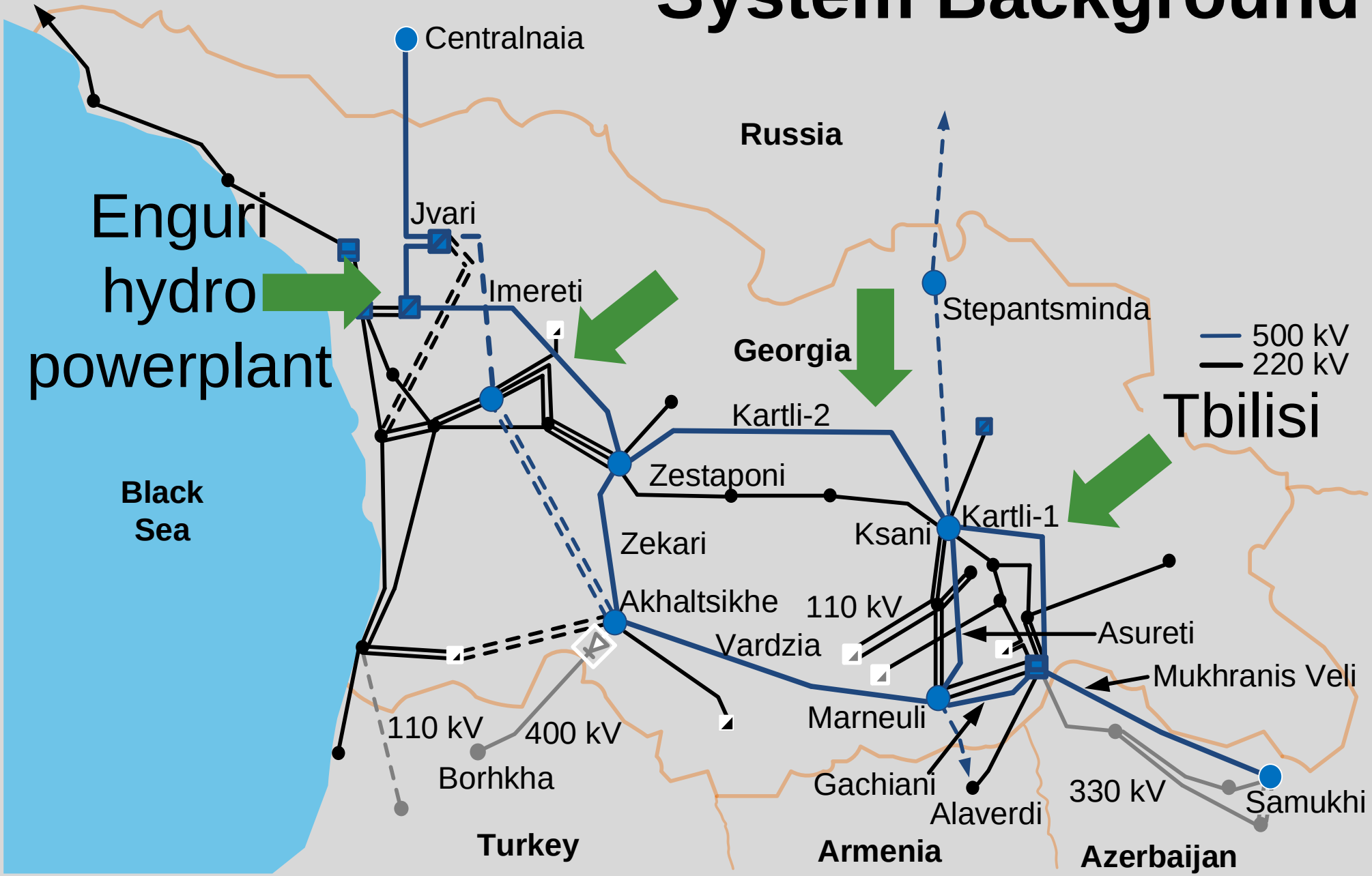
Introduction

- System background
- Emergency Control System requirements
- Contingencies considered
- Distributed vs Centralized
- Reliable Communications
- The future of GSE’s Emergency Control System

