Moving the Focus from Relay Element Testing to Protection System Testing

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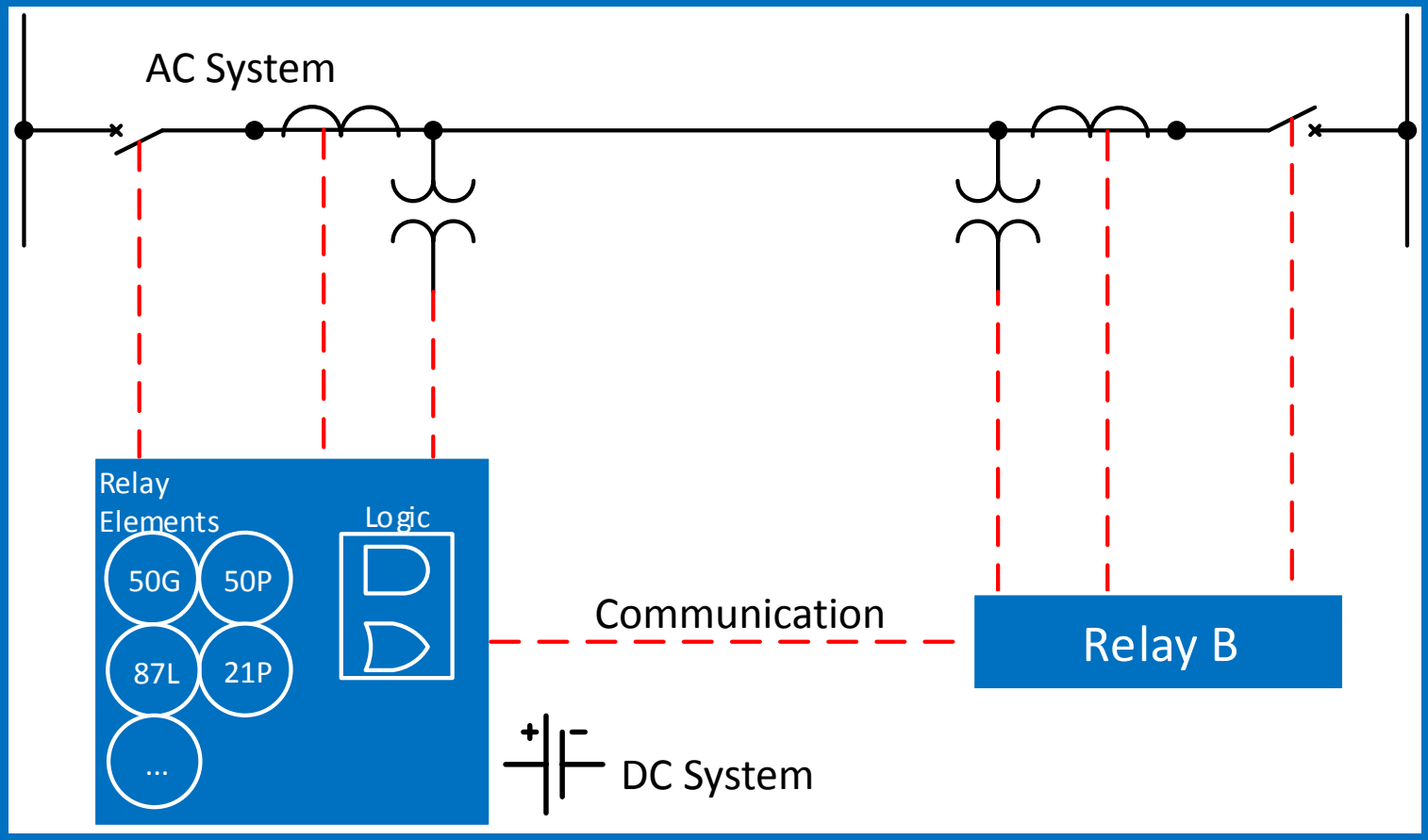
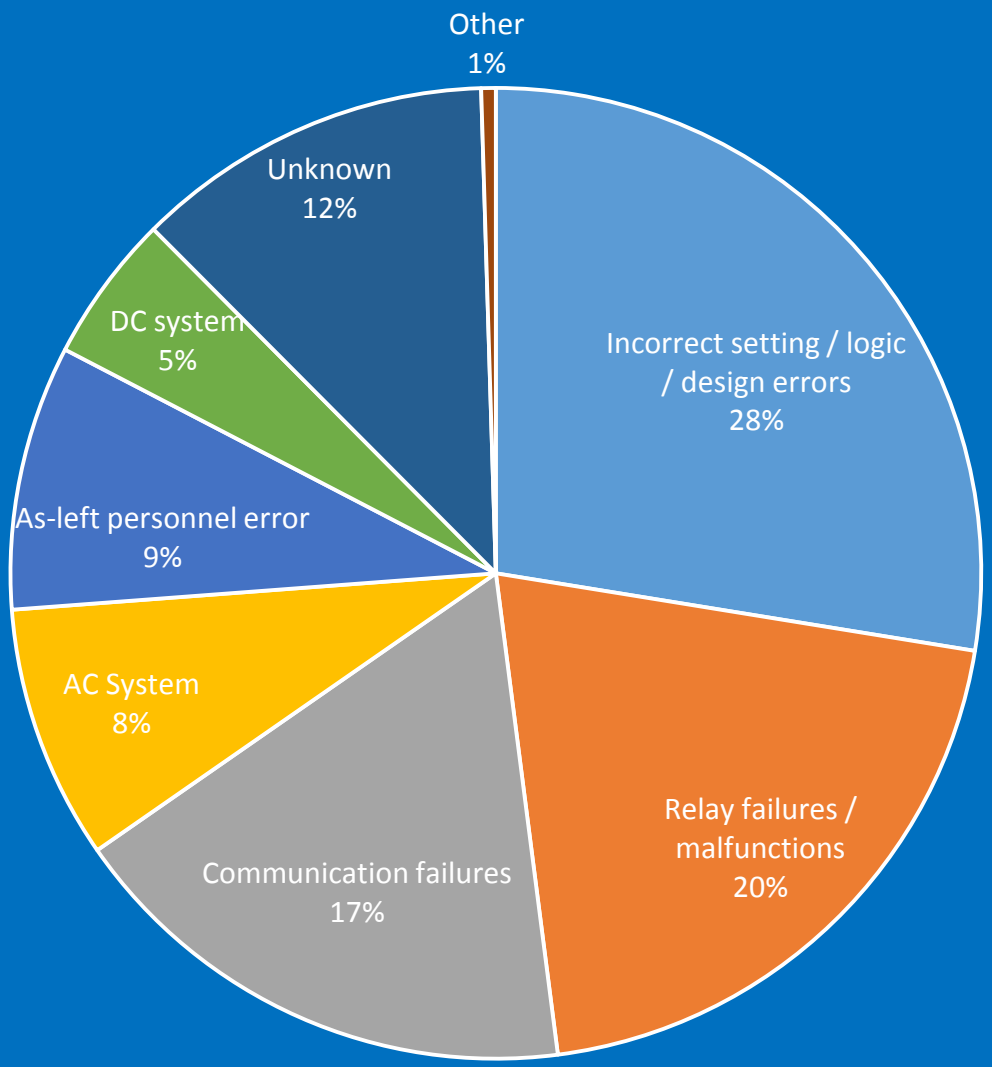
The Driving Goal for Protection Testing

