

Automated Fault Location Analysis Data Gathering Assessment



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Problem Statement

- Operating staff expressed concern with further improvement of the fault-location process, especially for their 115-kV system, which is heavily tapped with industrial customers and substations.
- They had mitigated the major time elements that were driving the outage duration metric and that the next major contributor to the time delays was the need to call out staff to run the fault-location program.

Objective

Investigate the ability to automate the protection engineers process

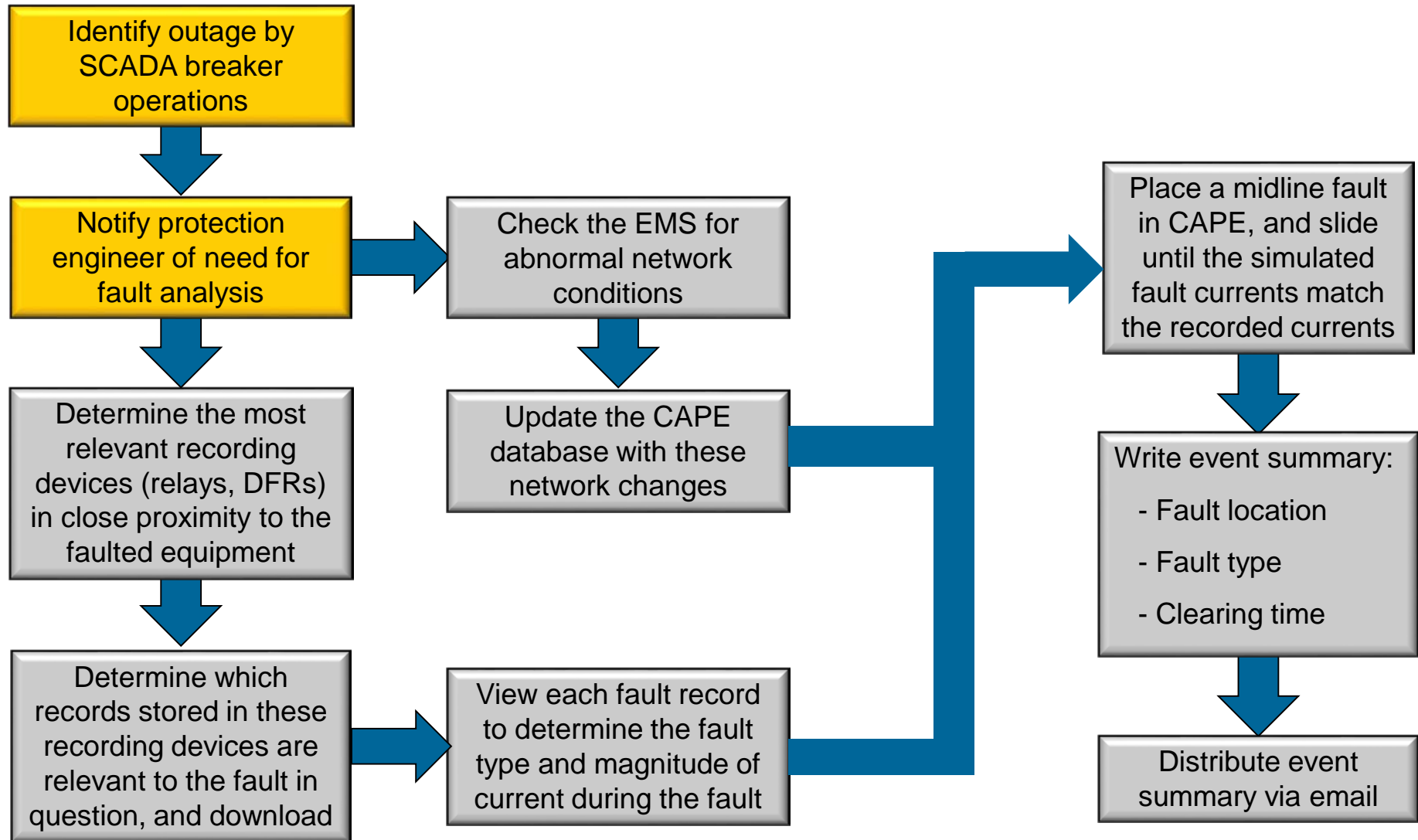
- Reduce the time to determine where a fault has occurred with sufficient certainty to begin sectionalizing the 115-kV transmission network and begin restoring customers in areas not directly affected by the faulted line section.