System Background



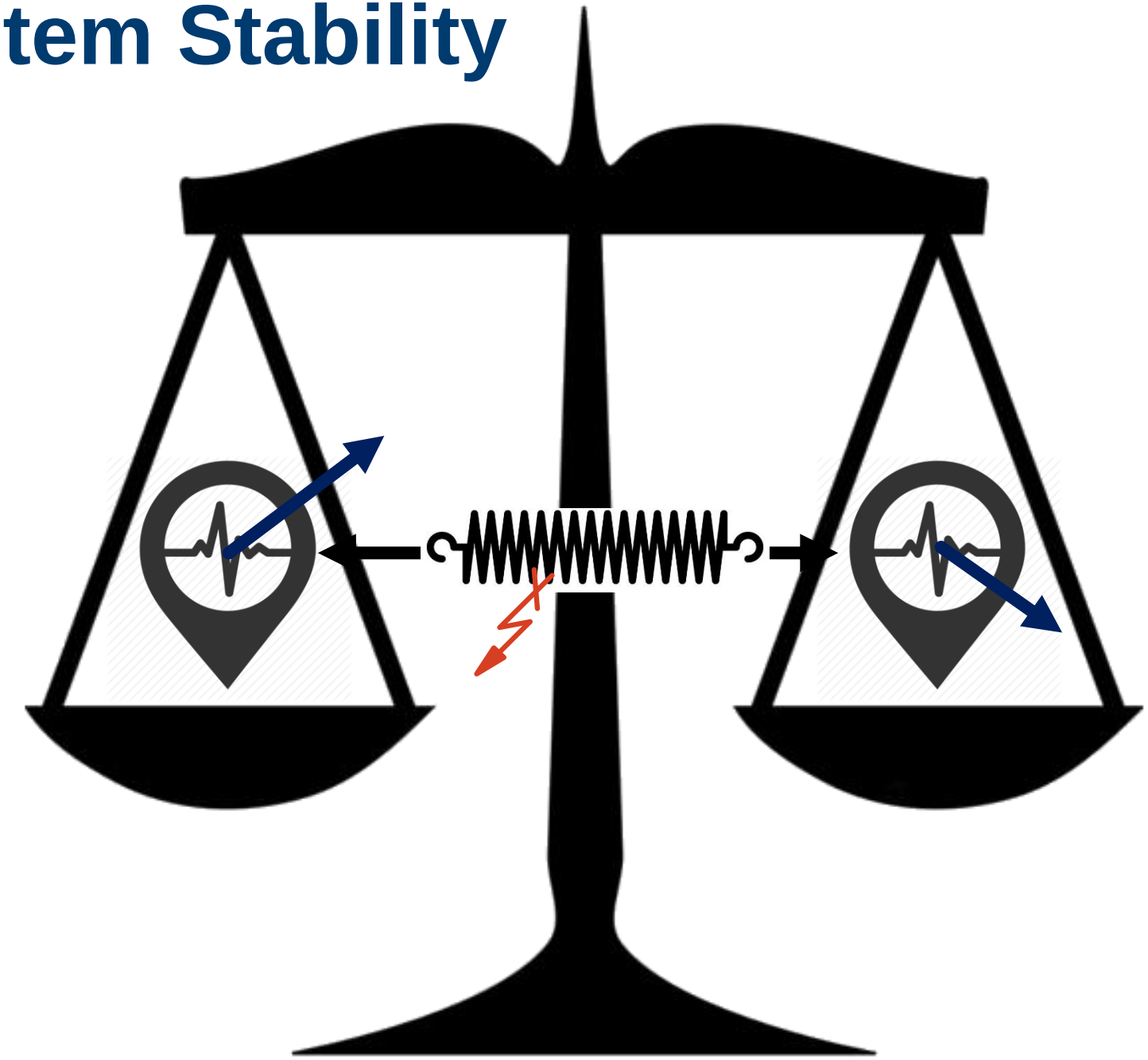
Power System Stability

“... is the ability of an electric power system, for a given initial operating condition, to regain a state of **operating equilibrium** after being subjected to a physical disturbance, with most system variables

—IEEE / CIGRE Task Force

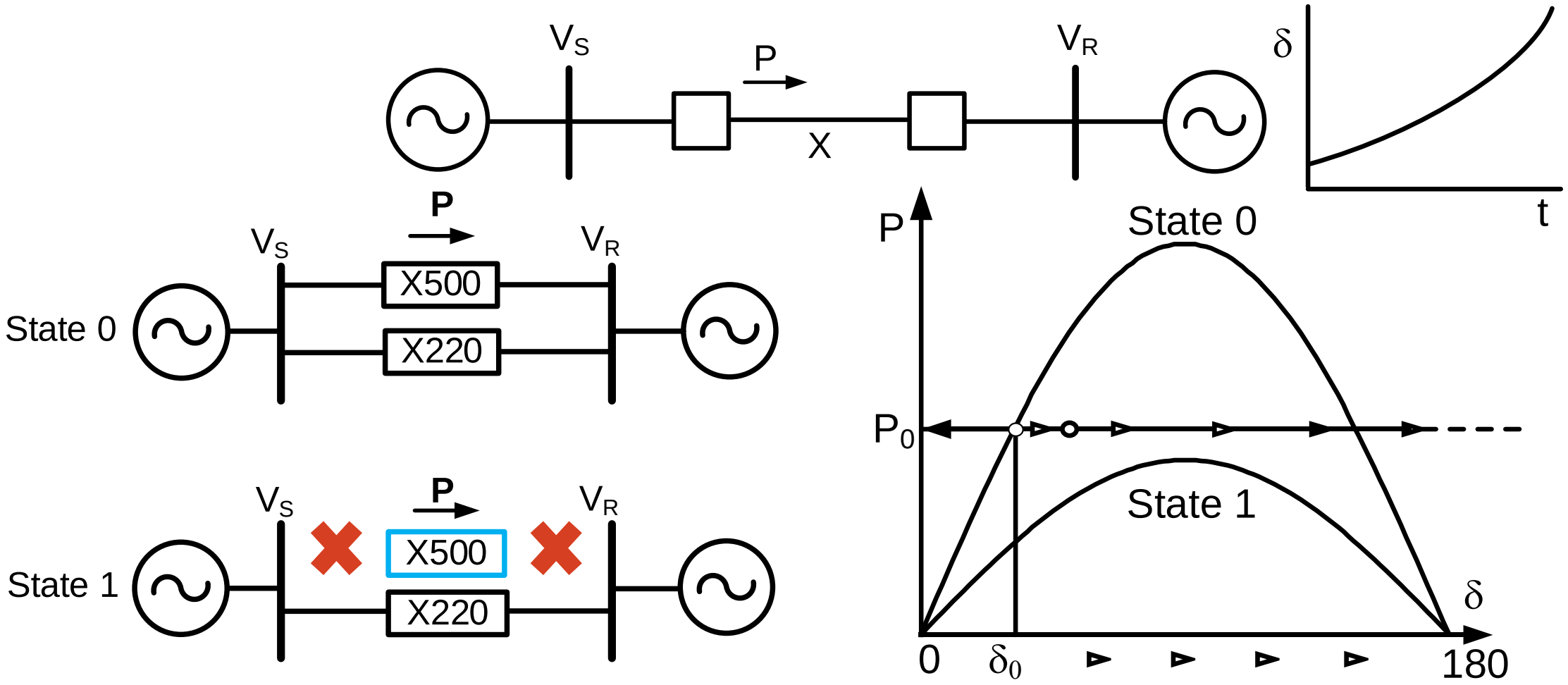
Power System Stability

Generation
Supply



Loads
Demand

GSE Power System Instability



Emergency Control System Benefits

System Installed in 2011

- Economic and social
- Power system stability

Year	Blackouts	Brownouts	Total
2014	14	11	25
2015	2	16	18
2016	9	15	24
2017	10	8	18
2018	9	15	24
2019	5	13	18
2020	6	34	40
2021*	4	5	9