- Protect equipment from damage
- Maintain system stability

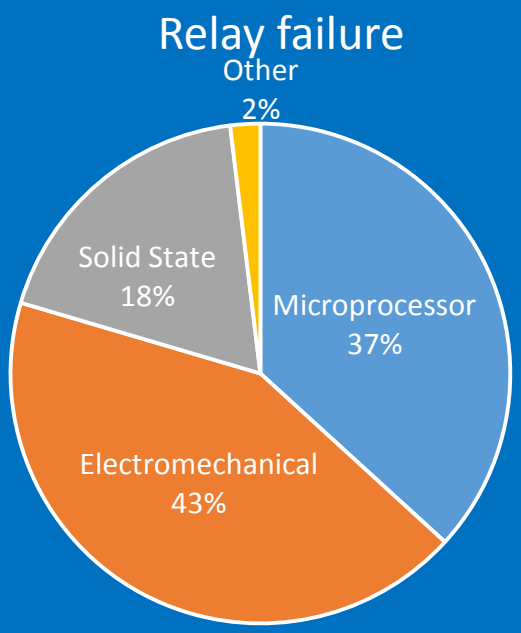
Network of Components Involved in Protection

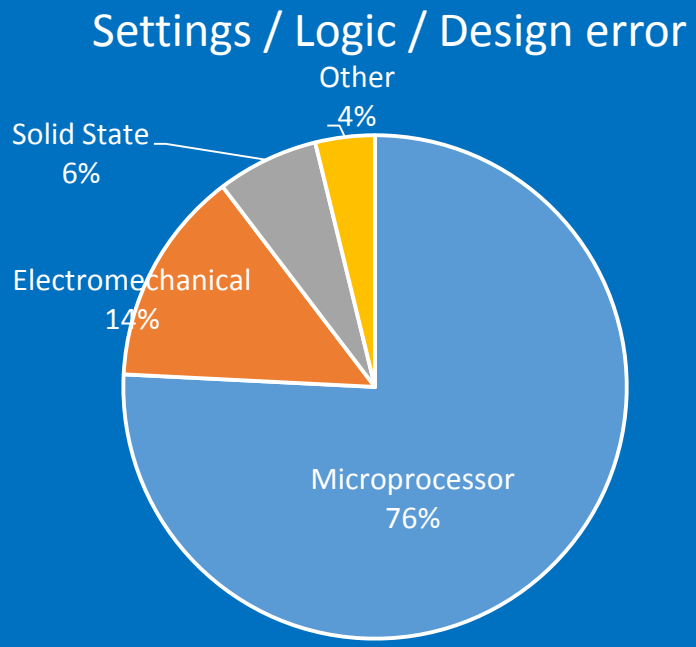


NERC Misoperation Study

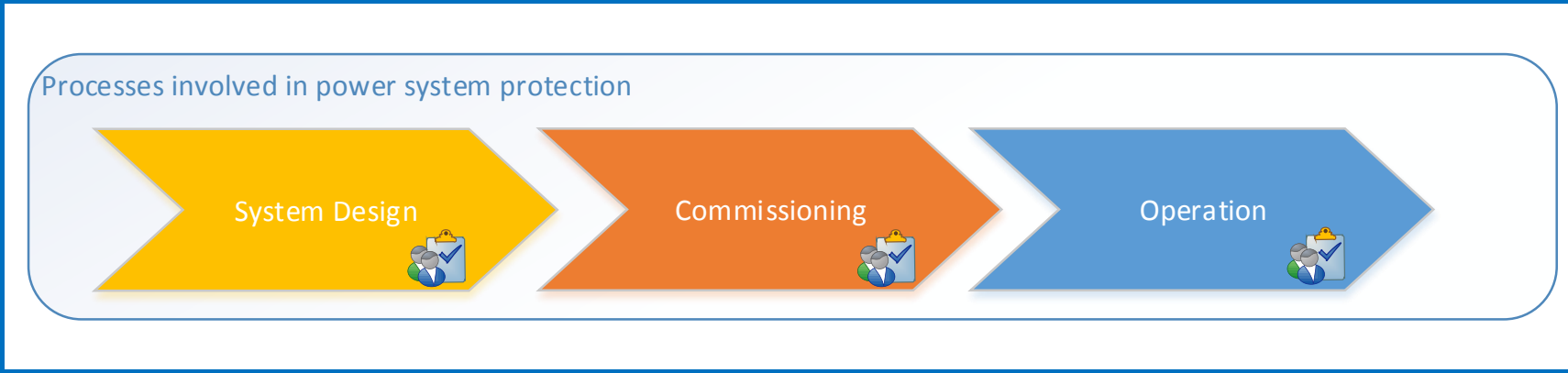


Cause by Relay Technology

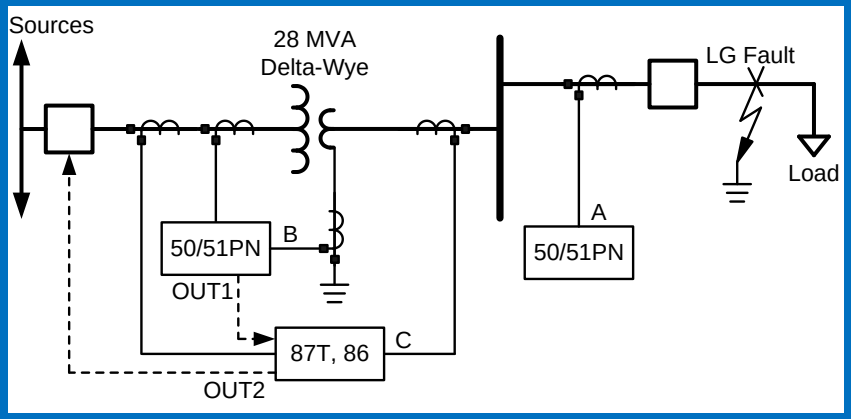


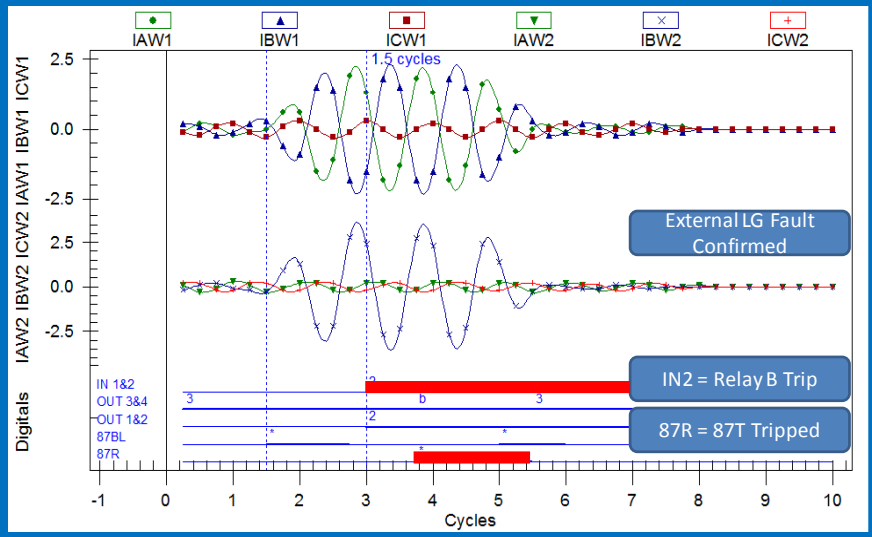


