

Benefits of a Risk-based Comparison of Electrical Distribution System Operation

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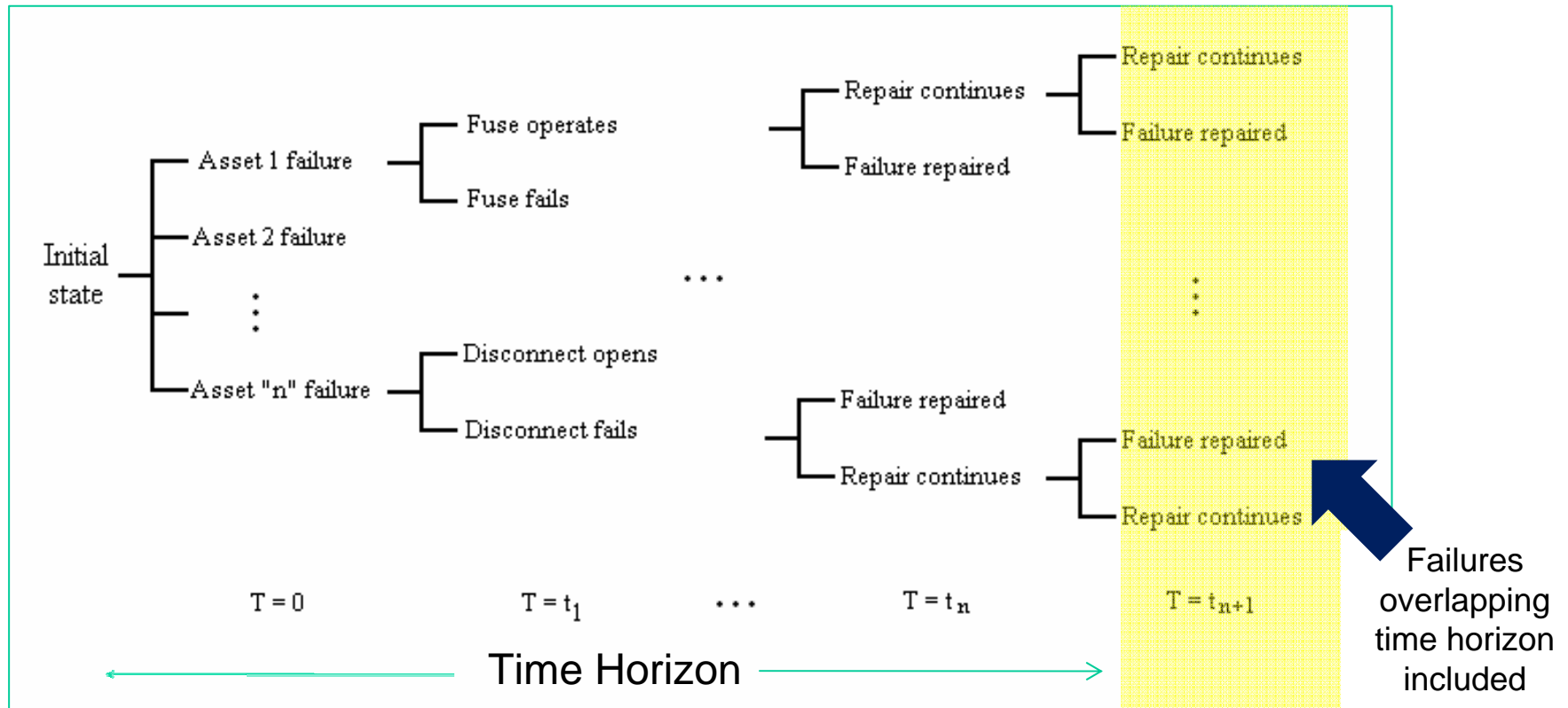
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Distribution Operation

- Personnel work under high stress
 - Error can bring immediate undesirable consequences
- Short decision time-frames
 - Real time to weeks or months
- Increasing uncertainty in operational parameters
- Trade-off between reliability & risk often disregarded
 - Attitude of avoiding risk at almost any cost

Can a measure of the risk accepted in short term operation guide network management?

