FAST MONITORING OF VOLTAGE COLLAPSE MARGIN WITH SYNCHROPHASORS ACROSS TRANSMISSION CORRIDORS WITH MULTIPLE LINES IN COLOMBIA

filial de isa

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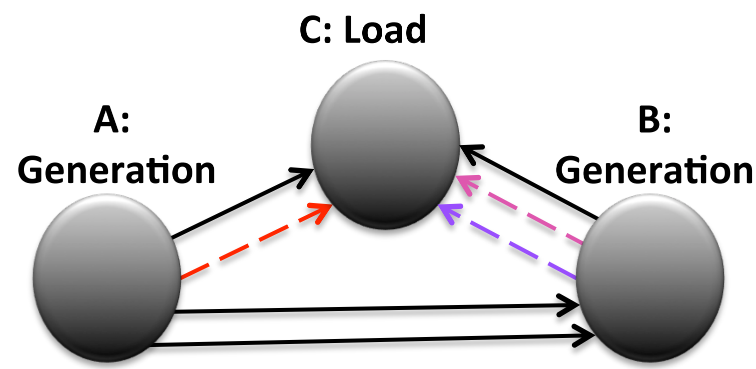
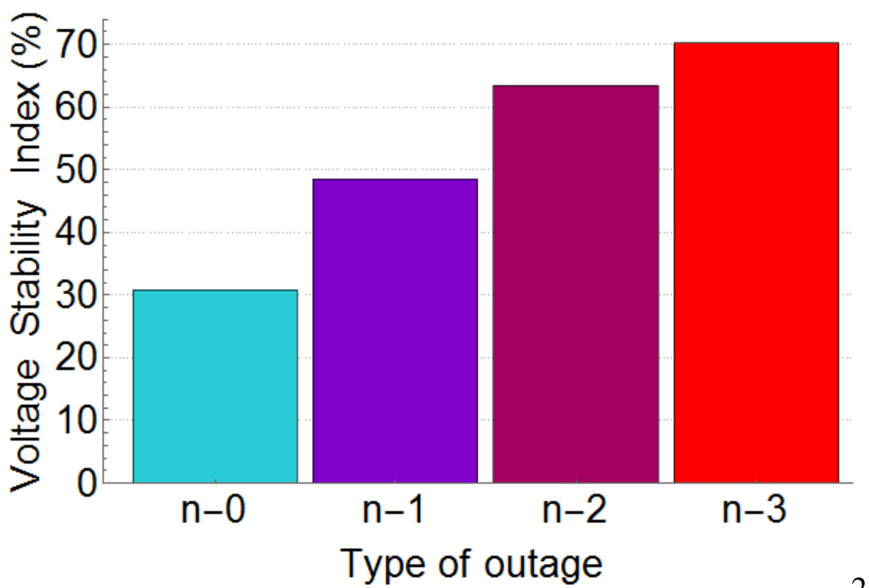
Introduction

Industry Problem

- Power systems are only cover by n-1 contingencies.
- Multiple outages are prone to occur during bad weather or cyber-physical attacks.
- Contingencies and large transfers of power through the corridors increase the risk of voltage collapse and blackout.

Objective





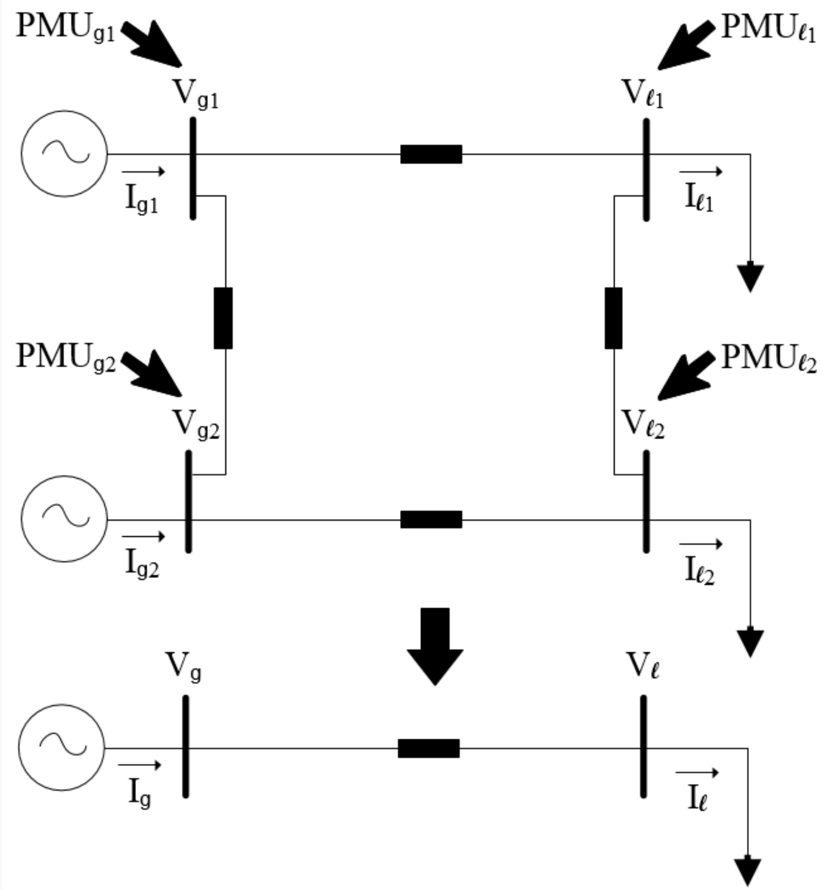
Reduction and Voltage Index

Steps

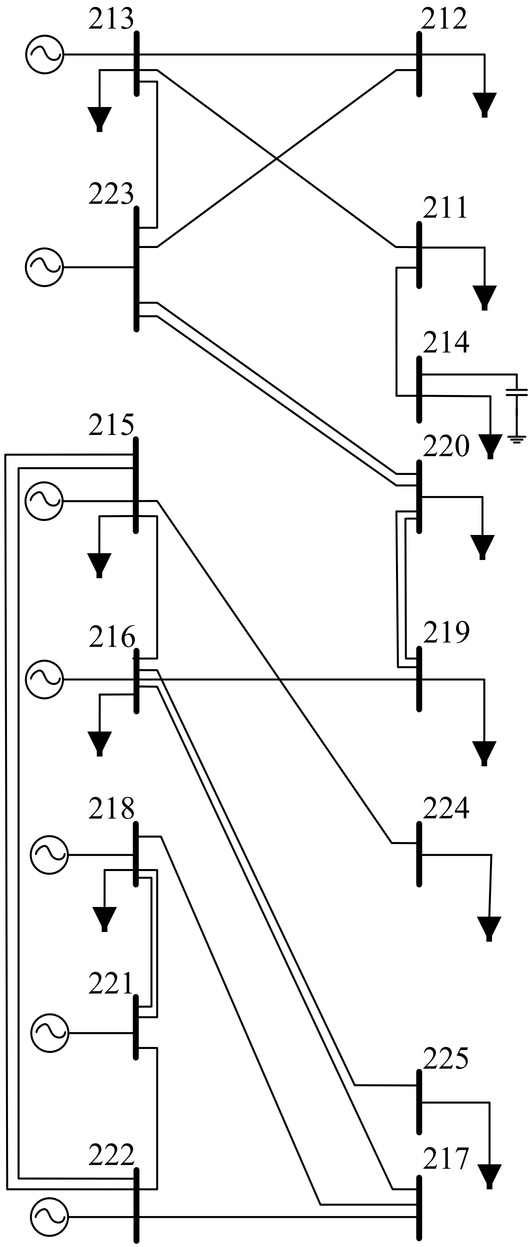
- Measure with a PMU $V_{g1}, V_{g2}, V_{\ell 1}, V_{\ell 2}, I_{g1}, I_{g2}, I_{\ell 1}, I_{\ell 2}$.
- Check the reactive power limit signal of the generation buses. In case that the generator bus reaches its reactive limit then the bus is considered as negative load.
- $S_g = S_{g1} + S_{g2} = V_{g1} * {I_{g1}}^* + V_{g2} * {I_{g2}}^*$

