Survalent.

Fault Location, Isolation and Service Restoration (FLISR)

Training by
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ROAD
CLOSED

Your Experience with FLISR

Who here has worked directly with FLISR?

How would you rate your knowledge of FLISR?

Beginner | Intermediate | Advanced

Who here has seen FLISR in action at a utility?

Training Objectives

- Understand What FLISR is and The Role It Plays in Modern Distribution Networks
- Understand How SurvalentONE FLISR Works
- Identify What SurvalentONE FLISR Needs to Function
- Understand Database and Graphics Considerations for Optimal FLISR Operations
- Answer Some of The Commonly Asked Questions About SurvalentONE FLISR

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- Why FLISR?
- SurvalentONE FLISR
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  - FLISR Capabilities
  - FLISR Requirements
  - Illustrations: How it Works
  - Load Calculation Methods
- More Details on The KB

Module 2: System Setup

- Licenses
- Database
- SmartVU

Module 3: Operation and Demonstrations

- End-to-End FLISR Sequence
- Handling Exceptions

Module 1: The Basics

What is FLISR

- **F**AULT, **L**OCATION, **I**SOLATION and **S**ERVICE **R**ESTORATION
- A distribution automation application that utilities can deploy to:
  - Enable automatic load sectionalization and restoration
  - Detect and locate faults in real time
  - Automatically isolate faulted sections
  - Reroute power to minimize affected customers
  - Restore service quickly and safely

Centralized FLISR vs Decentralized FLISR

Decentralized FLISR

- **Decentralized** – A **scripted solution** that executes pre-defined, programmed activities to re-energize feeders using power from adjacent feeders
- Requires **script** creation for **every possible network configuration**
- Use **proprietary vendor equipment**, you may not be able to utilize all the smart devices you invested in
- Difficult to scale to large grids because the number of **restoration scenarios increases exponentially with each additional device**
- Best suited for feeders with critical loads that require **sub-second restoration**, such as hospitals
- May prove to be laborious to maintain long term

Centralized FLISR

- **Centralized** – **A model-based solution** that uses real-time data from the network to identify the best network reconfiguration, isolate the faulted area, and restore power to customers outside the faulted area
- **No need to define a "normal" state**. FLISR will base its analysis on the current state of the network eliminating the need to write a script for each possible state
- Before transferring load to an adjacent feeder, the solution analyzes that the feeder has sufficient capacity to avoid overloading it
- **Vastly scalable**, so ideal for any size of network, small to large

Survalent's FLISR is Centralized

Centralized FLISR

Impact on Customers without FLISR

Fault Occurs

Fault Discovered (through customers/ SCADA devices)

1 - 10 mins

Travel Time

30 - 45 mins

Locating the Fault

10 - 15 mins

Manual Switching for Partial Restoration

10 - 20 mins

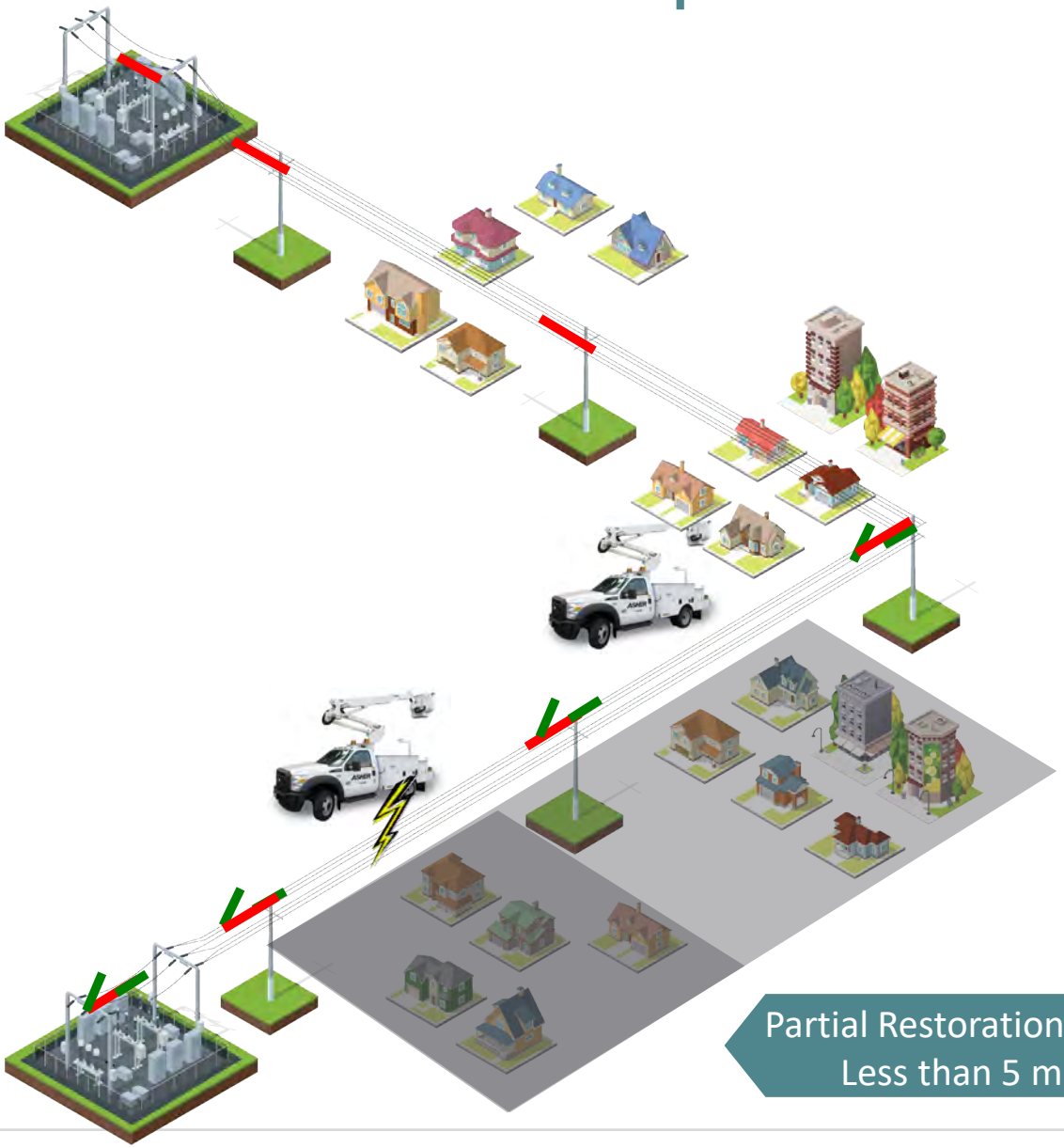
Repair Time

1 - 4 hours

Return to Normal State

Partial Restoration Occurs
50 - 90 mins

How It Works And Its Impact on Customers



Fault Occurs

Partial Restoration at utility control room

Less than 5 mins

Travel Time & Locating the Fault

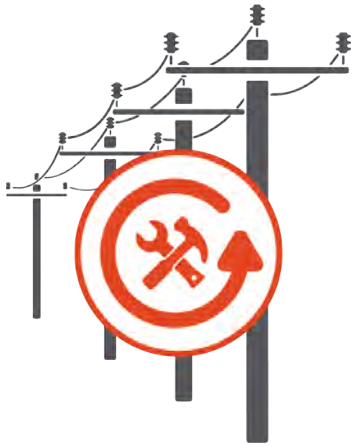
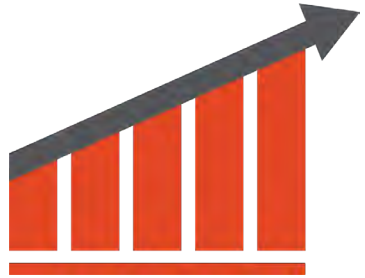
40 - 60 mins

Repair Time

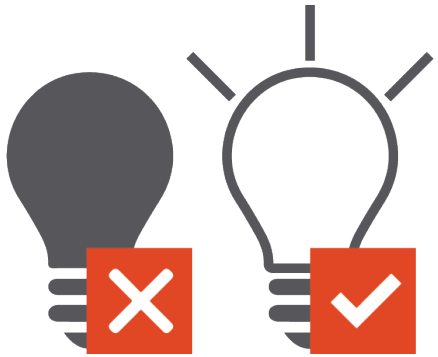
1 - 4 hours

Return to Normal State

Why FLISR - Utility Benefits

				
Rapid fault location & service restoration	**Reduce operating expenses**	**Lower field costs**	**Increase revenue**	**Better decision - making in the control room**

Why FLISR - Utility Benefits

			
Improve reliability indicators	**Less outage downtime**	**Attract C&I customers with premium power**	**Compliance with regulatory standards**

What's The Biggest FLISR Benefit for You?

SurvalentONE FLISR

DMS Application Deployment

PHASE 1:
No network model/connectivity required

- Switch Orders
- Load Management
  - Power Factor Control
  - Dynamic Voltage Regulation (DVR)
  - Voltage Reduction
  - Load Curtailment
  - Rotational Load Shedding
- Short-term Load Forecasting / Load Estimation

PHASE 2:
Connectivity required

- Fault Location, Isolation and Service Restoration (FLISR) & Loss of Voltage (LOV)
- Protection Settings Manager (PSM)
- Distribution Contingency Analysis (DCA)
- Schematic Generator

PHASE 3:
Network model/connectivity required

- Distribution Power Flow (DPF)/Distribution State Estimation (DSE)
  - FLISR with DPF
  - Short-circuit analysis
- Contingency Analysis
- Fault Location
- Volt/VAR Optimization (VVO)
- Optimal Feeder Reconfiguration (OFR)

SurvalentONE FLISR and LOV Overview

- SurvalentONE FLISR comes in one package with Loss of Voltage (LOV)
- Handles any network configuration
- Triggered by a Lockout. The breaker/recloser that triggers FLISR/LOV can be located inside or outside the substation
- It determines fault location using fault targets/indicators
- Can adapt to exclude disabled, telemetry failed & tagged devices (including hot-line tags applied by the field crew)
- Load transfer segmentation available
- Single phase or multi-phase fault detection
- SurvalentONE Loss of Voltage (LOV) application: Monitors the network for sudden voltage drops. LOV attempts to isolate the cause of voltage loss; Reroute power to customers
- You can set FLISR and LOV mode and status on a per-device basis. Global option is also available to disable FLISR on all feeders

Available Operating Modes

Manual Mode

- Only detects if a fault is in the network

Semi-Automatic Mode

- Creates a switch order that isolates the fault & provides service restoration around the isolated area to the operator for approval & execution

Automatic Mode

- Creates & executes a switch order that isolates the fault & provides service restoration around the isolated area without operator intervention
- Quickest option to restore power
- Most likely to turn sustained outages into momentary outages

FLISR Requirements

License Requirements

FLISR and LOV

- FLISR and LOV requires a license
- Single license for both applications

Topology Processor

- Calculates and displays the energized or de-energized status of network line sections

Switch Orders

- Uses switching operations and tags that produce conditions for which a guarantee may be issued

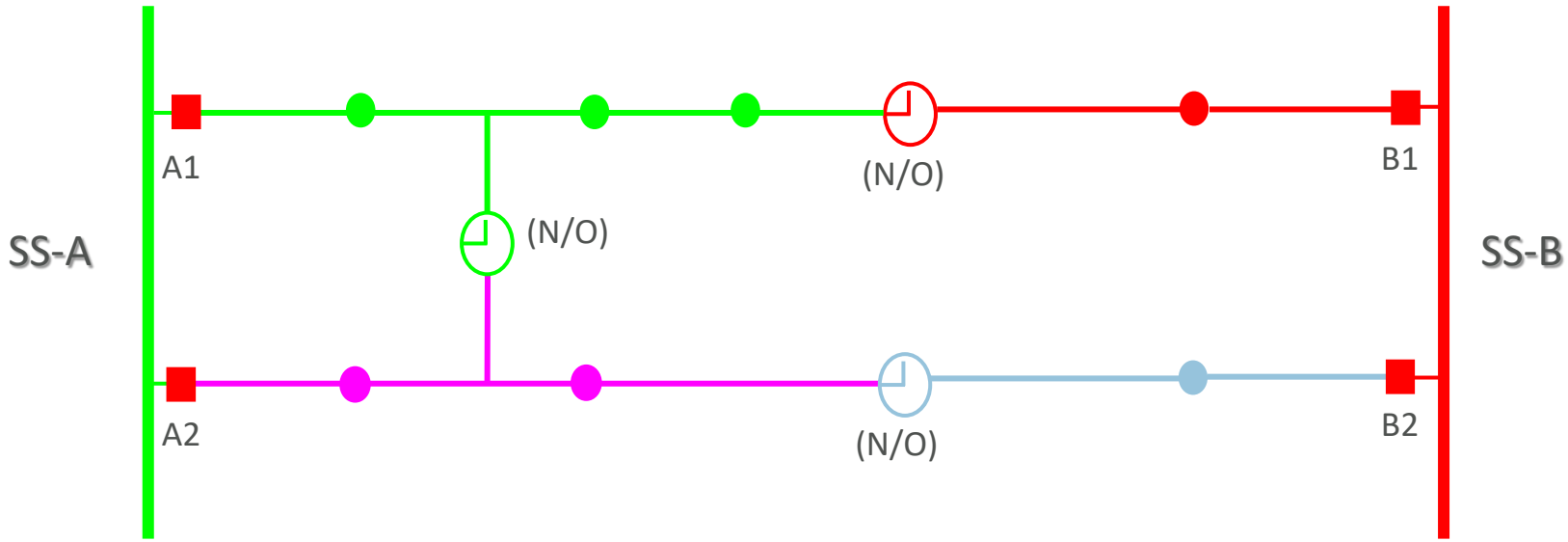
Technical Requirements

Non Survalent (Dependencies)

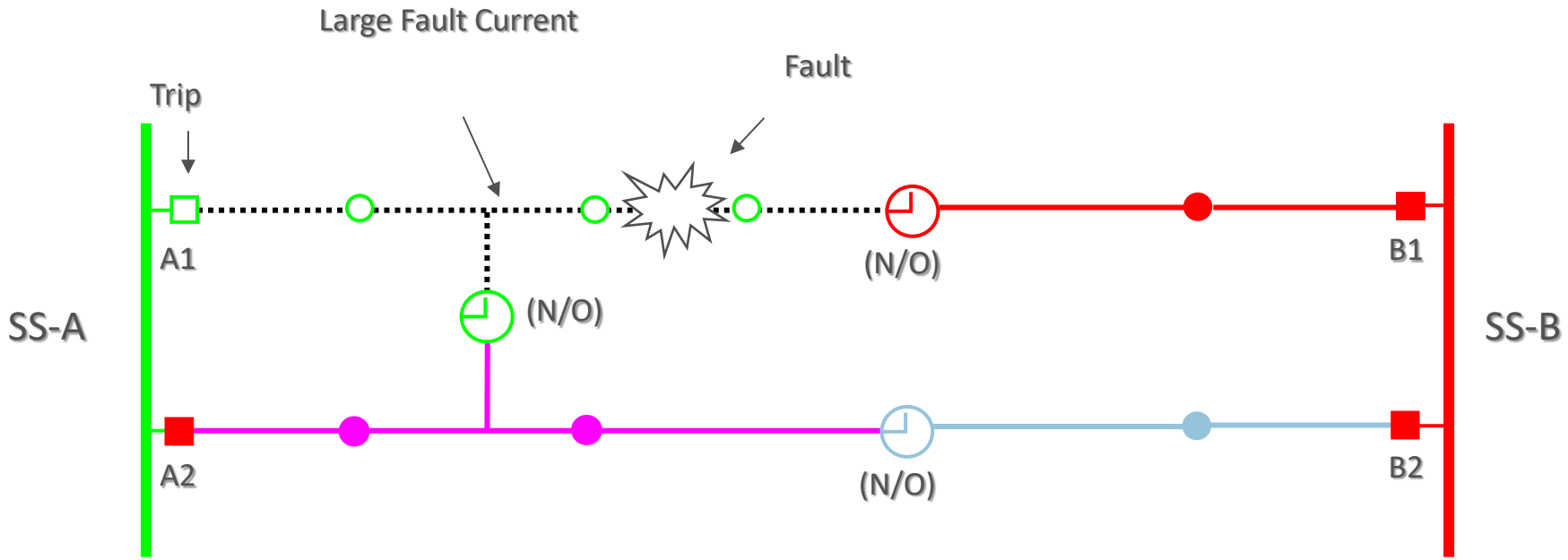
- Telemetered Switches
- Telemetered Tie Switches to backup feeder(s)
- Fault Targets/Indicators
- Current Measurements
- Reclosing (EN/DIS)