Risk Assessment Process



- Event tree populated by Monte Carlo simulation of network behaviour
- Each realization corresponds to an operational “cost”

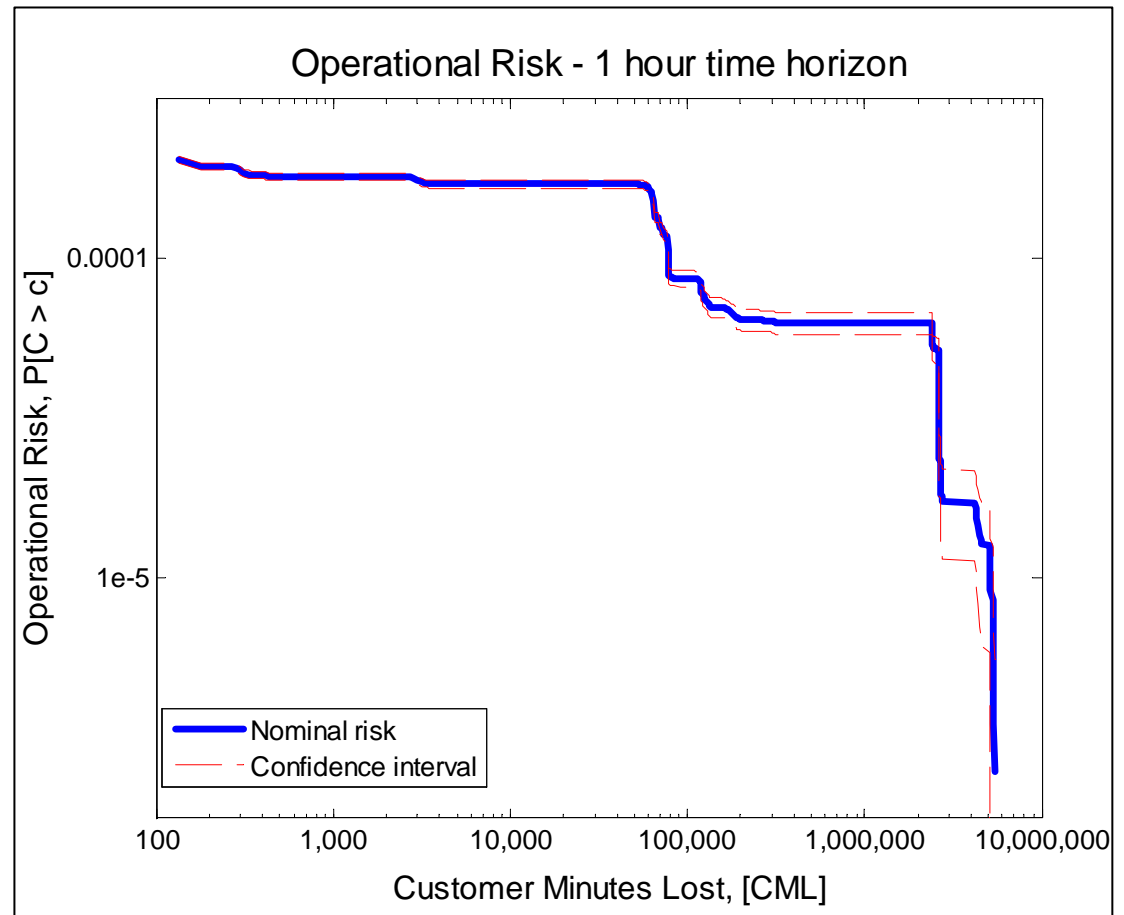
Generating Risk Profile

Risk defined as probability of operation exceeding some “cost”