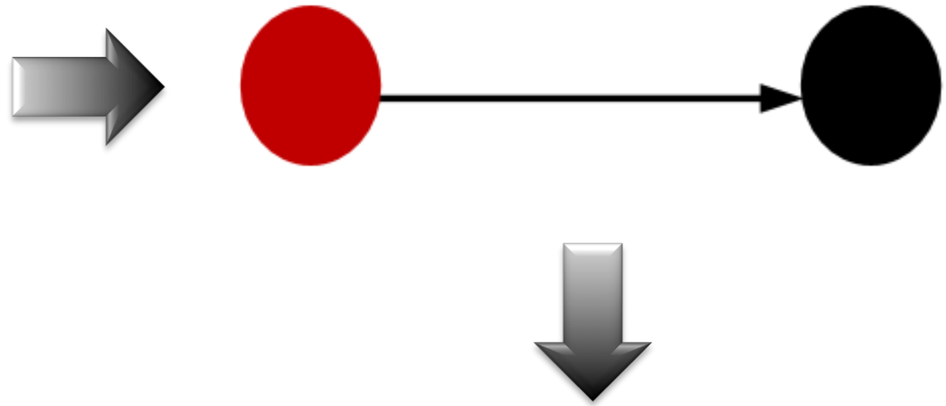
  $S_\ell = S_{\ell 1} + S_{\ell 2} = V_{\ell 1} * {I_{\ell 1}}^* + V_{\ell 2} * {I_{\ell 2}}^*$
- $I_{g\ell} = I_{g1} + I_{g2}$
- $V_g = \frac{S_g}{{I_{g\ell}}^*}$ $\qquad V_\ell = \frac{S_\ell}{{I_{g\ell}}^*}$
- $Index = \frac{P_\ell * 100}{P_{max}} =$

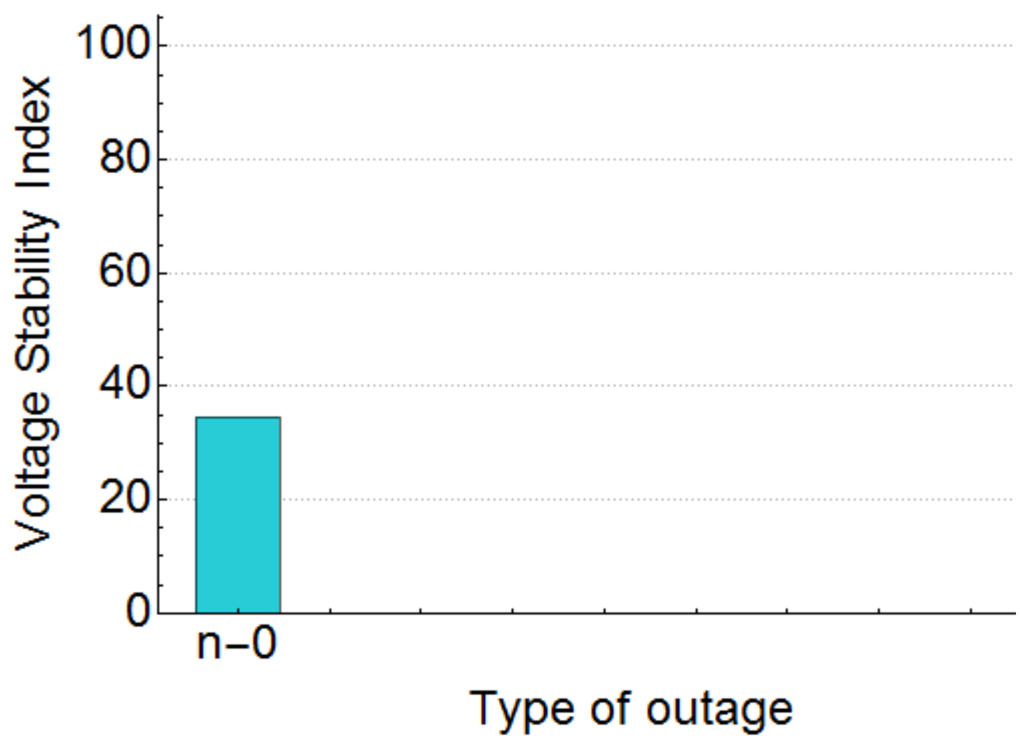
$$\frac{200\, P_\ell\, (X_{g\ell} - \mathrm{R}_{g\ell} \tan\varphi)}{-{V_g}^2 R_{g\ell} - {V_g}^2 X_{g\ell} \tan\varphi + \sqrt{{V_g}^4 (1+\tan^2\varphi)({R_{g\ell}}^2 + {X_{g\ell}}^2)}}$$



IEEE 25 Bus System Case – Cascade Analysis







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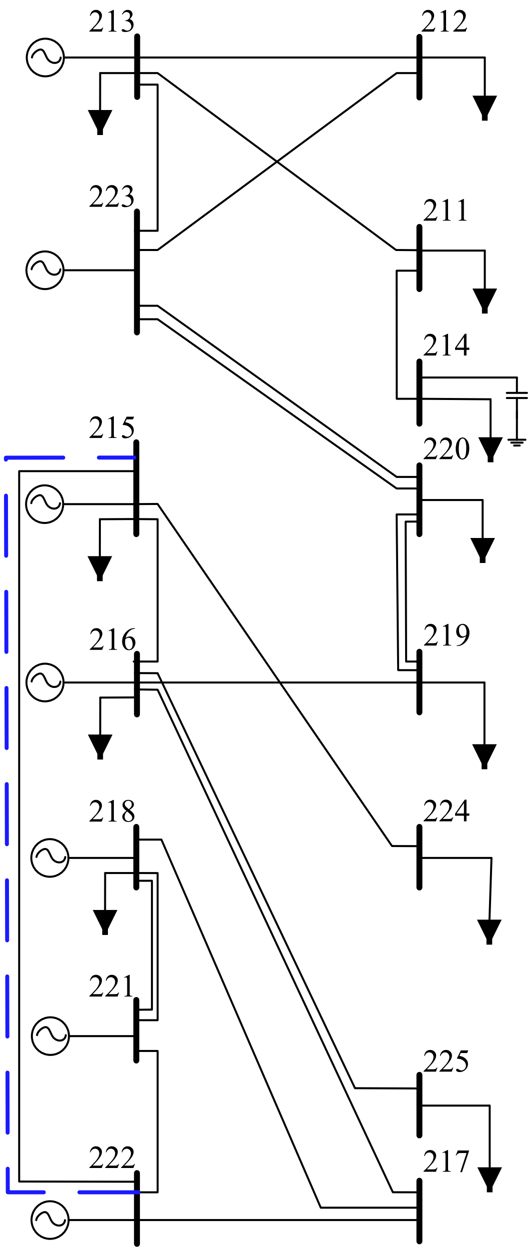

