State Estimation Convergence and R/X Ratios

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Motivation

- Putting a meter at each and every node of a system becomes costly.
- State estimation provides us with an estimate of the nearly real-time state of a system.
- The R/X ratio (the ratio of resistance to reactance) of the lines, can cause many numeric challenges for the commonly used Weighted Least Squares (WLS) state estimators.

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Graphs/Results

This graph shows the convergence characteristics of the solution when the R/X ratio of the line is increased.

This graph shows solution accuracy as a function of the number of iterations required.

Future Goals

- Better understand the numeric conditioning that leads to slow convergence and decreased accuracy of solutions.
- See how similar procedures will result when scaled into larger systems.
- Quantify risk due to high R/X ratio

Ybus

The Ybus, also known as the admittance matrix, for a power system, represents the line parameters (reactance and resistance) and system topology.

\[ Y = \begin{bmatrix} Y_{11} & \ldots & Y_{1n} \\ \vdots & \ddots & \vdots \\ Y_{n1} & \ldots & Y_{nn} \end{bmatrix} \]

Typical format for a Ybus matrix

Weighted Least Squares

- The WLS state estimator uses pseudo measurements, metered measurements, and the system’s topology to calculate the system’s state.
- The approach was to then use the iterative Newton’s Method to calculate the voltage magnitude and angle.
- Using our own state estimation algorithm in MATLAB, the voltage profile was calculated and then compared to the true state.

Comparing this graph to the one above it, you can see that despite the fact that many solutions did not converge within the set number of iterations, they still remained quite accurate.

What this shows is that the numeric conditioning of the problem can lead to slow or oscillating convergence.