

The Influence of System Loading on Risk-based Security Profile of a Power System

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Risk-based Security Profile

Increased uncertainty:

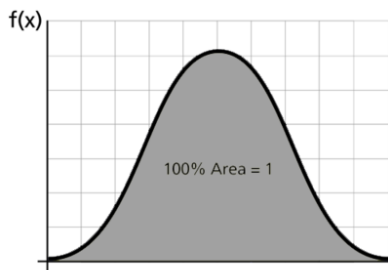
- Intermittent renewables
- New types of loads



Probability of Instability:

- Probabilistic analysis
- Probabilistic outputs

Risk-based Security Profile



Minor



Moderate



Major



Critical



Severity is missing:

- Potential consequence is unknown
- High impact low probability events !

The full picture:

Risk

= *Probability* (of instability)

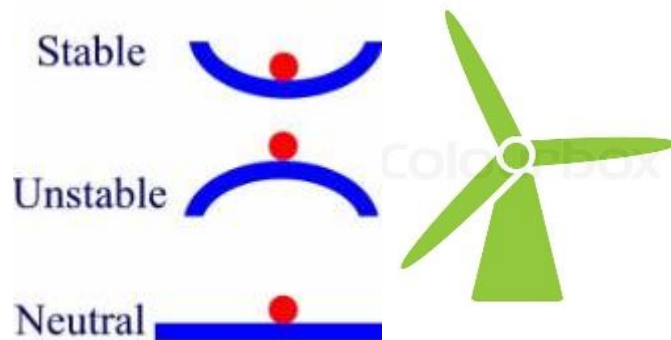
× *Severity* (caused by the instability)

Risk-based Security Profile

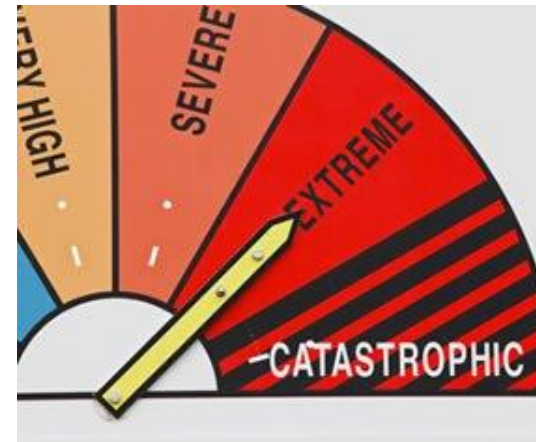
Risk

= Probability (of instability)

× Severity (caused by the instability)



