

Single Point of Failure

Redundancy

i – PCGRID – 2014

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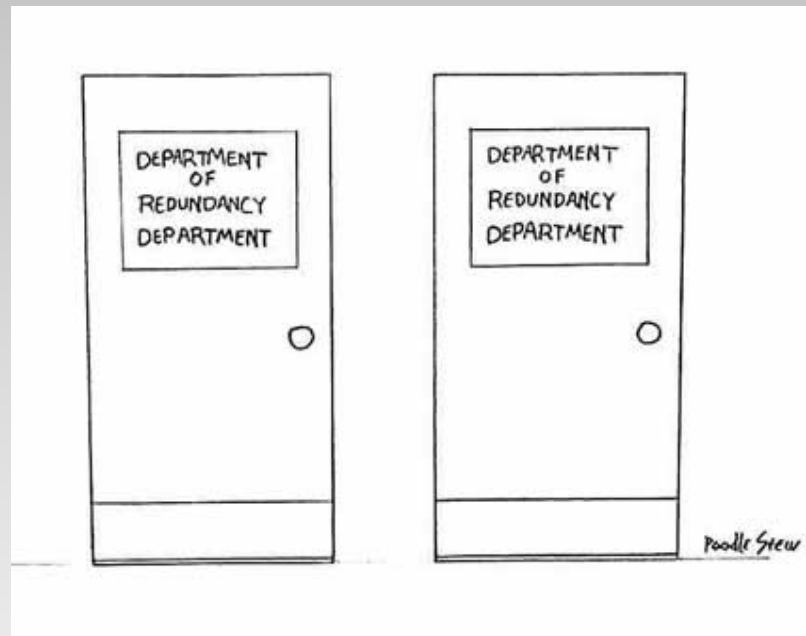
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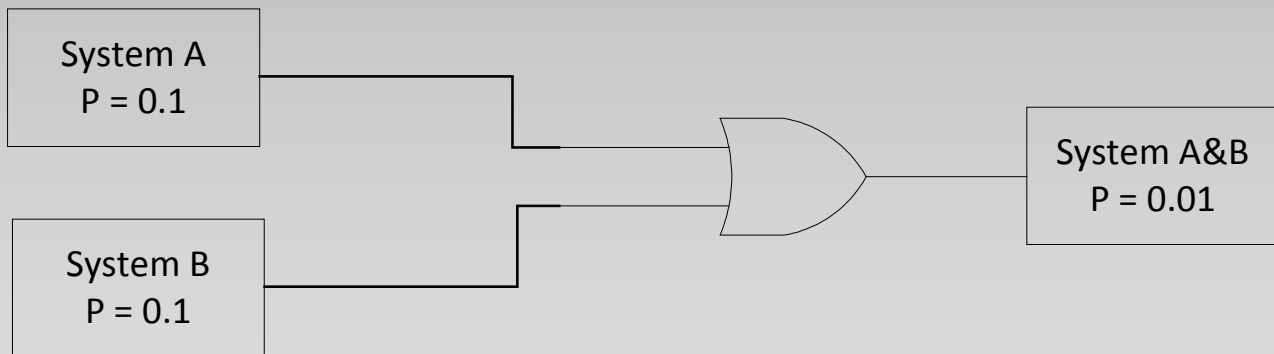
Redundancy

- General: Redundancy is the duplication of critical components or functions of a system with the intention of increasing reliability of the system
- PSRC: Redundancy is the existence of more than one means for performing a given function.
- One of the main objectives: Increase reliability by eliminating single point of failures