Process Steps Involved in Power System Protection

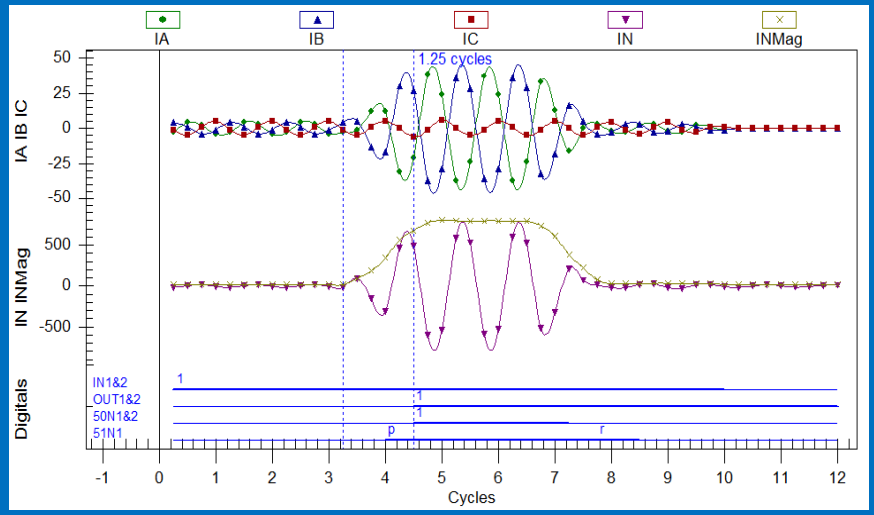


Real-World Misoperations





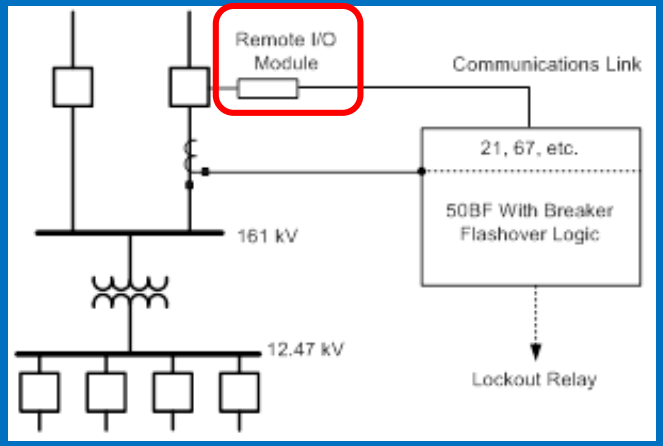
- The fault was an external fault.
- The fault was a BG fault on the distribution side.
- The transformer backup (B) tripped instantly (1.5 cycles).
- 87T (C) would have tripped even without miscoordination.