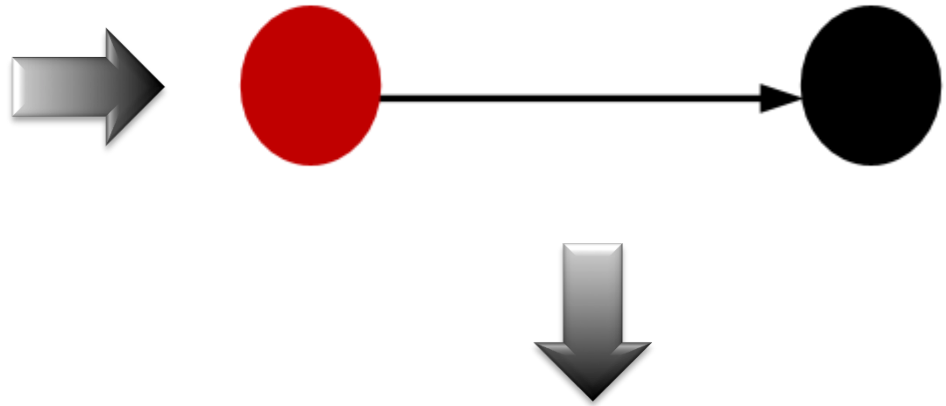

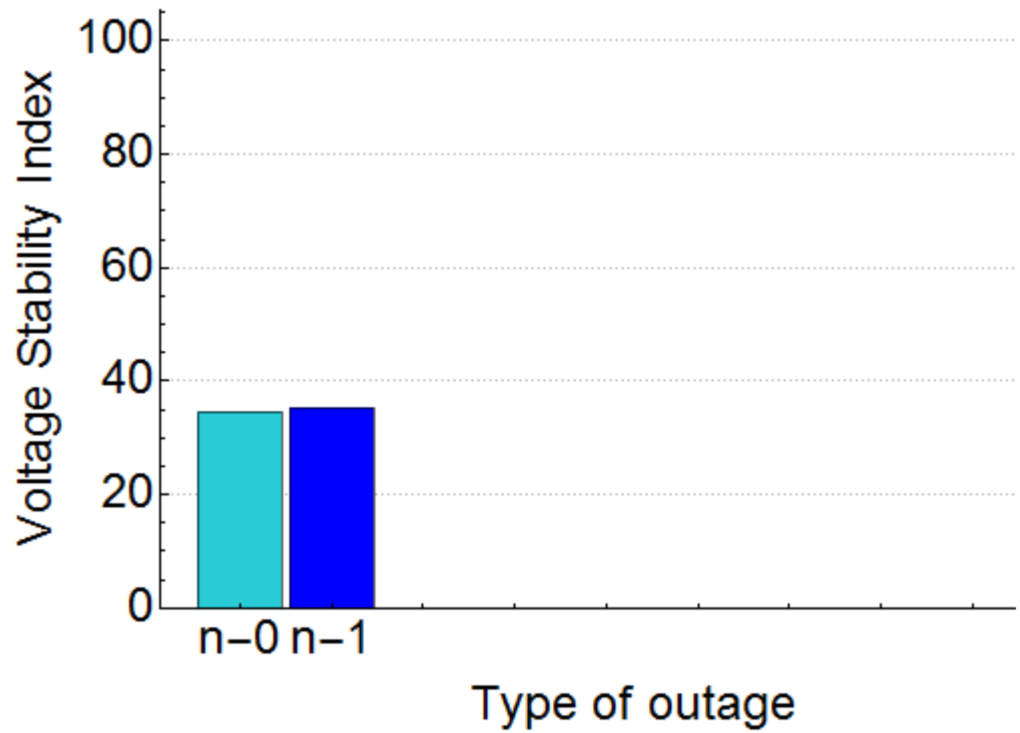

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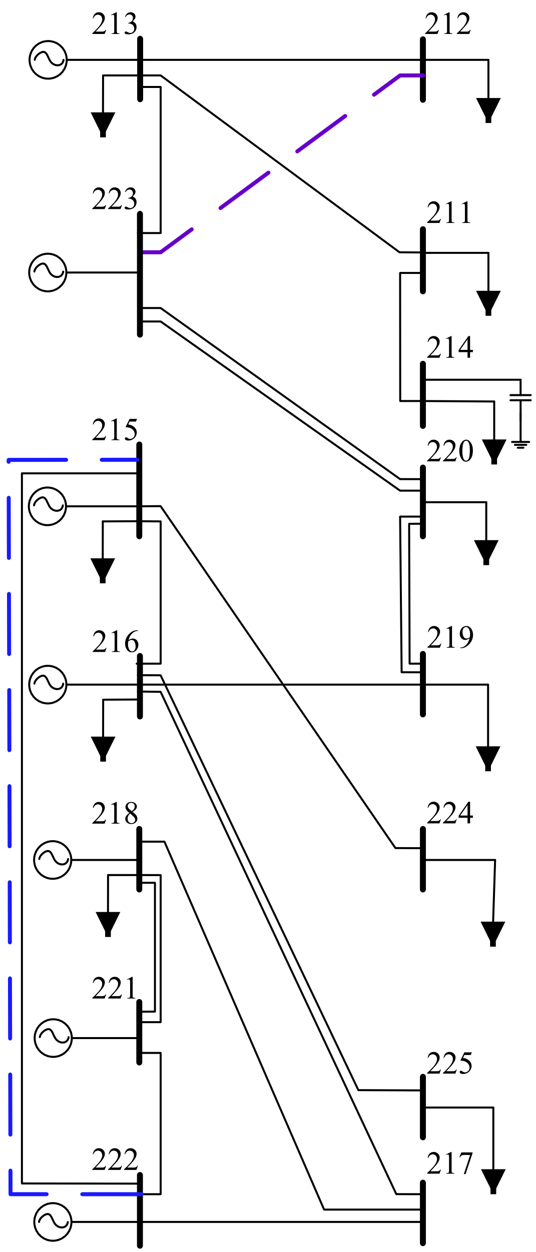