Approach

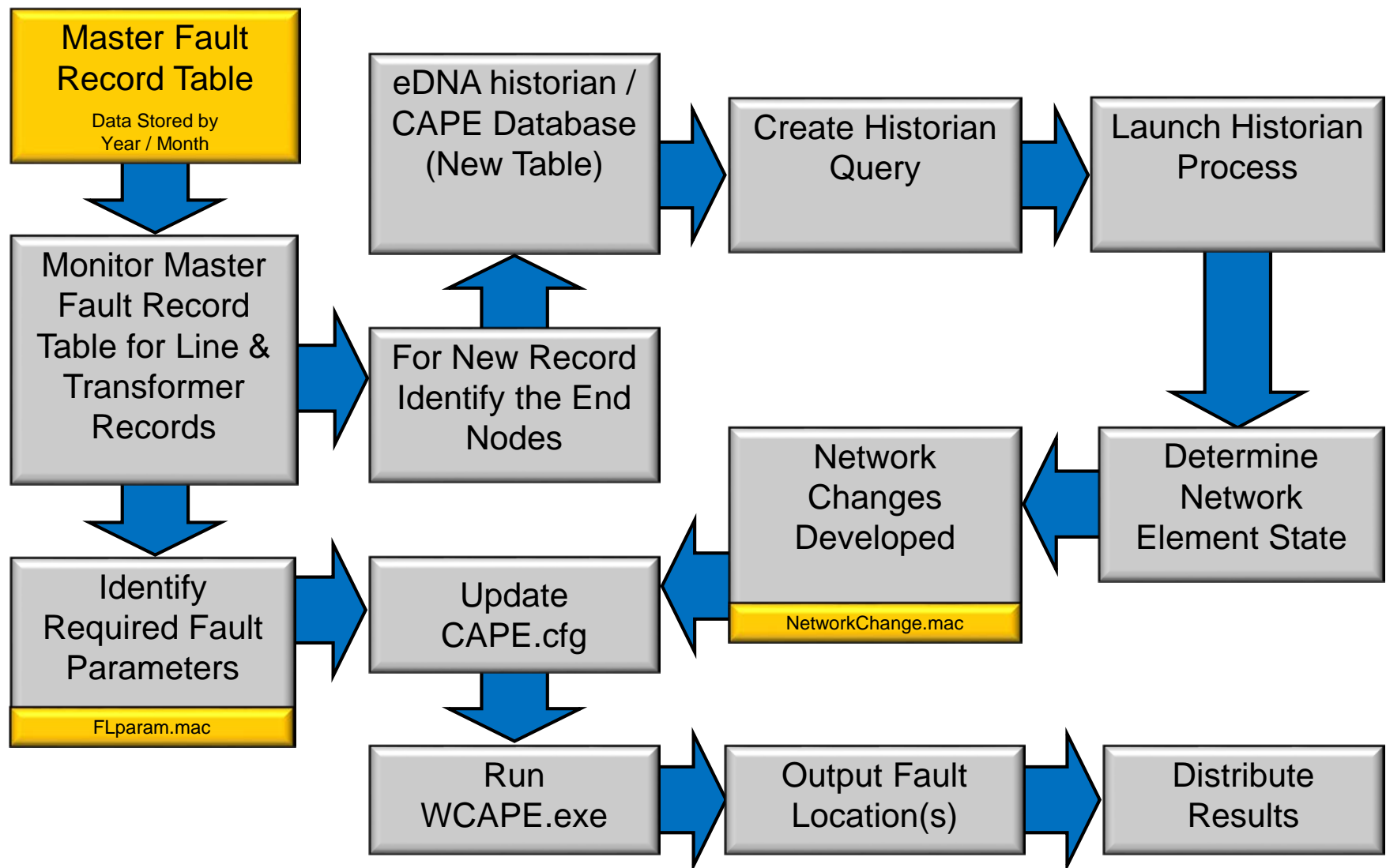
For each company:

