Using State Estimation for Parameter and Model Error Identification

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Outline

- Abstract
- Introduction
- Parameter and Model Error Identification
- Conclusion and Discussion

Abstract

- Problem:

  Operation engineers at EMS control center
  - State Estimation (SE) features
    - Identifying parameter errors
    - Identifying model errors
  - Two scenarios
    - Invalid SE solution
    - SE solution with significant residuals

- Objective:

  Sharing experiences in dealing with these SE issues

Introduction

- SE solution problems since1st field installation in 1984 [5] include errors in model, parameters, analog and status measurements.
- SE base case is used for monitoring current EMS operating conditions and further studies in downstream real-time network security applications and market management applications.
- Periodicity (10 to 1 minutes) for running SE solution and the frequency (month or week or day) for updating network model (5k to 50k buses).
- Many factors can affect SE solution status and a SE tuning process considers both solution reliability and robustness in the long term versus short term.

Parameter and Model Error Identification

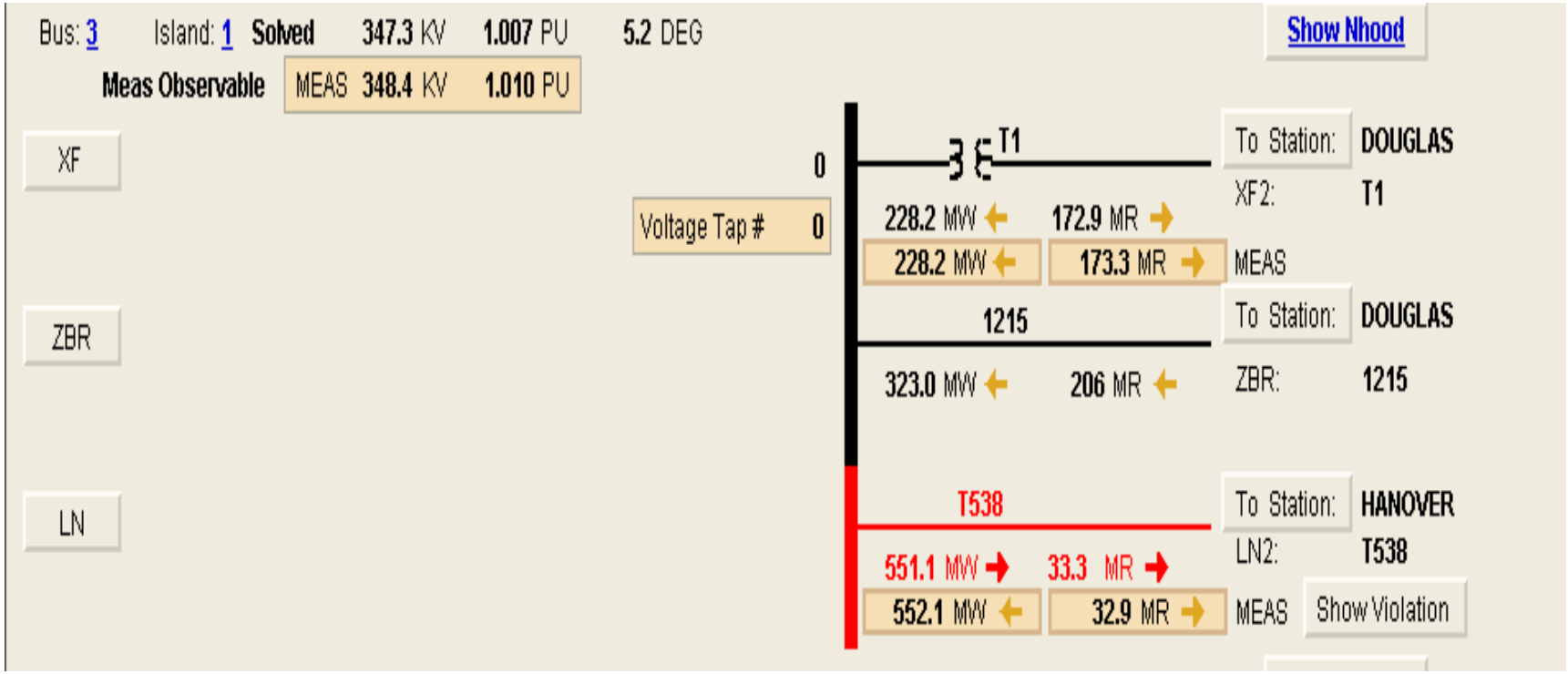
- New or updated network model via modeling tools like CIM XML modeler
- Online procedures for brining new network model to EMS systems depends on different business rules.