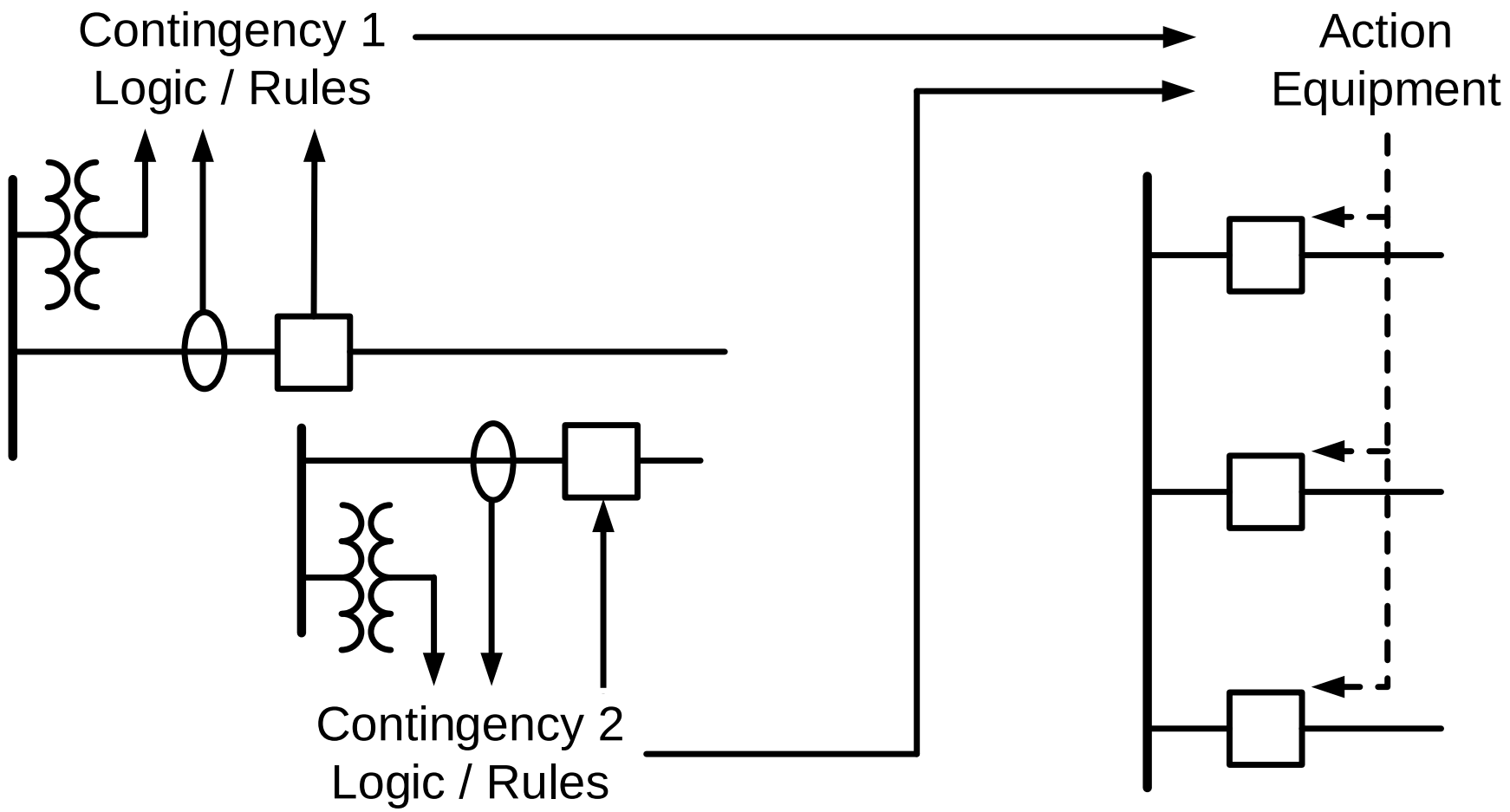
*As of April 2021

Contingencies Considered

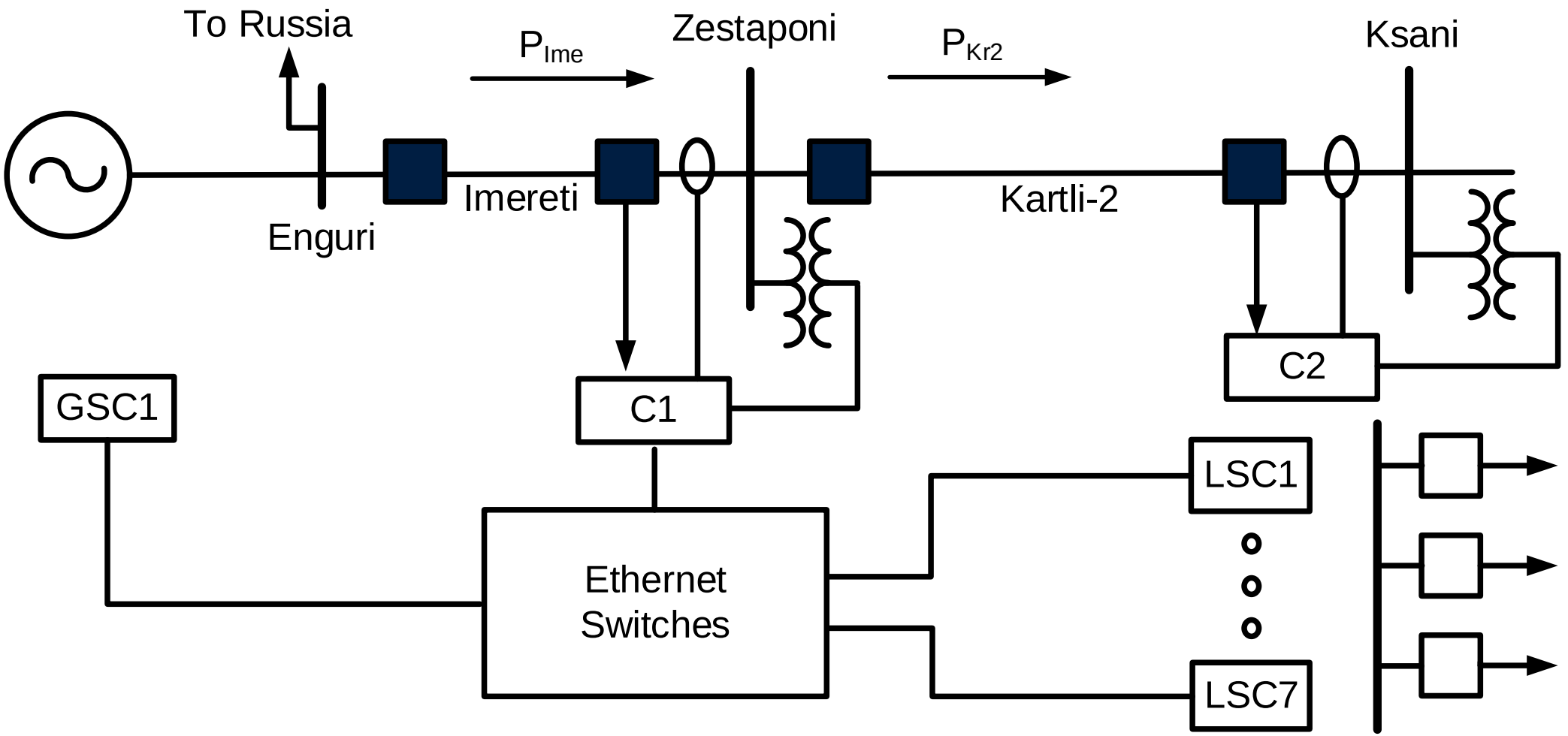
- N-1 criterion
- Highly probable contingencies (e.g., loss of line)
- Power system studies performed
- Angular instability and overloads
- Coordination with neighboring countries
- Emergency control actions (balancing generation and load after contingency)
- Validation through accurate simulation models

