Utility Implements Communications-Assisted Special Protection and Control Schemes for Distribution Substations

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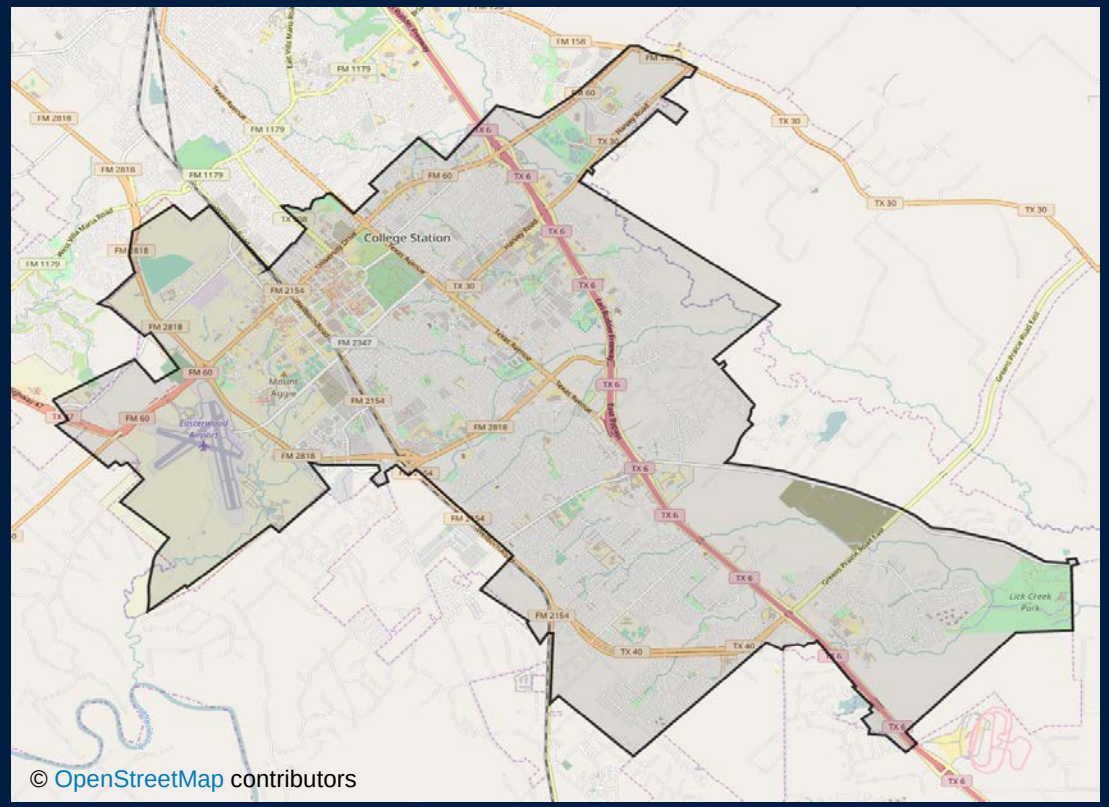
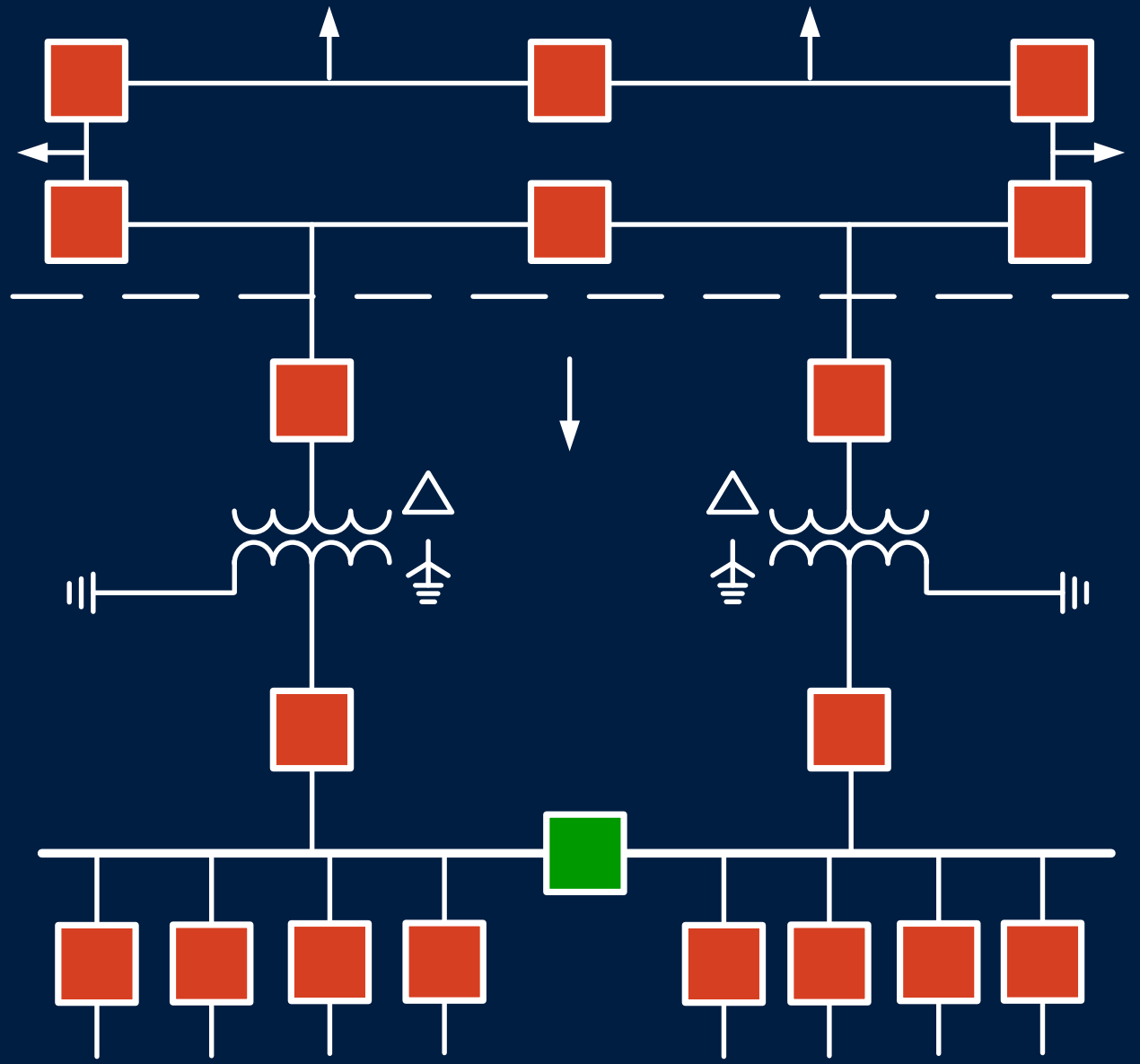
City of College Station (COCS)
College Station Utilities (CSU)

