

Lesson Learned

Loss of State Estimator Due to Propagated Database Values with Invalid Data

Primary Interest Groups

Reliability Coordinators (RCs)
Balancing Authorities (BAs)
Transmission Operators (TOPs)
Transmission Owners (TOs) that own and operate State Estimators

Problem Statement

The entity encountered an operational problem, causing the state estimator (SE) to become non-convergent. As a result, the Real Time Contingency Analysis (RTCA) application stopped running. An evaluation indicated that the SE application had encountered invalid data referred to as NaN (not a number, or invalid number, resulting typically from a divide by zero). This created invalid results that were propagated through many of the SE calculations, causing the SE to fail. The NaN values were generated by the application. These values were manually overridden to temporarily correct the issue.

Details

The entity encountered an operational problem, causing the SE to become non-convergent. This caused the RTCA application to stop running.

An evaluation indicated that the SE was failing upon encountering database points containing invalid data, referred to as NaN. The NaN values existed in four points that were SE inputs. These values were propagated by the SE into other points, and ultimately resulted in the SE failure. Additionally, the invalid data was sent via an ICCP link to another entity, Entity A, on the border of its Region and to its Reliability Coordinator (RC) and subsequently to another entity, Entity B, via the (RC). This caused both Entity A's and Entity B's SEs to fail. To correct the SE failures, the NaN values were manually overridden with valid data allowing the SEs to converge, including Entity A and Entity B's SEs. The immediate issue was resolved and the SE and RTCA applications resumed normal operation.

Subsequently, the EMS vendor identified a bug in the EMS software that allowed NaN values to be stored and propagated in database points. The source of the NaNs was identified and the entity is working with the vendor to determine the best solution to prevent recurrence of this issue.

The entity notified the area RC that the SE and RTCA were down and requested that they monitor contingencies until the SE and RTCA could be restored.

The EMS SCADA functionality (control and indication) was not affected by this event and no transmission facilities were impacted.

Corrective Actions

SE and RTCA vendor identified the root cause and implemented a solution to prevent the occurrence and propagation of this invalid data. The vendor provided and administered a fix to address the propagation issue (the entity has implemented this fix successfully). Based on results from the vendor review, evaluation, and identification of the root cause, the vendor implemented two base software fixes to prevent NaNs from being generated and being propagated. These software fixes were issued to the vendor's user base so that corrective action was distributed to all affected users.

Lesson Learned

Although generating and testing invalid numbers is complex and involves processes to replicate, the vendors and entities should invest more efforts to perform such testing and implement software codes specifically intended to prevent the formation and propagation of such values.

Suggested steps to perform in the event of a NaN problem or the potential propagation of other types of invalid SCADA data:

If you are performing updates that could result in sending SE invalid data or if you do not have vendor issued corrective solutions implemented for the NaN issue:

- Halt the incoming ICCP and/or RTU data exchange (to “hold” last known good data) immediately before you reinitialize the SE;
- Check the SE result after re-initialization while still using last known good data and;
- If no “NaN” or other invalid data problems are encountered, restore the ICCP data exchange.

The suggested steps will help protect other parties during SE re-initialization and allow SE results to be validated using last known good data. If the data exchange cannot be halted and a NaN or other invalid data problem is encountered, make sure to inform the other parties immediately so they can take appropriate actions to rectify the problem in their area of control.

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