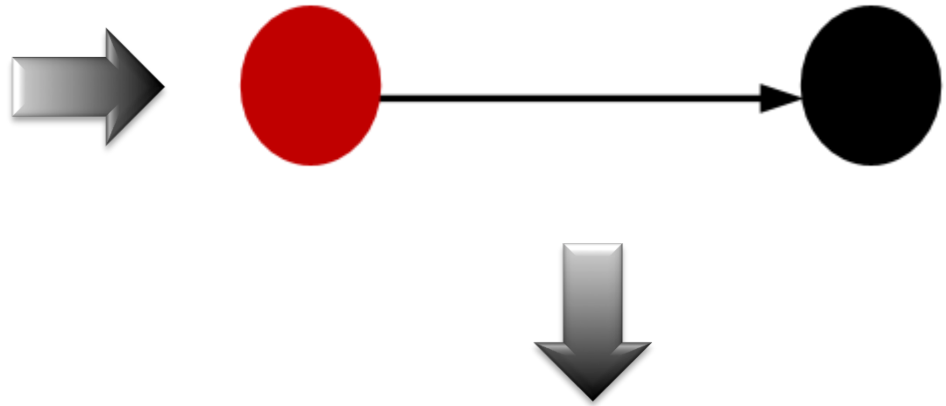

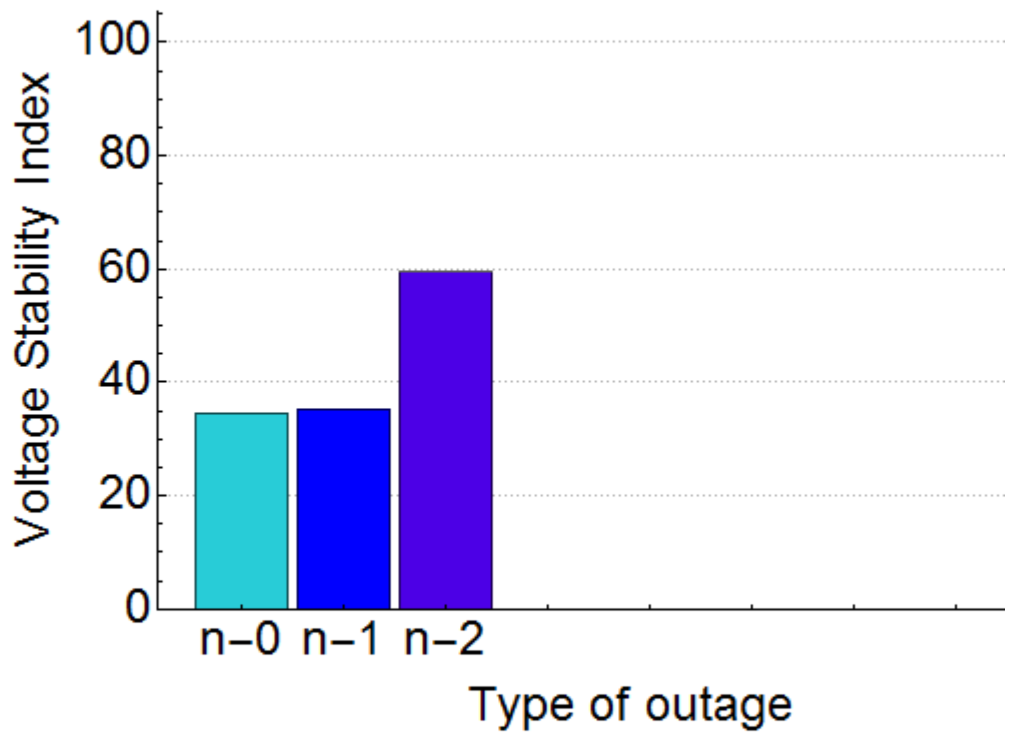

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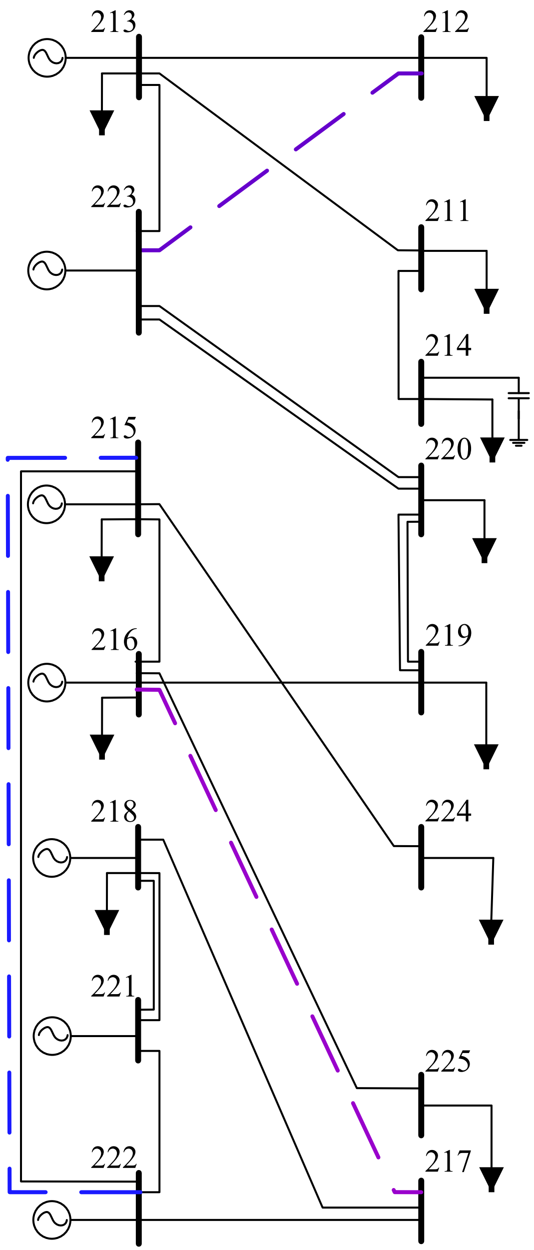

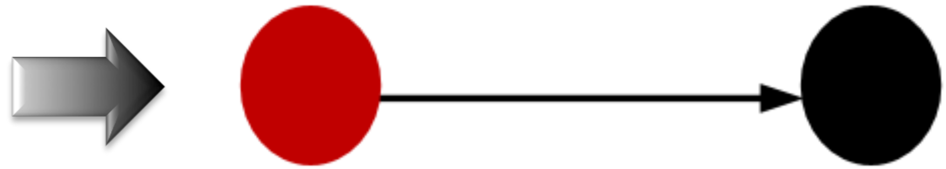

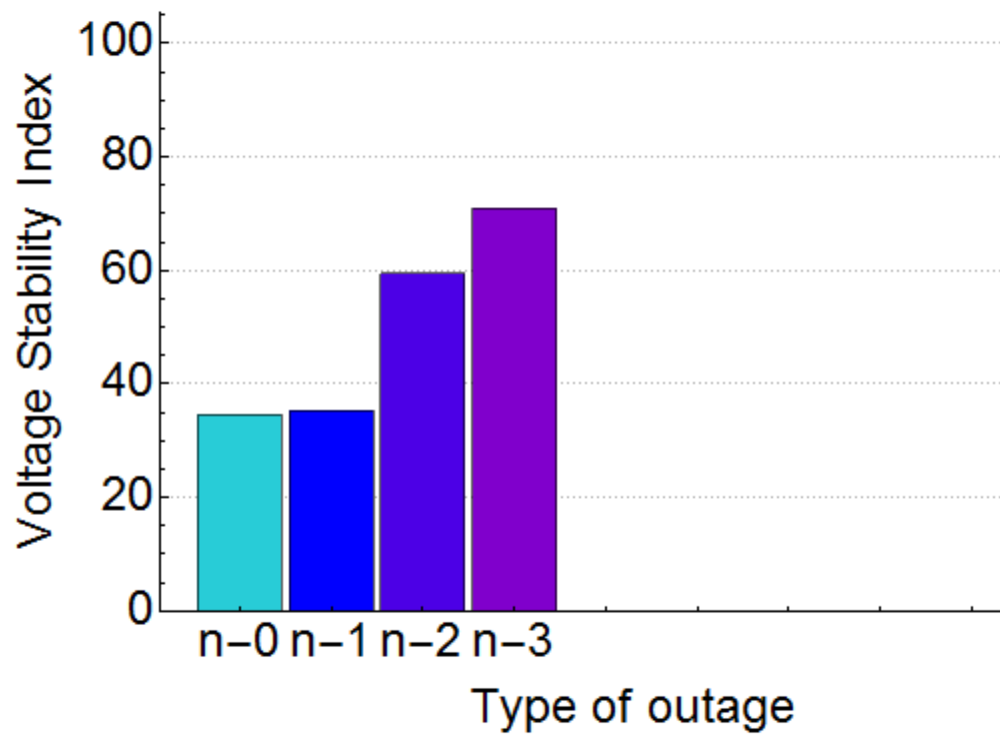

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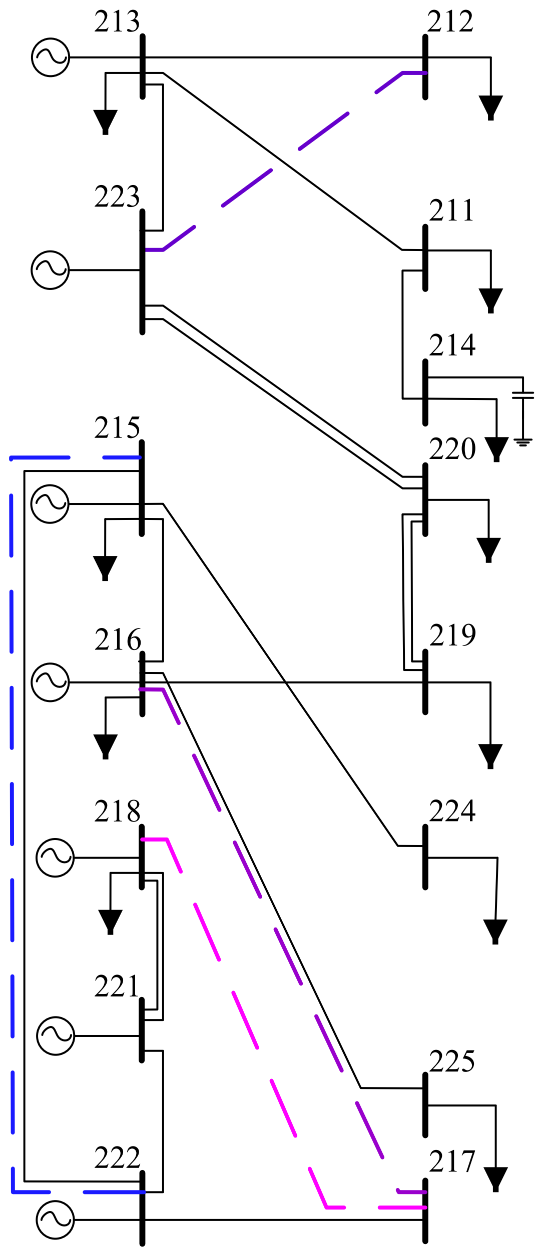