- Provides electric power to residential and commercial customers
- Is composed of
  - ~20 miles of transmission lines
  - ~458 miles of distribution lines
  - 7 substations

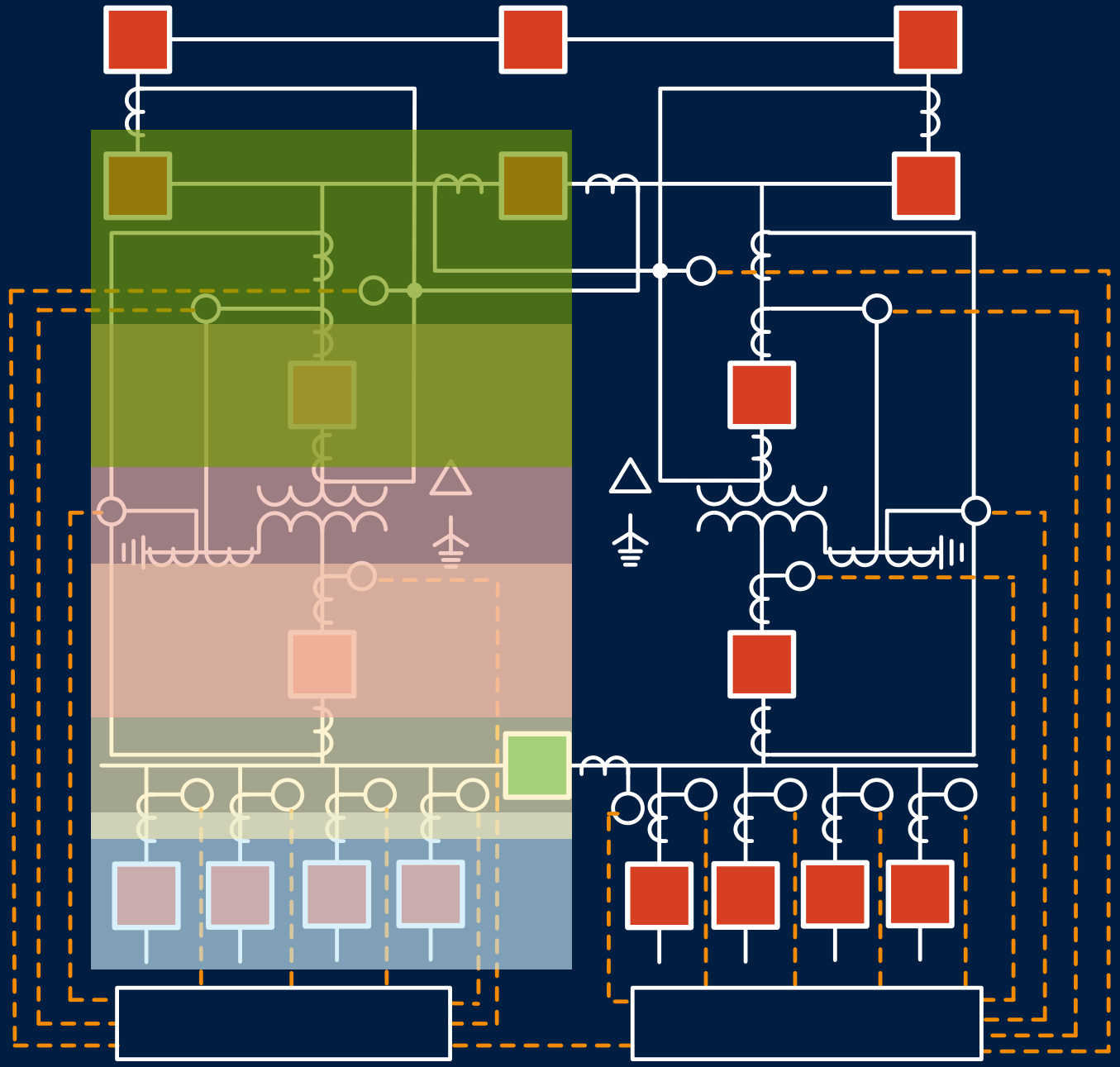


Traditional 13.2 kV Distribution Substation

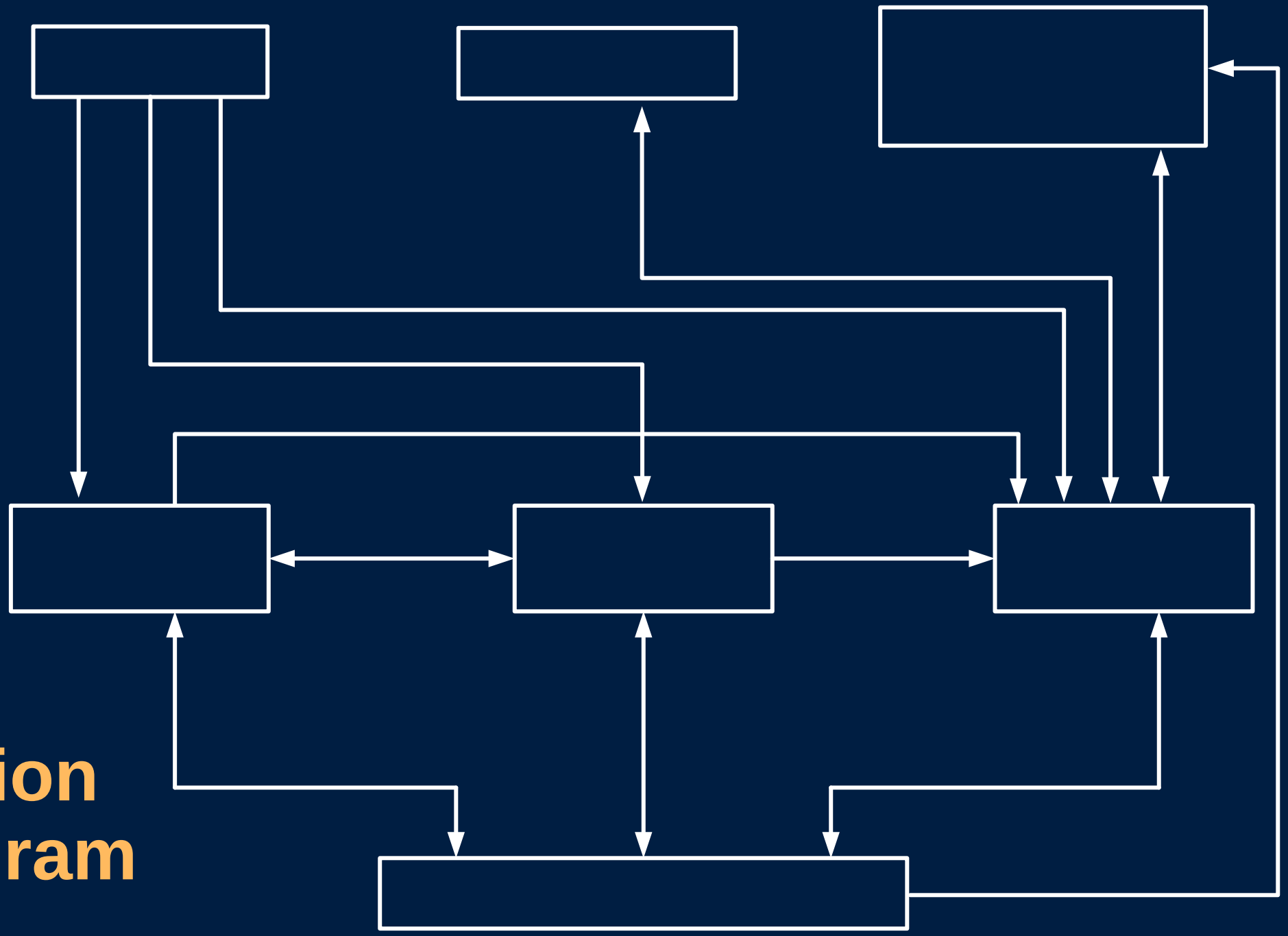