1. Document the existing manual process
2. Adjust process based on data gather method
3. Process has two paths through it and required the creation of a new table.
 - a) The first path identifies the parameters of the fault such as fault type and magnitude.
 - b) The other path determines what network changes are required due to grid elements out of service in the vicinity of the fault.
4. A new table was developed to essentially “connect” the operations’ field data historian with the fault study program Cape.
5. Execute automated process

Fault Location Process Flow - A



Fault Location Process Flow - B



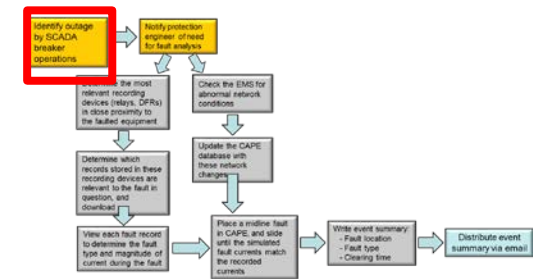
Process Comparison

- Major Difference

- One company essentially “pushes” the data to a central location while the other uses a “pull” method to gather the data

Gather Fault Records

Company A



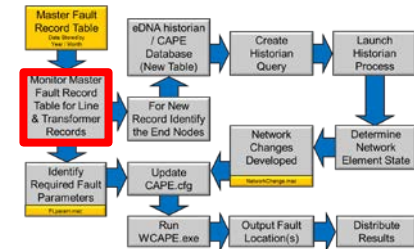
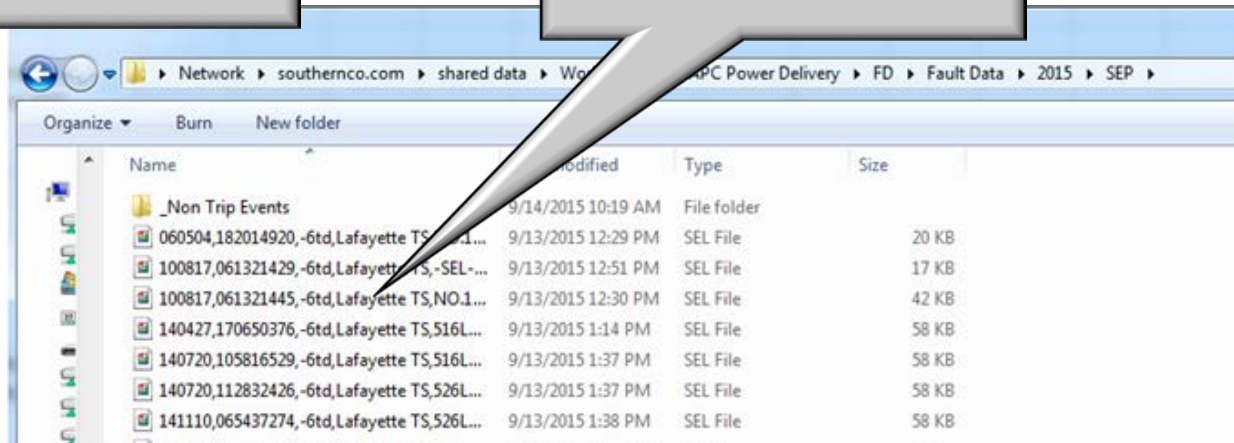
- System Operator enables process when required.
- Enables data gathering port at each relevant substation
- Remote access process initiated to gather data from field devices
- Fault location process triggered

Gather Fault Records

Company B

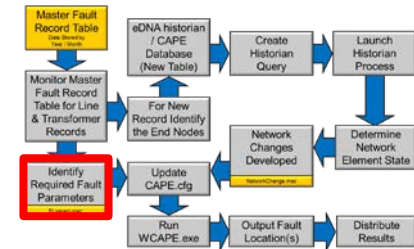
Monitor Master
Fault Record
Table for
Line Records

Watch dog program will monitor
this folder for fault records
related to lines arrive.



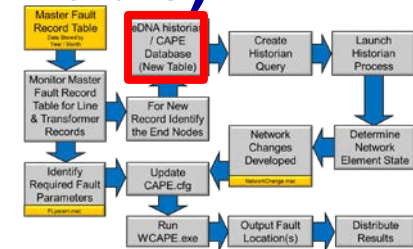
- When a new record arrives determine the end nodes (busses) for that element within CAPE.

