Leveraging Pennsylvania Power & Light's EFD for Fusing Opportunities

Abstract

PPL is leveraging its Electric Facilities Database (EFD) to determine placement of protective devices in the field. In an effort to reduce the frequency of outages, PPL is using its ArcStorm and Oracle database along with transformer and customer databases to determine where to optimally place fuses in the field. PPL is utilizing upstream device information and downstream customer information to determine conductor spans which best qualify for additional protective devices. The process targets single-phase laterals with a high number of customers that lack an upstream fuse protecting a three-phase recloser or sectionalizer. This paper discusses the process developed at PPL to support this need.

Introduction

In an effort to reduce the frequency of outages, PPL is using its ArcStorm and Oracle databases along with transformer and customer databases to determine where to optimally place fuses in the field. This project was commissioned by PPL to identify locations in the field that need a protective device or possibly tree trimming.

Approach

Extracting Data from ArcStorm and Oracle

The spatial data in PPL's EFD is stored in an ArcStorm database. PPL's EFD is a production database accessed by over 80 editors at any given time. The spatial extent of the data is approximately the eastern third of Pennsylvania. In order to minimize the impact to PPL's production database updates, the spatial data is extracted from ArcStorm into a single coverage. All primary circuits and devices are extracted along with poles. Additionally, Oracle records associated with the extracted features are exported and translated into INFO. This process ensures access to the entire dataset for processing without impacting other users of the EFD.

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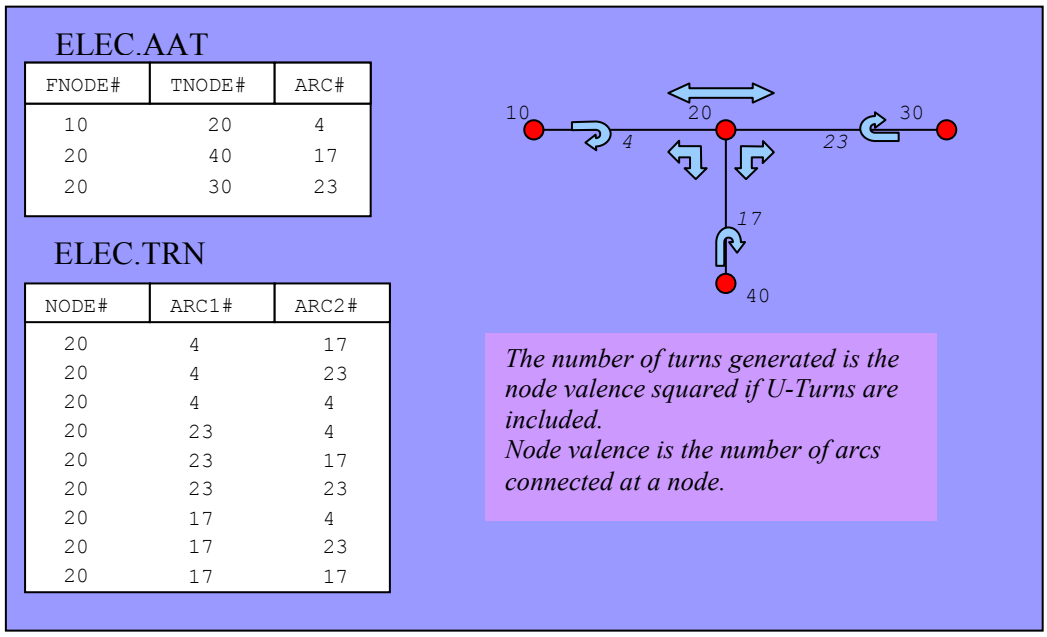
Applying a Network Turntable