FLISR Example Scenarios

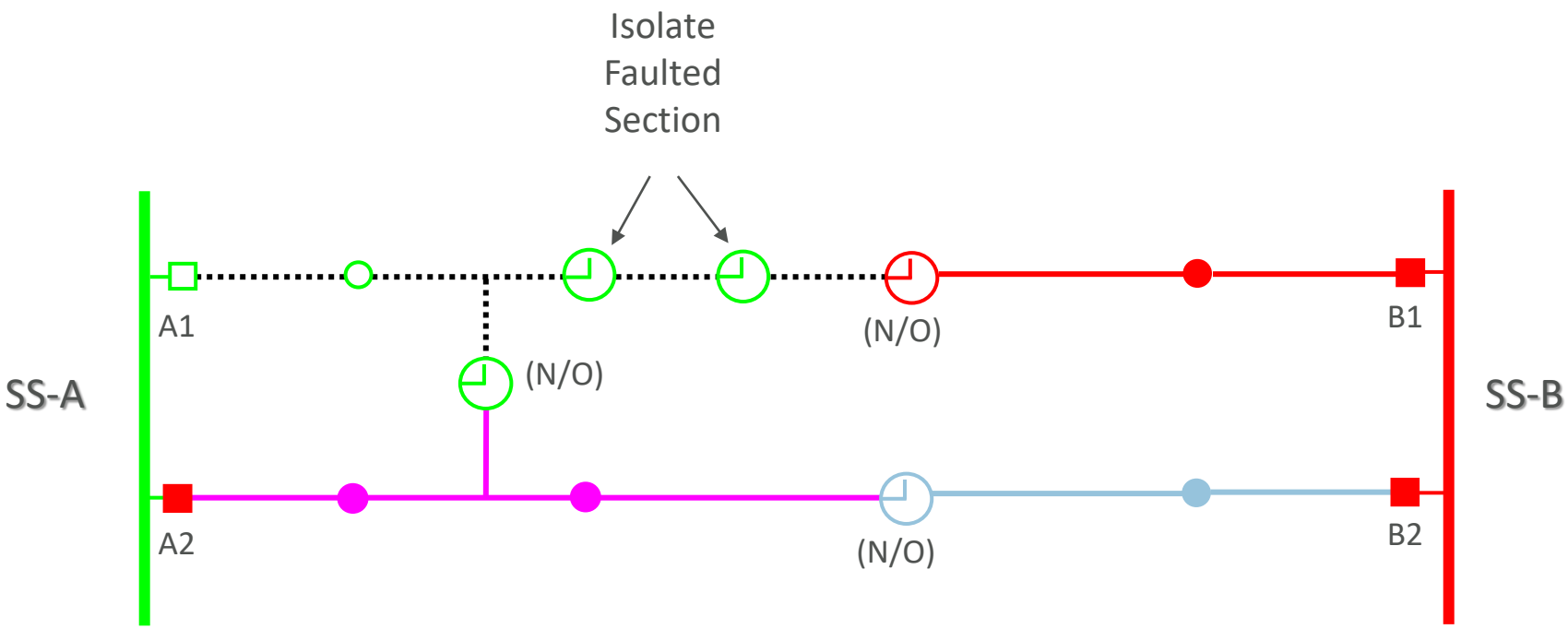
FLISR Scenario 1: Normal Configuration



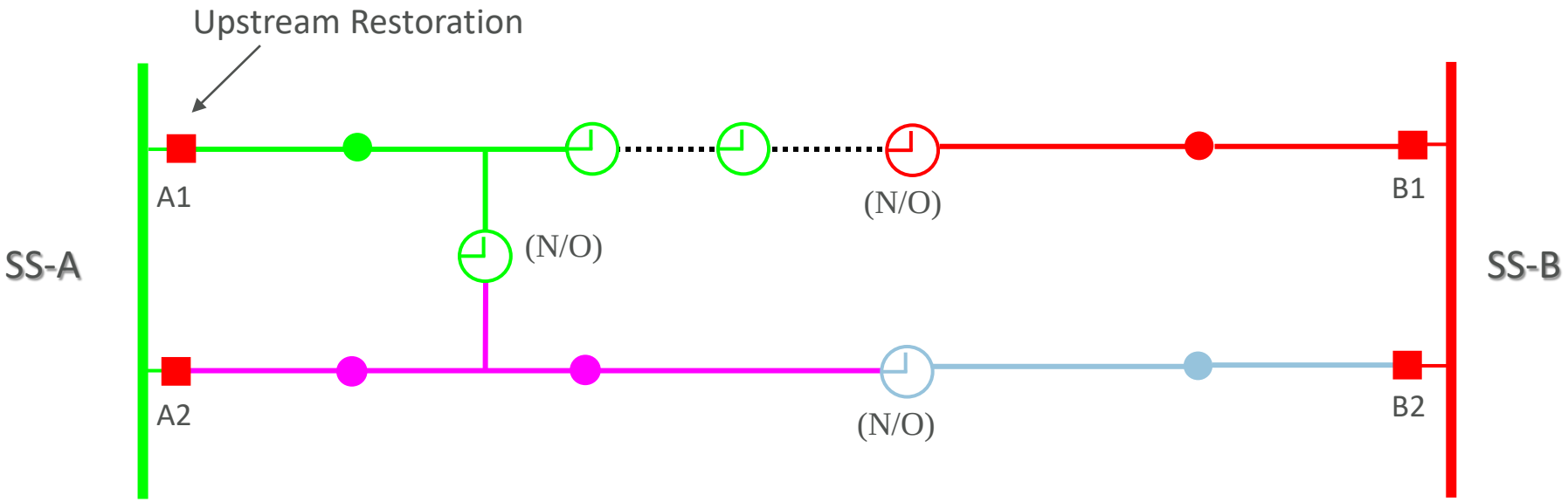
FLISR Scenario 1: Fault Occurrence



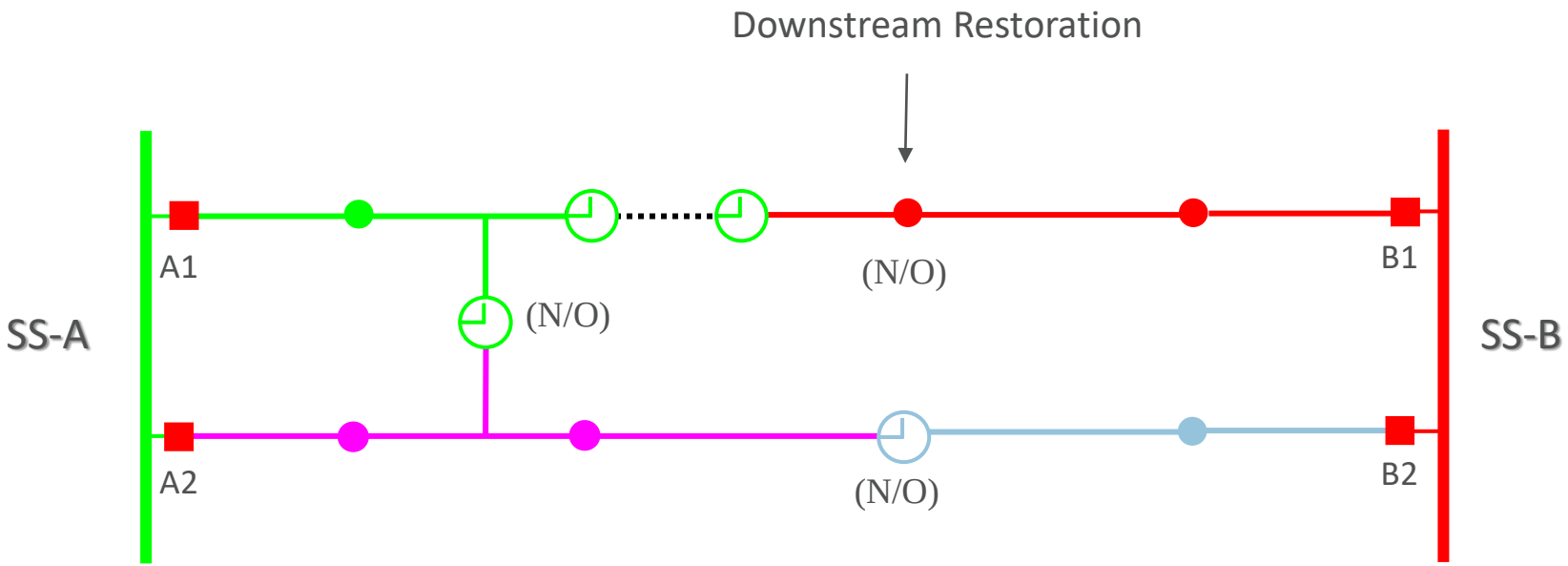
FLISR Scenario 1: Isolating Faulted Section