Distributed vs. Centralized Architecture

Distributed



Original Emergency Control System



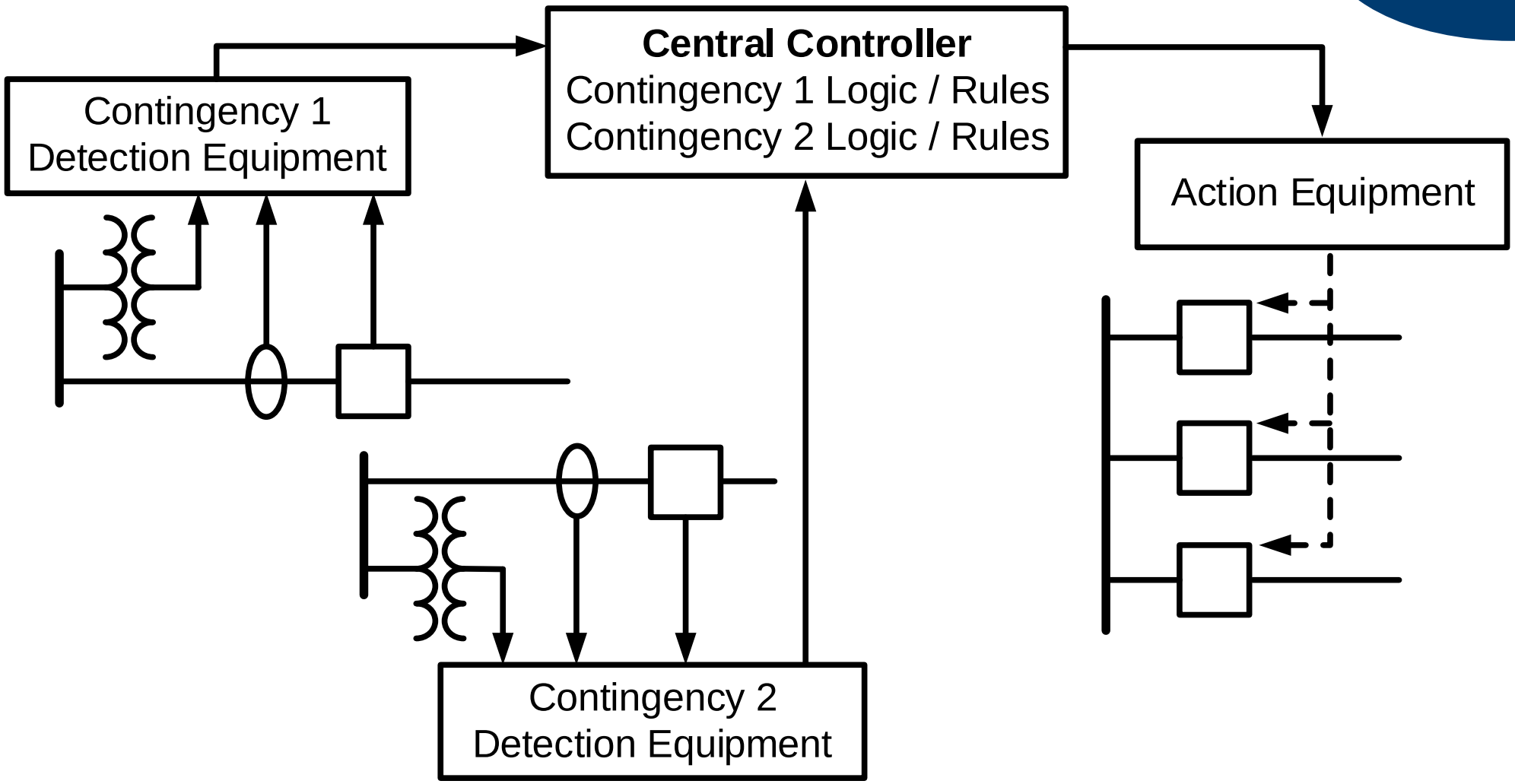
Distributed Architecture Details

Component	No.	Possible Actions
500 kV line	8	• Load and generator shedding HVdc control
500 / 400 / 330 kV interconnection lines	5	• Load shedding • Generator shedding if exporting • HVdc control Disconnection of other interconnecting lines
220 kV lines	1	• Load and generator shedding
Autotransformers	2	• Load and generator shedding
HVdc converters	2	• Load shedding if importing • Generator shedding if exporting
Generators	6	• Load shedding and HVdc control

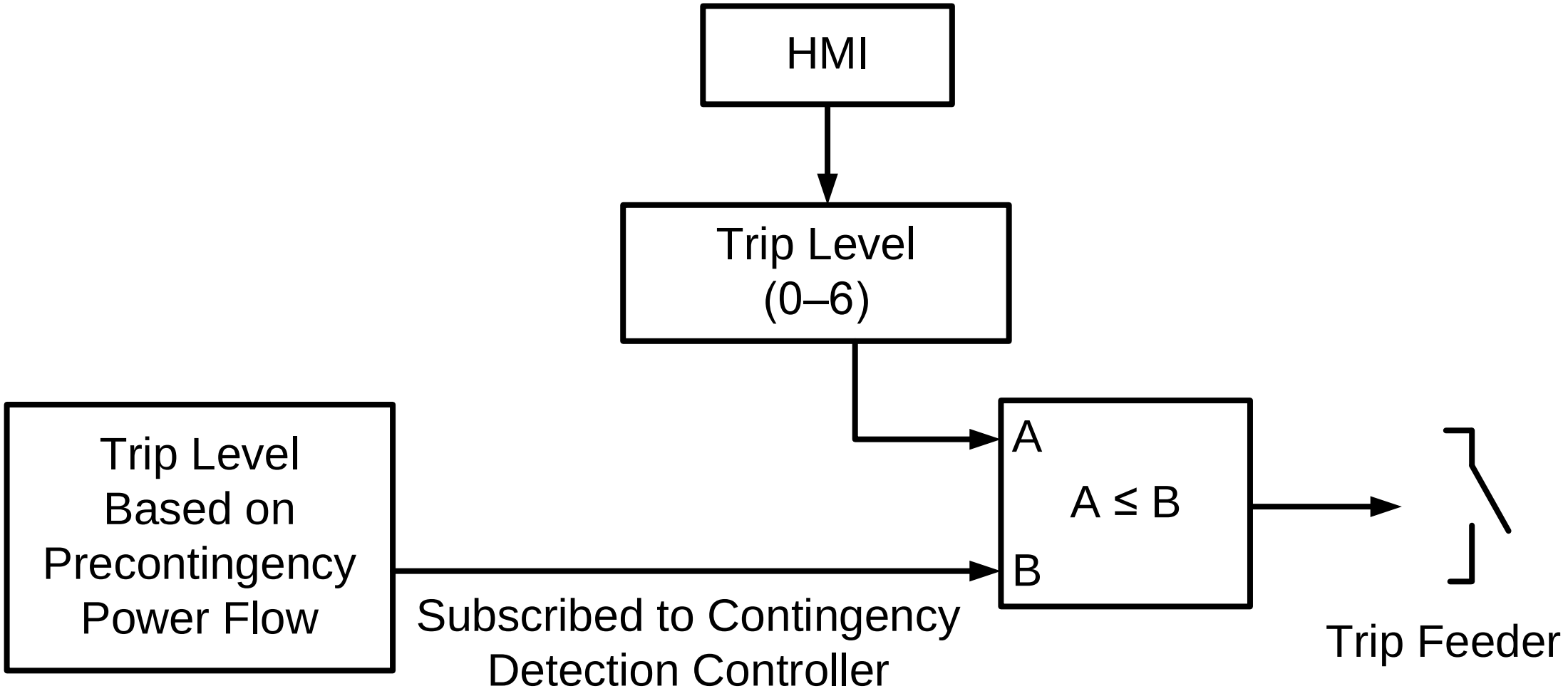
Distributed vs. Centralized Architecture