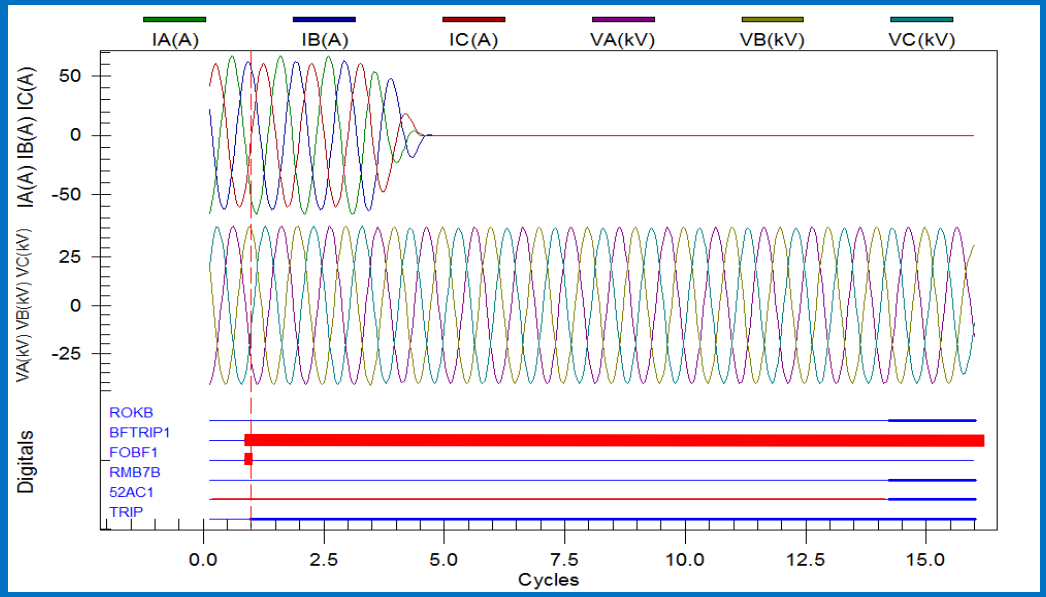


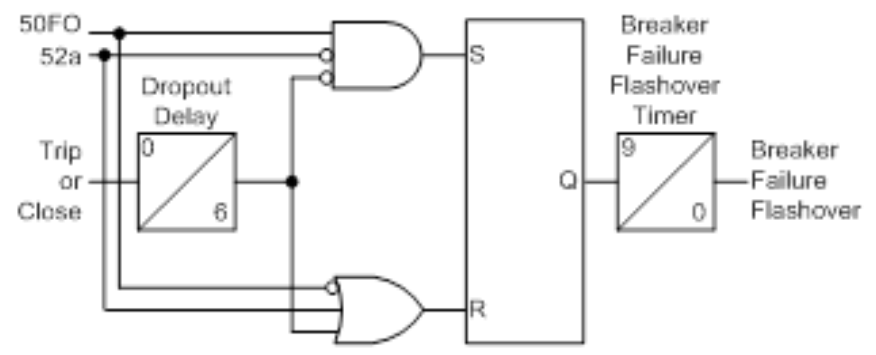
Analysis & Conclusion of the Misoperation

Incorrect phasing	→	Improve test procedures or use synchrophasors, if available.
Incorrect drawings	→	Use peer review and document controls and revisions.
Incorrect CT wiring from the system to the relay	→	Use primary injection for commissioning testing.
Poor coordination	→	Test protection schemes in the laboratory.
Incorrect transformer differential settings	→	Use primary injection and commissioning checklists.
Insufficient testing	→	Commit to allowing adequate time and budget for proper testing, test plan creation, and reviews.

Real World Misoperation





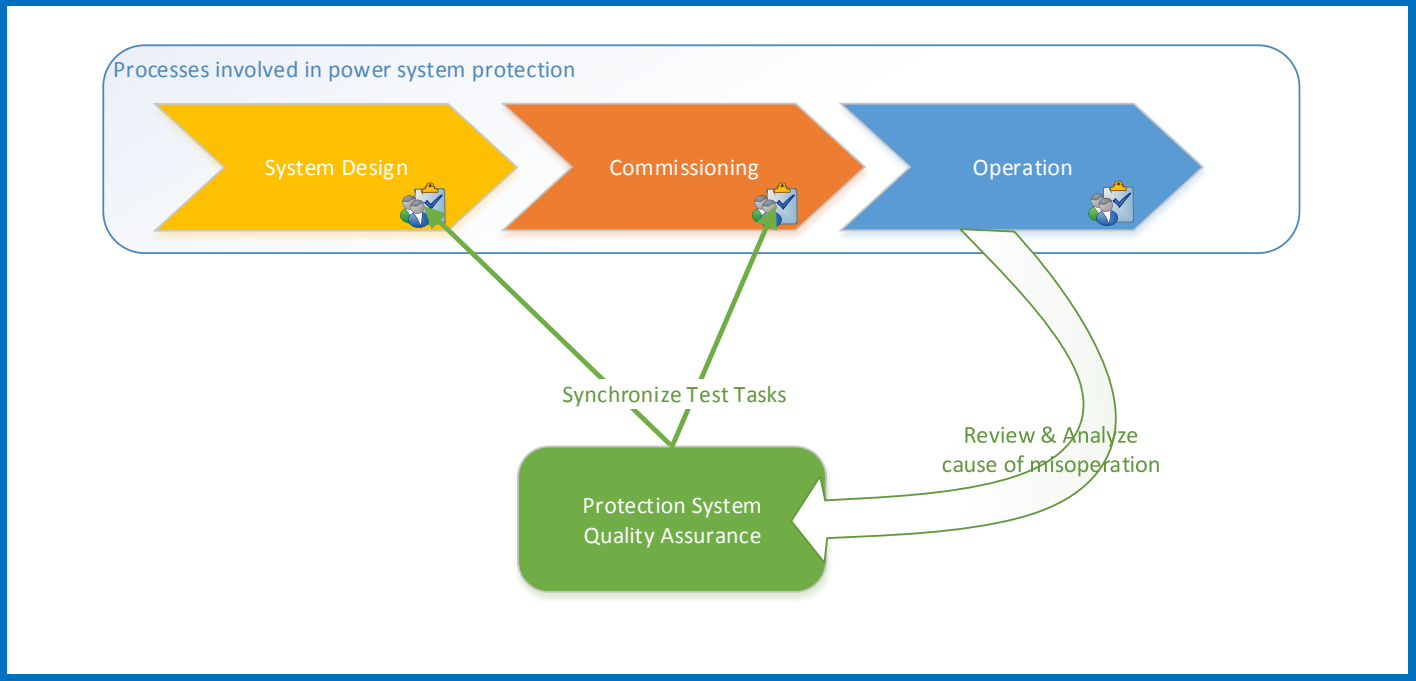


- A DC Power cycle caused the Remote I/O module to evaluate all binary inputs to Logic 0
- Asserting the 52a as 0 tripped the flash over logic

Intermediate Misoperation Conclusion

- Some errors can't be found by relay testing.

- There will always be errors uncovered by the test. It is important to learn from them!