FLISR Scenario : Upstream Restoration

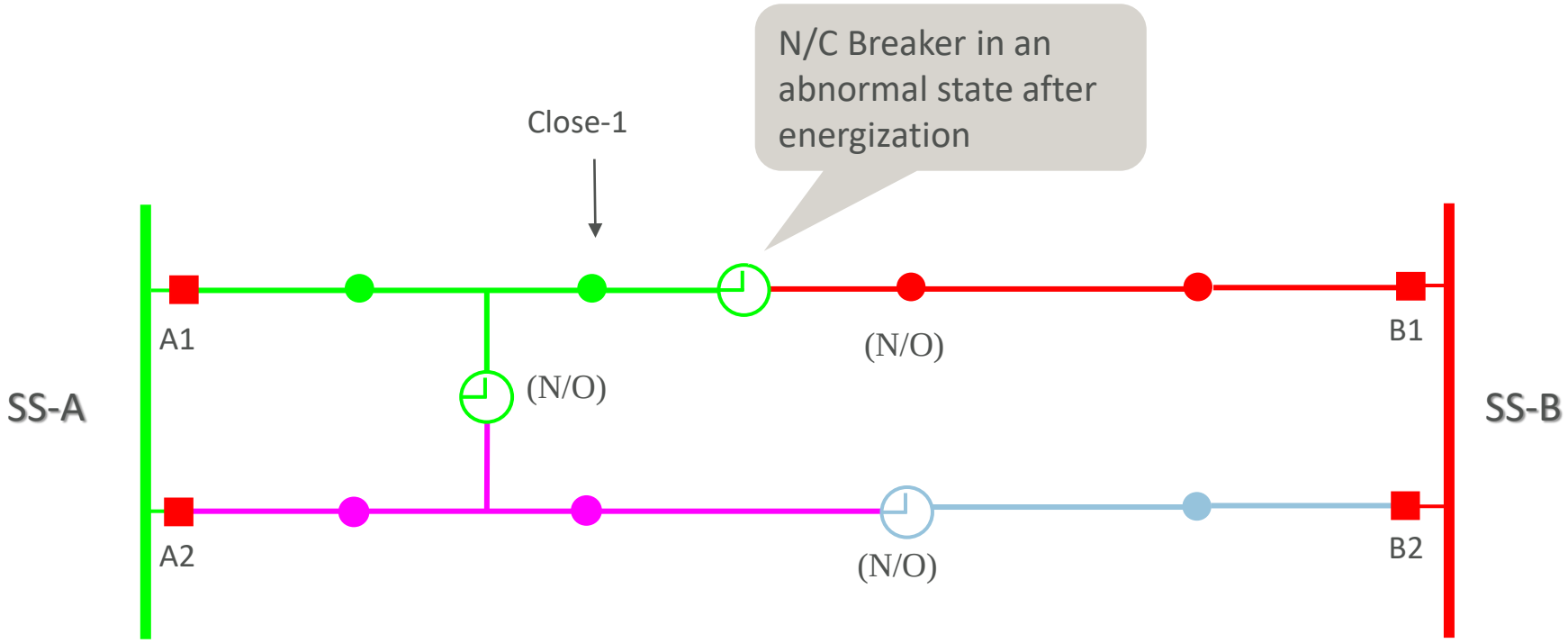


FLISR Scenario 1: Downstream Restoration

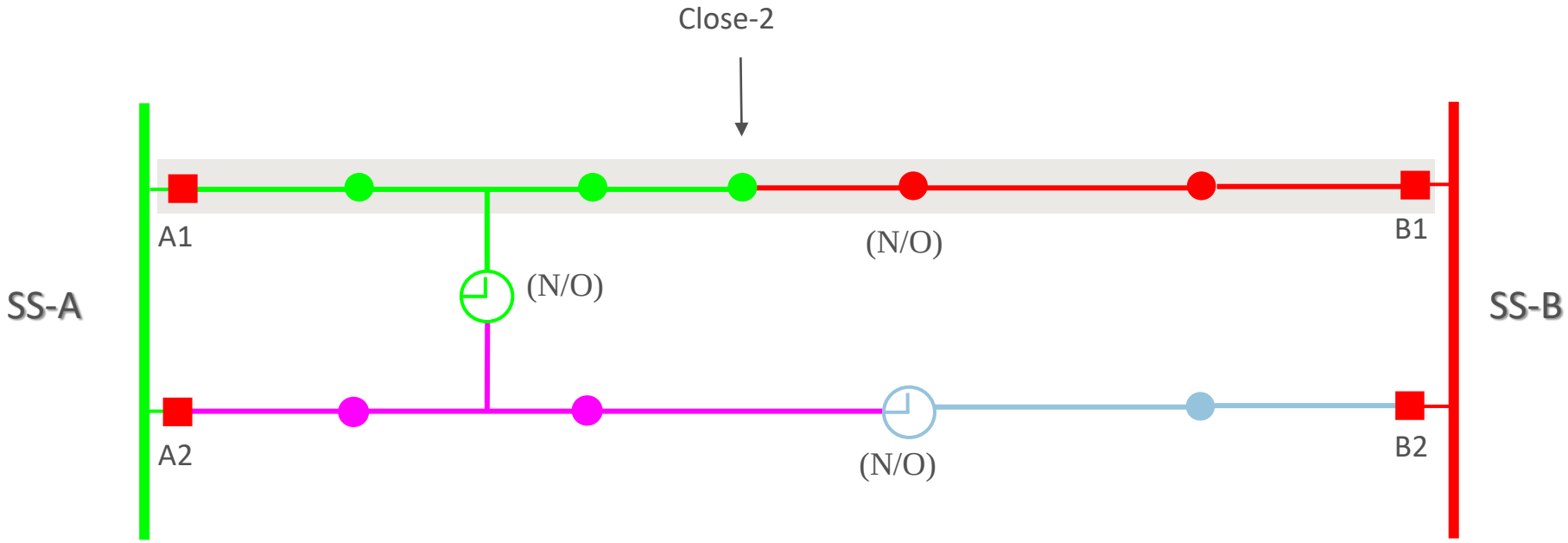


Send crews to investigate and repair the faulted section

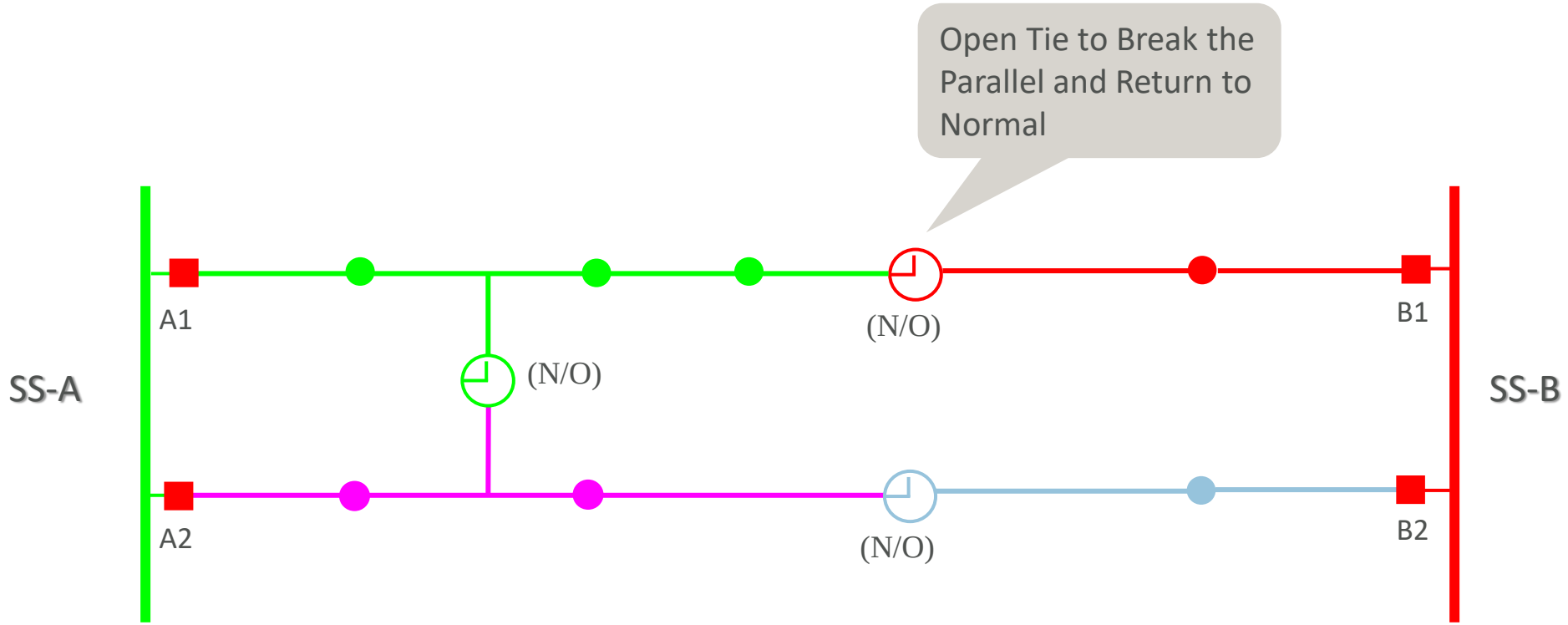
FLISR Scenario 1: Return to Normal



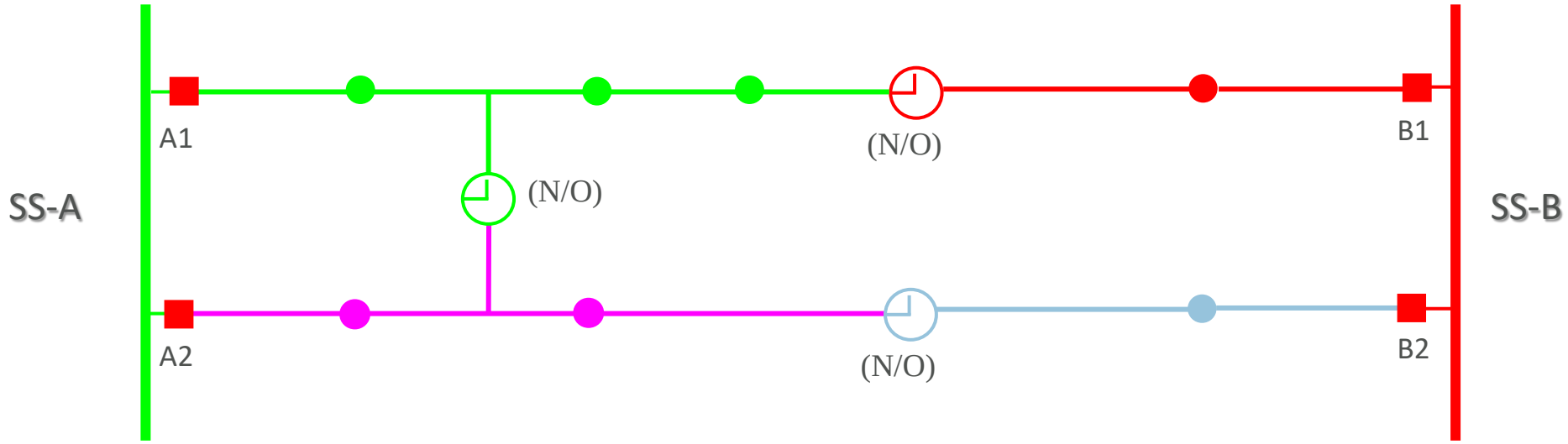
FLISR Scenario 1: Temporary Parallel



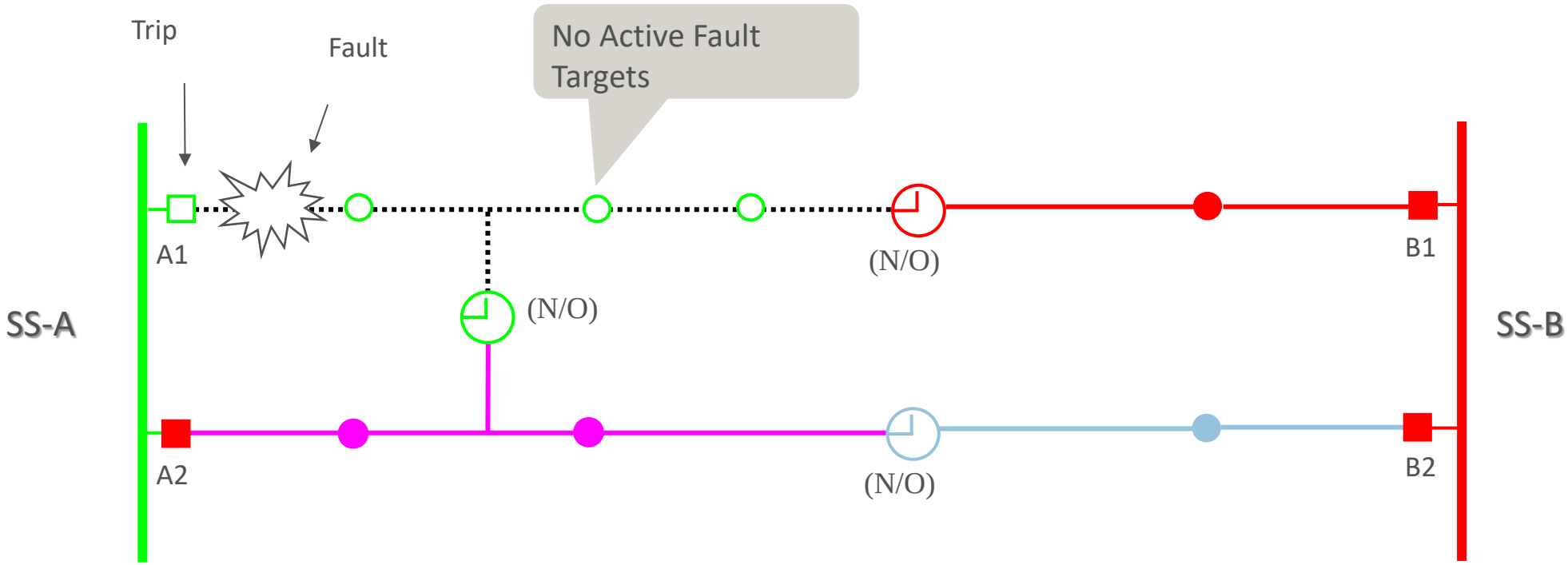
FLISR Scenario 1: Last Step



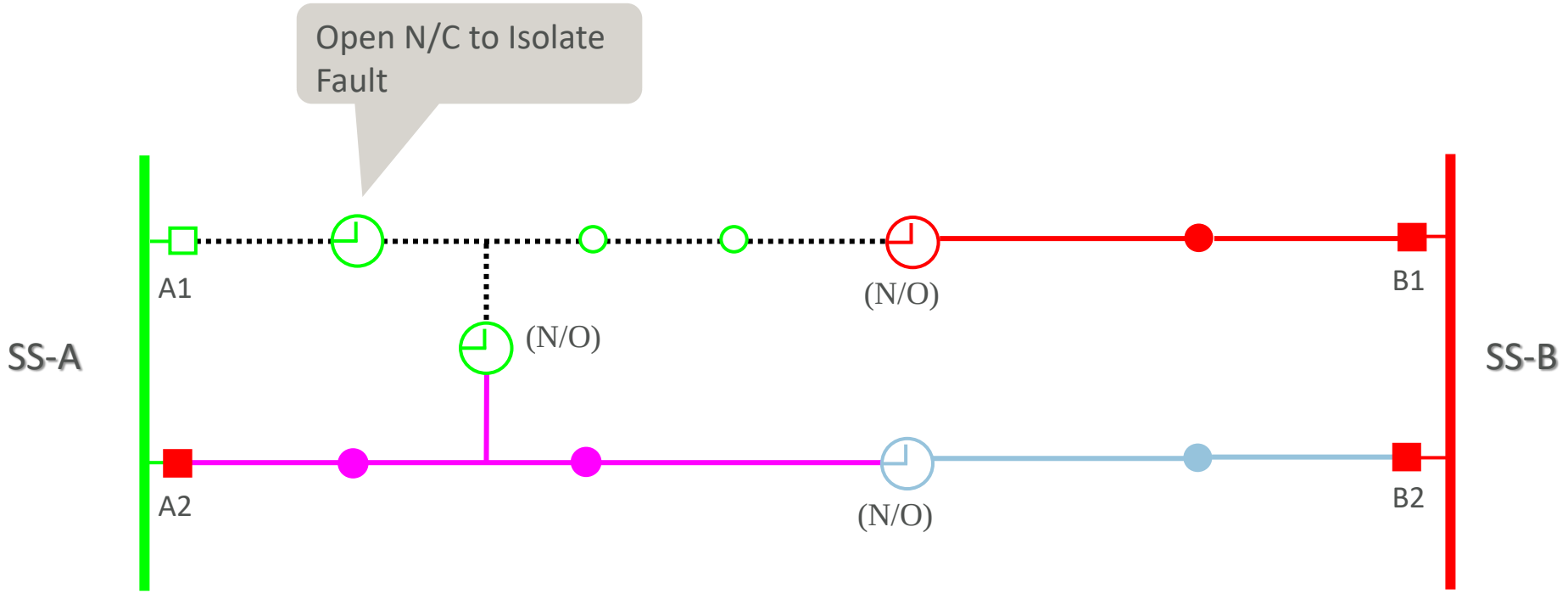
FLISR Scenario 2: Normal Configuration



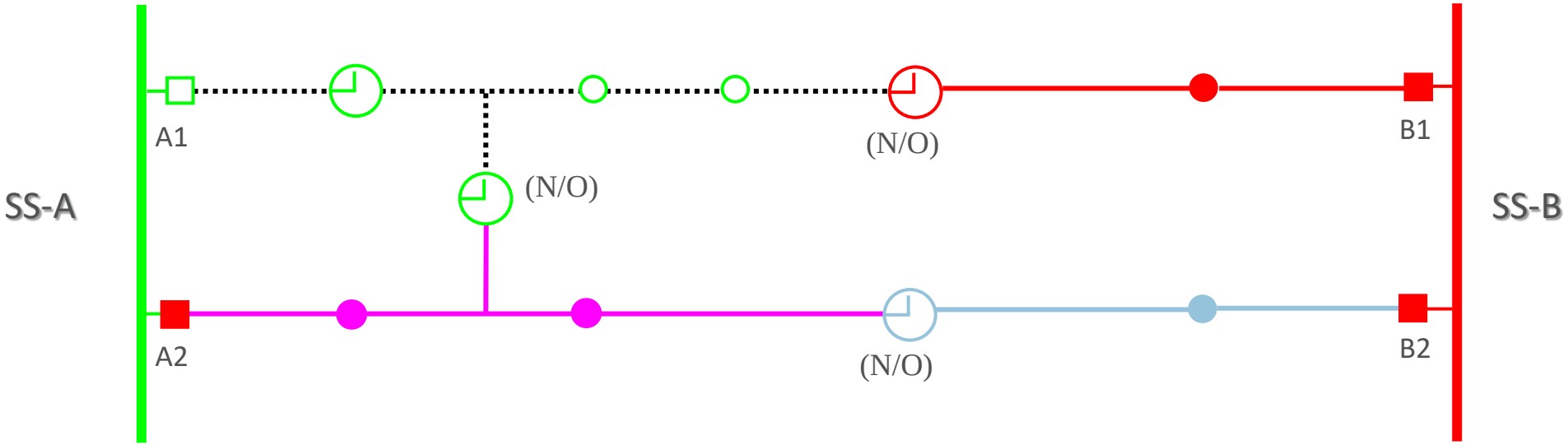
FLISR Scenario 2: Fault Occurrence



FLISR - Scenario 2 - Isolate Faulted Section

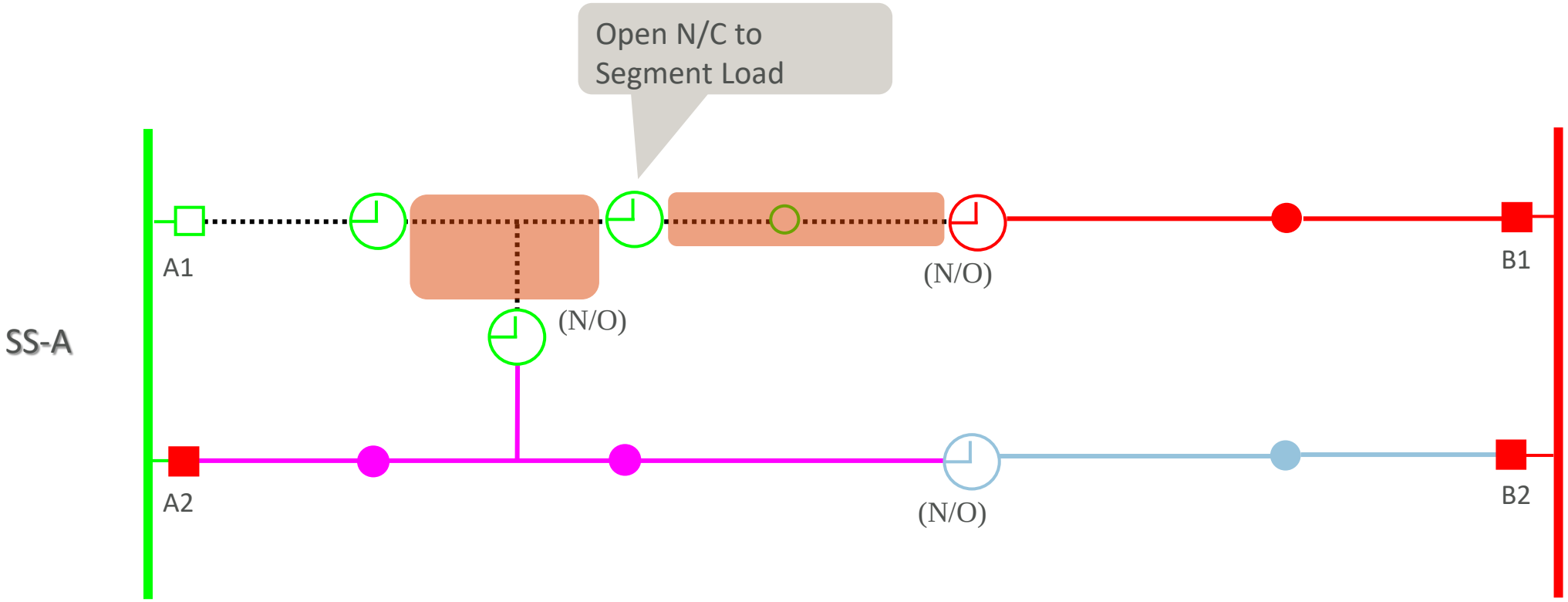


FLISR Scenario 2: Downstream Restoration

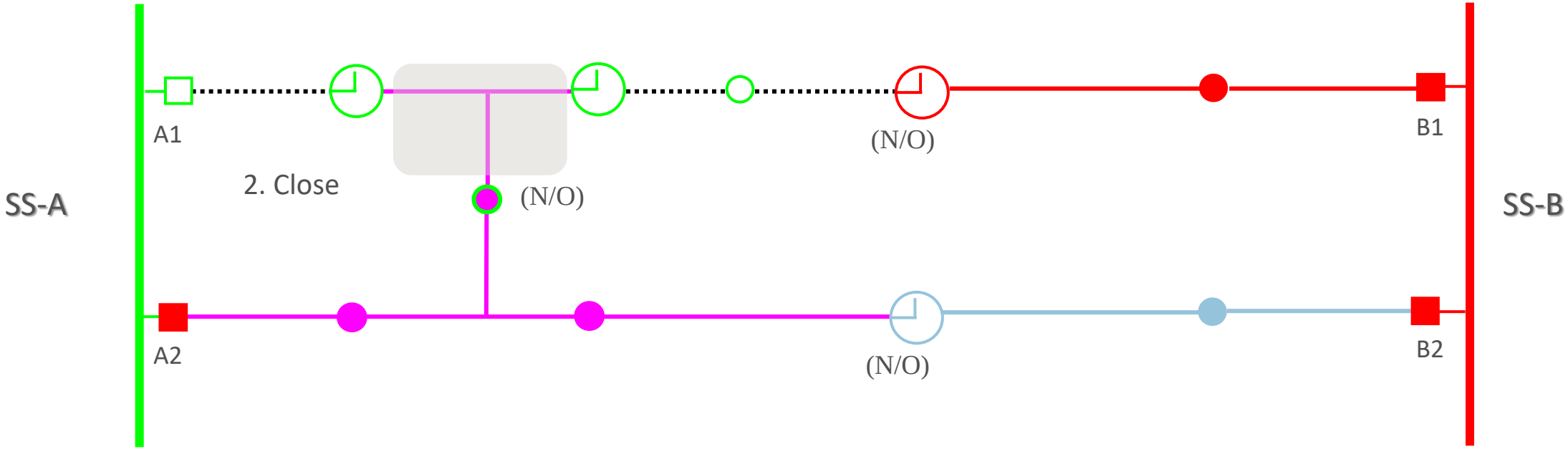


** If the load is too large to be picked up, FLISR will do load segmentation and then load transfer

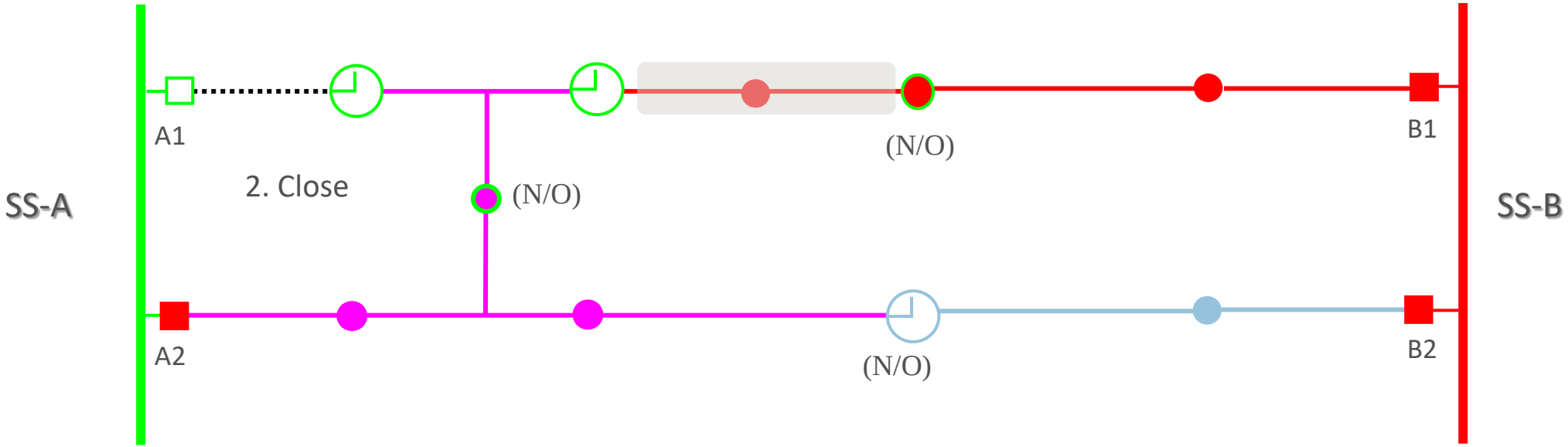
FLISR Scenario 2: Load Segmentation



FLISR Scenario 2: Downstream Restoration 1



FLISR Scenario 2: Downstream Restoration 2



Send crews to investigate and repair the faulted section

Demo

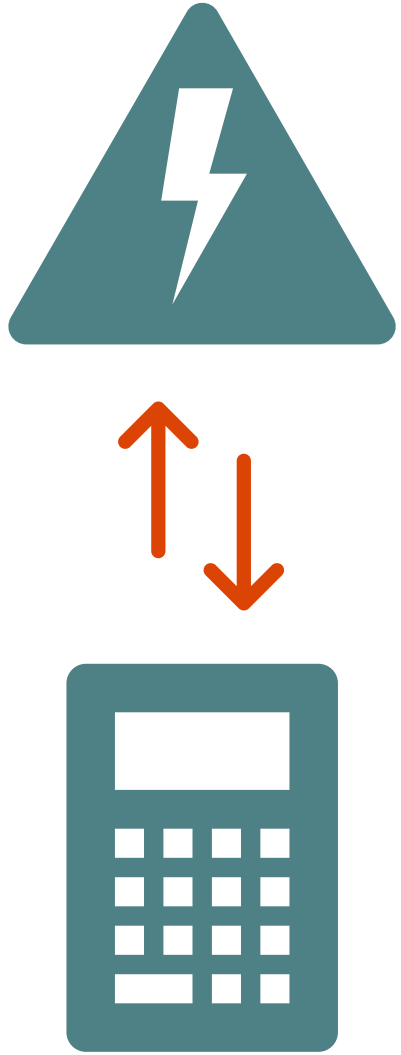
Communication Considerations

Factors that can affect the response time of FLISR:

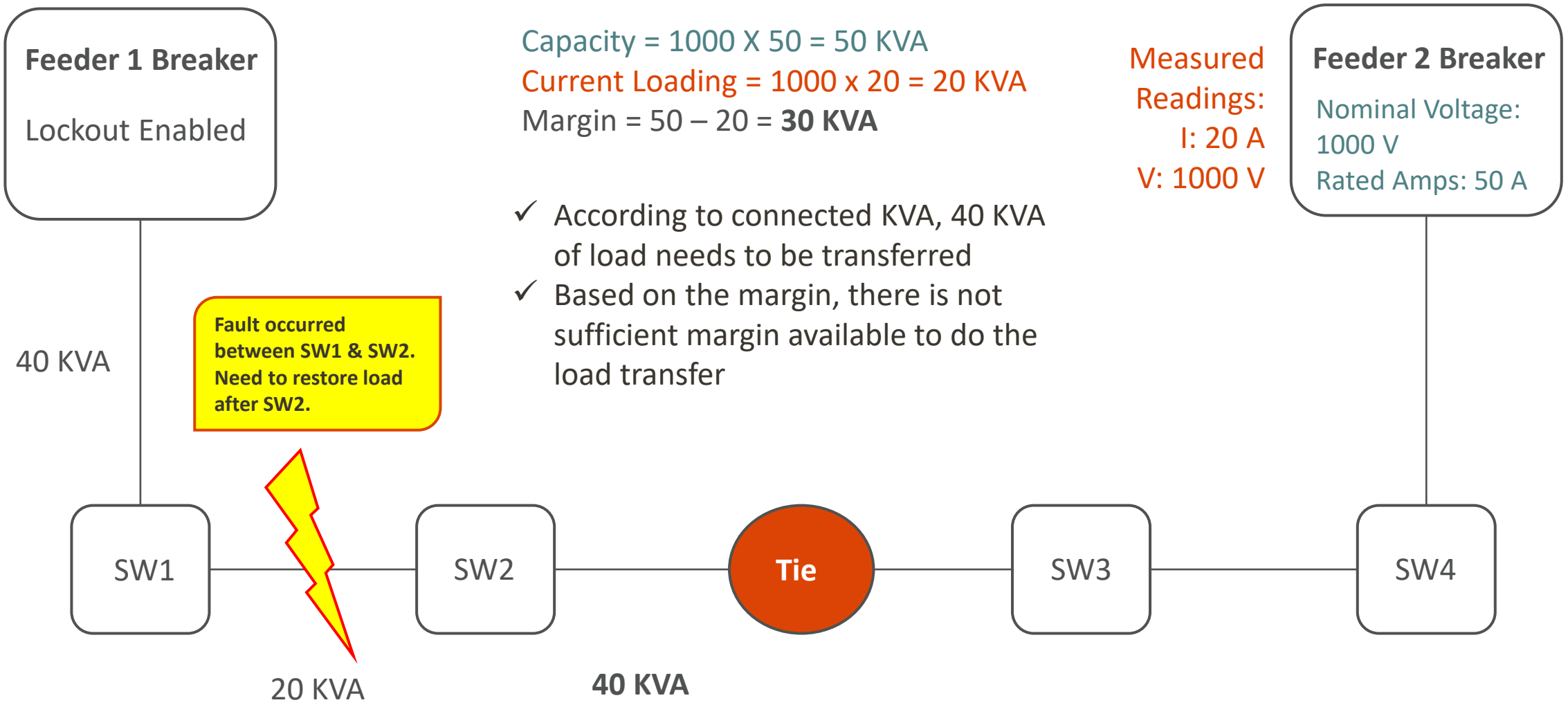
- **Lockout Timer:** FLISR will only start once a lockout has occurred
- **Verification Phase:** after the lockout has been detected, FLISR updates the status of all the devices/points that could be used. This can take up to two minutes. Any device/point who does not respond within two minutes is automatically excluded from consideration
- **Issuing Commands:** before going to the next step, FLISR needs to be sure that that the command was successfully sent. After receiving an ACK from a device, FLISR repolls the device in 5s to ensure that the operation was successful