Increased Reliability

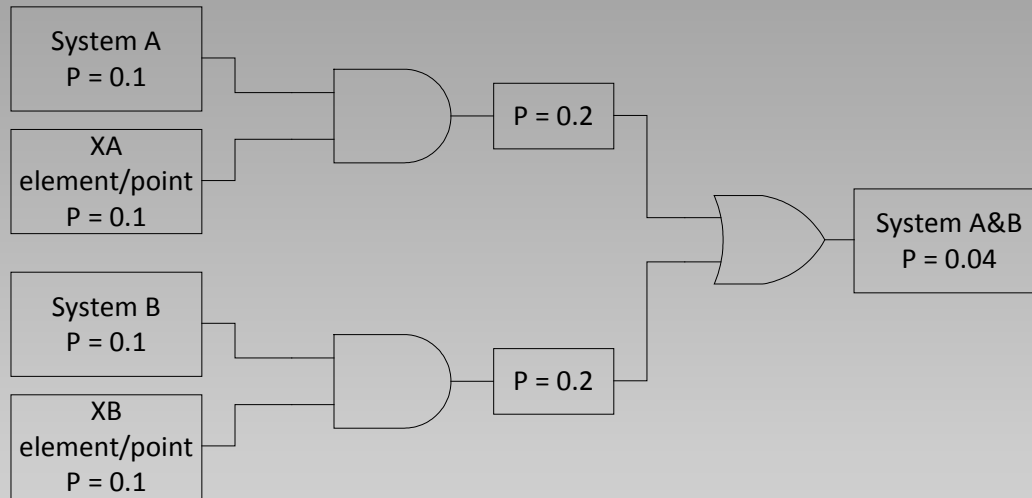
- Probability of failure for single system (lack of operation)
 - $p = 0.1$ (*)
- Probability of failure for redundant system
 - Assumed fully independent



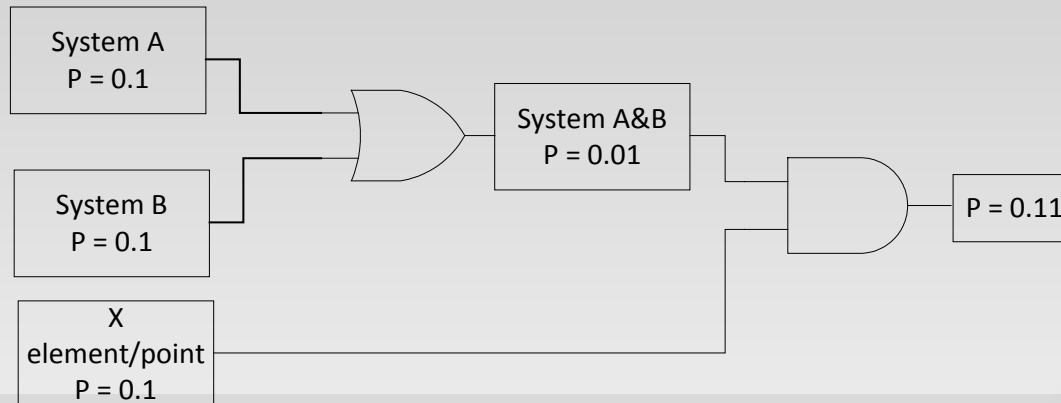
- ❖ Probability 0.1 is used for illustration only
- ❖ Realistic p is in the order of $10^{-4} = 0.0001$