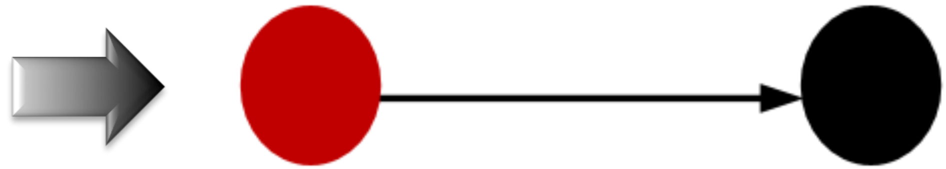

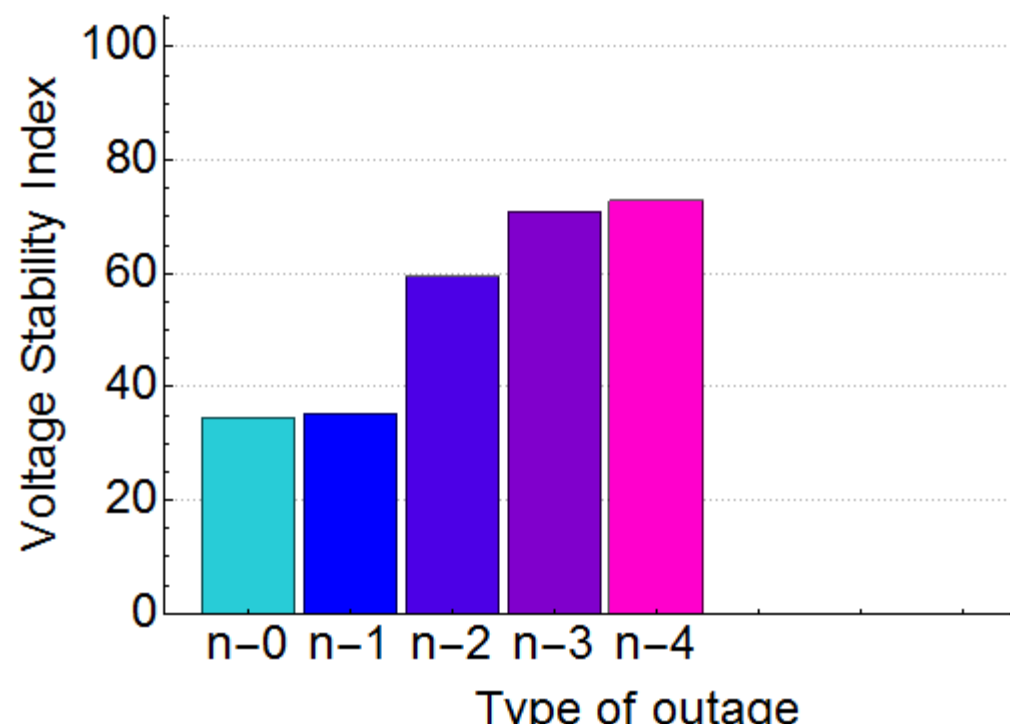

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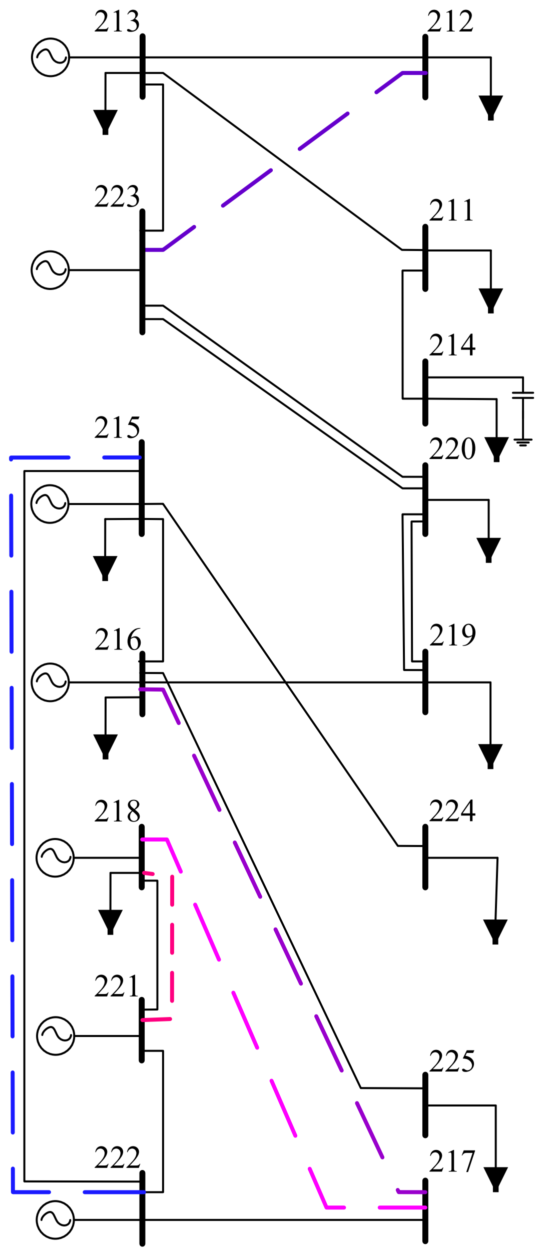

