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Question 14: What are the worldwide experiences in situations where the overall power system model failed to predict an actual system event or ongoing occurrences of abnormal responses, and were the causes could be deterministically identified and rectified?

The challenge of achieving accurate models

An accurate model is ideally that the predicted curves and the real curves overlap. However, overlapping curves when performing comparisons between models and real power systems are rare. Such accuracies can only be expected on experimental setups. But why are the models rarely accurate?

- Most of the time the models are created to specific purpose and might lead to inaccurate for other purposes. For example, models used for overvoltage studies and rating of arresters are not suitable to study fault right-through, as arresters cannot be accounted to control the fault.
- Models are often used to obtain rating values, and for the purpose the models are often less damped than the reality.
- AC networks included in the models often envelope extreme conditions and sometimes even future scenarios. These scenarios often are not close the studied event.
- The measurement equipment used in the models is often considered ideal. But in reality, real measurement equipment can fail to measure, saturate or even resonate.

Despite all these differences the sources of the mismatch can often be found and corrected in few attempts. However, one should not expect complete overlapping curves. The modes common source of mismatches include:

- Breaker opening times
- Transformer saturation curves
- Measurement equipment saturation
- AC configuration changes due to breaker opening in the AC grid
- Station ground impedance representation
- Interaction between overhead lines

If one is not able to find the source of the mismatch one should take step backwards and look at the problem from a bird view. Some common reasons that to not find the source of mismatch are:

- There are other representations of the event which lead to similar behavior.
- The control been modified afterwards.
- The steady state has not reached for all intermediate signals.

To achieve accurate models, it is important to consider the following points:

- It requires the correct information of the event, the AC network, the site, and the project. All information that is not available needs to be assumed and will by default contain uncertainty and lead to mismatches.

- Achieving accurate models requires time and a network of multidisciplinary experts to discuss with. Not asking those who know more in that specific topic to validate the assumptions taken, leads to mismatches.
- Data management system need to be in place so project documentation, models and C&P code can be created, read, and updated with back traceability across the engineering teams. Updating the models with latest information at the time of the event is vital to achieve accurate results.
- Engineering processes need to be in place, so models are updated and revised after commissioning, upgrades, or service outages. If the processes are in place instead of spending the time on administration, the time can be spent on working on the model.
- These aspects apply both to offline and online models. At the end, both are EMT models.

In general, accurate models in power systems will rarely provide overlapping curves. The most important is that the model is accurate to the specific purpose to which it was created.