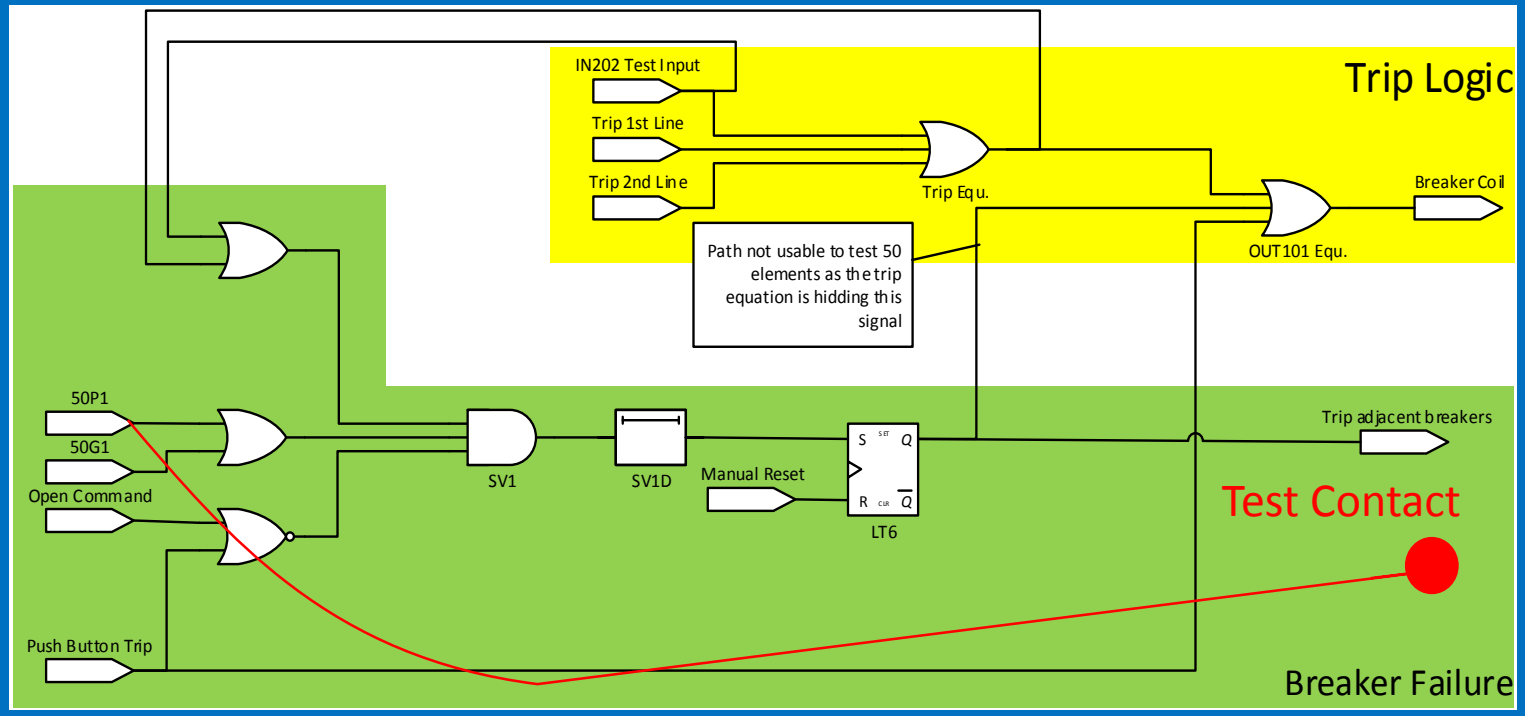


From Check-Lists to Executable Test

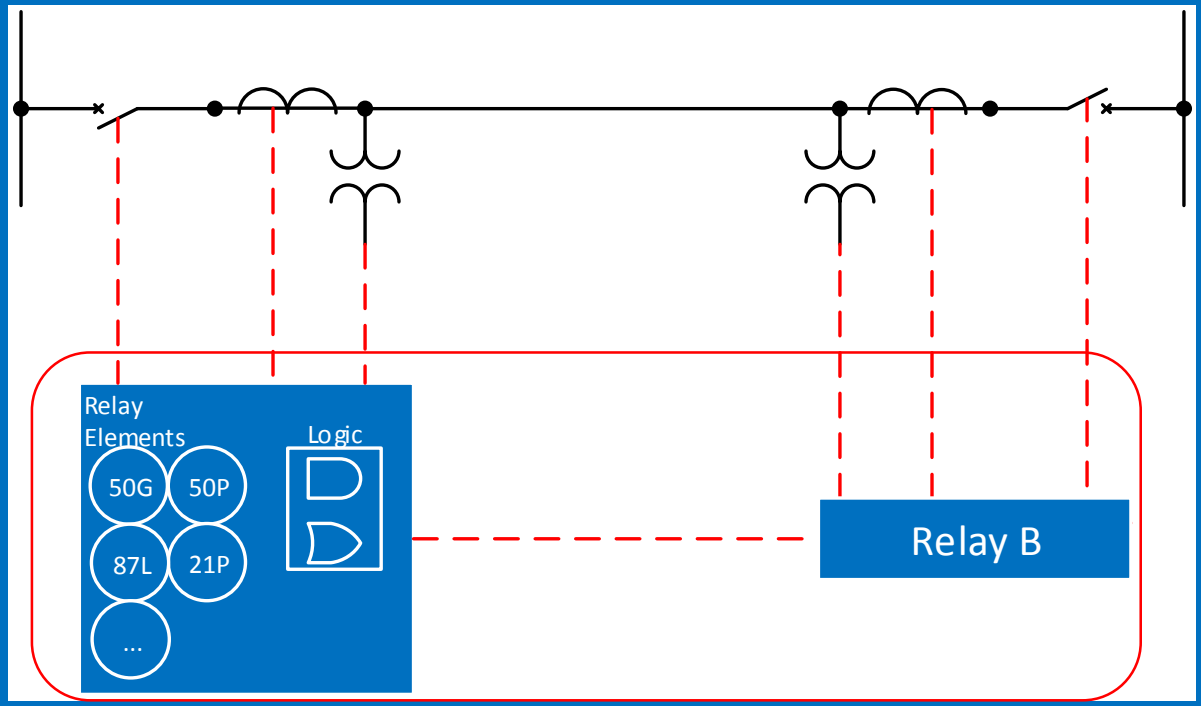
- While check lists are important it is beneficial to transfer list items into the executable test routines
- A predefined assessment clearly communicates intention
- Reusable test plans guarantee a more even test quality