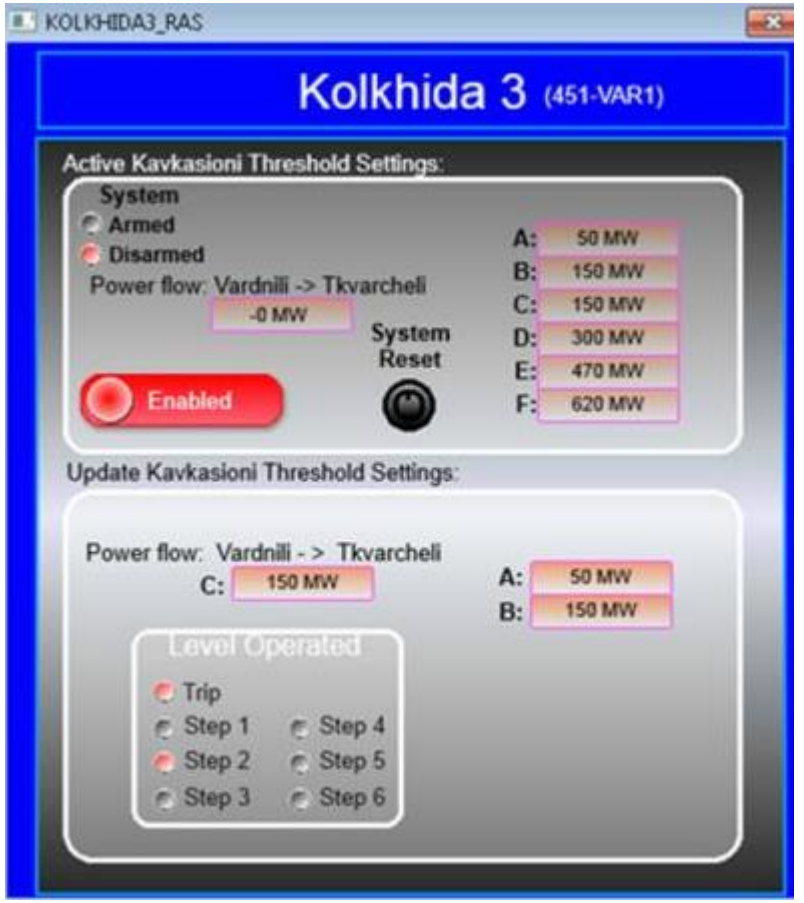
Centralized

GSE operates both schemes



Load Shedding Controller Logic

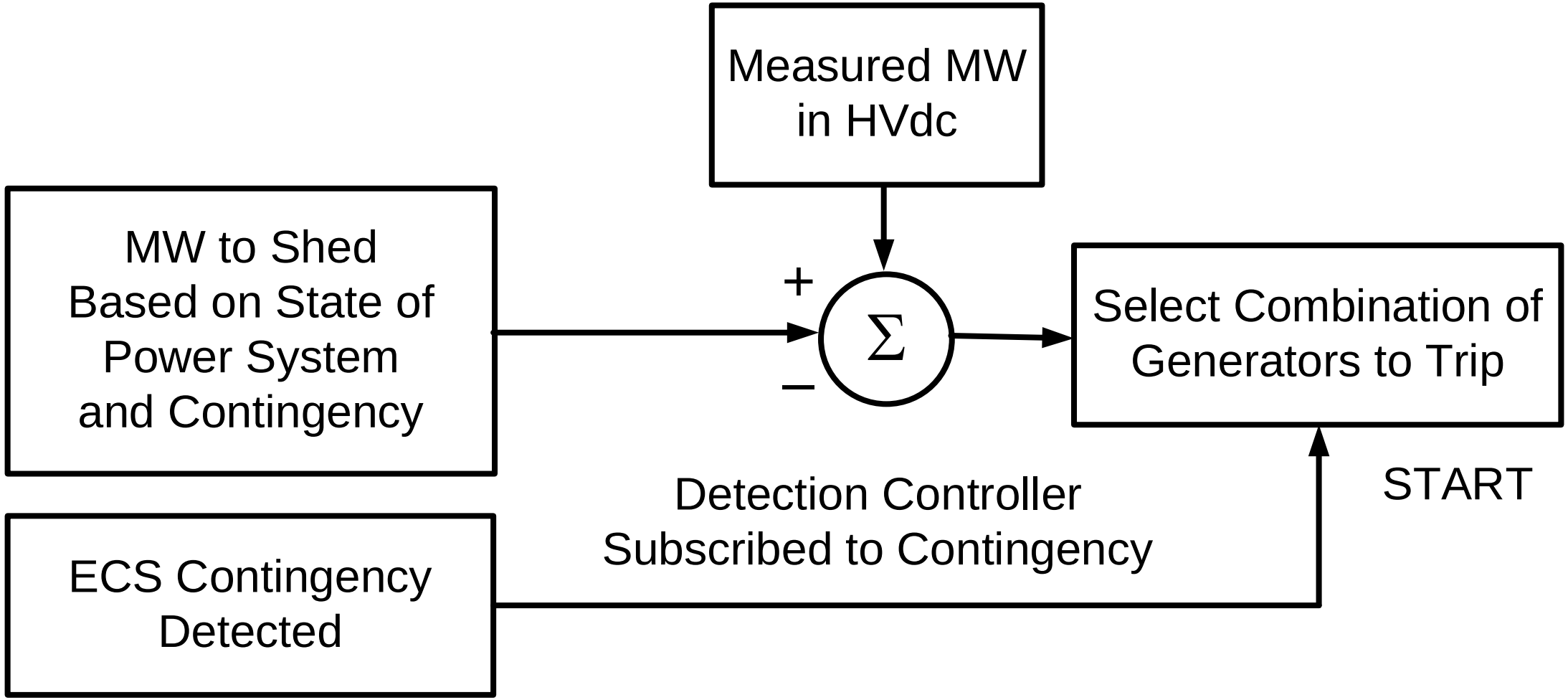




- System overview (SCADA complement)