FLISR Service Restoration Options

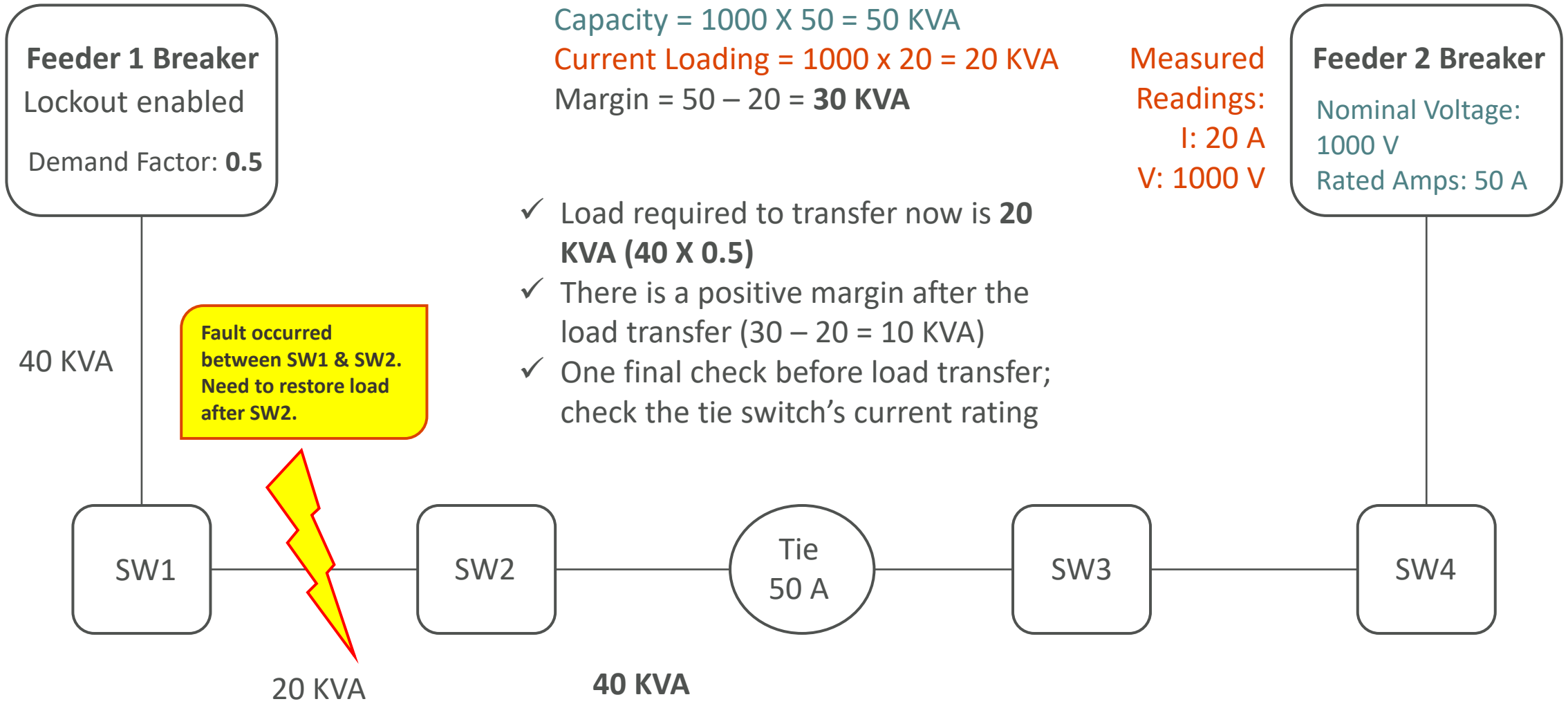
- Transformer's connected KVA
- Transformer's connected KVA scaled by demand factor
- Transformer's connected KVA scaled by feeder injections
- Telemetered values
- Power flow study



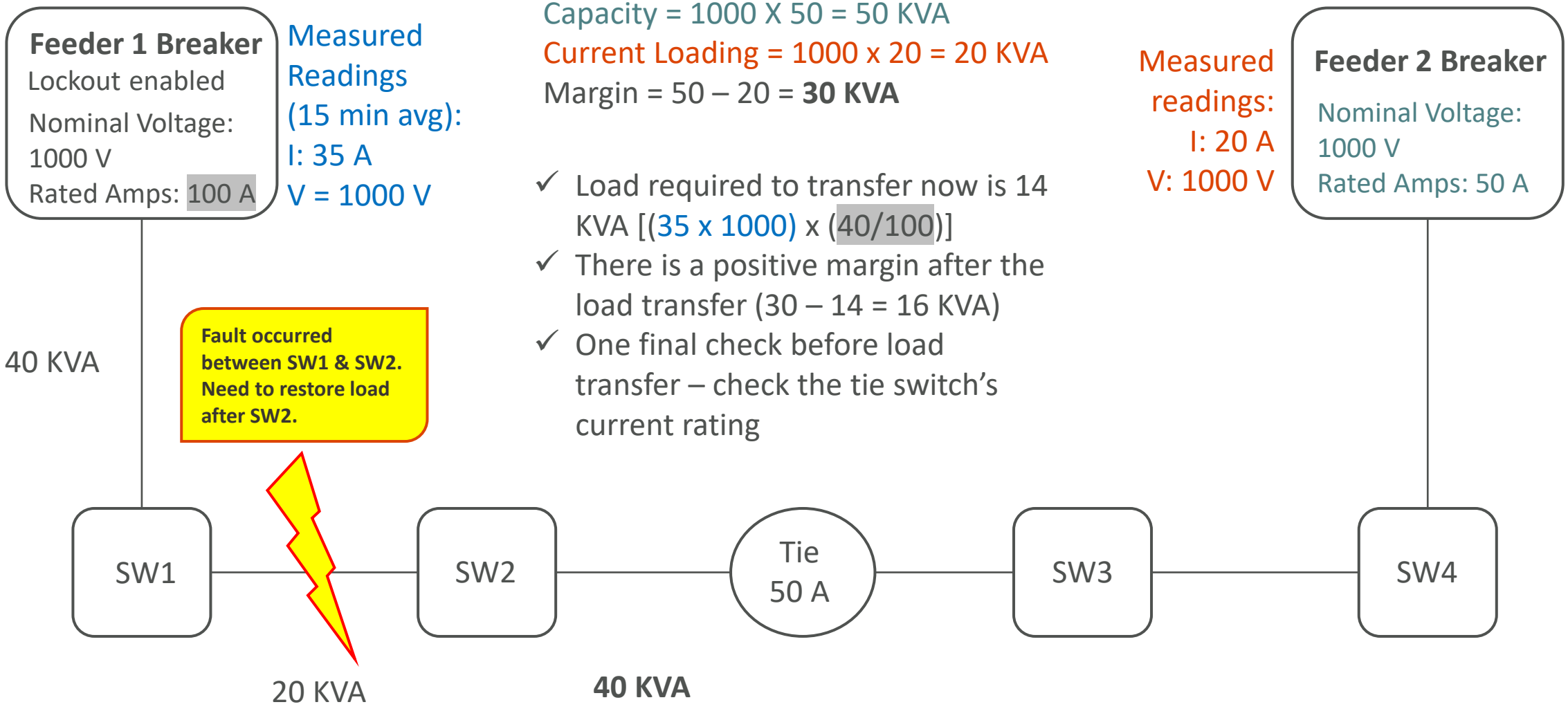
Load Transfer Using Connected KVA



Load Transfer Using Connected KVA with Demand Factor

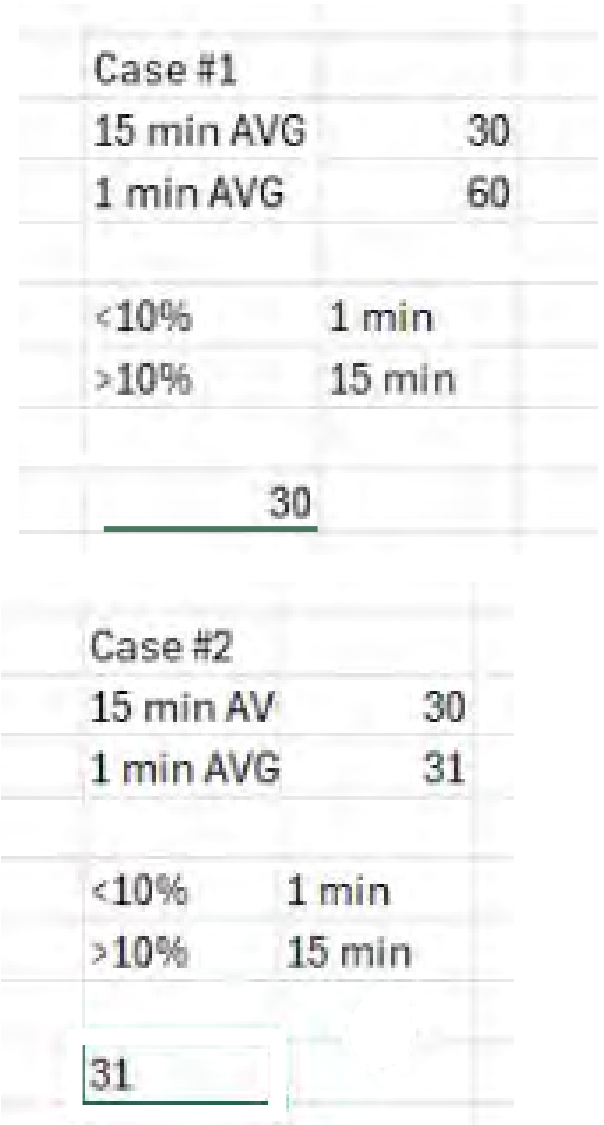


Load Transfer Using Connected KVA Scaled by Feeder Injection

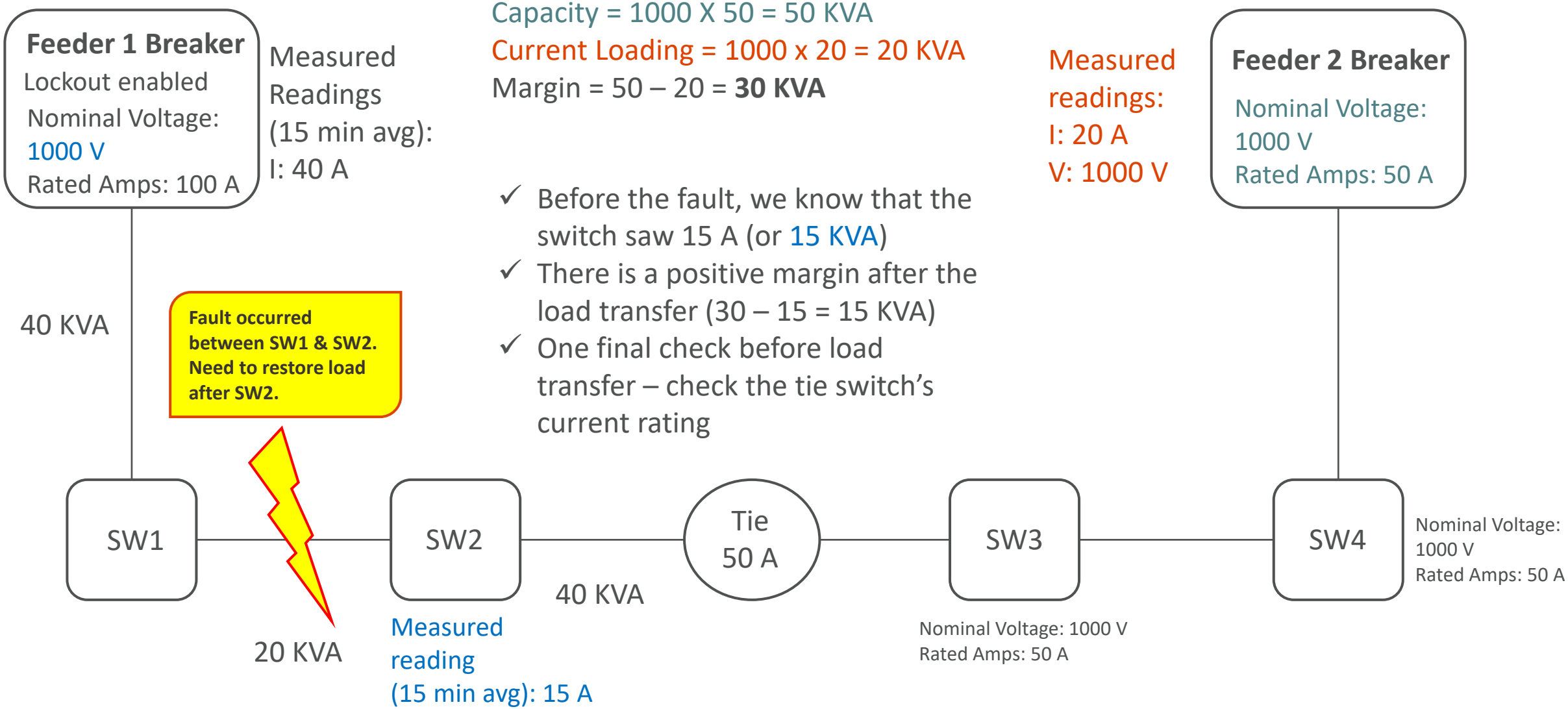


How Do We Determine The Current Reading

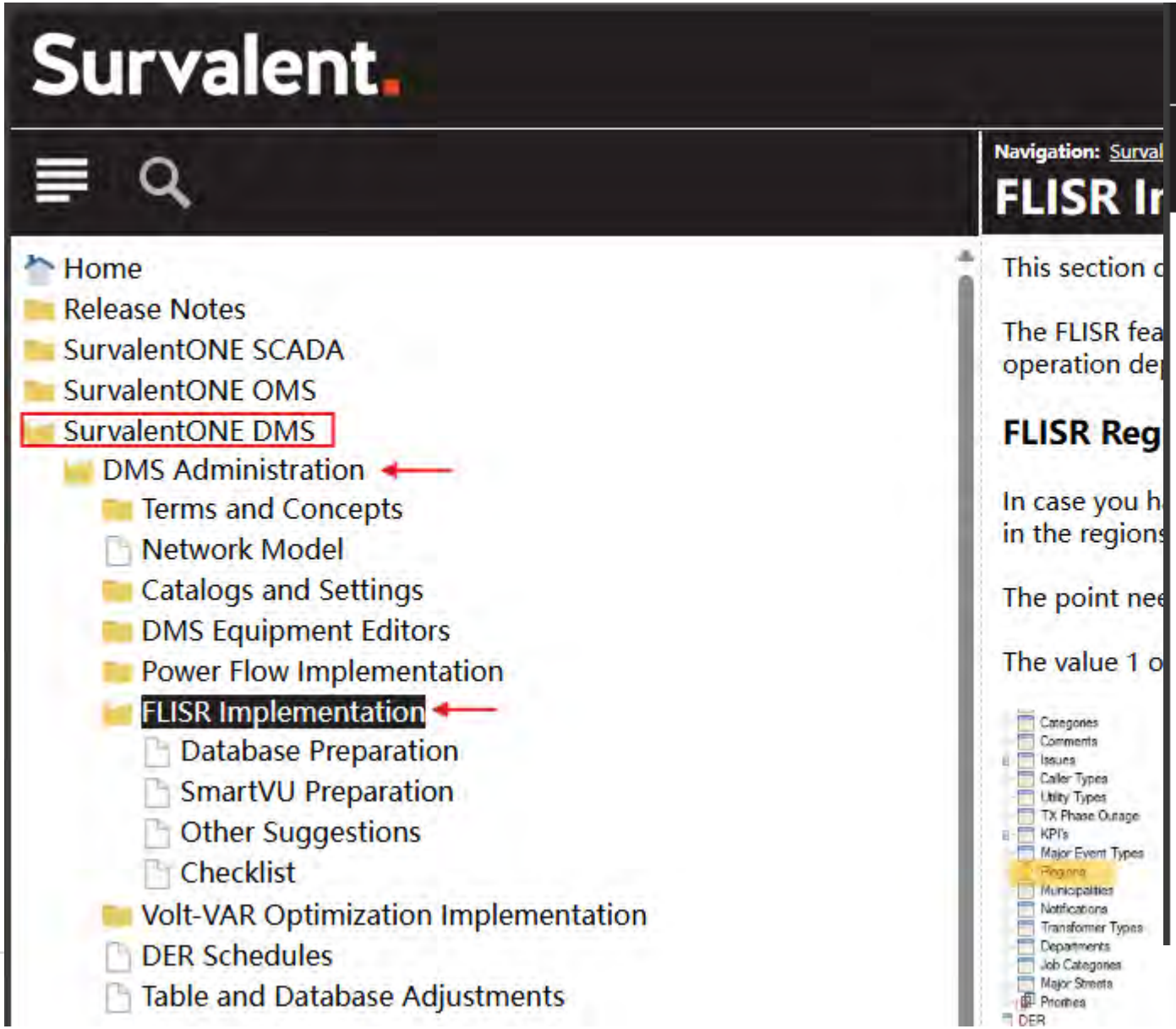
- Loading is Nominal Voltage * Current Reading
- In memory we keep 1 min average, for points related to FLISR
- When the fault happens, if the 1 min average is altered by the fault, we compare it with the 15 min average
  - If the discrepancy is <10%, take the 1 min average
  - If the discrepancy is >10%, take the 15 min average

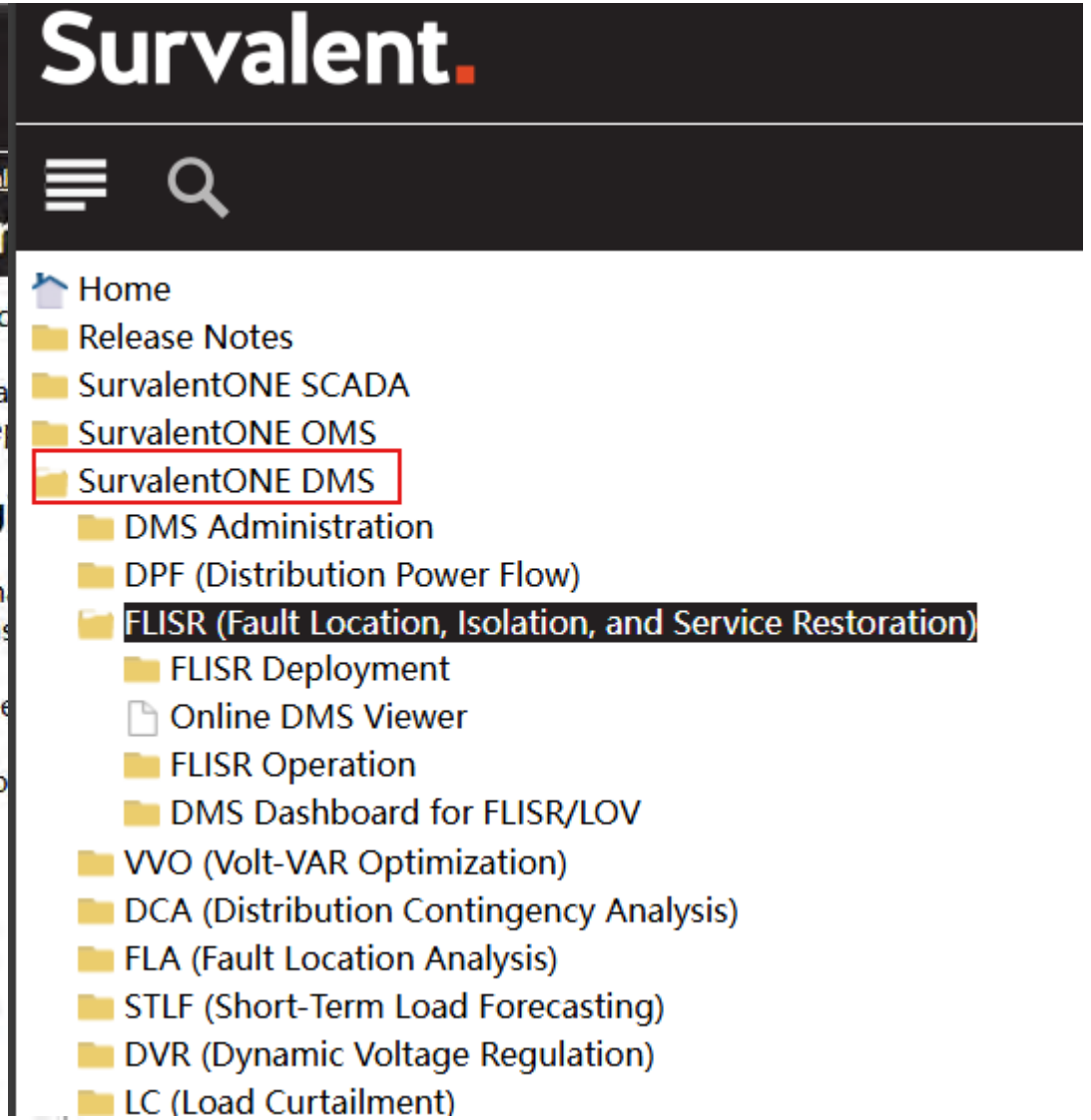


Load Transfer Using Telemetered Values



FLISR in The KB





Module 2: Setup

Setup – Knowledge Check

How Familiar Are You with Database Editing?