Element Testing Approach

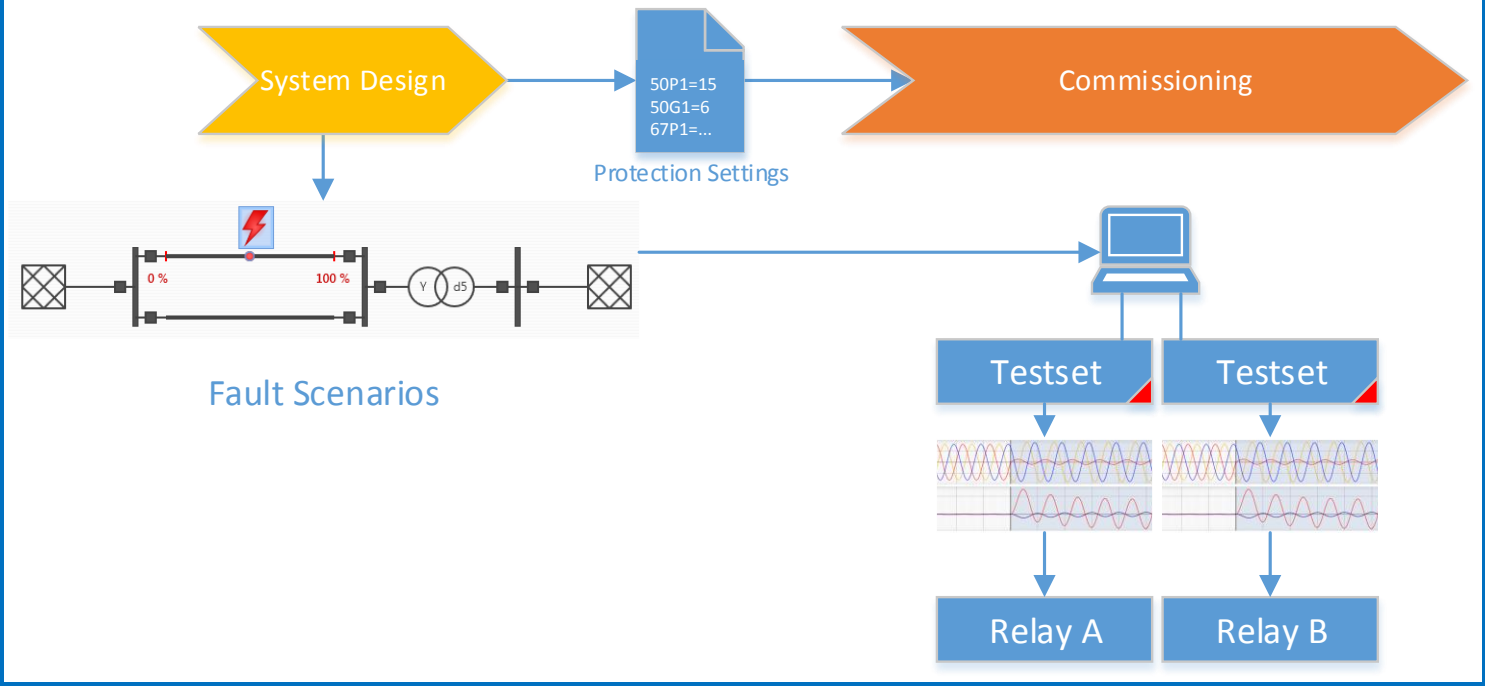
- Test Contacts e.g. mask out the elements bypassing the logic
- Changing settings for the sake of testing can do more harm than it can help!