- Electromechanical relays
- No 138 kV/13.8 kV protection
- No breaker failure backup
- No automatic source transfer
- Four feeders per bus
- Challenge coordinating for simultaneous fault conditions



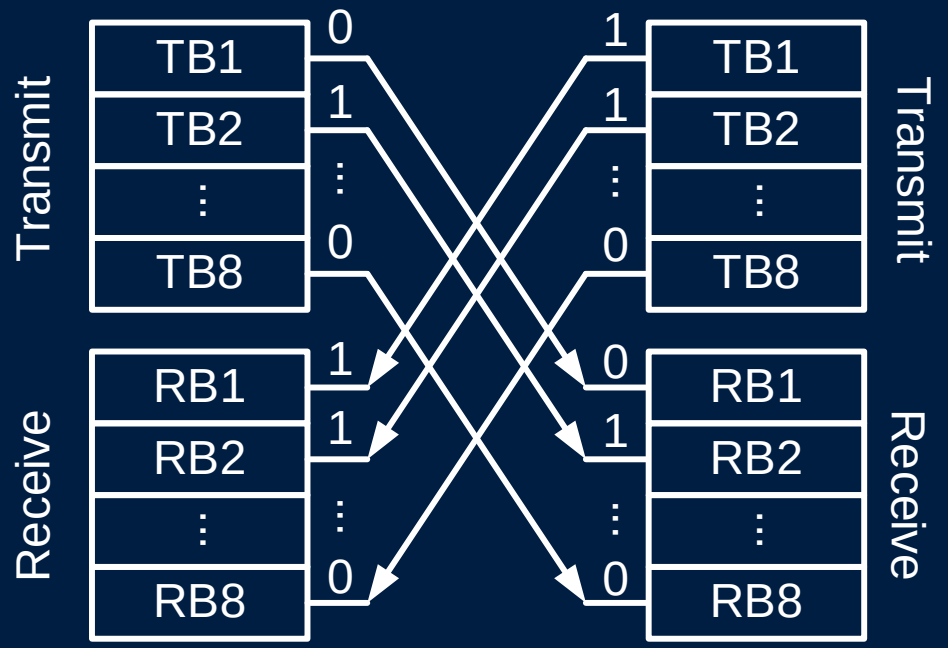
13.2 kV Distribution Substation for Special Protection and Control Scheme (SPCS)