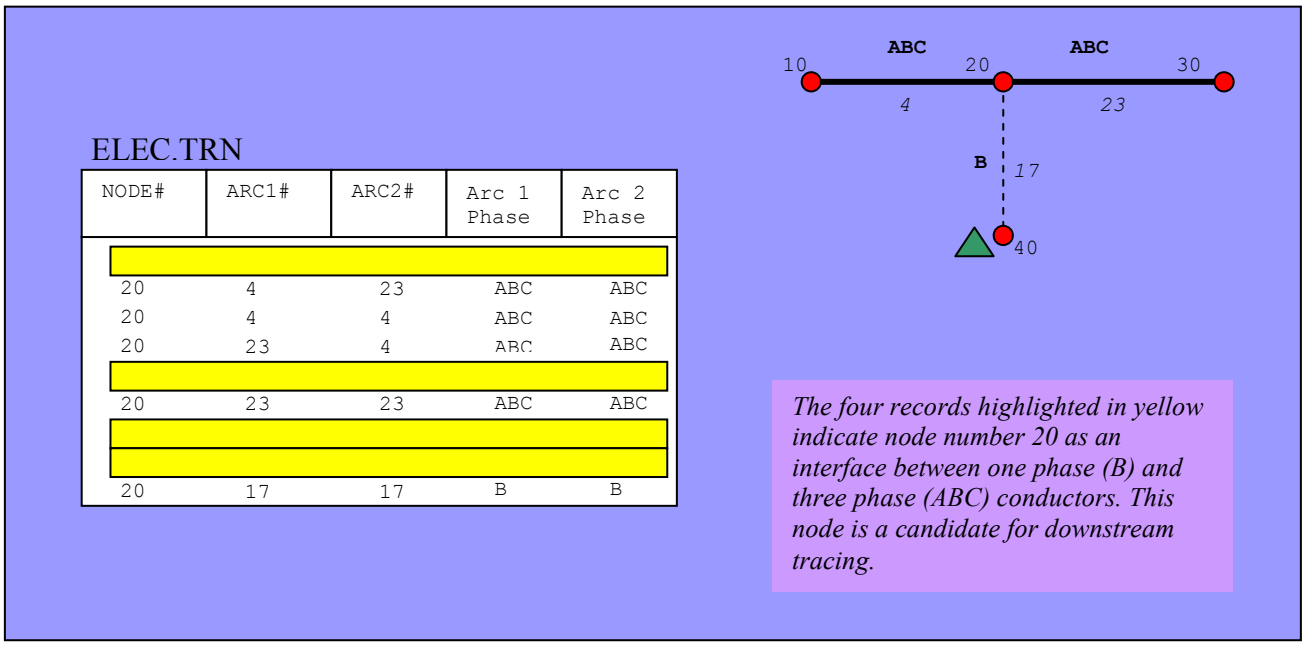
Once the spatial and tabular data is extracted from the EFD, then network analysis can begin. Network analysis provides information about the arc-node connectivity within a dataset. The first step is to create a network turntable. A turntable contains information regarding the relationship between nodes and their connected arcs. The diagram below shows a standard turntable created from ELEC.AAT.

Diagram 1 Standard Network Turntable



Arc attribution, such as, type and phasing, are joined onto the turntable. Node attribution, such as, related point type and node valence, are joined to the turntable. By joining information about the nodes and arcs onto the turntable, we can easily identify the locations where single and three phase circuits connect. These locations or nodes are called interface nodes. Interface nodes identify the location for downstream tracing.

Diagram 2 Enhanced Turntable with Arc Phasing and Node Type Attribution



The Downstream Trace

In order to trace downstream from the interface nodes, all two and three phase primary circuits must be excluded from the trace. All protective devices, such as, reclosers, sectionalizers and fuses, must also be excluded from the trace.

A cursor is used to loop through each interface node to kick off the trace down the single-phase circuit or lateral. Laterals that are not protected by a fuse or other protective device will be traced, revealing candidate transformers. Each candidate transformer is correlated to an interface node identifier.

Determining Supplying Device

The supplying device of each candidate transformer is determined with the PPL table elec_supply.dat. The table originates in PPL's Power Delivery Management group and is used by PPL's Outage Management System. The table stores the unique identifier of each device as well as the unique identifier and device type of the upstream supplying device.

For each candidate transformer, if the upstream device is a fuse, then the lateral is protected. If the upstream device is a recloser, sectionalizer or feeder circuit breaker, then the lateral is unprotected.