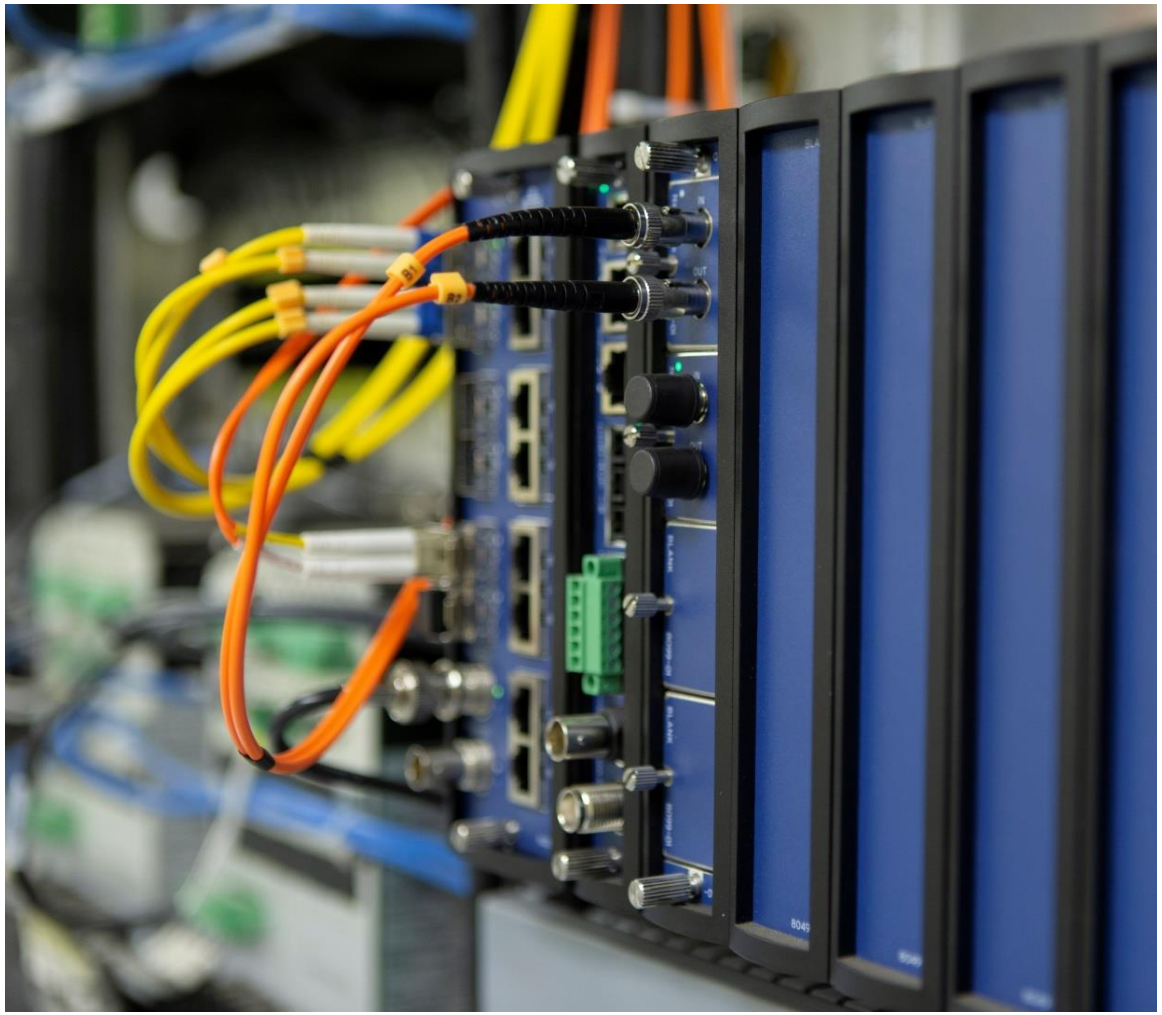
- Thresholds and settings
- Alarms and status