Information Flow Diagram



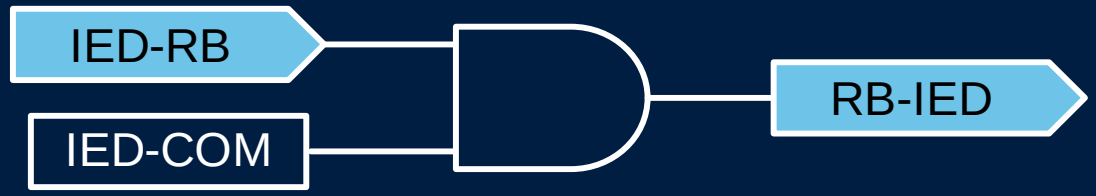
Communications Link Supervision for High-Speed Data Bits



IEDs	Status Description
ROK = 1	Communications channel good
ROK = 0	Communications channel bad

Inverse (NOT) of ROK is used to create digital alarm bit to alert operations of communications failure

Communications Link Supervision for High-Speed Data Bits



Logic Processors	Status Description
COM = 1	Communications channel good
COM = 0	Communications channel bad

Communications link supervision in logic processors only allows received data bits of good quality to be considered in algorithms

Different Schemes Implemented

- **Fast bus tripping scheme** for significantly reduced bus fault-clearing time
- **Breaker failure protection scheme** for shorter breaker failure clearing time
- **Double-circuit feeder trip scheme** for faster clearing of simultaneous faults without causing substation outage, and **stall reclose logic** for system availability
- **Automatic source transfer scheme (ASTS)** for higher power system availability

SCPS Six Major Design Criteria

Dependability

Security

Selectivity

Resilience

Speed

Cost

Fast Bus Tripping Scheme

Limitation of traditional bus protection philosophy

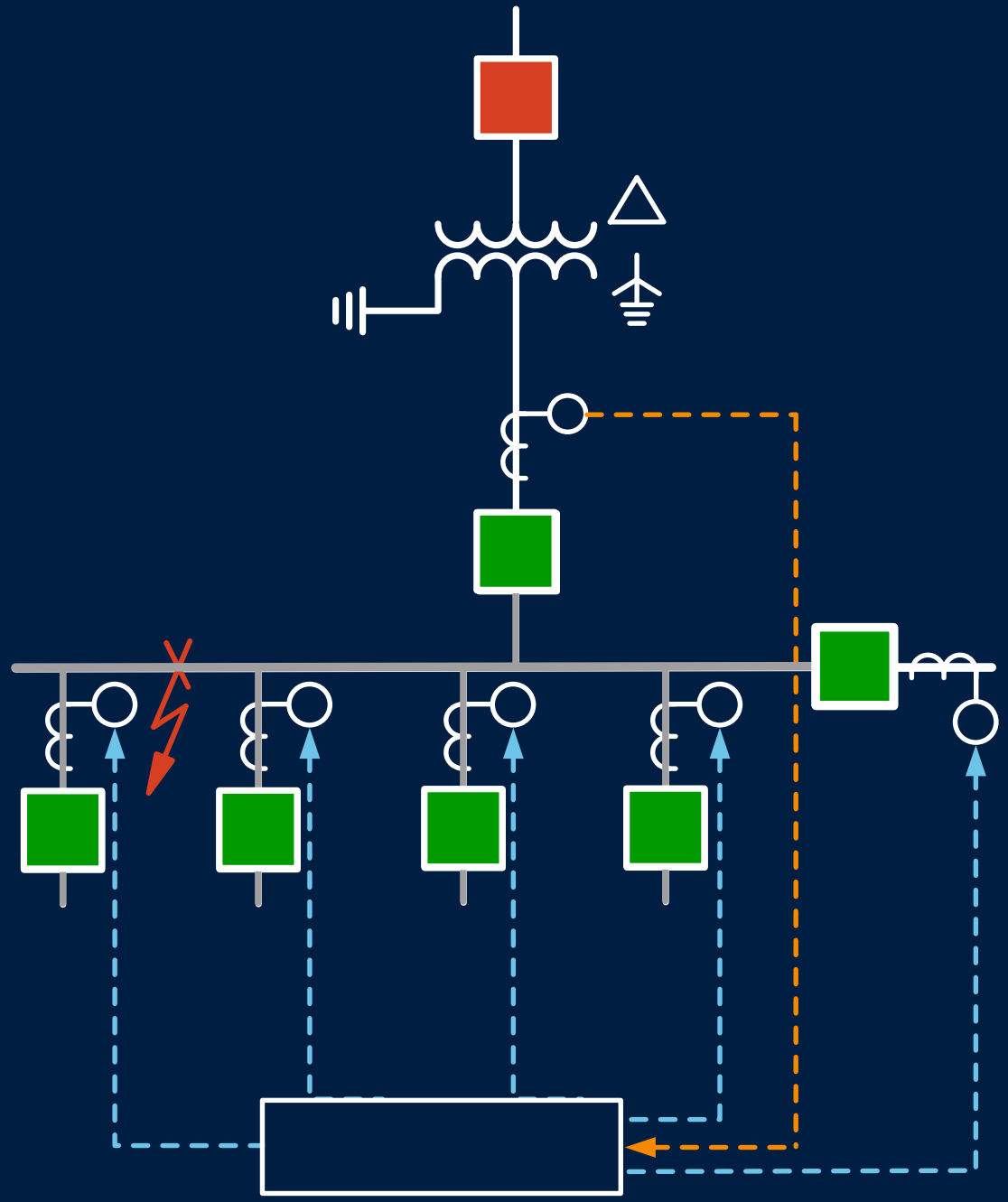
- Bus fault is cleared with time-delayed transformer backup protection
- Typical fault-clearing time is between 0.6 and 1.0 seconds