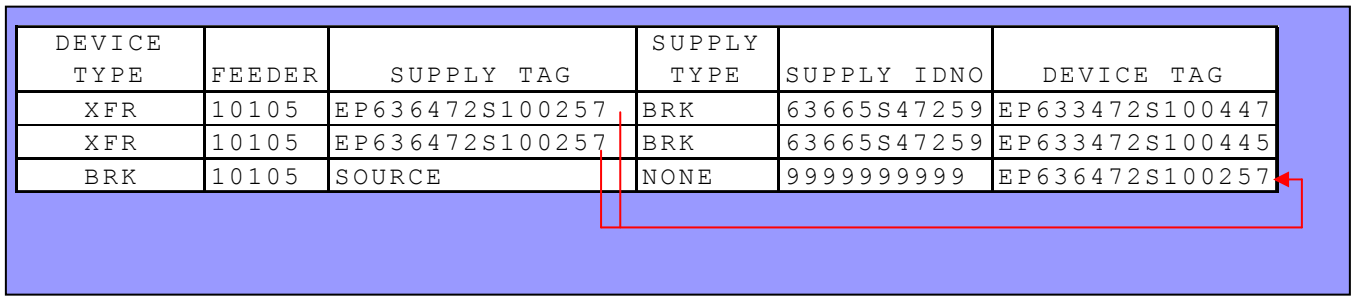
In the event of an air brake switch or other normally closed switching device is the upstream device, then it is overlooked in order to find either a fuse, recloser, sectionalizer or feeder circuit breaker upstream from the candidate transformer.

Customer Number

The elec_supply.dat table also stores the number of customers fed by each device. This is critical information for analyzing candidate transformers. The transformers with the largest number of customers are prioritized for review by the operations unit.

An example of the elec_supply.dat table is shown in the diagram below.

Diagram 3 Sample ELEC_SUPPLY.DAT Table



DEVICE TYPE	FEEDER	SUPPLY TAG	SUPPLY TYPE	SUPPLY IDNO	DEVICE TAG
XFR	10105	EP636472S100257	BRK	63665S47259	EP633472S100447
XFR	10105	EP636472S100257	BRK	63665S47259	EP633472S100445
BRK	10105	SOURCE	NONE	9999999999	EP636472S100257

The third record is the supplying device for records 1 and 2.

Reporting Program Results

A Microsoft Excel spreadsheet is the best method for reporting the transformers found on unprotected laterals. Each row in the spreadsheet is a transformer. The information attributed to each transformer includes but is not limited to type of transformer, number of customers, feeder, unique identifier, supplying device unique identifier and supplying device idno (a PPL assigned identifier). The number of effected customers is noted in order to help prioritize the device listing. The diagram below shows a sample report.

Diagram 4 Sample Report Output

SUPPLY IDNO	SUPPLY TAG	SUPPLY TYPE	FEEDER	Number of CUSTOMERS	INTERFACE NODE ID	DEVICE TYPE
63665S47259	EP636472S100257	BRK	10105	5298	63344S47426	XFR
63665S47259	EP636472S100257	BRK	10105	5298	63315S47356	XFR
63665S47259	EP636472S100257	BRK	10105	5298	63554S47354	XFR
63665S47259	EP636472S100257	BRK	10105	5298	63331S47318	XFR
63665S47259	EP636472S100257	BRK	10105	5298	63572S47307	XFR
63665S47259	EP636472S100257	BRK	10105	5298	63555S47271	XFR
63665S47259	EP636472S100257	BRK	10105	5298	63555S47271	XFR
63665S47259	EP636472S100257	BRK	10105	5298	63555S47271	XFR
63665S47259	EP636472S100257	BRK	10105	5298	63587S47269	XFR

In this sample report, the feeder circuit breaker for feeder 10105 has nine transformers on seven different unprotected single-phase laterals. The INTERFACE NODE ID column notes the location of the interface pole where a potential fuse could be located.

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Assessing the Results

PPL's Operations group uses this report, along with other information, to decide whether or not to add a protective fuse to a particular lateral. In some cases tree trimming may be a better alternative for preventing potential outages. Also, the report must be verified, as it may not reflect the data existing in the field. New facility development is always ahead of the EFD update cycle. Also, a data error may exist where a protective device is missing from the PPL EFD.

Conclusion

This project is unique in that it attempts to find locations of features that do not currently exist in the EFD. A prediction of feature locations is based on several types of spatial and tabular data processing. The program utilizes several modules of workstation ArcInfo and is controlled by Arc Macro Language (AML). The network turntable is created with the NETWORK module, and an INFO program adds the phasing information to create the enhanced network turntable. Downstream tracing uses Arcplot with the NETWORK trace command. An INFO cursor program is used to determine the upstream supplying device. The report output is managed by INFO.