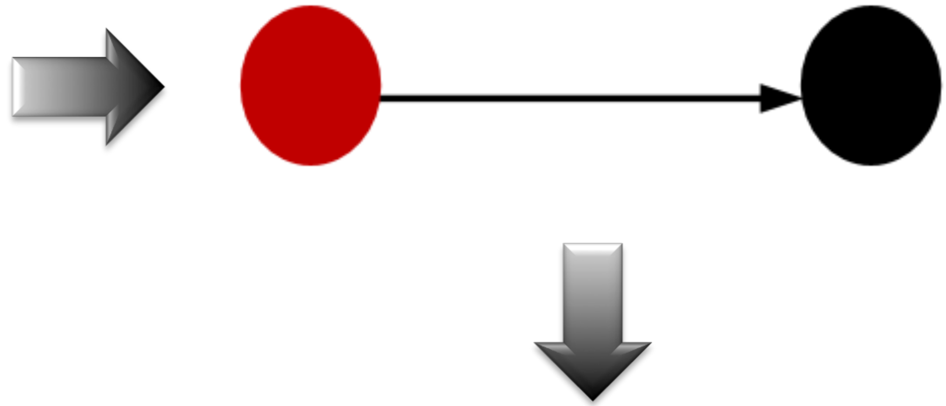

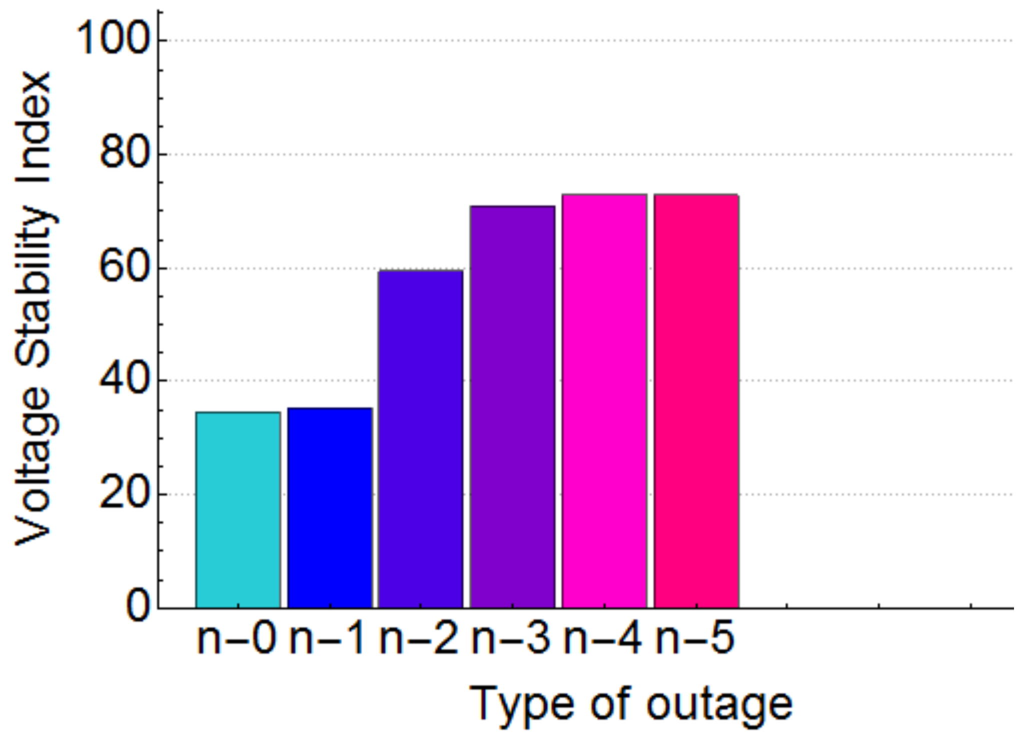

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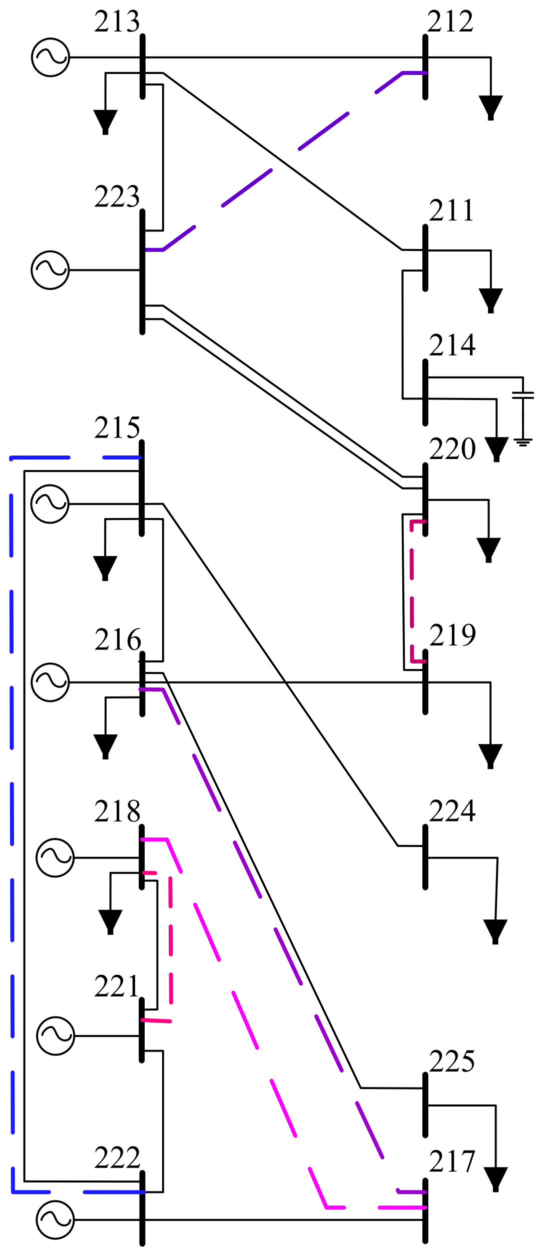