Familiar | Somewhat Familiar | Not Familiar

How Familiar Are You with How NTP Works?

Familiar | Somewhat Familiar | Not Familiar

How Familiar Are You with Line Section Editing?

Familiar | Somewhat Familiar | Not Familiar

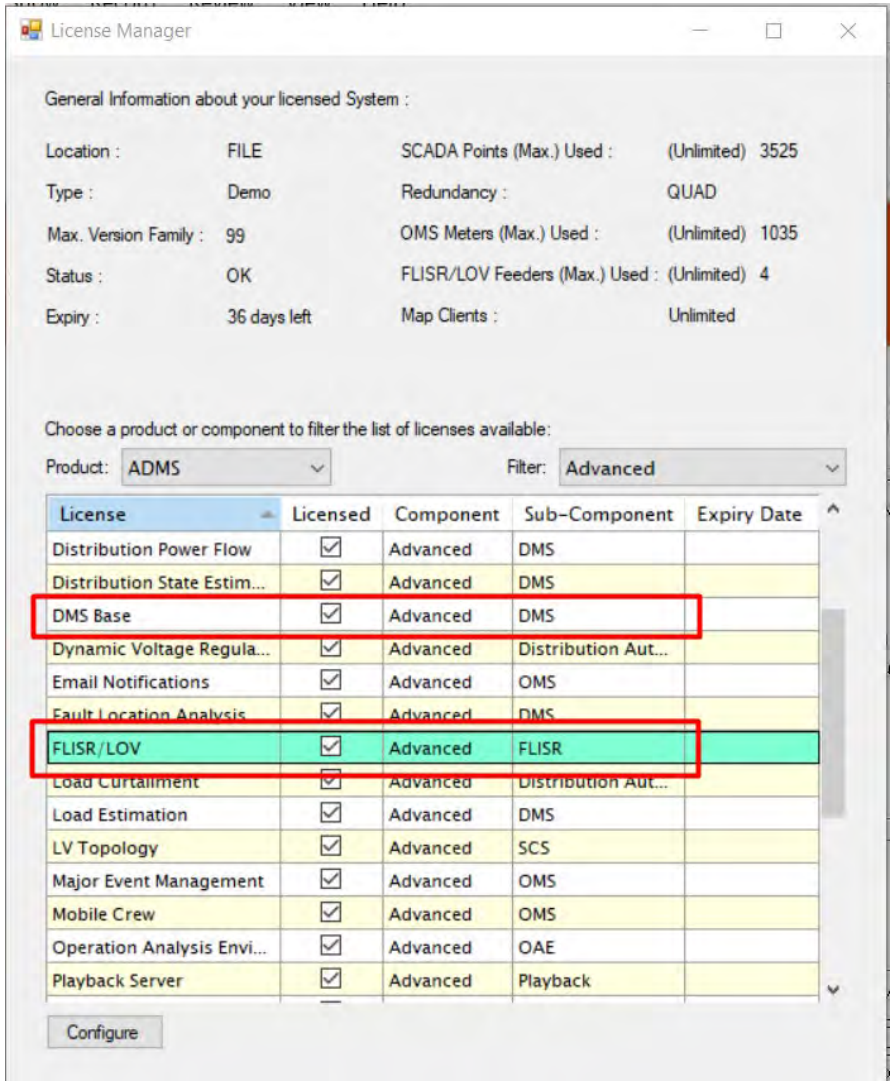
How Familiar Are You with Switch Orders?

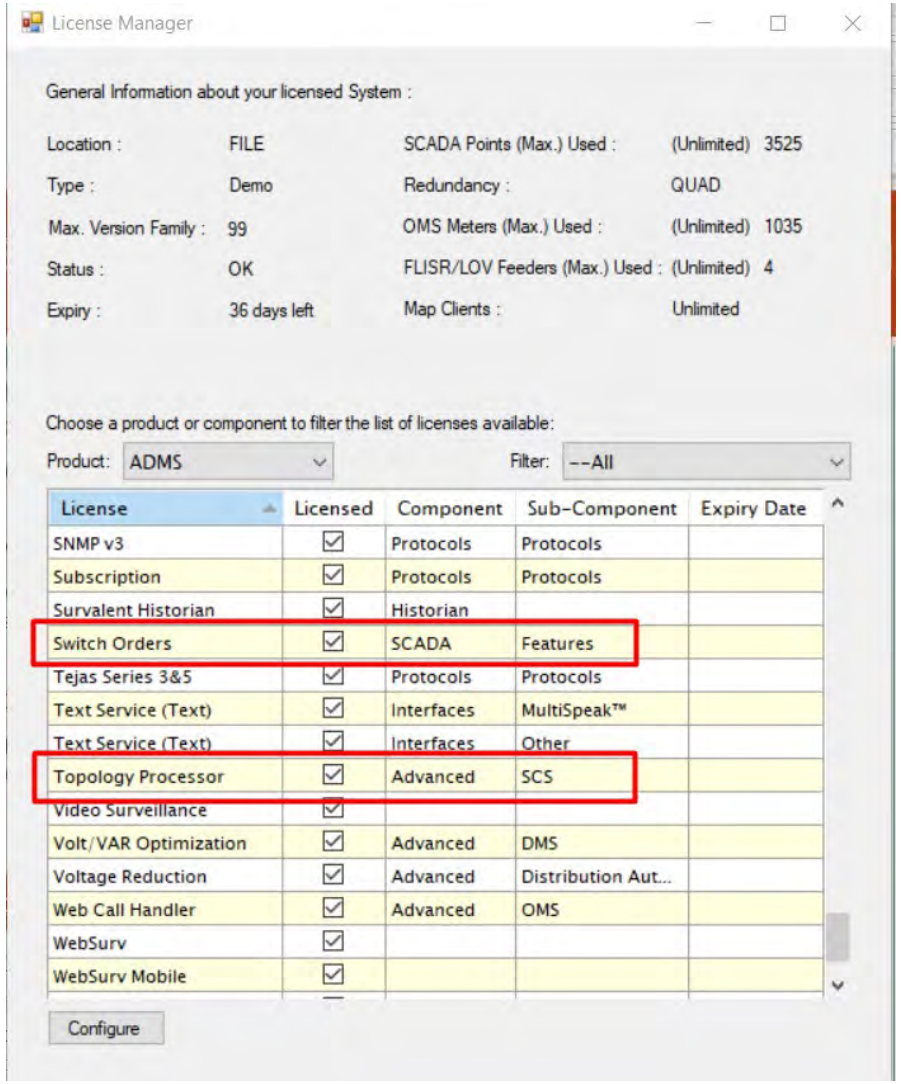
Familiar | Somewhat Familiar | Not Familiar

Licensing

Licenses

- DMS BASE
- FLISR/LOV
- Switch Orders
- Topology Processor





Database Preparation

Database Preparation – Table Resizing

Prior to running FLISR you must first adjust the following table sizes

- ScsData, ScsEdit, ScsCalc and ScsWork
- LfData, LfEdit, LfWork,LfMeans
- LfFeederData, LfFeederEdit, LfFeederWork
- LfTransformerData, LfTransformerEdit, LfTransformerWork
- LfSwitchData, LfSwitchEdit, LfSwitchWork
- LfConductorsData, LfConductorsEdit, LfConductorsWork

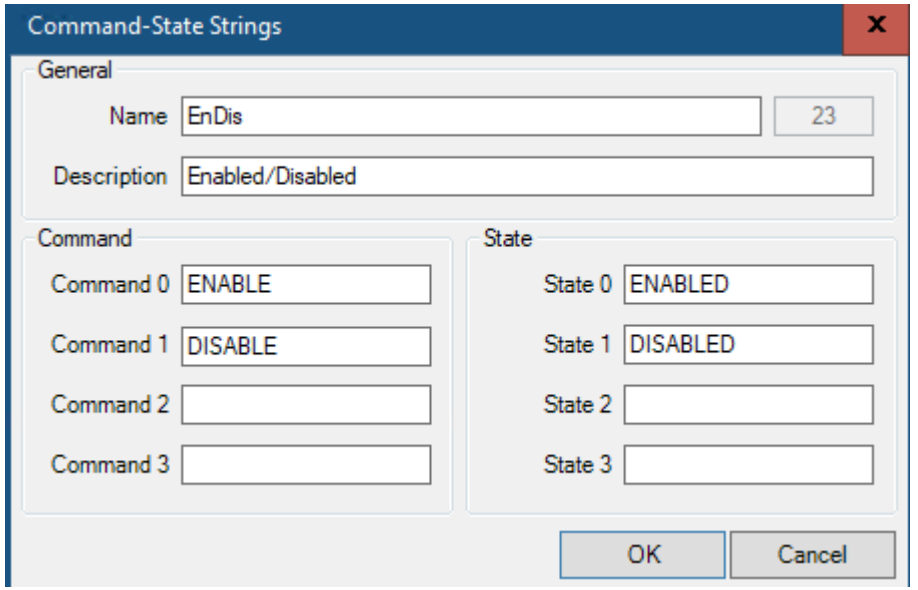
Notes

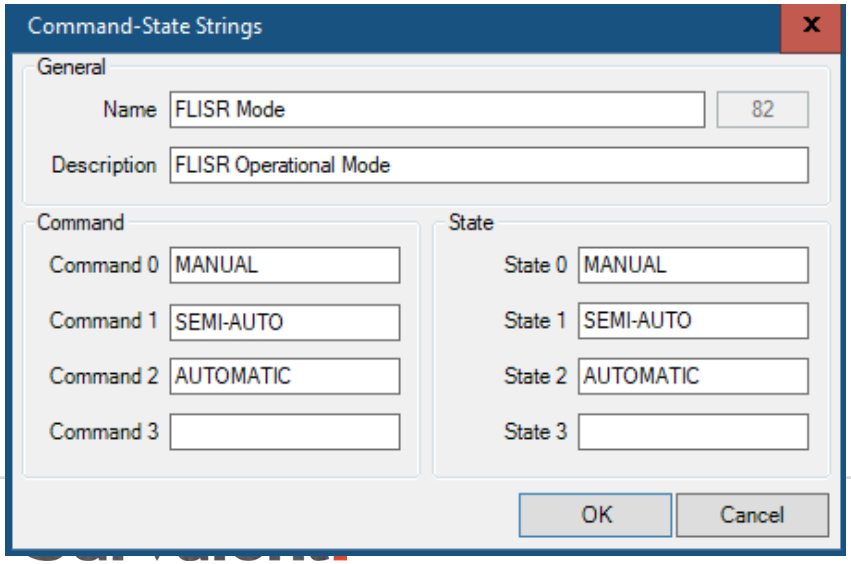
- ADMS server needs to be turned off before adjusting the tables sizes
- Lf stands for Load Flow
- SCS stands for System Configuration Status which is now called Topology Processing
- SCS Calc, SCS Data, SCS Edit, and SCS work all must have same size
- LfFData, LfEdit, LfMeas, and LfWork all must have the same size

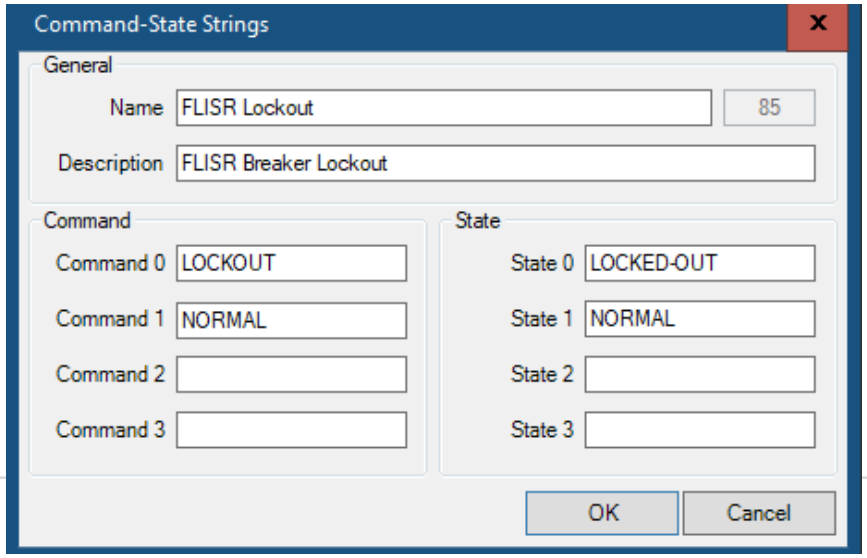
Demo

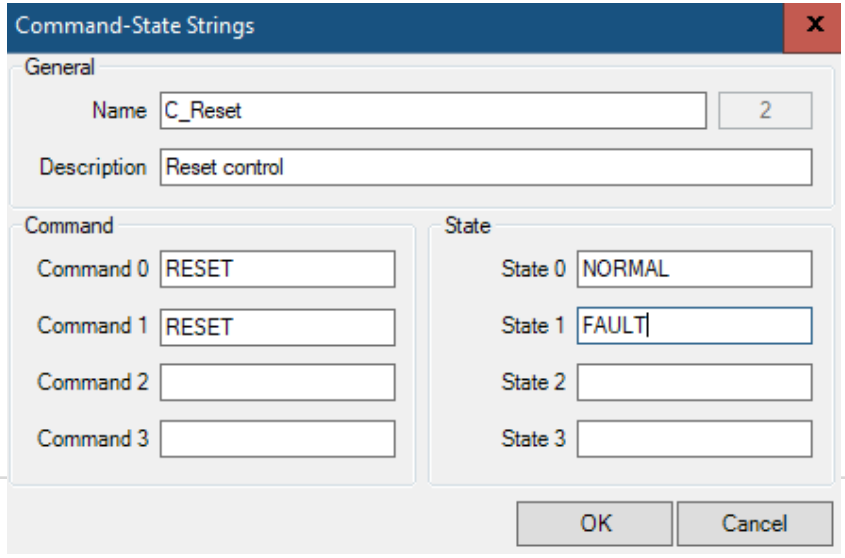
Database Preparation – Command State Strings

- Some Command State Strings such as EnDis might already be in the Database
- Create only the missing ones, these are
  - FLISR Mode
  - FLISR Lockout
  - Fault Reset







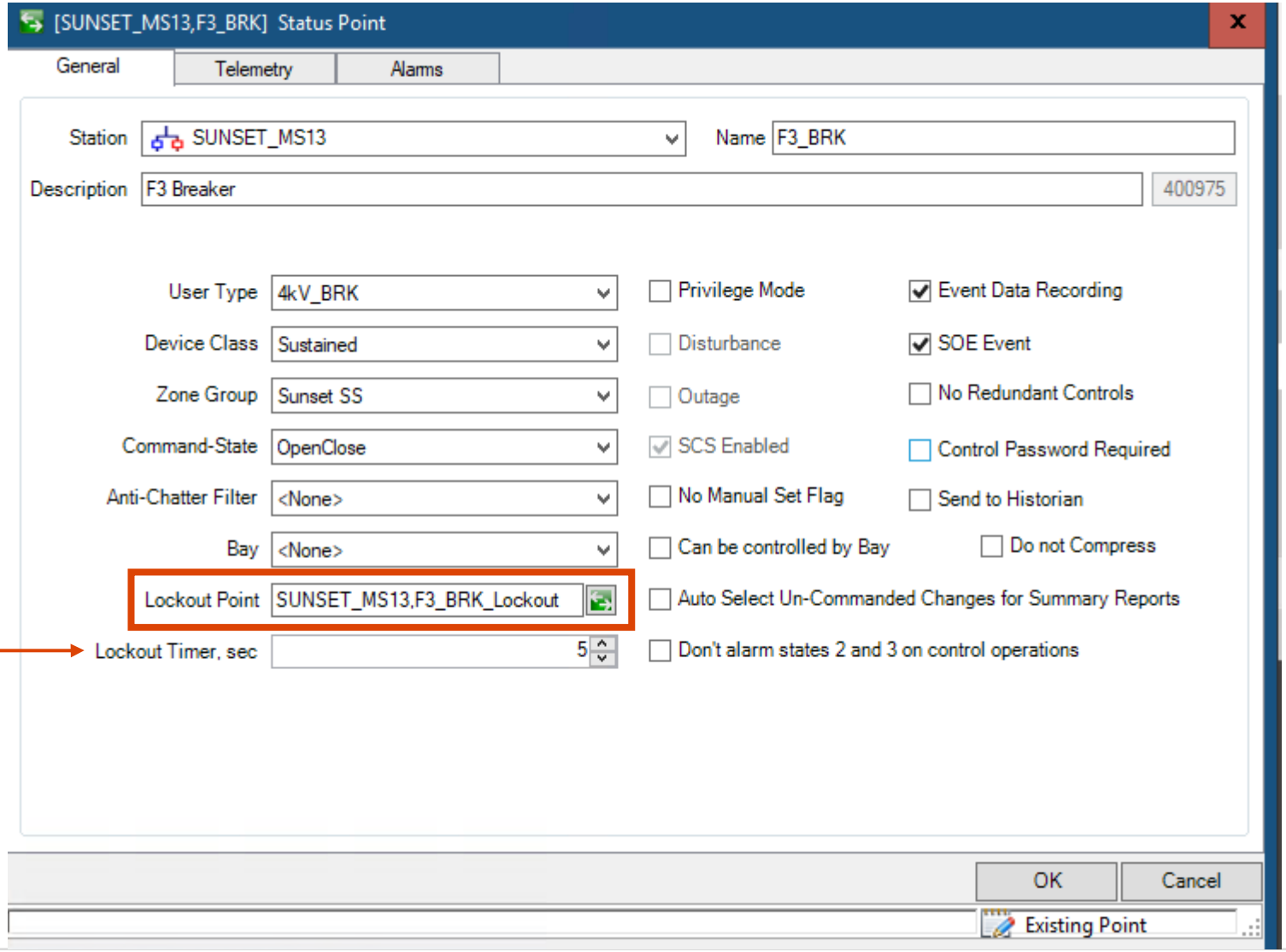


Database Preparation – Admin Point Creation

- FLISR Enable/Disable Points
  - Global
  - Regions (optional)
  - Transformers
  - Feeders
  - Individual Switches/Reclosers
- FLISR Mode Point (Manual, Semi-Automatic, Automatic)
  - Can be per feeder or switching device
  - For FLISR to consider a device/feeder, they must have the same mode of operation
- FLISR Lockout Point