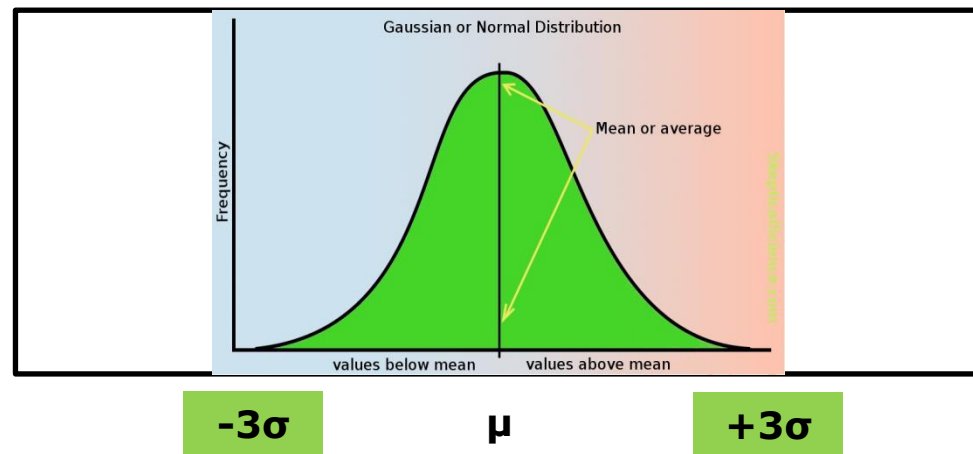
Probability



Severity

Probabilistic Simulation

Monte Carlo Simulation



Probability of (in)stability

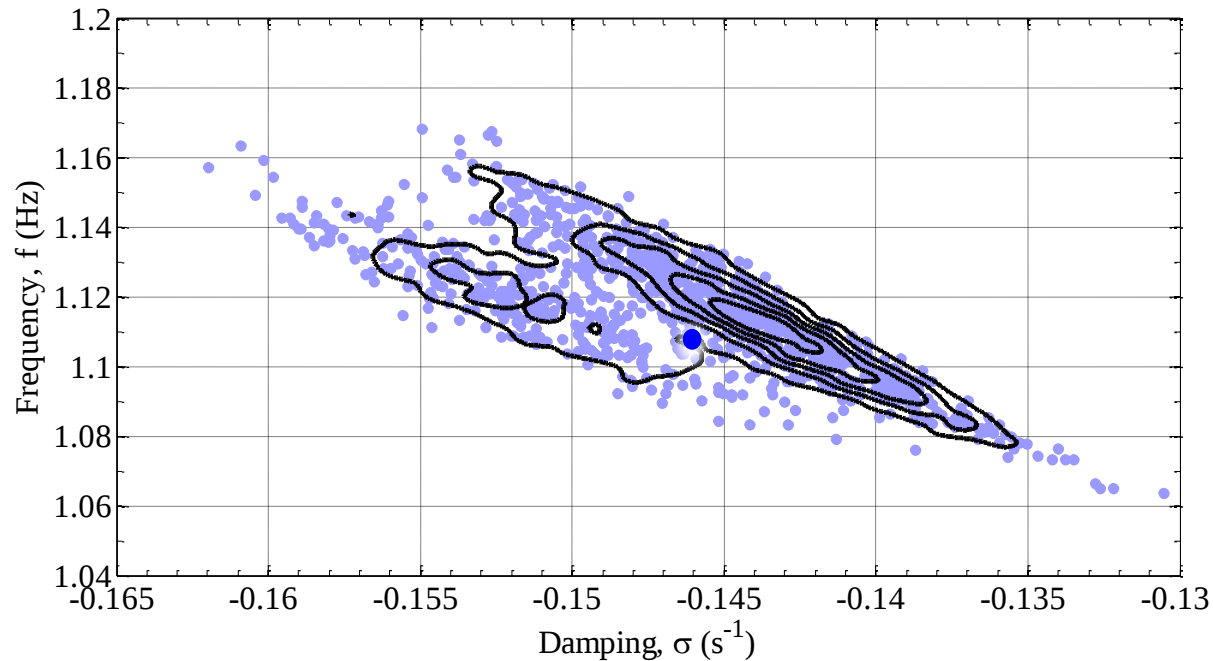


Fig: Critical eigenvalue as affected by input parameter uncertainties.