Fault Parameters



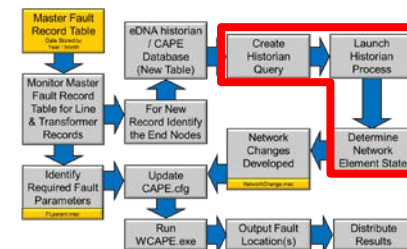
- The following parameters need to be determine from the fault record
- Fault Time, used in the report text and file name. Use 'NA' if no time is available
- Bus Number for the "From" bus on the Monitored Line
- Bus Number for the "To" bus on the Monitored Line
- Circuit Number for the Monitored Line
- Bus Number for the "From" bus on the Faulted Line
- Bus Number for the "To" bus on the Faulted Line
- Circuit Number for the Faulted Line
- Fault Type
 - PHASE_1_2,PHASE_1_2_G,PHASE_1_G,
 - PHASE_2_3,PHASE_2_3_G,PHASE_2_G,
 - PHASE_3_1,PHASE_3_1_G,PHASE_3_G,
 - THREE_PHASE)
- Fault Current Magnitude, in amps
- Monitored phase/value (1='Phase 1', 2='Phase 2', 4='Phase 3', 8='Residual')

Data Historian / Fault Analysis Database (New Table)



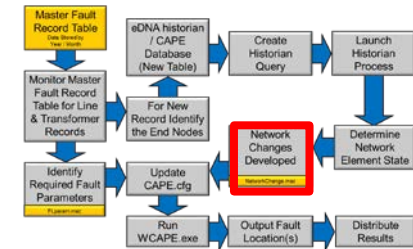
- Utility developed a new table that linked Fault Analysis Database bus names to historian state
- The result provides a listing of relevant network elements related to the fault
- The above listing will then be examined and used to determine state of each element

Determine Network Element State



- The previous result will be used by the process to determine the state of the network elements near the faulted element.
- Create historian query
- Launch historian process
- Determine network element state
- These results will be passed to the Network Changes Developed step where the file NetworkChanges.msc will be created.

Network Changes



- %% Examples of Network Change command syntax

- %%Open a branch/breaker

- nc opn 4 6005 1 x

- %%Outage a generator

- nc outage_shunt 5507 1 x

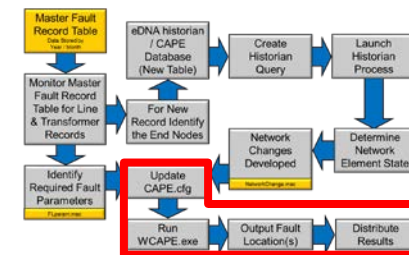
- %%Close a normally-open bus-tie/switch

- nc close_tie 41856 41384

- return



Final Steps



- Update the Fault Analysis configuration file as needed
- Run Fault Analysis application to locate fault
- Output results
- Distribute output

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      U t i l i t y
Protection and Control - Applications
      Fault Location Program V6

Monitored Line:  FULTON_SPRINGS_TO_GORGAS_NO2_115KV
Faulted Line:    FULTON_SPRINGS_TO_GORGAS_NO2_115KV

Time of Fault:
Time of Run   : Sep 10 2015 14:03:27

Fault Description:
  DFR located at Fulton Springs SS
  Fault Type = PHASE_1_2
  5650.00 amps Phase 1
  Data Resolution = 0.00 amps
  Remote Breaker Open

Approximate Fault Location:  ( 1 of 2 )
                             1.18 miles from NAdamsville* (3040)
                             3.36 miles from X-JWRBessie* (1061)

Approximate Fault Location:  ( 2 of 2 )
                             0.93 miles from NAdamsville* (3040)
                             3.04 miles from NAdamsville (3043)

System Conditions At Time Of Fault:

Auto_Clear_Change is OFF
Open breaker on "3 Gorgas#3 115" to "6670 FS-GOR2.9B" Ckt 1 at Gorgas
SP      New bus "999001 Gorgas#3 115" (NEWBUS1)

Calculation By:

=====
CAPE SC Information:
  Monitored branch: 690 6671 1

Results:
1: from 3040 NAdamsville* to 1061 X-JWRBessie* = 25.88 % 5649.99 amps
2: from 3040 NAdamsville* to 3043 NAdamsville = 23.50 % 5650.00 amps
  
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