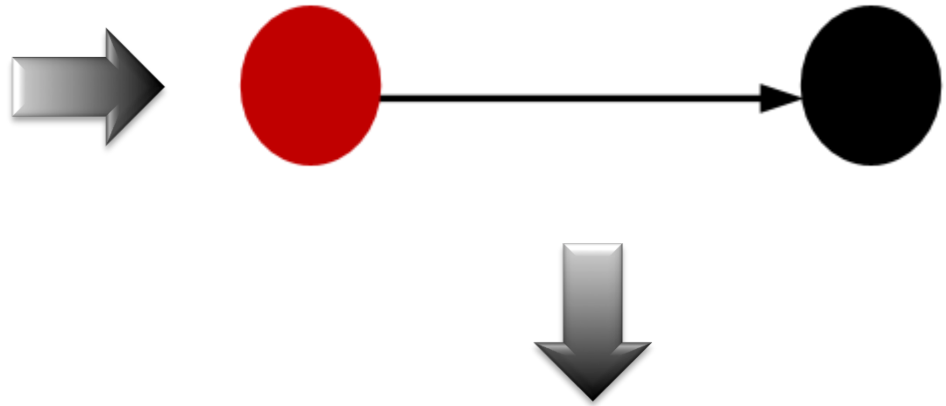

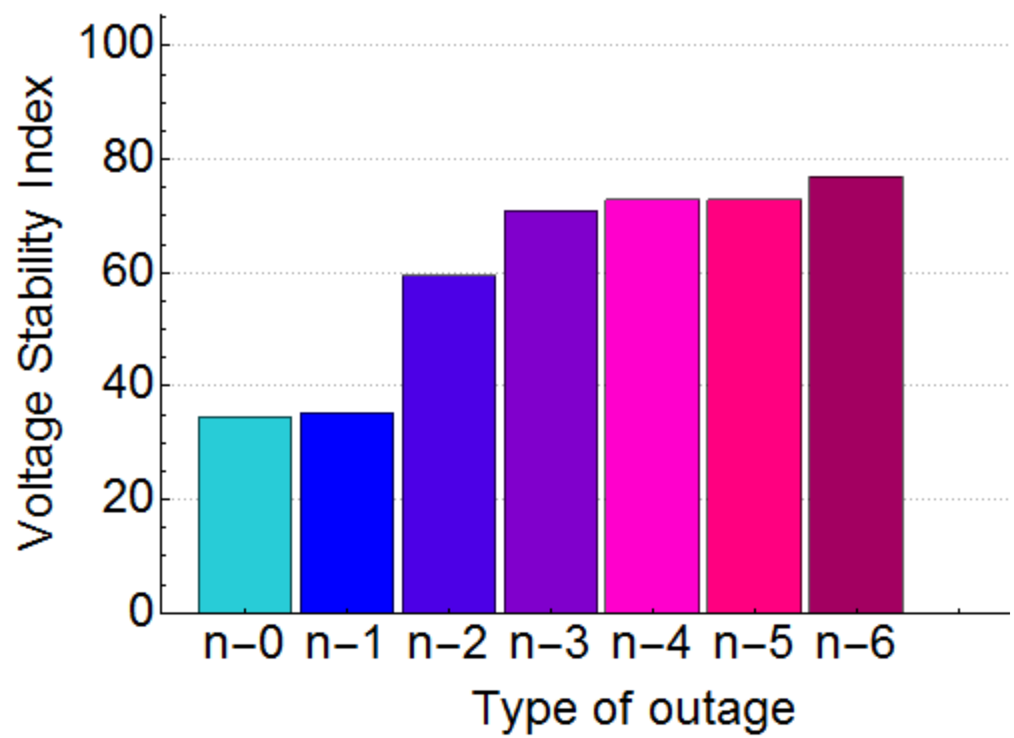

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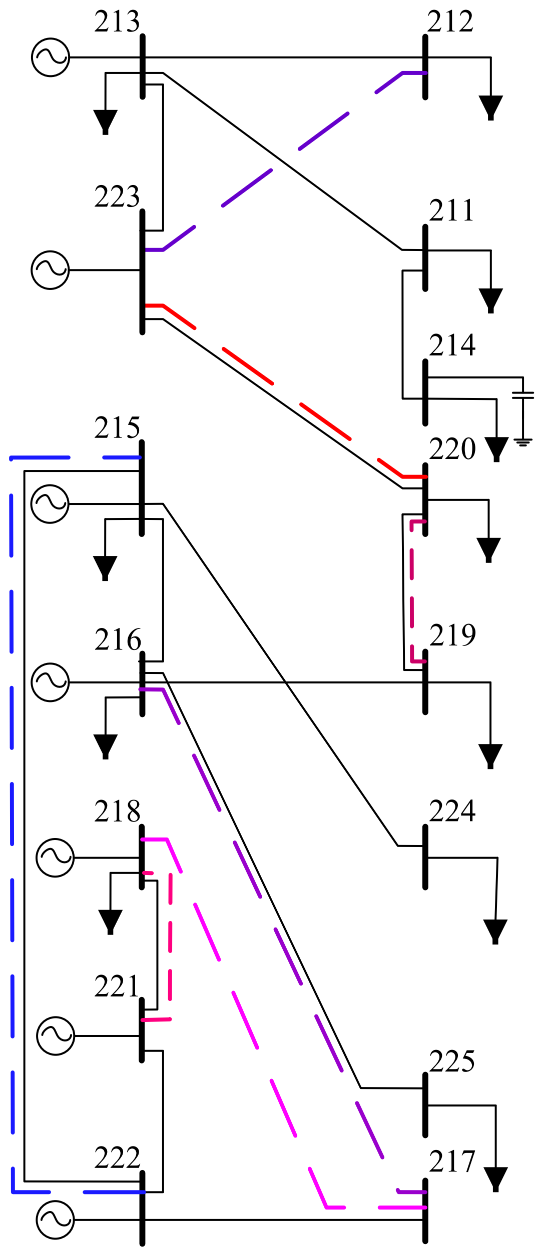
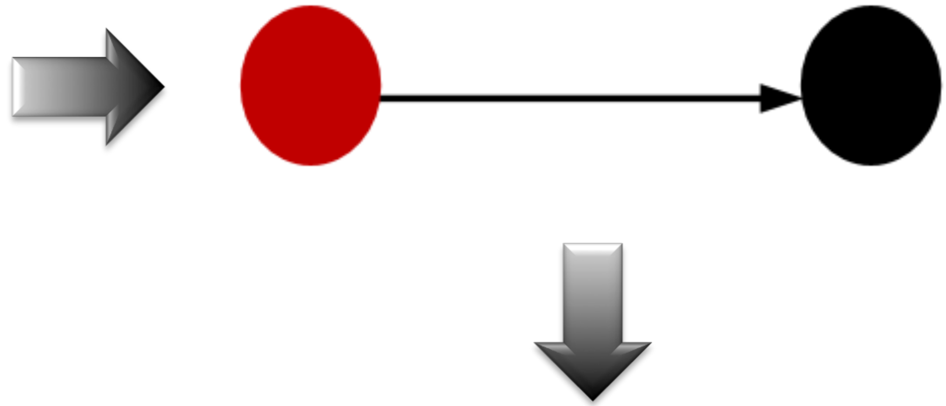
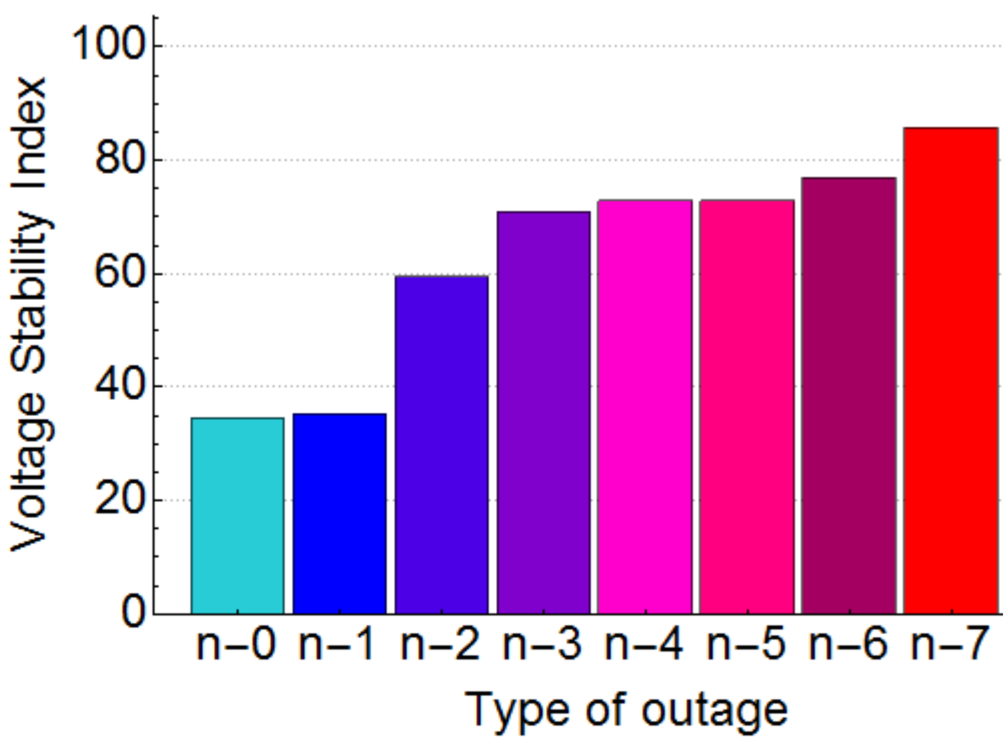
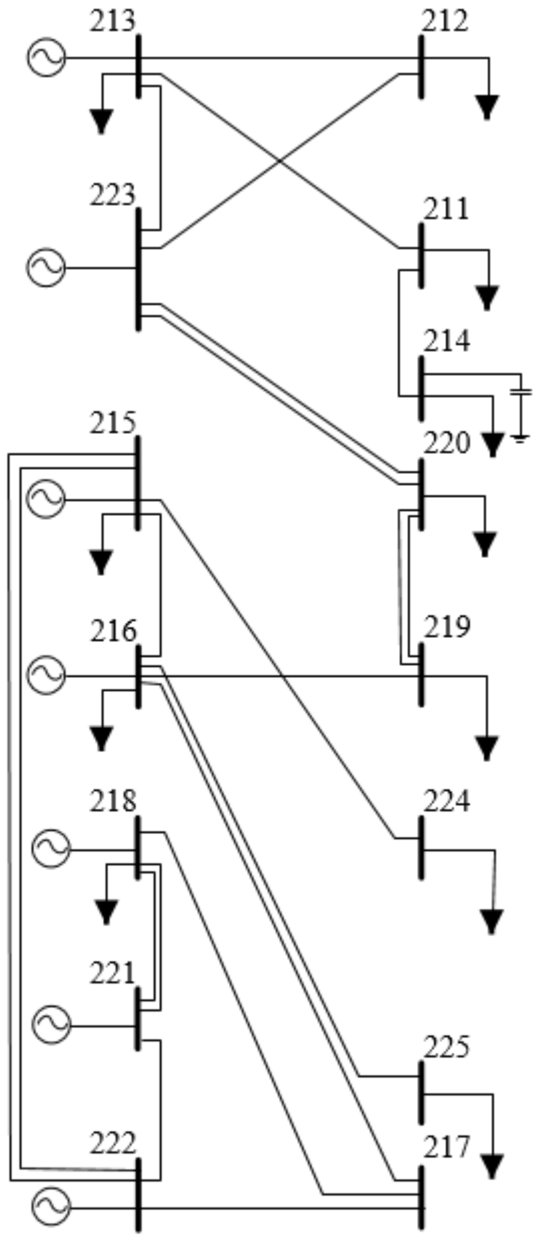
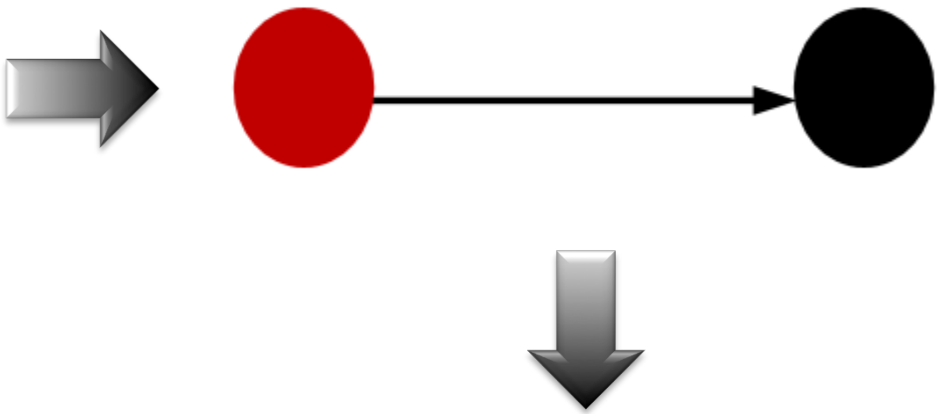