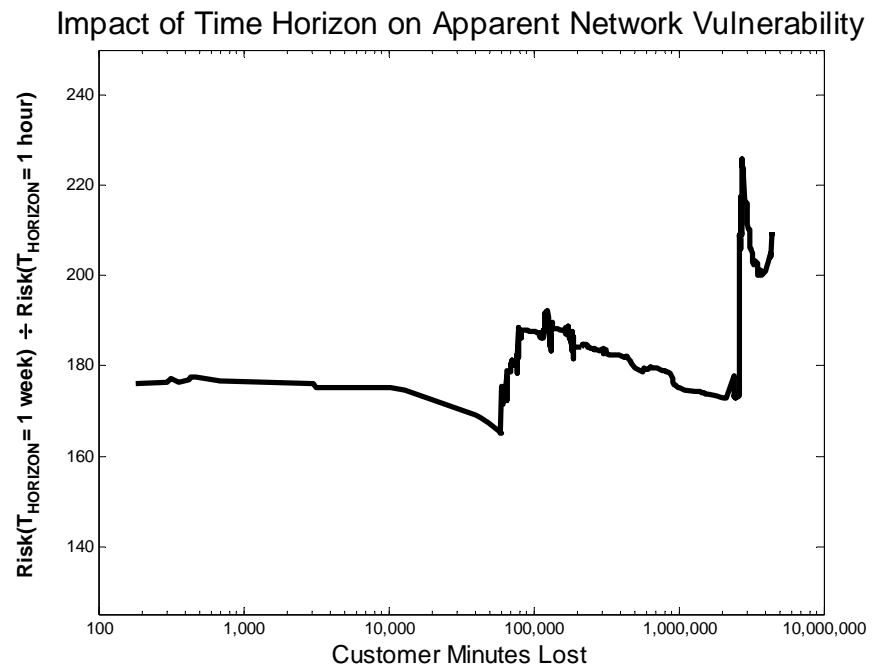
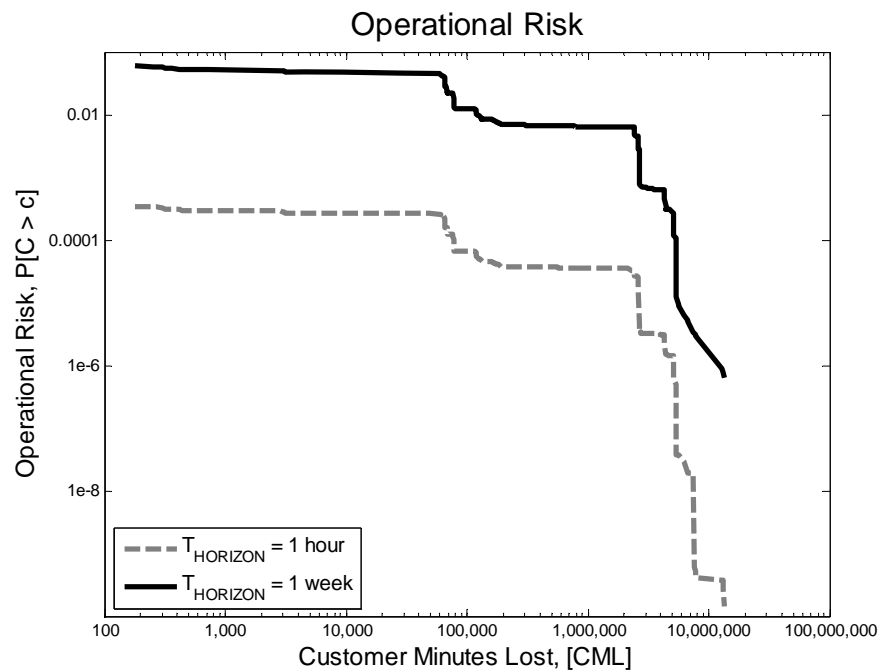
$$P[C > c] \approx \frac{1}{n} \sum_n I_{\{C > c\}}(C)$$

$I_{\{C > c\}}$ - indicator function, equal to 1 if the outage exceeds a given “cost”

Process converts results of Monte Carlo simulation into multiple formal estimates of risk



Operational Risk - Value



- Apparent network vulnerability dependent upon period of operational constancy (i.e. time horizon)
 - Longer time horizons provide conservative estimate of network vulnerability in short-term