Probability of (in)stability

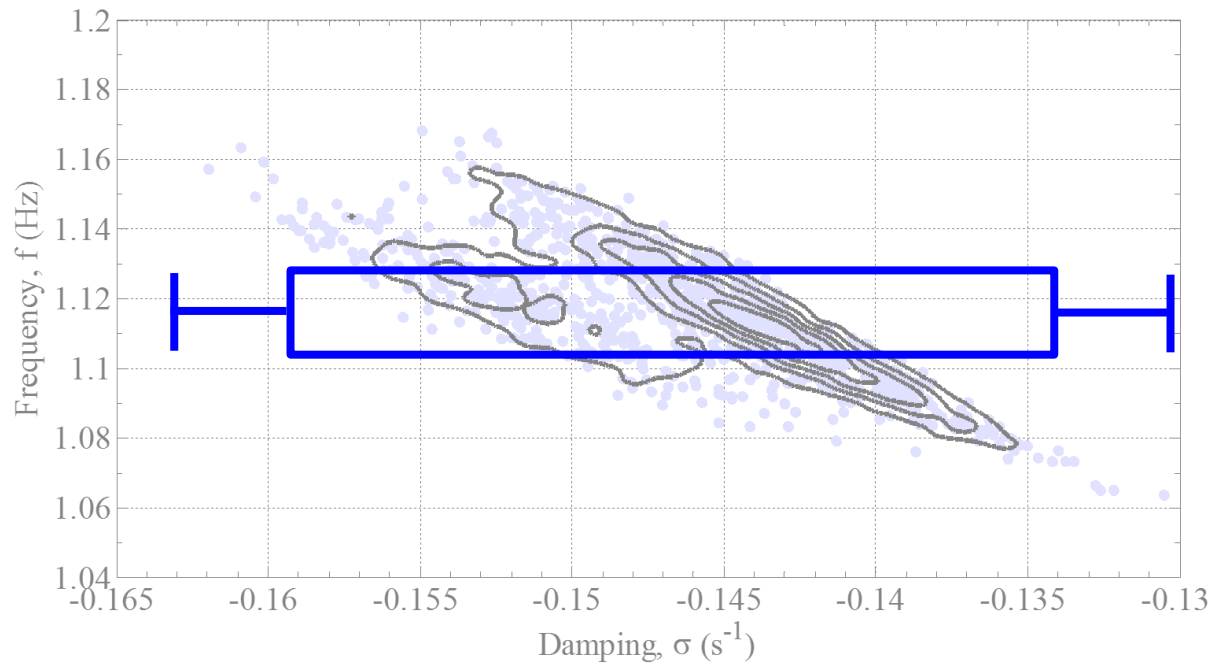


Fig: Critical eigenvalue as affected by input parameter uncertainties.

Probability of Instability

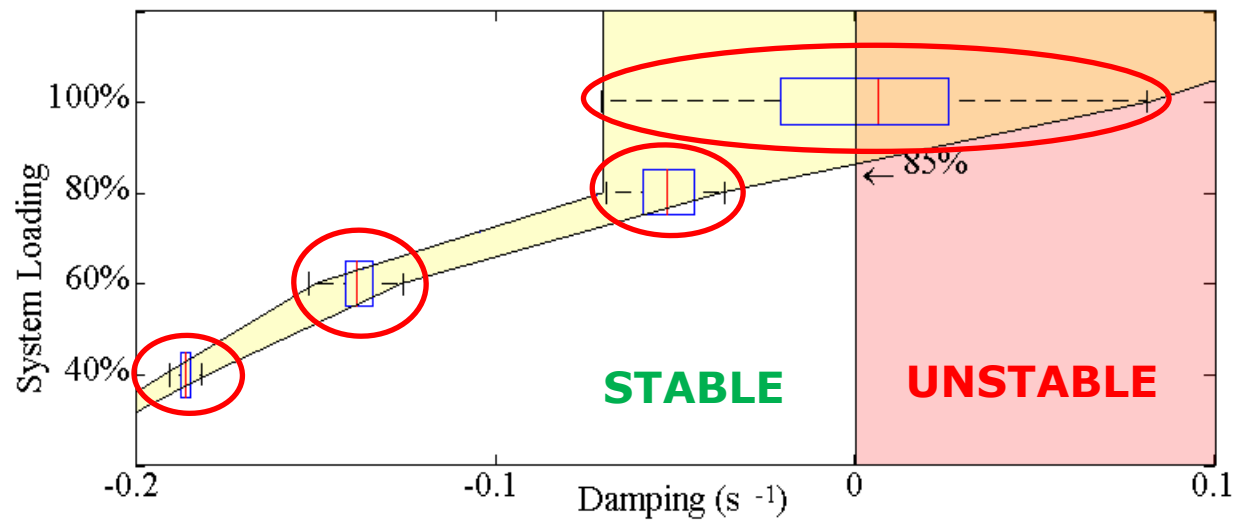


Fig: Impact of system loading on system stability.