Executable Logic & Communication testing

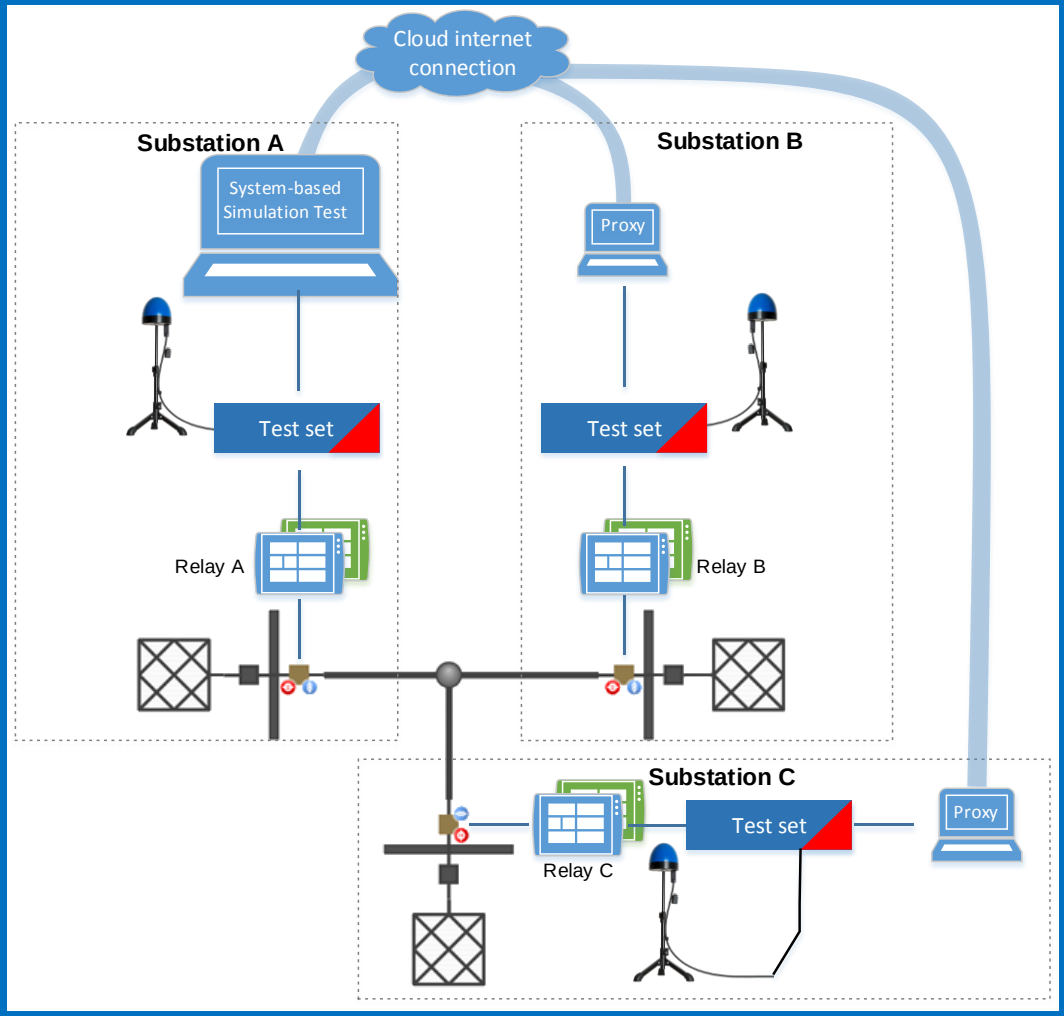


System-based Simulation Test

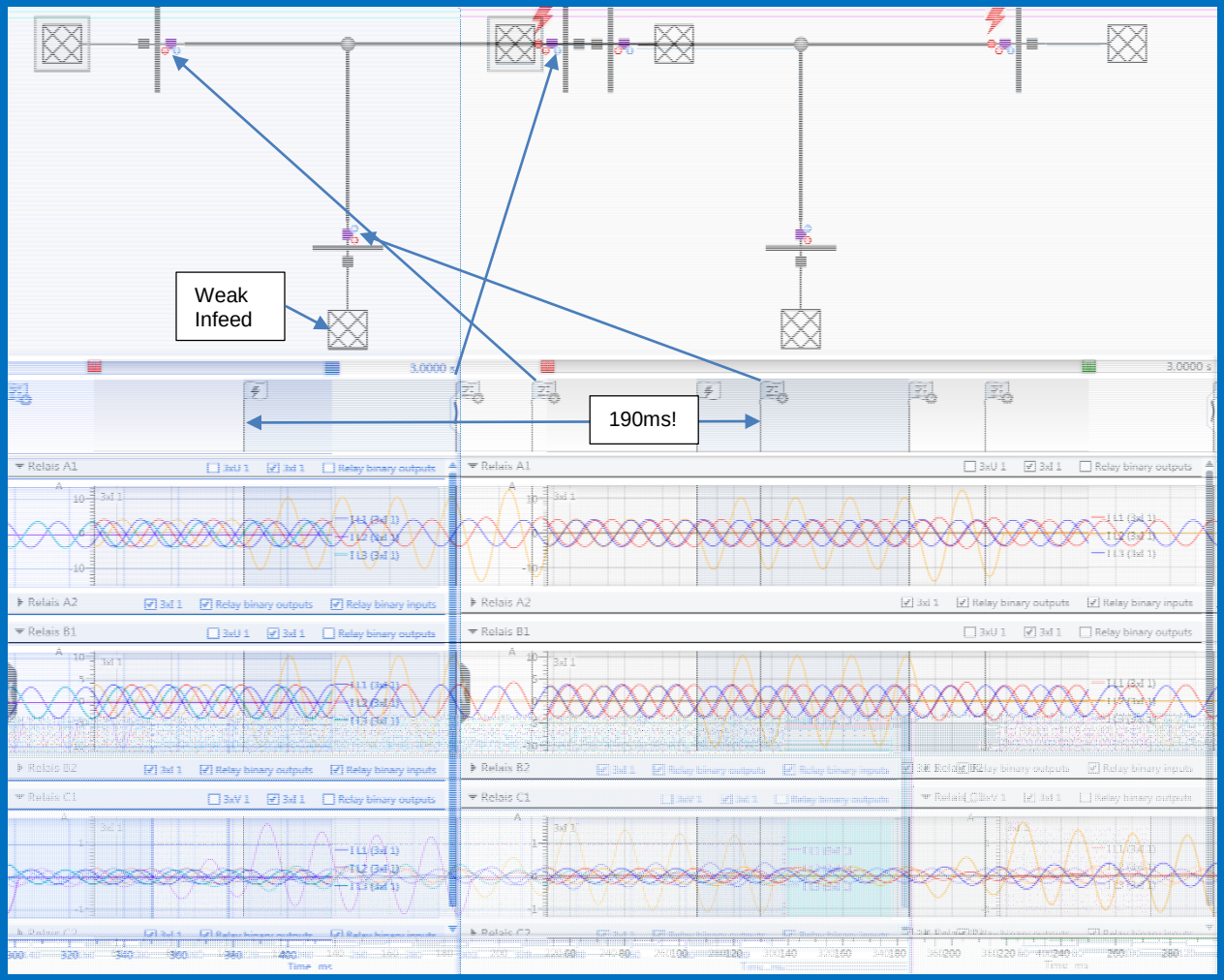


- Covers most parts of the process
- No error propagation
- Intention of test is clearly communicated