Solution

- Bus differential protection is fast and secure, but has added cost
- Fast bus tripping scheme is fast and cost-effective

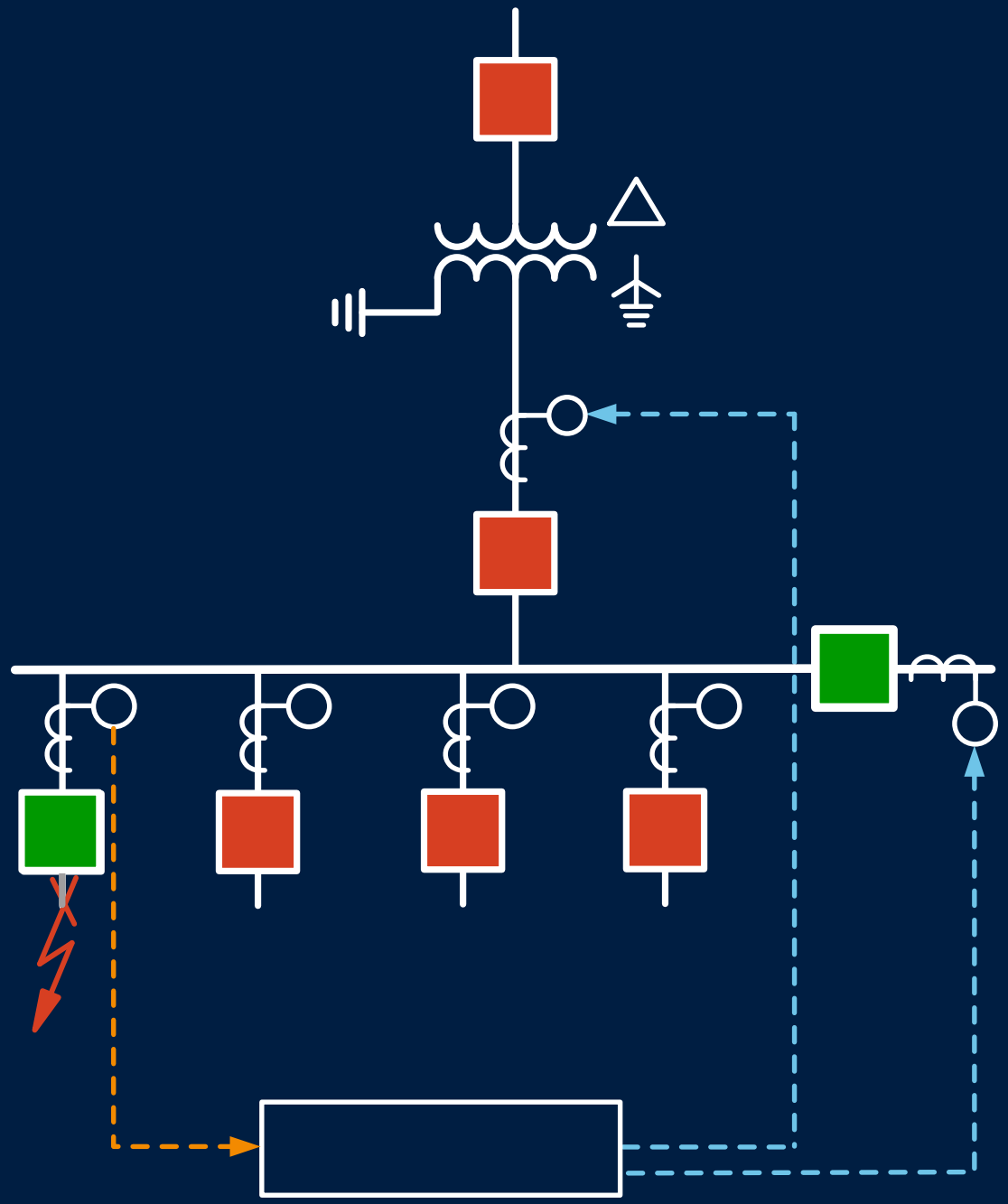
Fast Bus Tripping Scheme

Fault on Bus 1



Fast Bus Tripping Scheme

Fault on F1 Feeder Circuit



Breaker Failure Protection Scheme

Limitation of traditional breaker failure protection philosophy