Database Preparation – Breaker Lockout Point

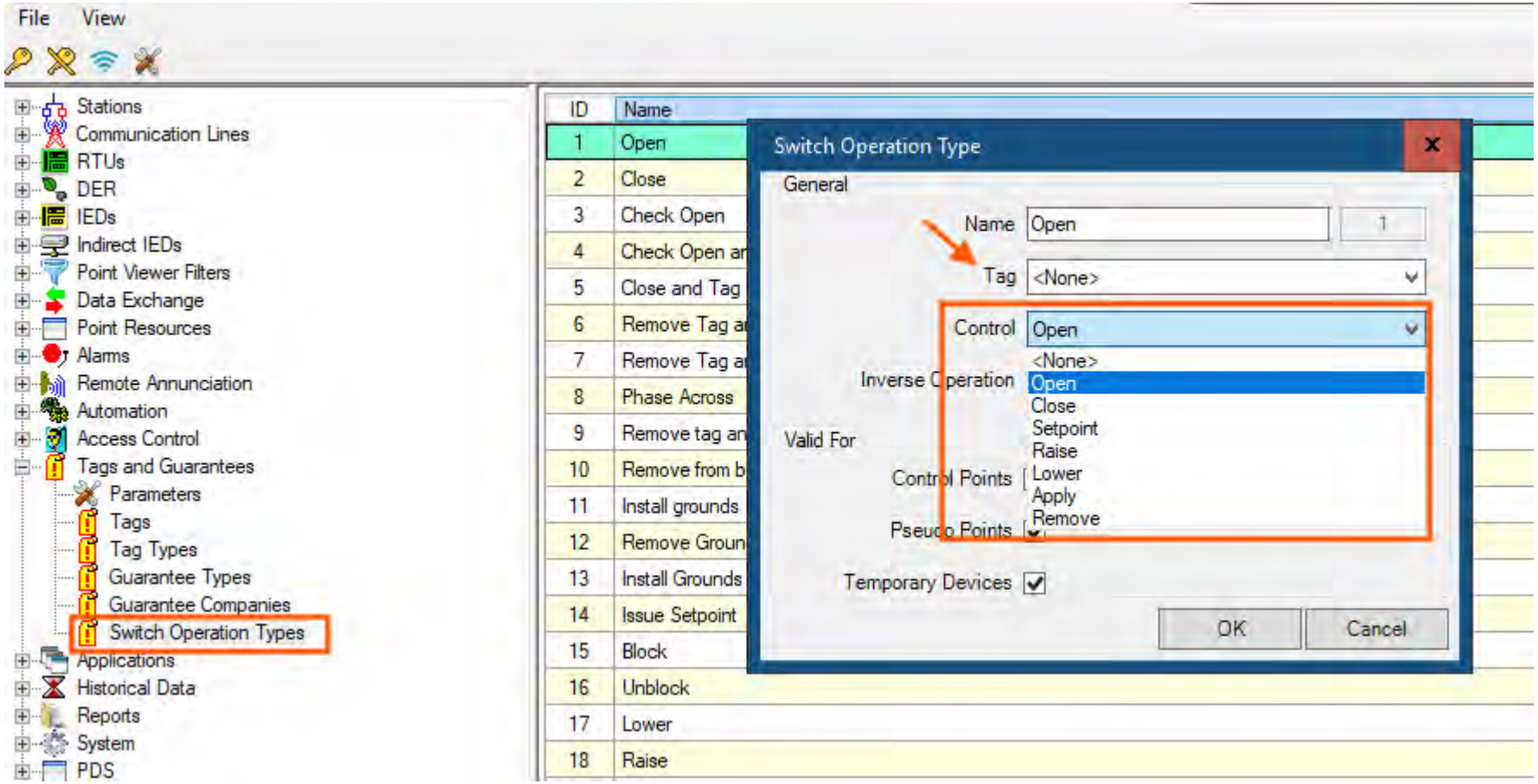
- For each reclosure that has FLISR enabled on it
- If the device doesn't have a telemetered LOCKOUT point, use a Pseudo point.
- For Pseudo points, you need to set the "Lockout Timer"
  - the timer should be long enough to account for one reclosing attempt
  - if the breaker recloses in the field, the timer will be reset.
  - if the breaker trips again, the timer will start again
  - the lockout timer doesn't start if the device was remotely operated
- If the device has a telemetered LOCKOUT point,
  - set the timer to 0
  - the Lockout points is set to "Active" when
    - Breaker locks out in the field
    - an operator issues a command from the control room or
    - the crew manually opens the device in the field



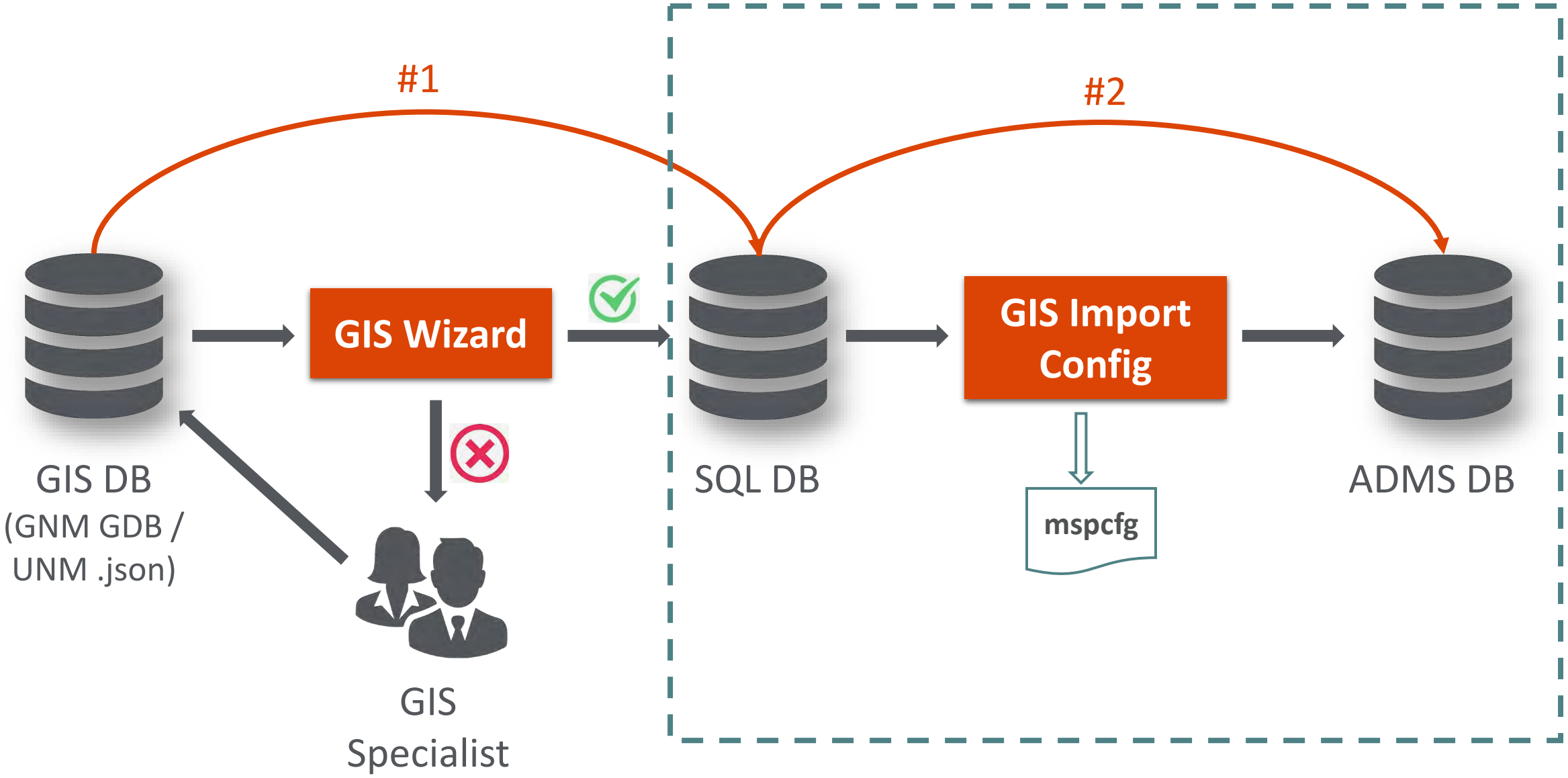
Database Preparation – Switch Operations Creation

If Switch Orders and Guarantees was not previously licensed and configured, you will have to configure the Switch Operations Types for FLISR to USE

- OPEN
- CLOSE
- OPEN and TAG
- CLOSE and TAG
- REMOVE TAG and CLOSE
- REMOVE TAG and OPEN
- BLOCK RECLOSING
- UNBLOCK RECLOSING
- RESET FAULT TARGETS

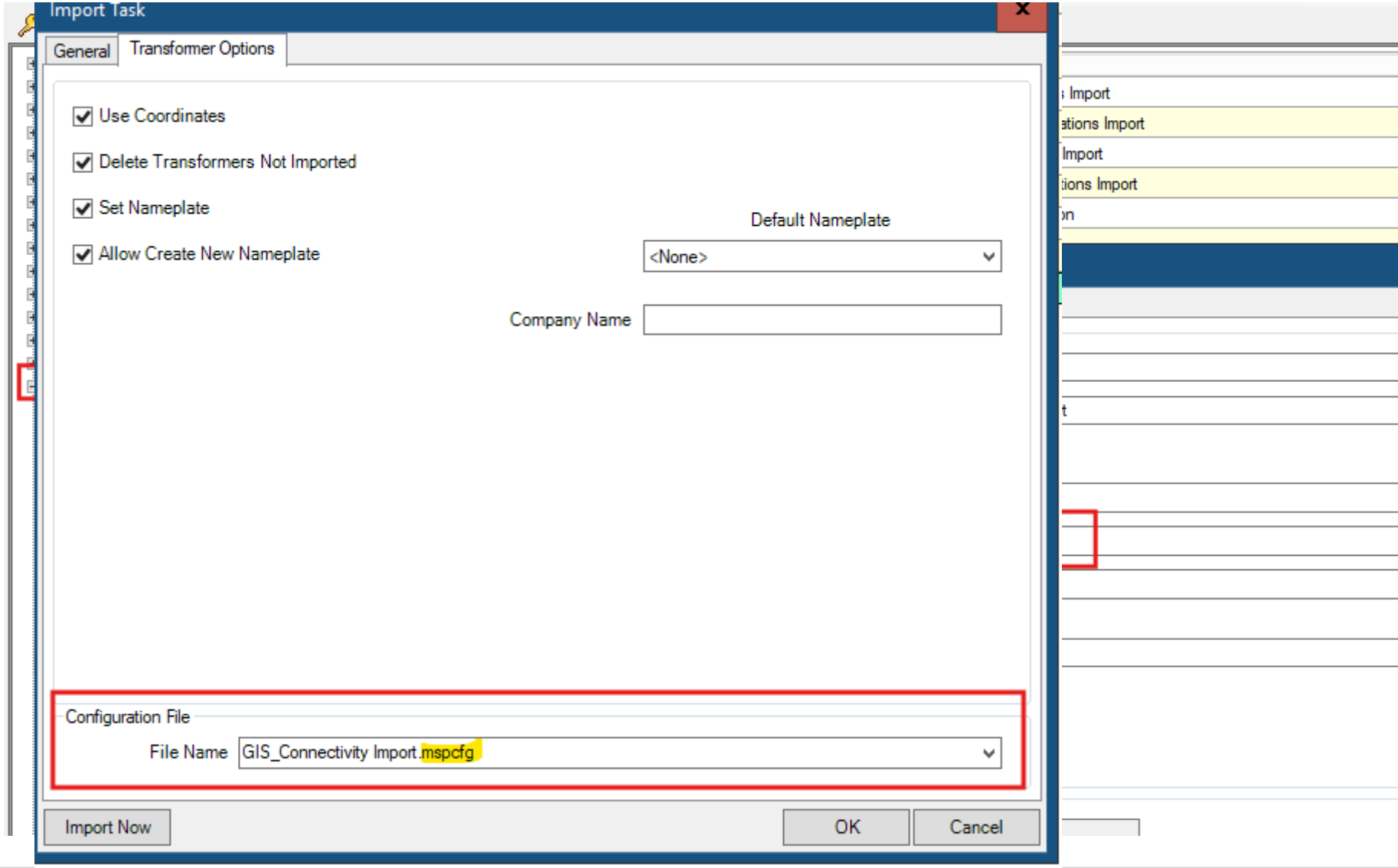


GIS Wizard – Importing Process



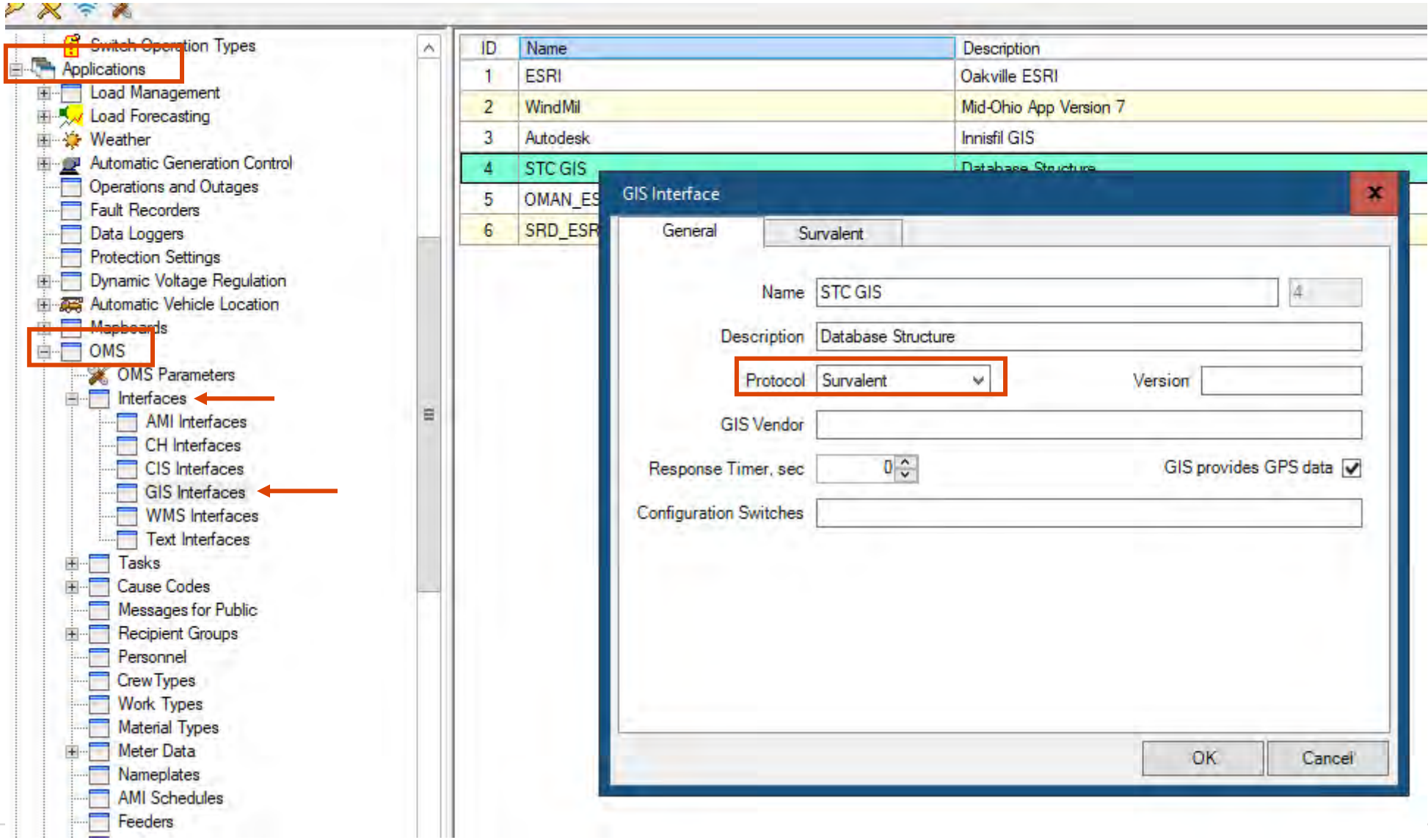
Database Preparation – Distribution Transformers Import

- This task imports all distribution transformation from the GIS Exported SQL data into the SCADA DB
- The same **mspcfg** file that is used for the connectivity import needs to be used for the distribution transformer import
- This task can be scheduled to run as frequently as needed

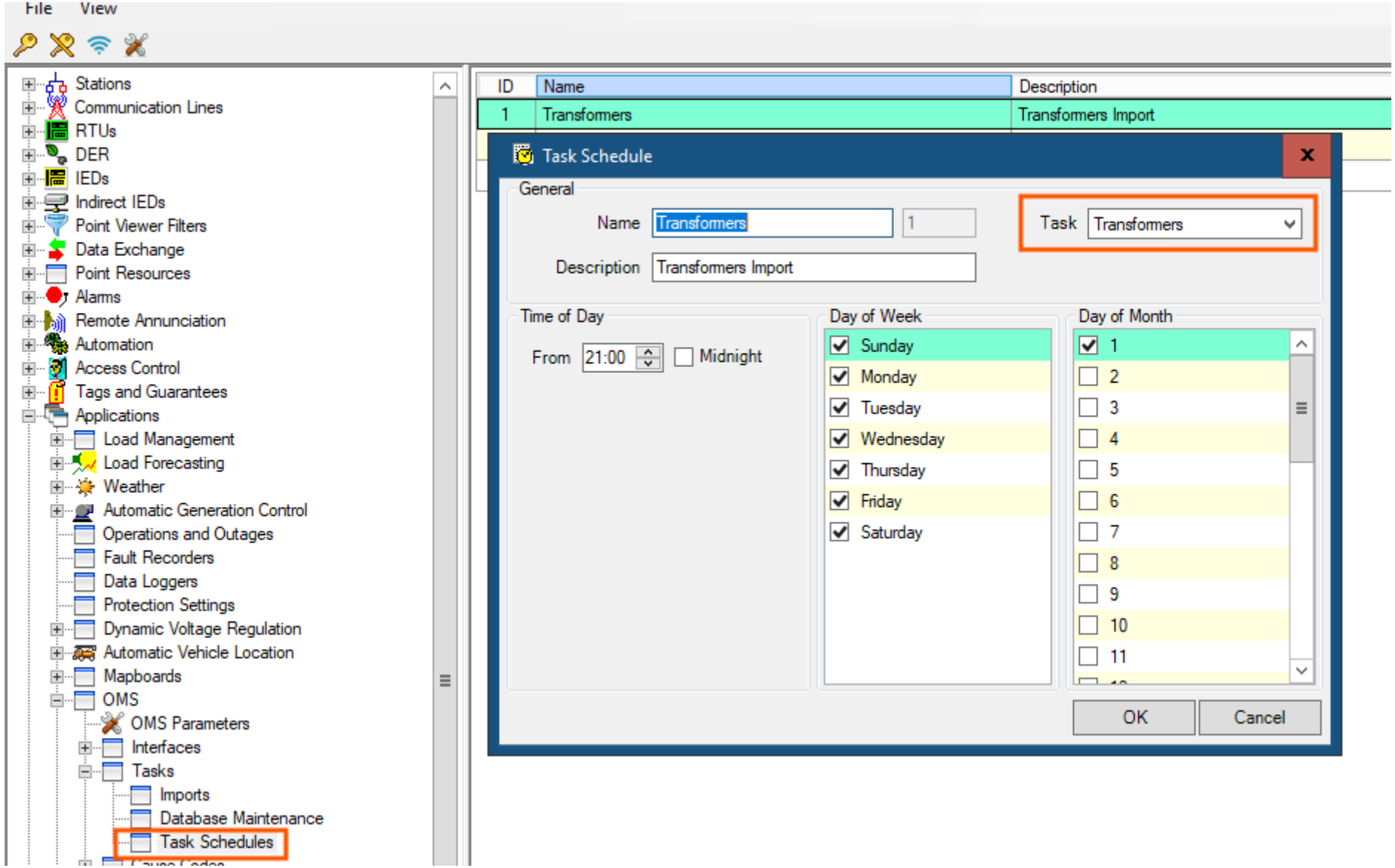


Database Preparation – GIS Interface

- To perform imports from GIS, you must first define a GIS interface
  - The protocol must be **Survalent**
- Once the GIS interface is defined you can import **Transformers**, Service locations and Generators