Test Setup for a distributed Protection



Sample Issue Found During a System-based Simulation Test



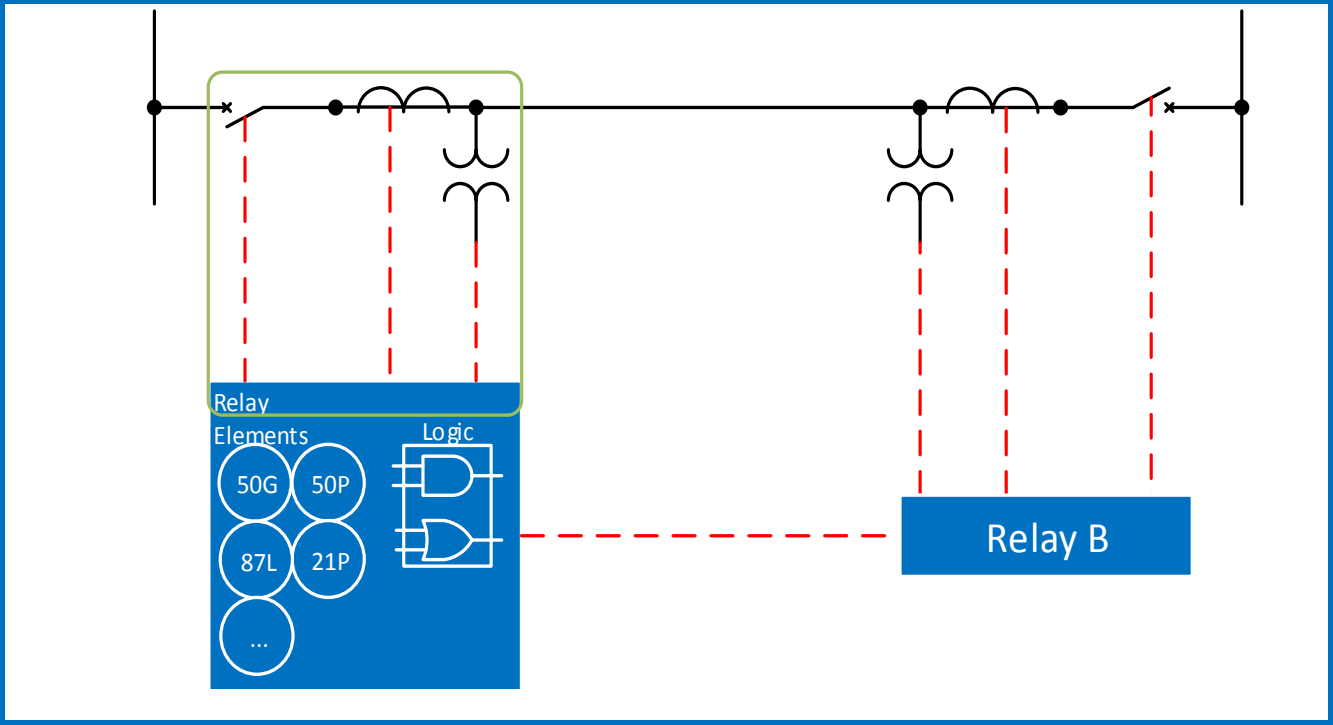
A Higher Quality Assessment

- Element testing only verifies that (maybe incorrect) settings are correctly transferred to the relay.

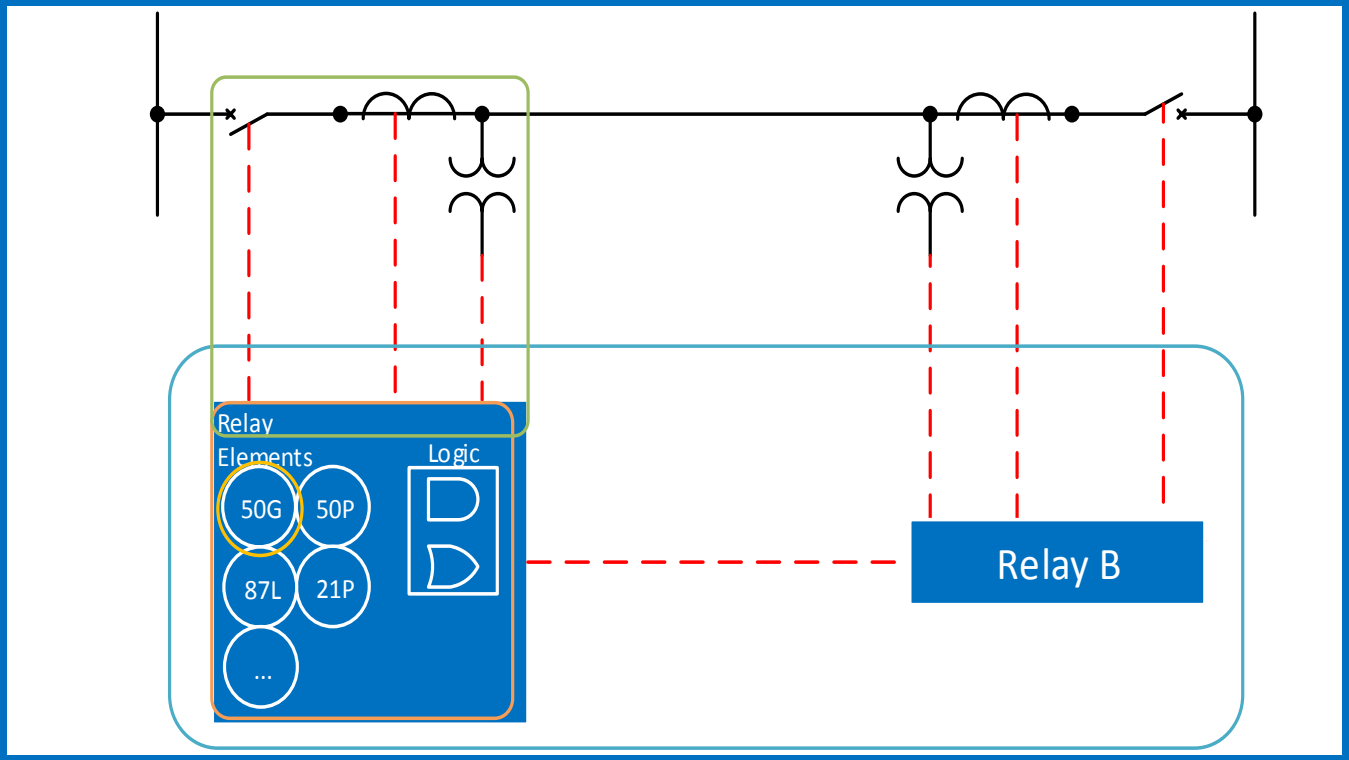
- System-based simulation testing validates that the protection system behaves as expected.

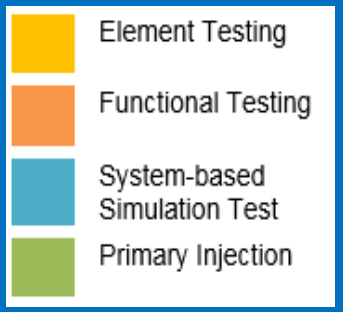
AC System Testing

- Trip breaker coil
- Primary current injection to check polarity etc.
- Terminal block closest to the AC System



Building a Test Strategy





Conclusion

- Protection testing is indispensable but its focus has to move protection system testing.
- Review misoperation and take actions also for testing
- Well trained engineers and technicians build the foundation
- identify & test not only components alone but also “overlap” their interfaces