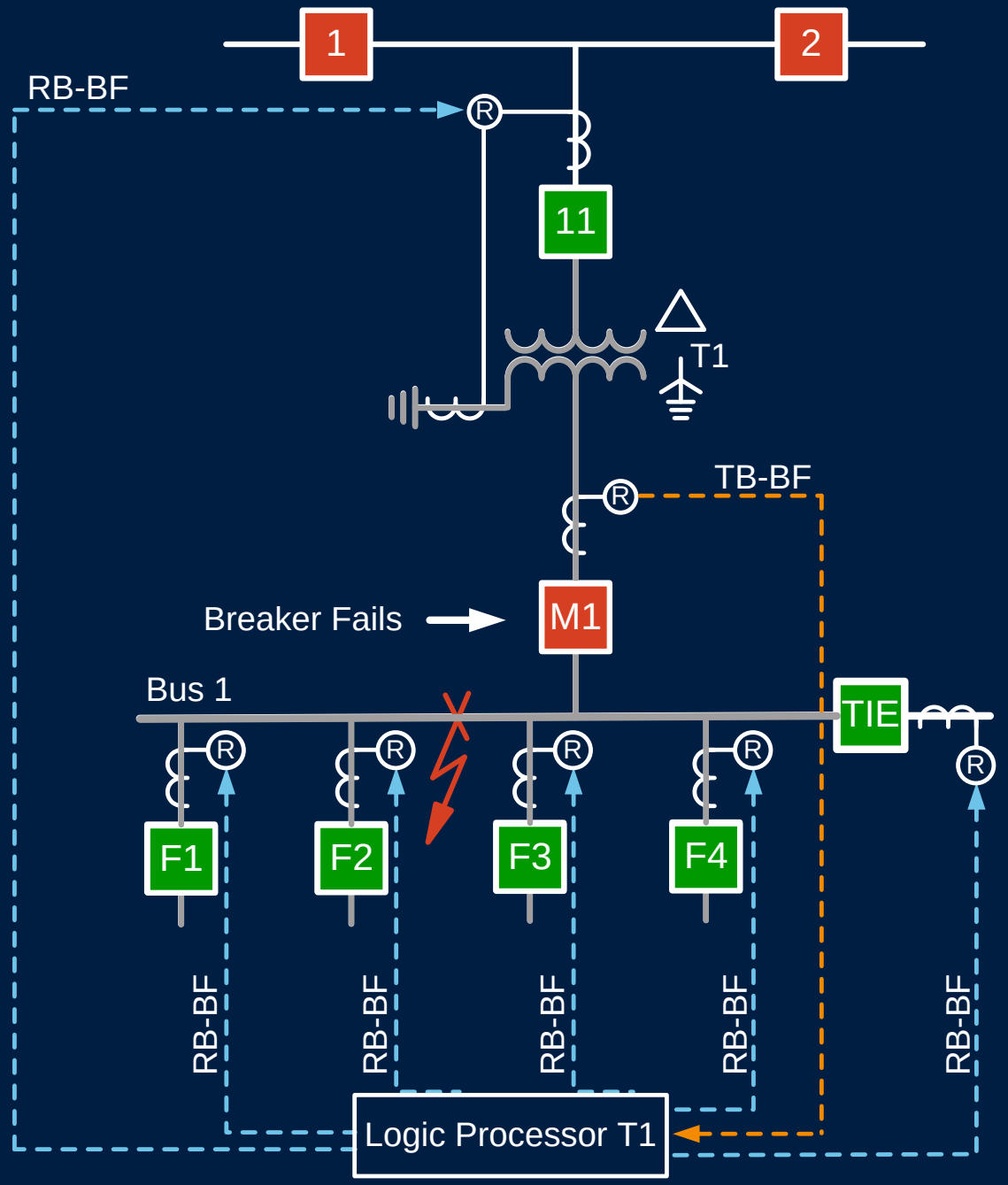
- Fault is cleared with upstream inverse-time overcurrent protection
- Long fault-clearing times lead to equipment damage or reduced equipment lifespan

Solution

- Dedicated, fast breaker failure protection scheme using existing IEDs and communications backbone
- Low implementation cost with minimal wiring