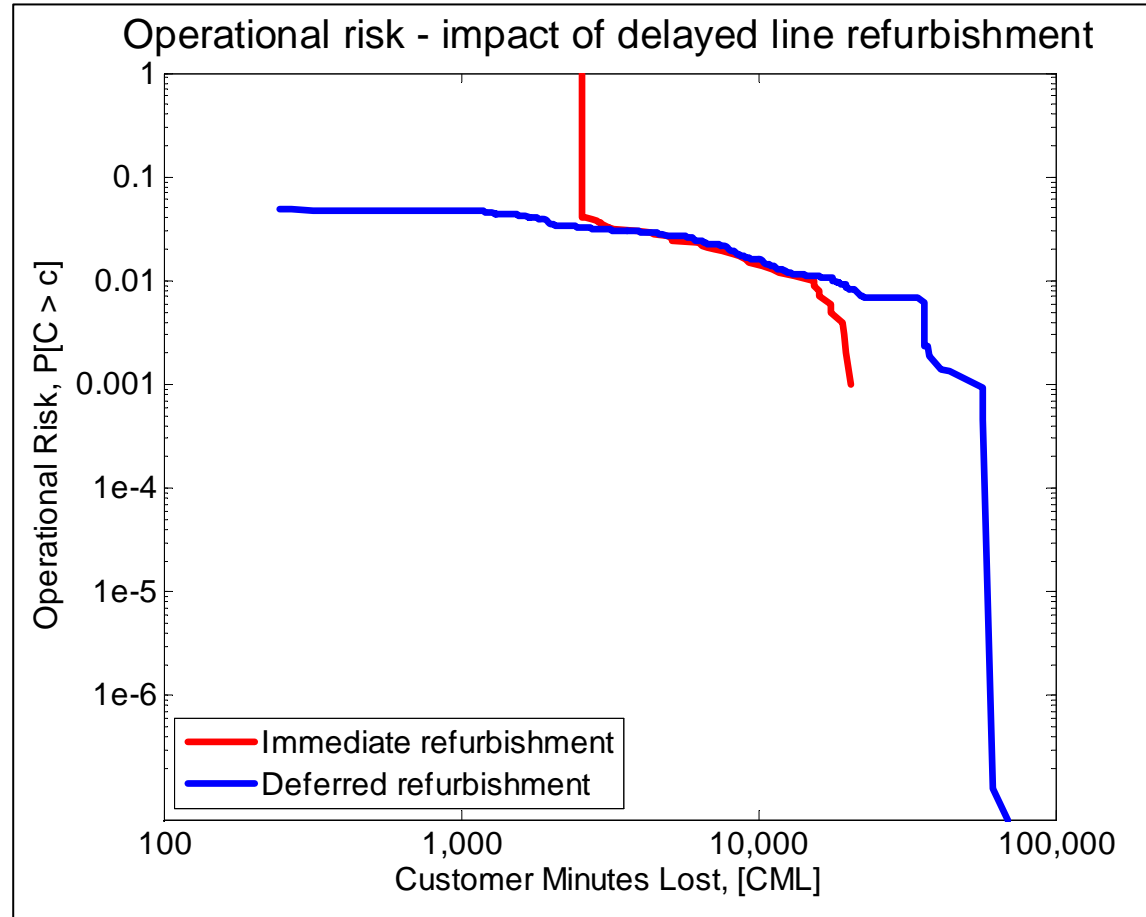
Operational Risk - Applications

- Risk measures most valuable during periods of changing operating condition including:
 - during restoration and/or repair processes;
 - changing physical network conditions due to
 - aging
 - adverse weather
 - incipient failures
 - maintenance activities
 - multiple failures and repair cycles
- Particular need for measures of operational risk when operating outside anticipated system behaviour
 - Increasing flexibility of distribution networks will heighten this need

Example: Line Maintenance Deferral

- Refurbishment options for aging line section
 - A. Refurbish as scheduled
(in 1st week of month's time horizon)
 - B. Postpone refurbishment to next month
- Condition of aging line:
 - Failure rate 3 time nominal before refurbishment
 - 75% nominal failure rate post refurbishment

What risk is incurred in postponing the refurbishment by a month?



Immediate refurbishment limits variability in operational “cost”

- Some disruption immediately incurred, but
- Reduced exposure to high consequence outages

Conclusions

- Distribution network vulnerability changes markedly within operational time-scales
 - Methodology proposed treating short-term operational choices as risk assessment process
 - Constitutes framework for visualising impact of range of short-term changes including:
 - topological changes
 - changes to operational process
 - variability in asset conditions
- Ongoing work focuses on establishing value of using risk measures for network operation



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Questions?