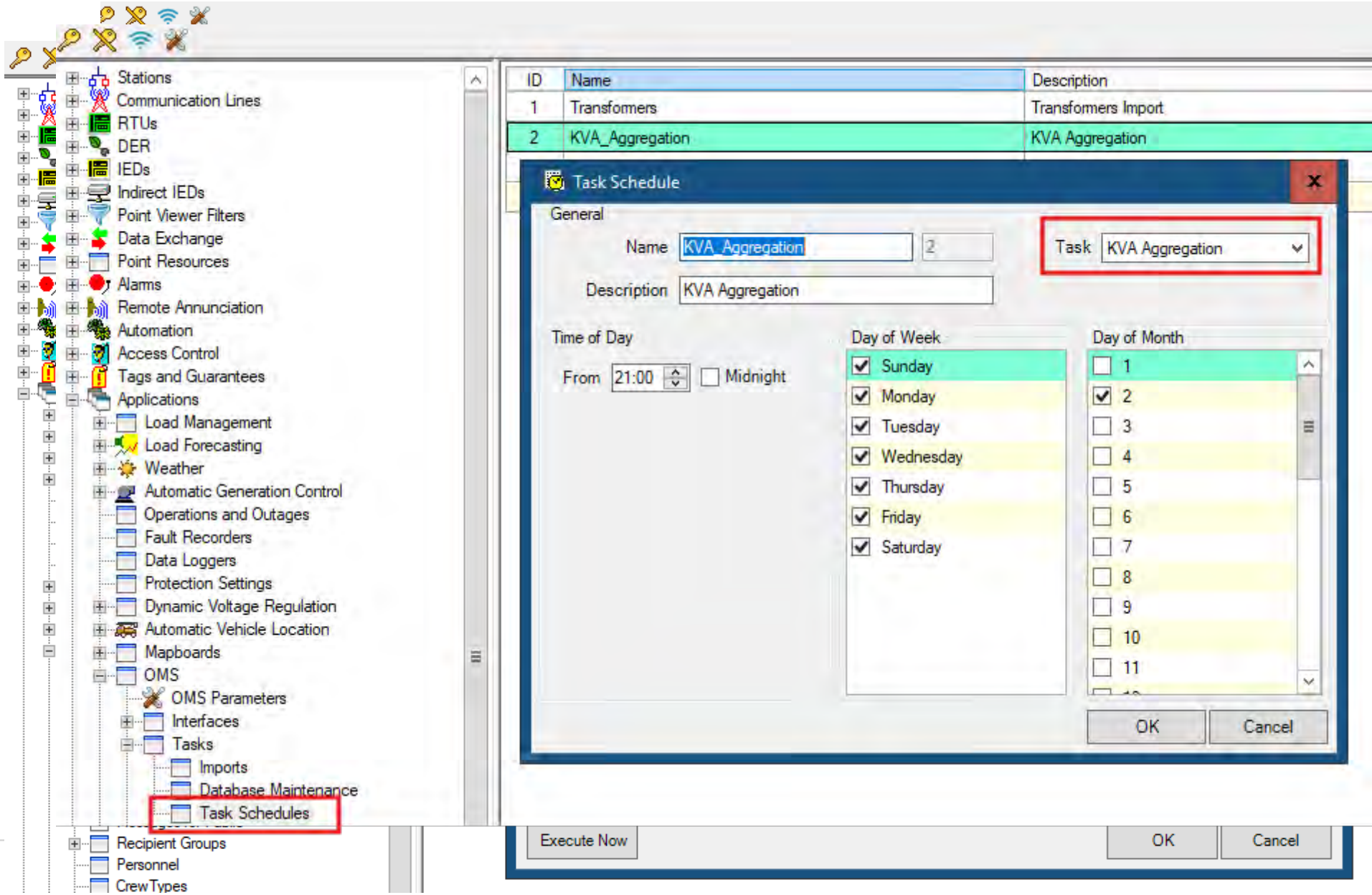


Database Preparation – Distribution Transformers Import



Database Preparation – KVA Aggregation

- This task runs through all the line section conductors and aggregate the KVA of the attached transformers
- The KVA info comes from the GIS
- Manually created transformers can be included in the aggregation
- You have to schedule a task for KVA aggregation, typically after the transformer import task



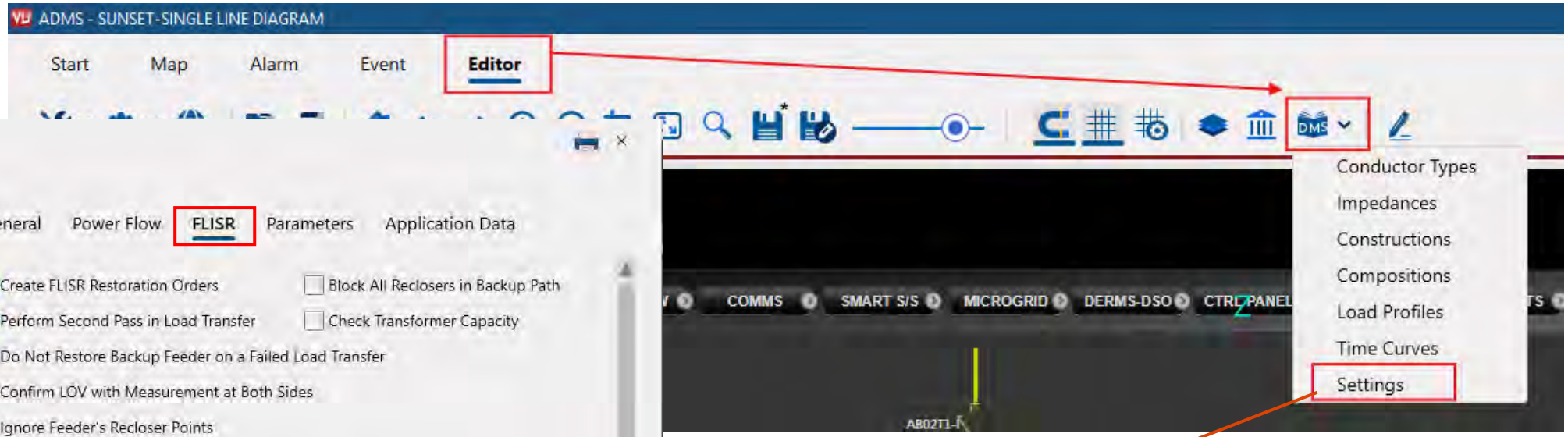
Survalent.

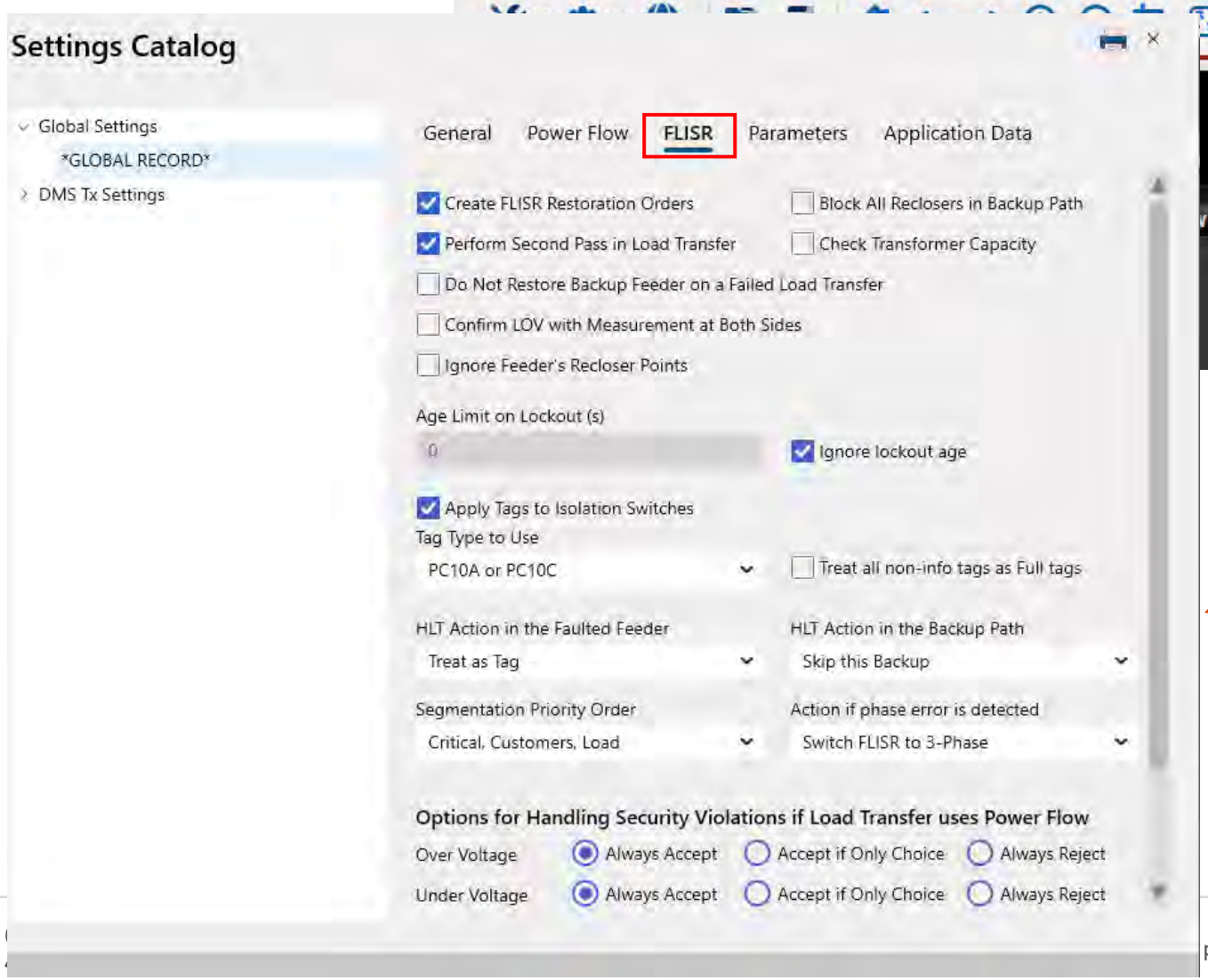
Database Preparation – Summary

- ✓ Table Resizing
- ✓ Command State Strings
- ✓ Admin Point Creation
  - ➢ Enable/Disable
  - ➢ FLISR Mode
  - ➢ Lockout
- ✓ Switch Operations Creation
- ✓ GIS Interface Setup
- ✓ Tasks Setup and Scheduling
  - ➢ Distribution Transformers Import
  - ➢ KVA Aggregation

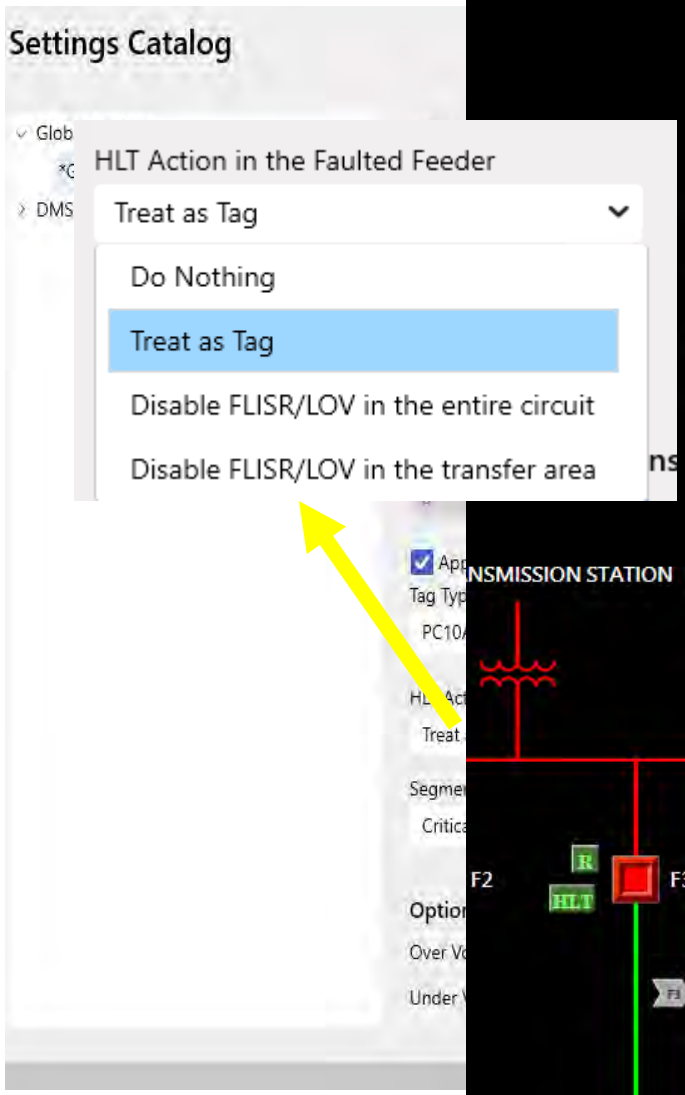
SmartVU Preparation

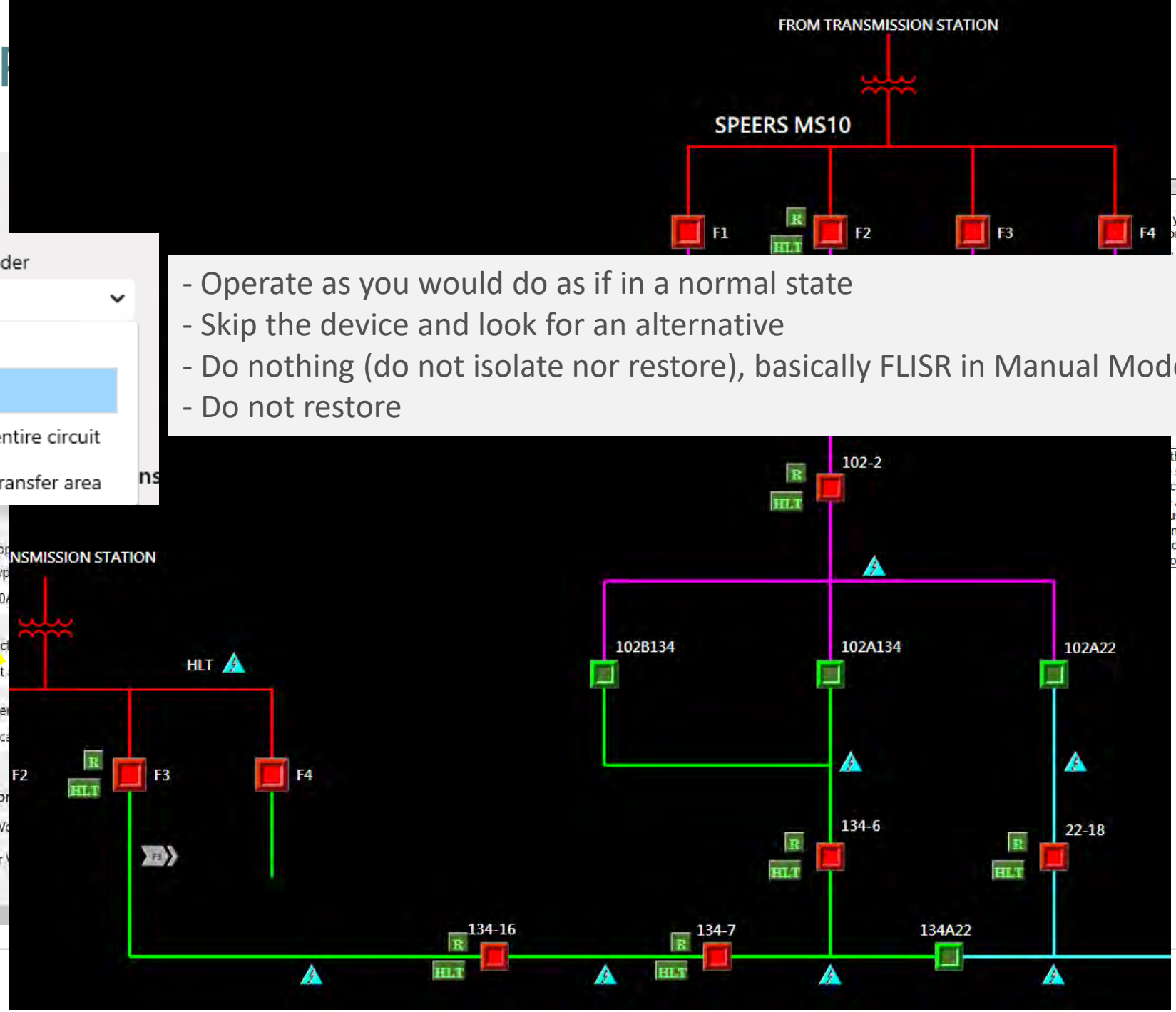
SmartVU Preparation - DMS Settings Catalog