Breaker Failure Protection Scheme

Fault on Bus 1



Double Circuit Feeder Trip Scheme and Stall Reclose Logic

Limitation of traditional system

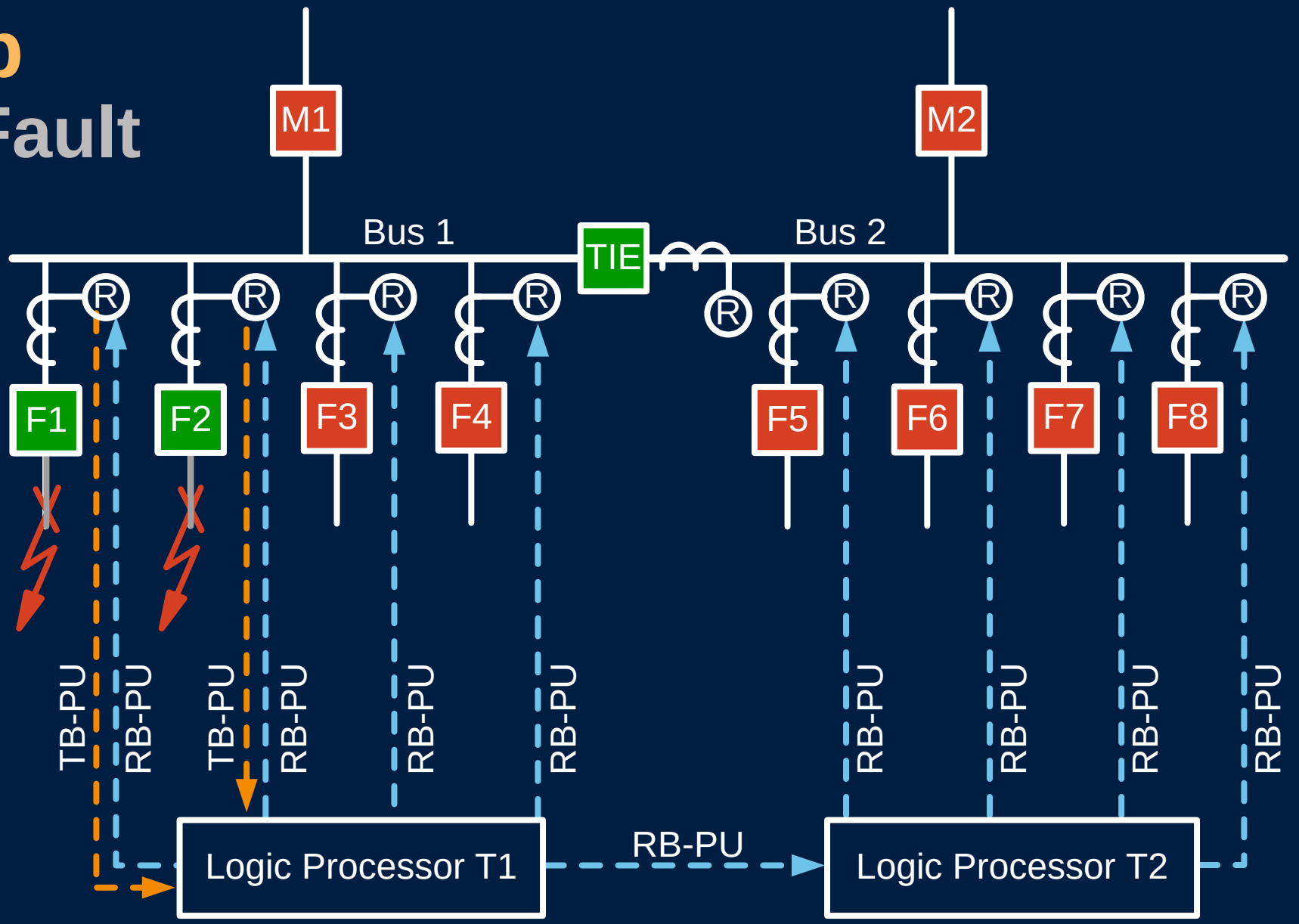
- Simultaneous faults may cause coordination issues
- Main breaker 51 element may misoperate
- IED overcurrent pickup and time-dial settings must be adjusted (resulting in slower tripping)

Solution

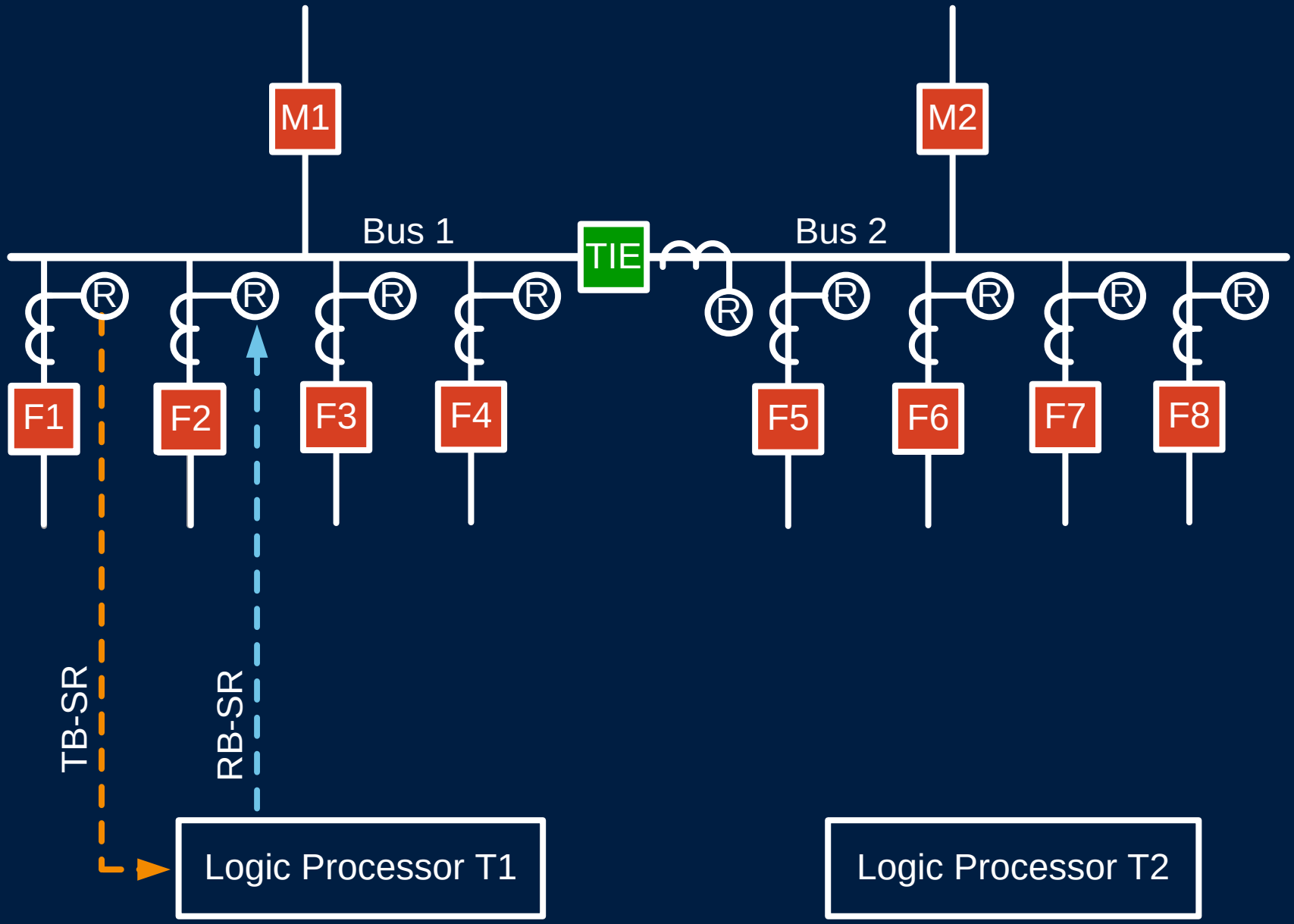
- Double-circuit feeder trip scheme with low implementation cost
- Fast 51 element setting and improved service reliability