Generator Shedding Logic

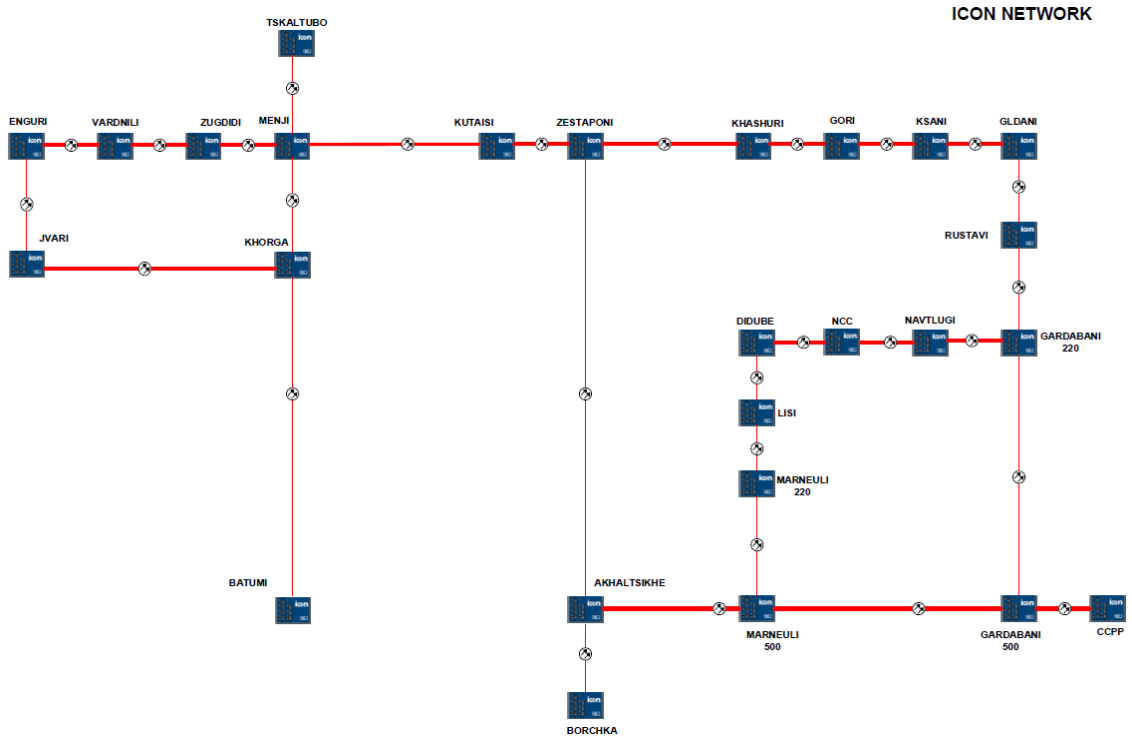


Communications Network Considerations

- Use Optical Ground Wire (OPGW) infrastructure
- Cybersecurity
  - Use of firewalls
  - Secure login
  - Secure, complex device passwords
- Careful traffic engineering
- Traffic segregation
- Time distribution



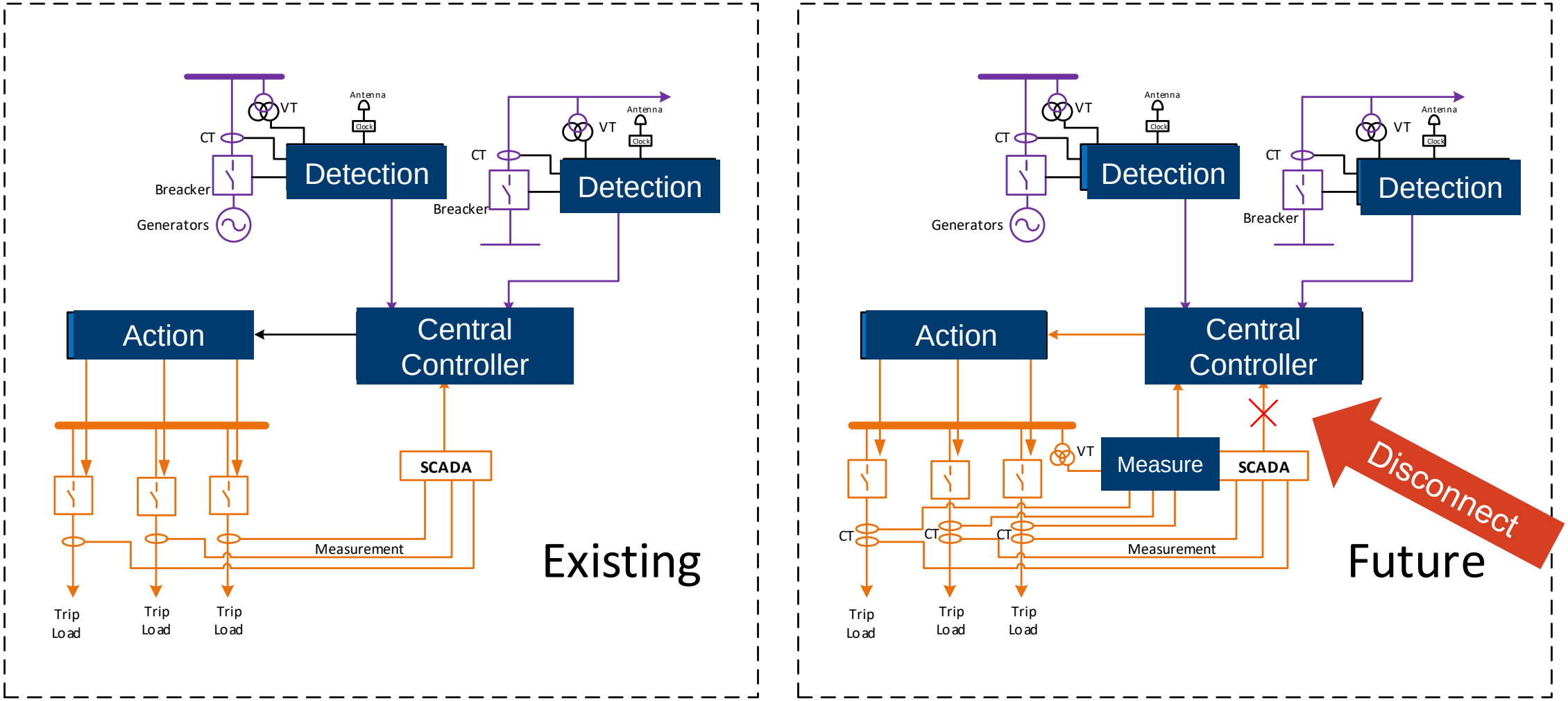
ECS Communication Network



- Synchronous Multiplexers allow separate Ethernet bandwidth:
  - One bandwidth routes critical GOOSE messages
  - Second network bandwidth routes TCP/IP traffic
- Multiplexers distribute precise time synchronization
- Ring networks provide redundancy

Work planned for the future of the ECS

ECS system will become completely independent of SCADA.
Connection to GSE SCADA will be removed.



Work planned for the future of the ECS

The Synchrophasor Metering System (SPM) project

Wide Area Monitoring System (WAMS)

Questions?

https://selinc.com/Solutions/Success-Stories/Republic-of-Georgia

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