  Validating via study testing systems
  - Running study Powerflow and Contingency Analysis
  - Running study State Estimation

  Validating via real-time test systems
  - Running Real-time SE and Contingency Analysis

- Using analyst tools and SE performance metrics to identify these model and parameter errors and then fix them

Parameter and Model Error Identification - A measured line MW flow with flip sign



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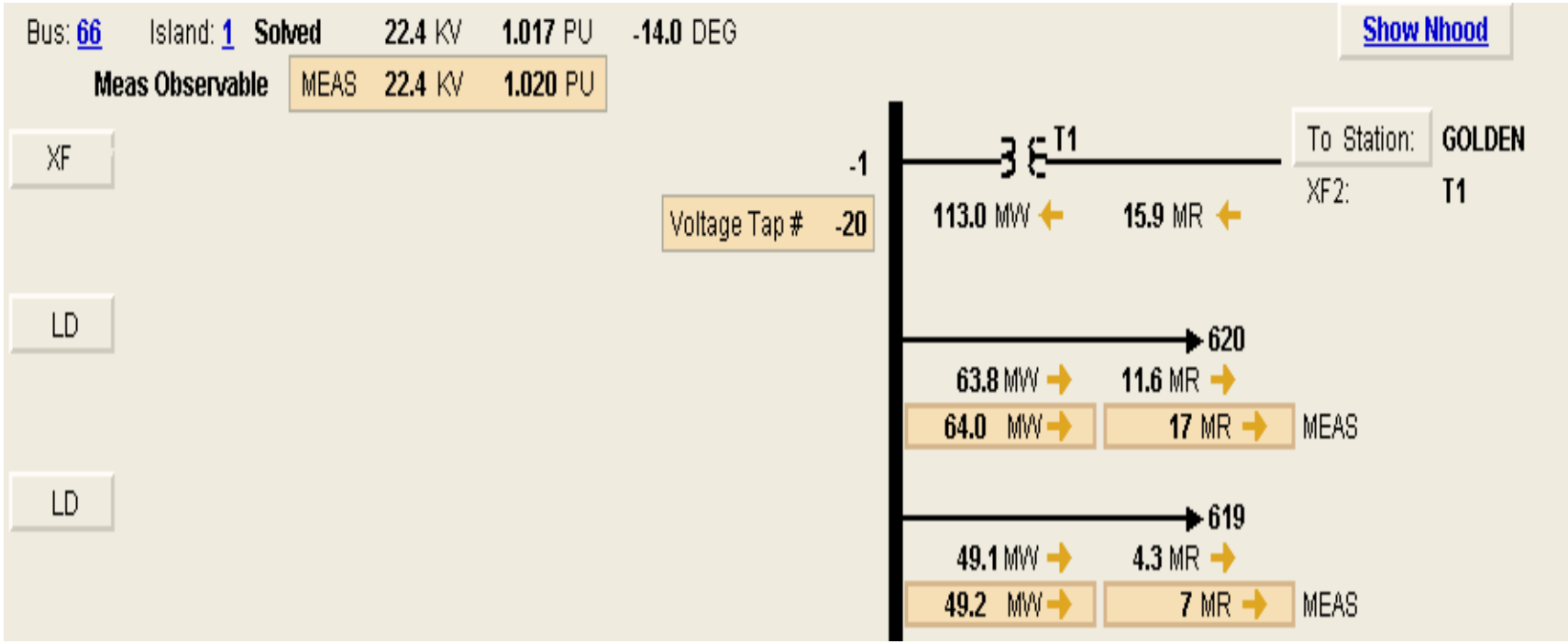
Parameter and Model Error Identification - A measured tap transformer with wrong tap range