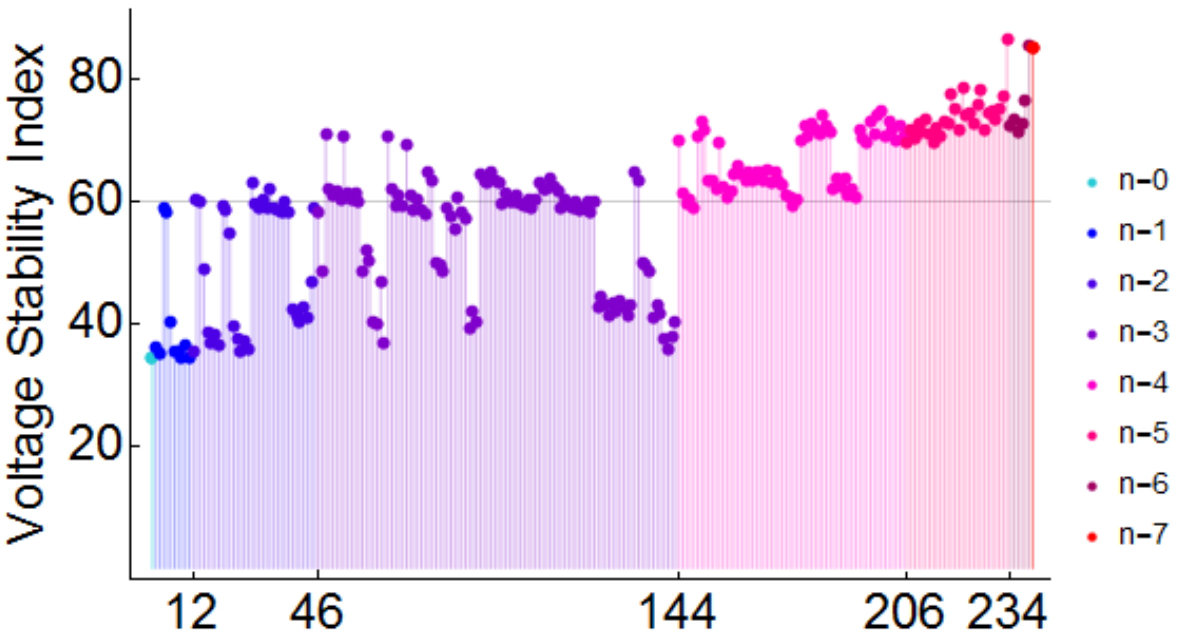




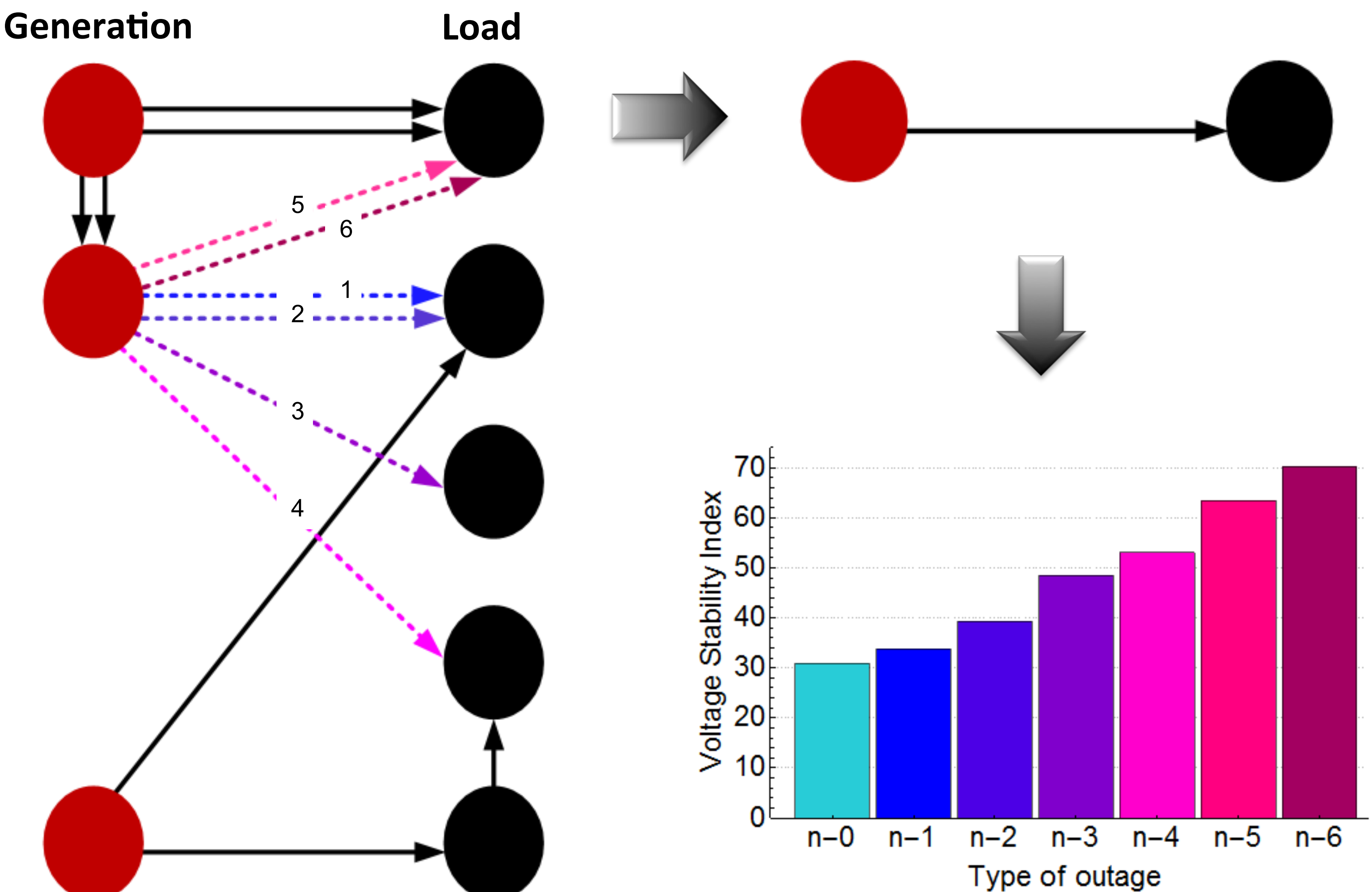
IEEE 25 Bus System Case - 240 Outages Analysis







Colombian Case – Cascade Analysis



Conclusion

- We show how to reduce multiple lines to a single line equivalent to which online monitoring of voltage stability with synchrophasors can be applied.

- The approach can give a fast, online indication of voltage stability that can accommodate both multiple contingencies and generator reactive power limits.

- This methodology, increase operator situational awareness under emergency conditions, and should be complementary to methods that make pre-contingency calculations from a model based on the state estimator.

Thank you