Severity

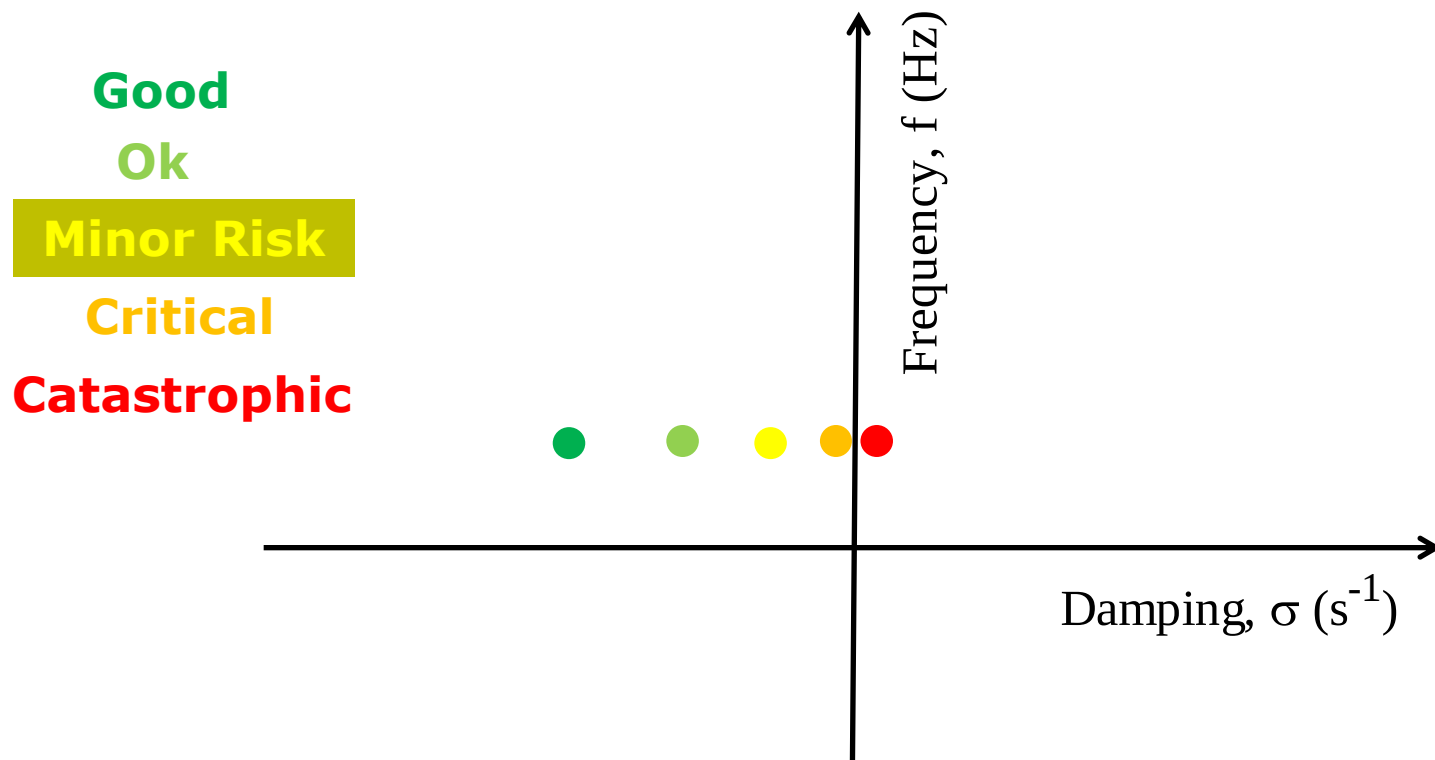


Fig: Concept of severity.