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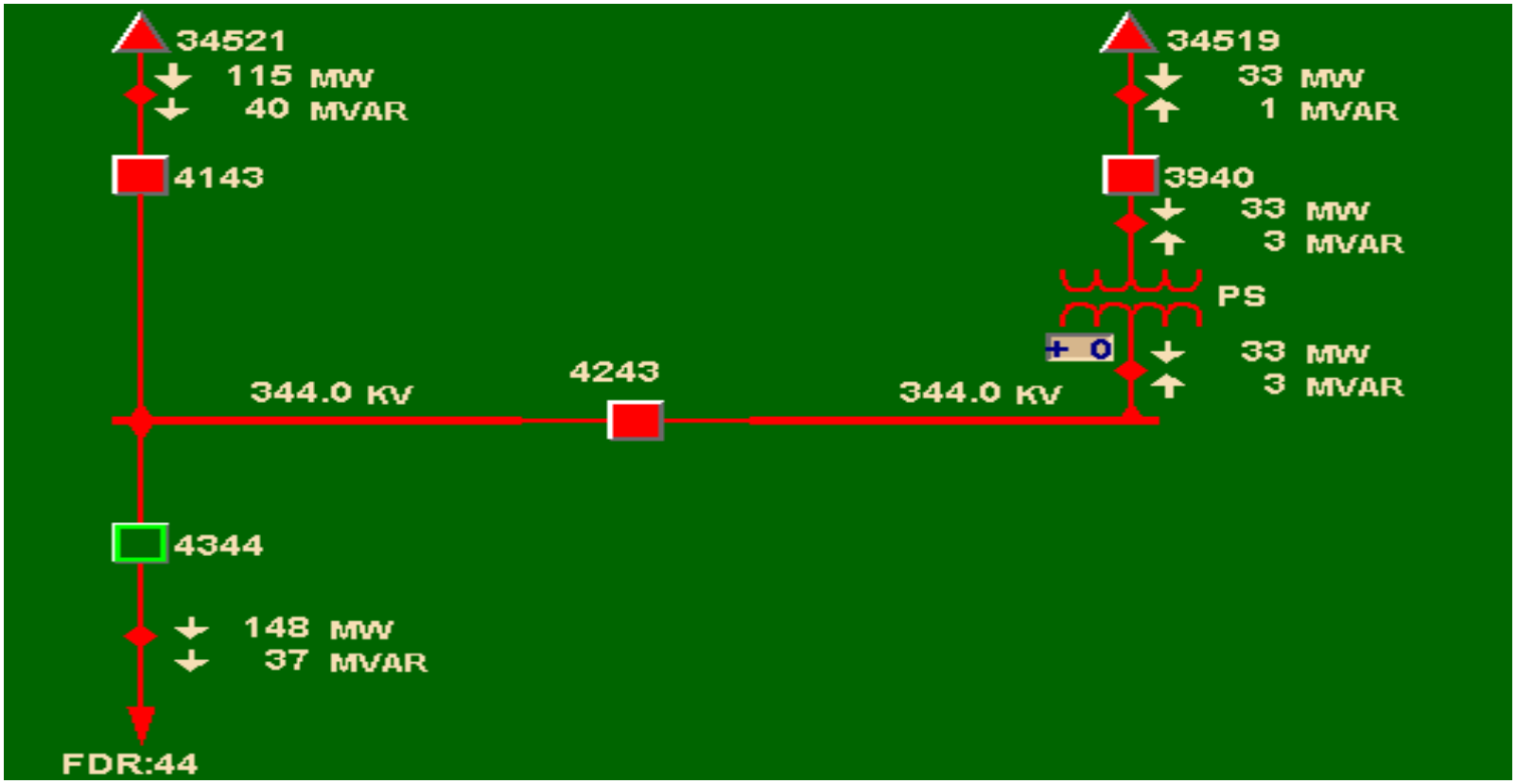
Parameter and Model Error Identification – Not obvious issues

- One common symptom exhibited in the presence of network modeling errors is when the SE solution suddenly becomes invalid or solved with significant residuals due to real-time network topology errors [1].
- SE performance metrics and historical network topology changes recorded by SE can be used to investigate the possible causes of these problems. Another troubleshooting approach is enabling the network topology reasonability checks, using both analog and status measurements [6] to identify the possible network topology errors.

Parameter and Model Error Identification - A measured breaker status with incorrect status



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Parameter and Model Error Identification – Not obvious issues

- Another possible cause of sudden invalid SE solutions is branch flow measurements with very large errors.
  - Enabling branch flow reasonability checks in SE can be used to eliminate this cause through automatic disabling of suspect flow measurements in the input data pre-processing phase.
- The operation engineers can rely on SE capabilities to detect and reject simple analog and topology errors, but most cases can be challenging due to the combination of gross analog measurement errors and potential bad status measurement.

Parameter and Model Error Identification – Not obvious issues

- Accurate modeling of generators is important to getting an accurate SE solution.
- Enforcing generation reactive power operation limits in the SE solution can be an issue if generator reactive power capability curves [3] are not modeled with sufficient accuracy and detail in the network modeling case.
- Manually overriding generator reactive power limits to allow reactive power output in the SE solution to exceed the calculated limits is one possible approach. Another approach is to enable SE capability to expand generation reactive power limits as needed.
- A similar limit expansion approach can be applied to the issue of generator real power output versus their real power limits. One important observation regarding the expansion of generator real and reactive power limits in SE solution is that the expanded limits must be transparent to the downstream network and market applications.

Parameter and Model Error Identification – Not obvious issues

- Branch flows exceeding their monitored rating limits in the SE solution should be reported as violations.
- Exceptions for certain branch rating limits can occur due to known limit inaccuracies and the operation engineers may have to temporarily override the rating limits so that false branch violations can be removed.
- A calculation of dynamic branch rating [7] based on the IEEE or CIGRE standard may be required. The pressure to obtain more accurate branch limits in real-time, based on dynamic thermal limit or voltage stability limit or transient stability limit, is another challenging issue in SE solution quality.

Conclusion and Discussion

- Experiences in cope with model and parameter errors.
- Management team may have high expectation on SE features and solution performance.
- Improving and expanding SE features are always necessary in order to minimize SE solution problems due to the potential issues like errors in network model and parameters.
- Operation engineers must be in the loop and take appropriate actions to correct SE solution problems via provided analyst tool and SE performance metrics.