Double Circuit Feeder Trip

Simultaneous Fault



Stall Reclose Logic



ASTS

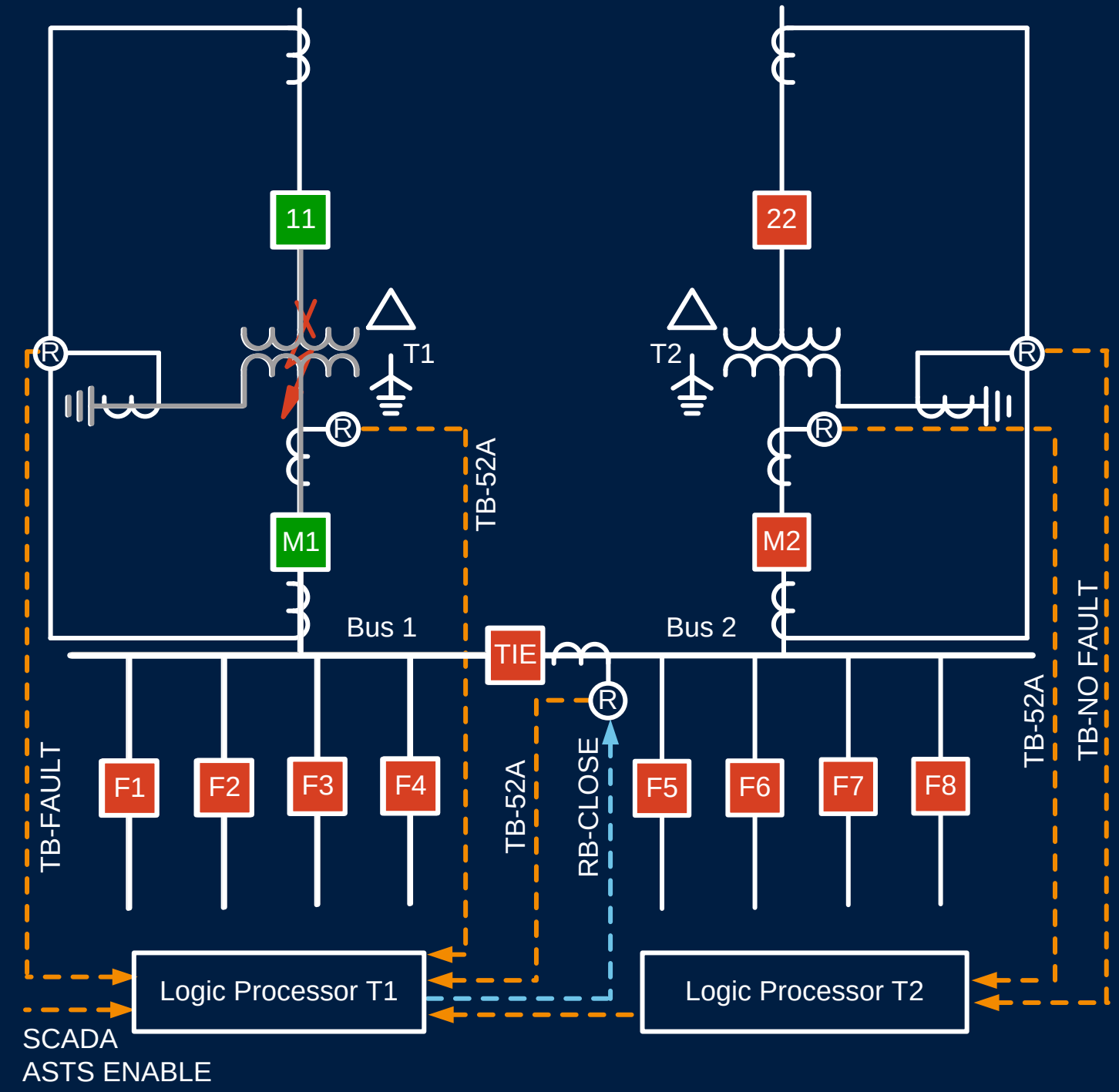
Limitation of traditional system

- Less power system availability with more disruption
- Long restoration times

Solution

- ASTS that automatically switches from primary source to alternate source
- Short restoration times to improve power system availability

ASTS
Transformer Fault



Other Schemes

- Multiple SPCSs run in parallel and coordinate with each other as complete, integrated solution
- Other control logic is implemented to improve system availability and dependability
  - Hot-line mode
  - IED health alarm

Questions?