Severity

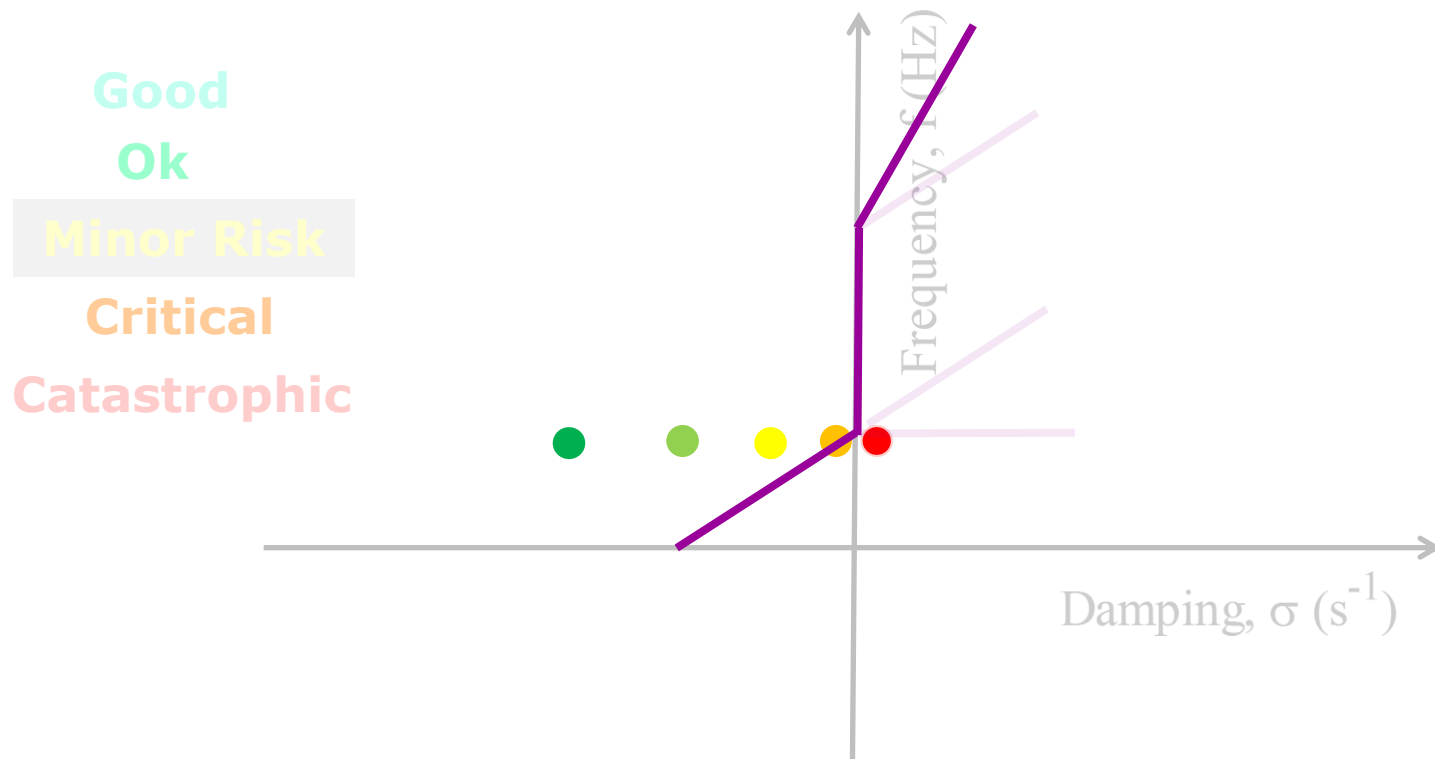


Fig: Concept of severity.

Severity

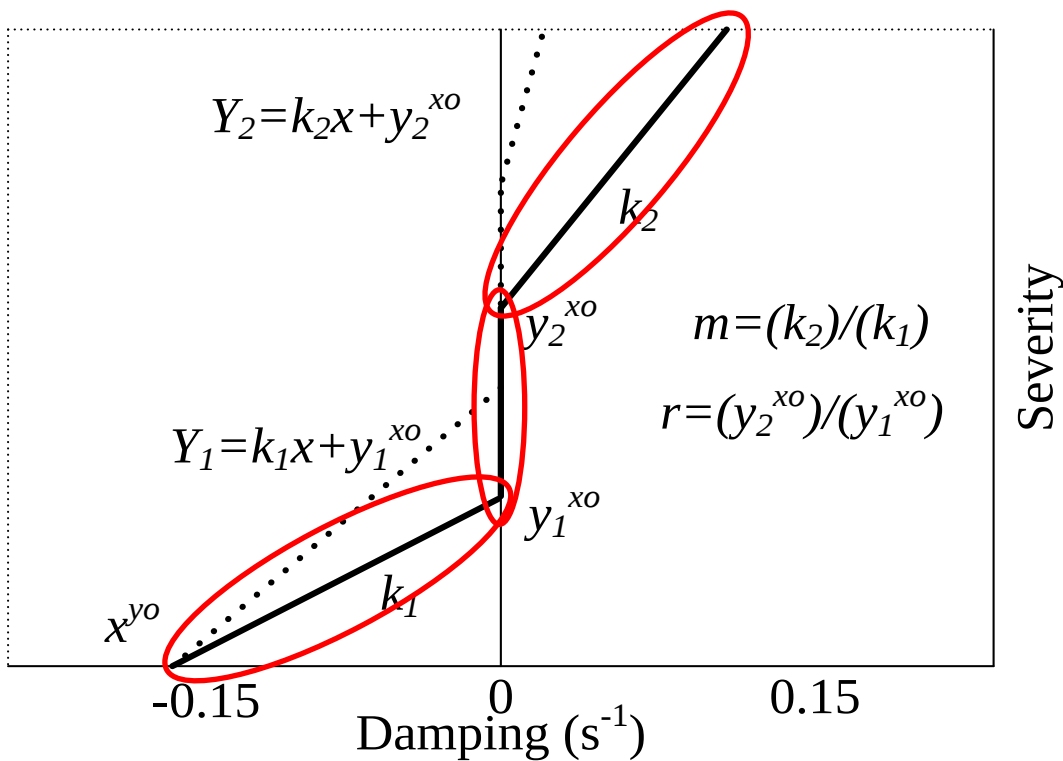
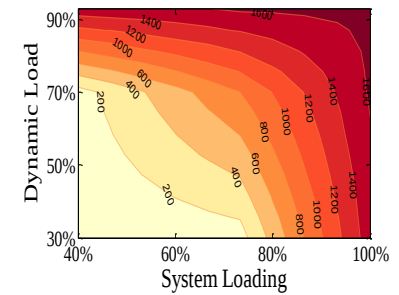
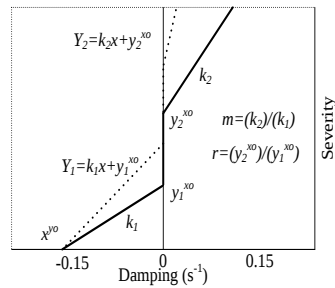
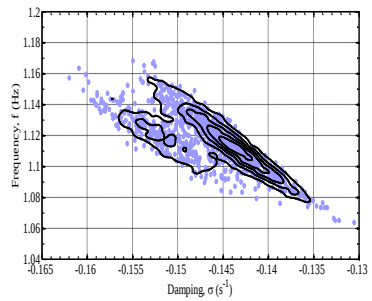