Single Point of Failure in a Redundant System

■ Fully redundant

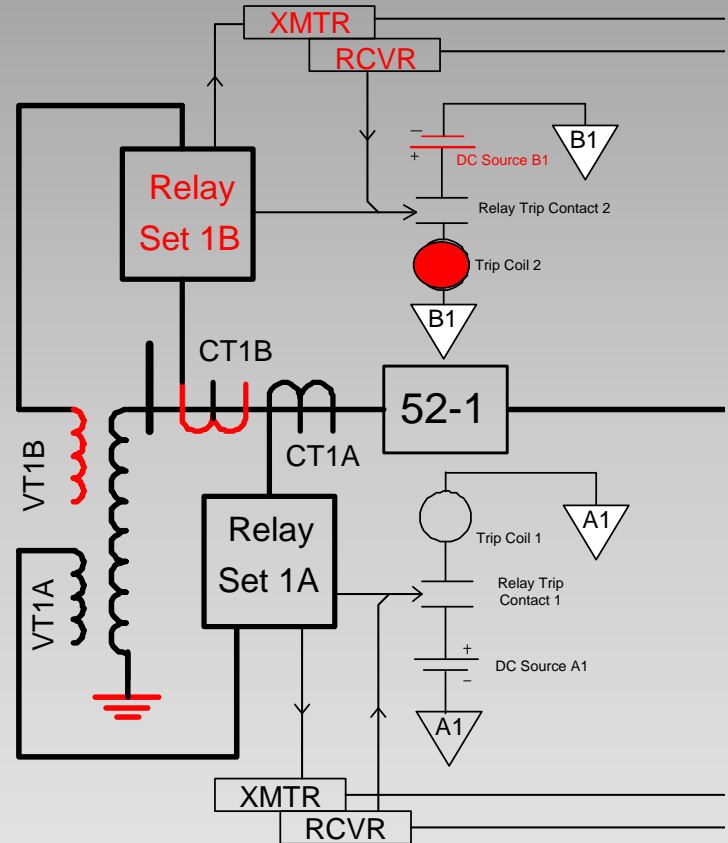


■ Common element / point – Single Point of Failure



Common Single Point of Failures

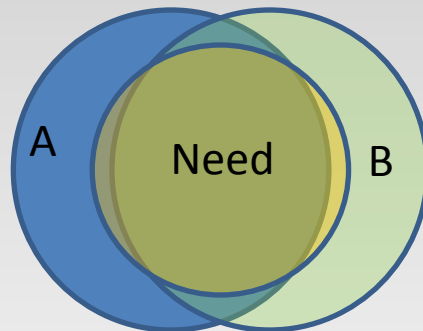
- Common CCVT winding
 - Shared CCVT ground connection
- Relay Set B limited functionality
- Common points in DC chain / battery
- Same Trip Coil
- Shared communications
 - Different pairs but same fiber
 - Common MUX



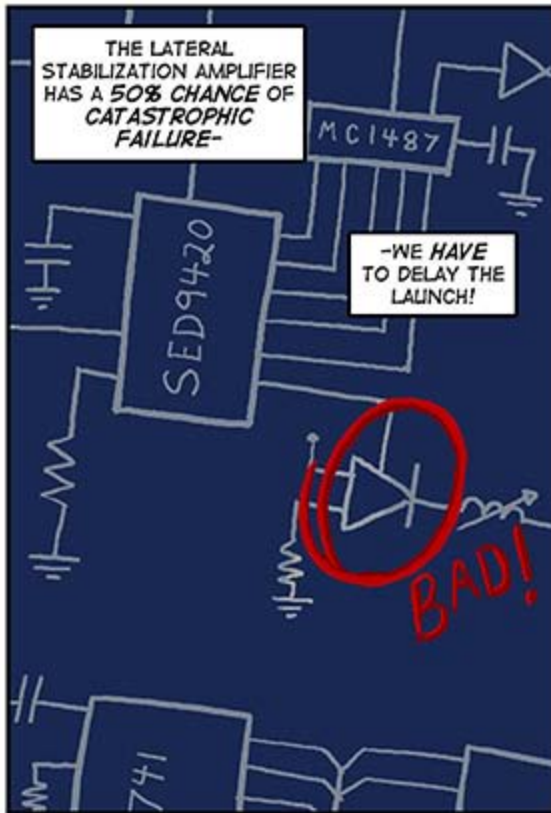
Redundancy Considerations

- Single Point of Failure
 - Hardware redundancy
- Good engineering practices
 - Functional redundancy, diversity
- System Impact
 - Outage time
 - Restoration time
 - Availability
- Economic considerations

- Main A and Main B of equal performance
 - Different or identical devices
 - Single source
 - Common mode failure
 - Hidden failures
- Diversity
 - Different operating principles
 - Functional redundancy
 - Different manufacturers
 - Supply chain
 - Engineering standards
 - Complexity



Questions?



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References

- IEEE PSRC Report: Redundancy Considerations for Protective Relaying Systems (2010)
 - <http://www.pes-psrc.org/> (Published Reports)
- NERC System Protection and Control Subcommittee: Redundancy of Protection System Elements (2009)
 - <http://www.nerc.com/filez/spctf.html>