Fig: Severity functions for system stability.

Risk !



Risk

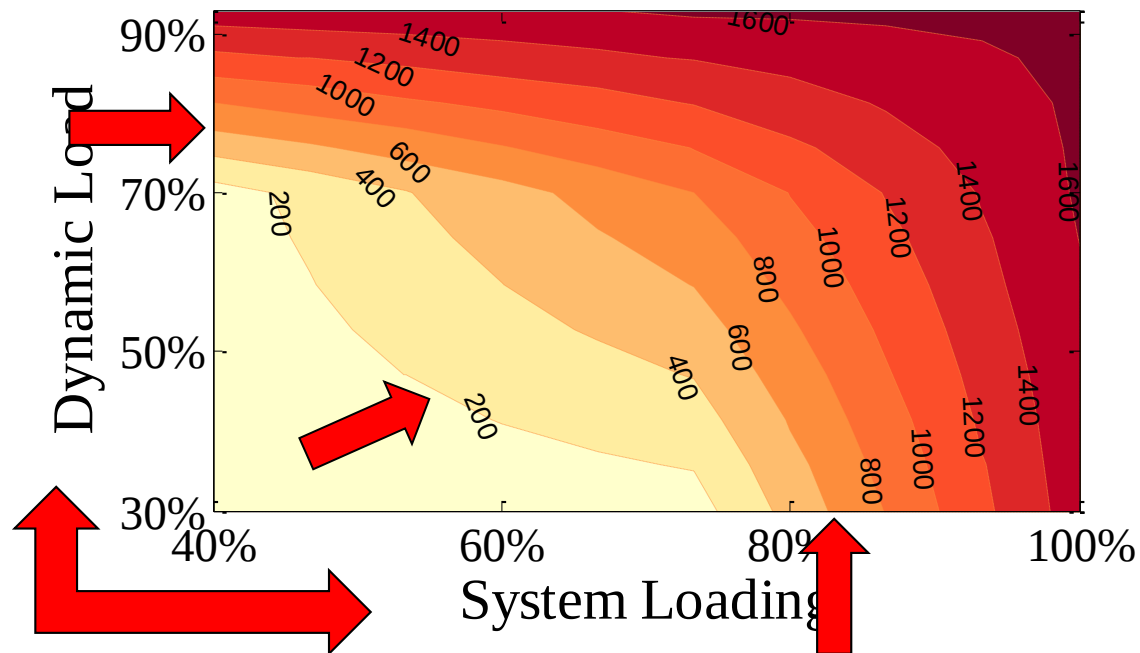


Fig: Risk-contour changes with system loading.

Conclusions

Summary:

- Risk-based security profile is a user-friendly visual tool
- Presents total composite risk having probability & severity
- It shows risk levels at different operating conditions

Next Steps:

- Unified severity function for all types of stability
- Combining technical profile and economic index in total risk

K. N. Hasan, R. Preece, and J. V. Milanović, "The Influence of Load on Risk-based Small-Disturbance Security Profile of a Power System," *IEEE Transactions on Power System*, vol. 33, no. 1, pp. 557-566, January 2018.

Thank you

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