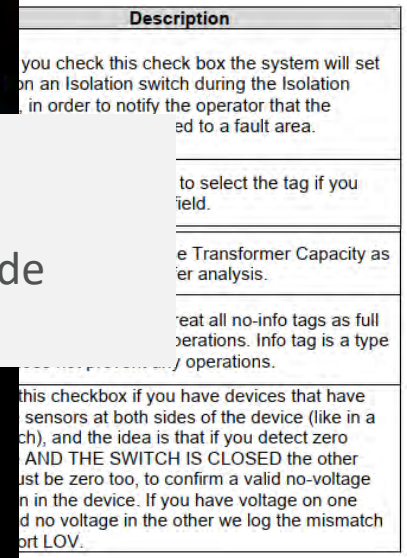


SmartVU

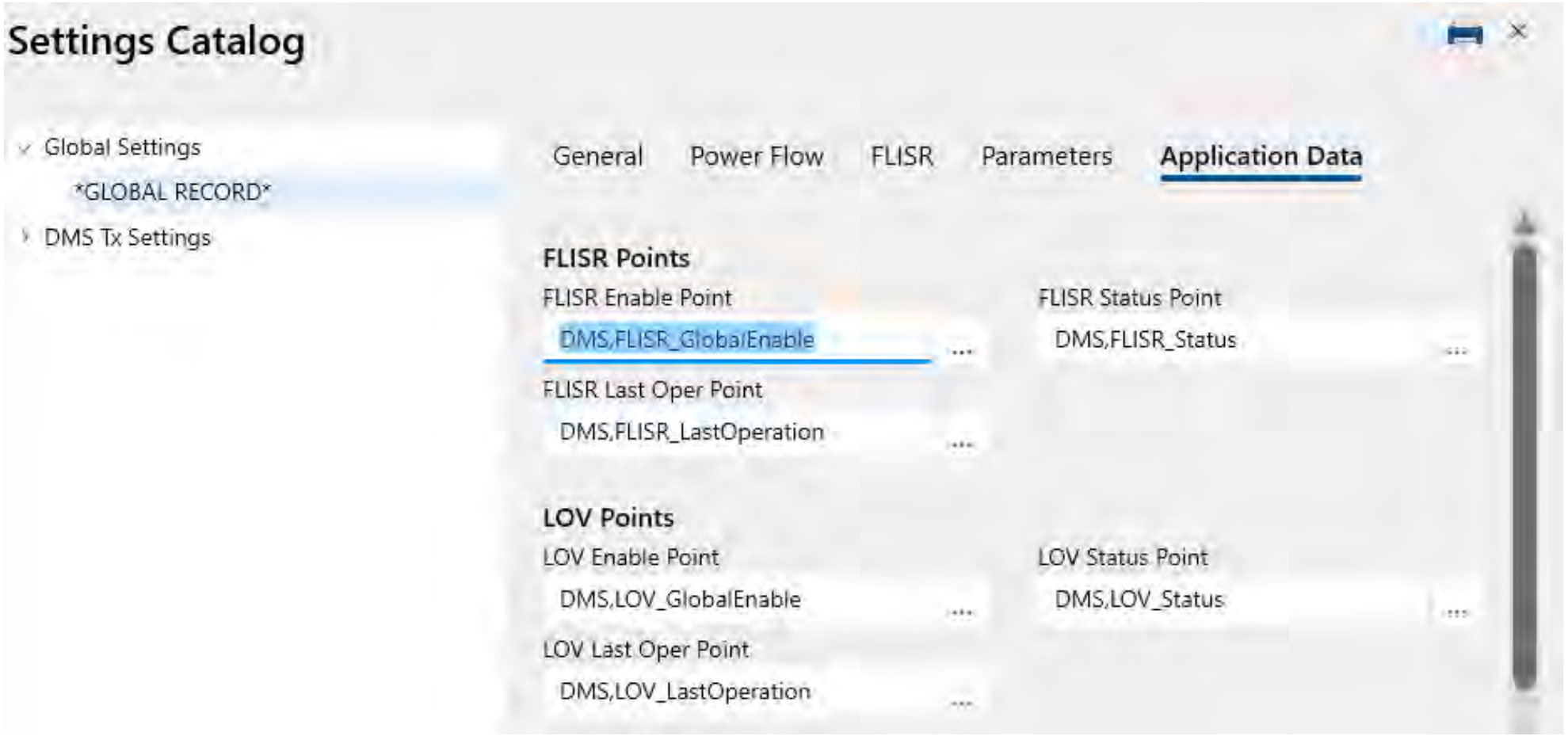




- Operate as you would do as if in a normal state
- Skip the device and look for an alternative
- Do nothing (do not isolate nor restore), basically FLISR in Manual Mode
- Do not restore

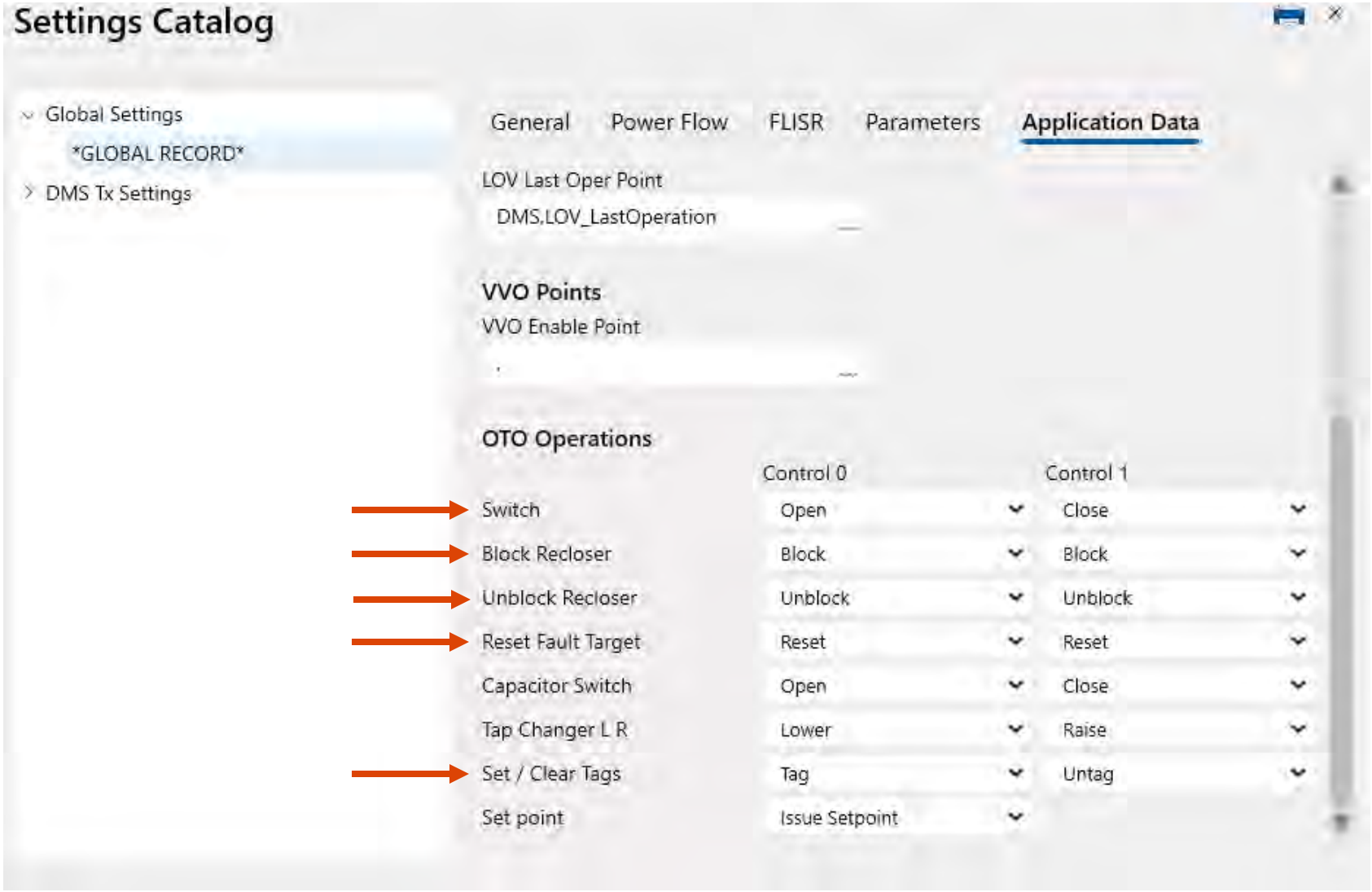


SmartVU Preparation - DMS Settings Catalog



Add the points that were created during the Database Preparation phase

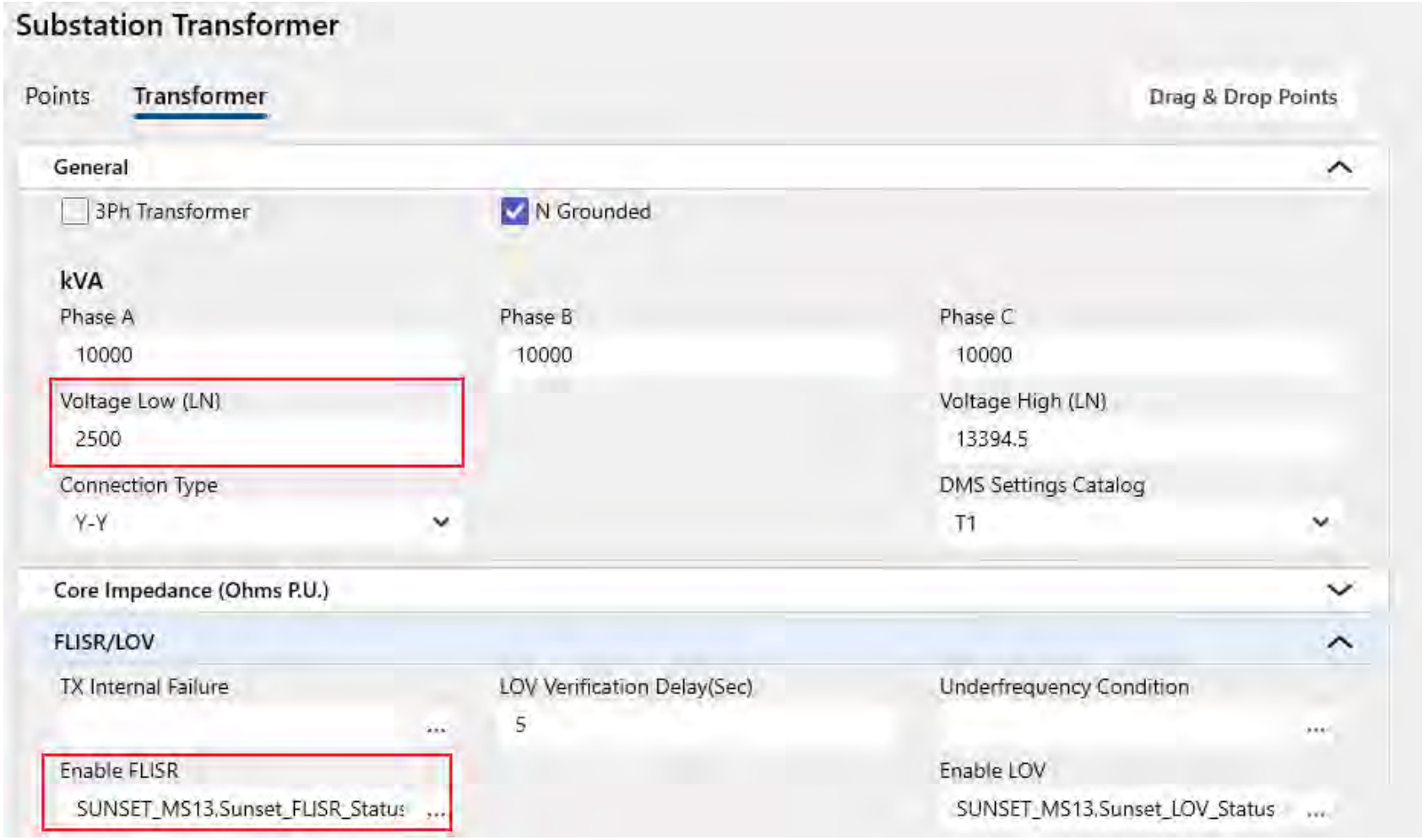
SmartVU Preparation - DMS Settings Catalog



- Select the Switching Operations (defined during the Database Preparation phase) to be used in switch orders for FLISR
- The following Switching Operations are used by FLISR
  - Switch
  - Block Recloser
  - Unblock Recloser
  - Rest Fault Targets
  - Set/Clear Tags

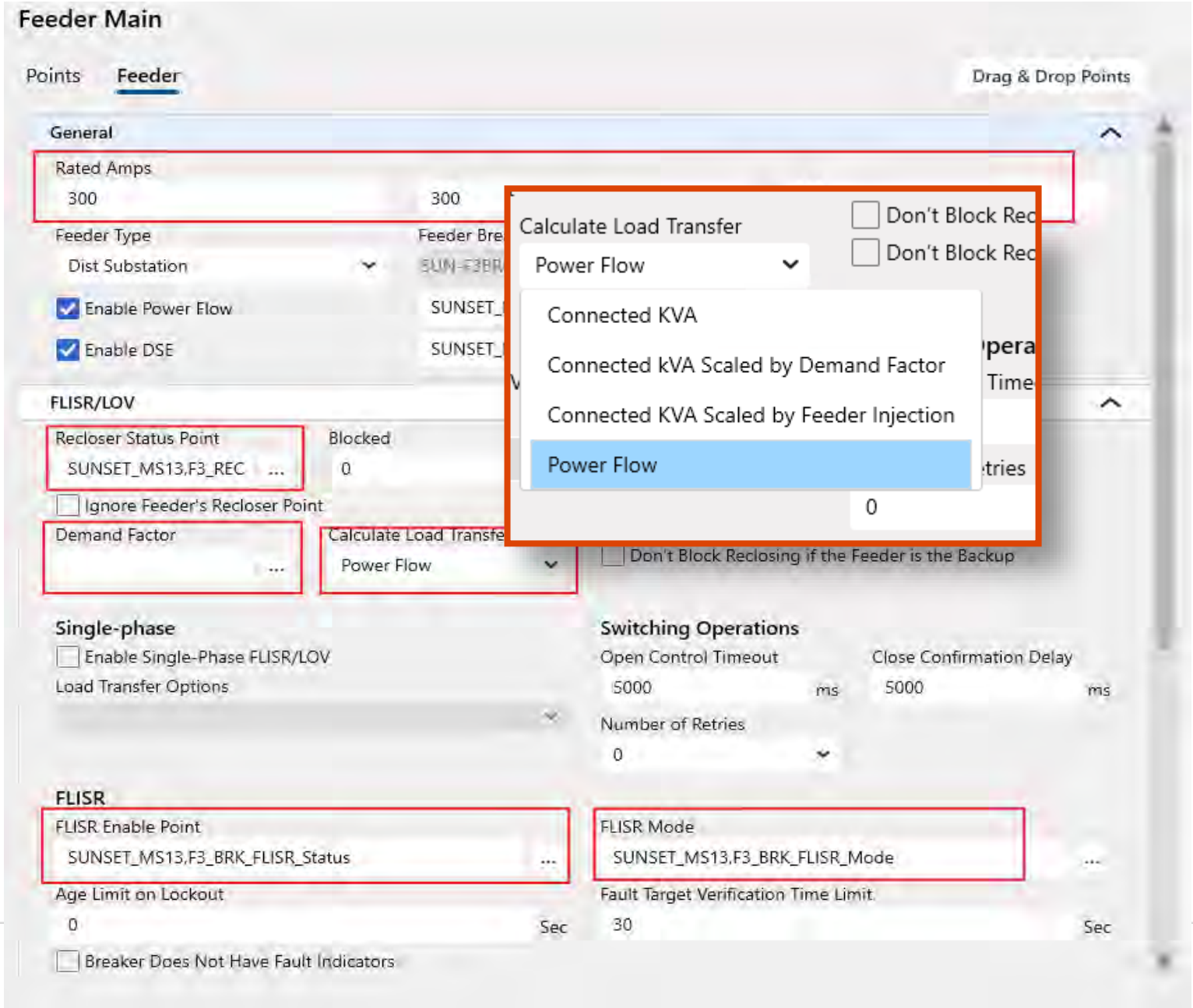
SmartVU Preparation – LS DMS Record – Substation TFXR

- The Nominal Voltage used for the FLISR calculation
- Transformer-level FLISR EnDis point



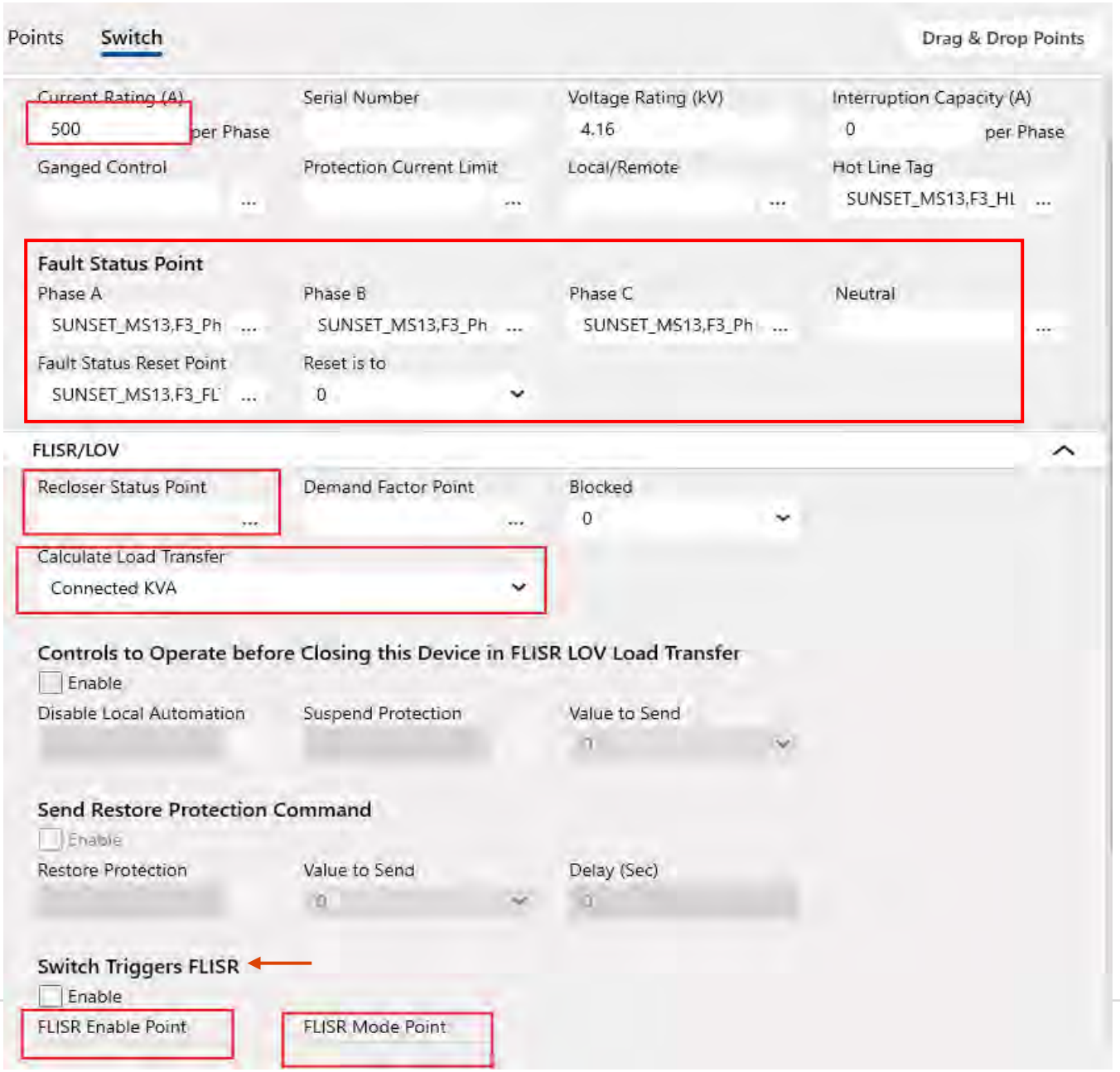
SmartVU Preparation – LS DMS Record – Feeder Main

- Rated Amps: important for FLISR when we are calculating the maximum load (KVA) a feeder can handle (Capacity).
- Reclosure Status Point: both Reclosers current state and for purposes of control
  - Blocked: Select the state (0 or 1) that corresponds to the "Blocked" state of the recloser
- Feeder-level FLISR EnDis
- Feeder-Level FLISR Mode



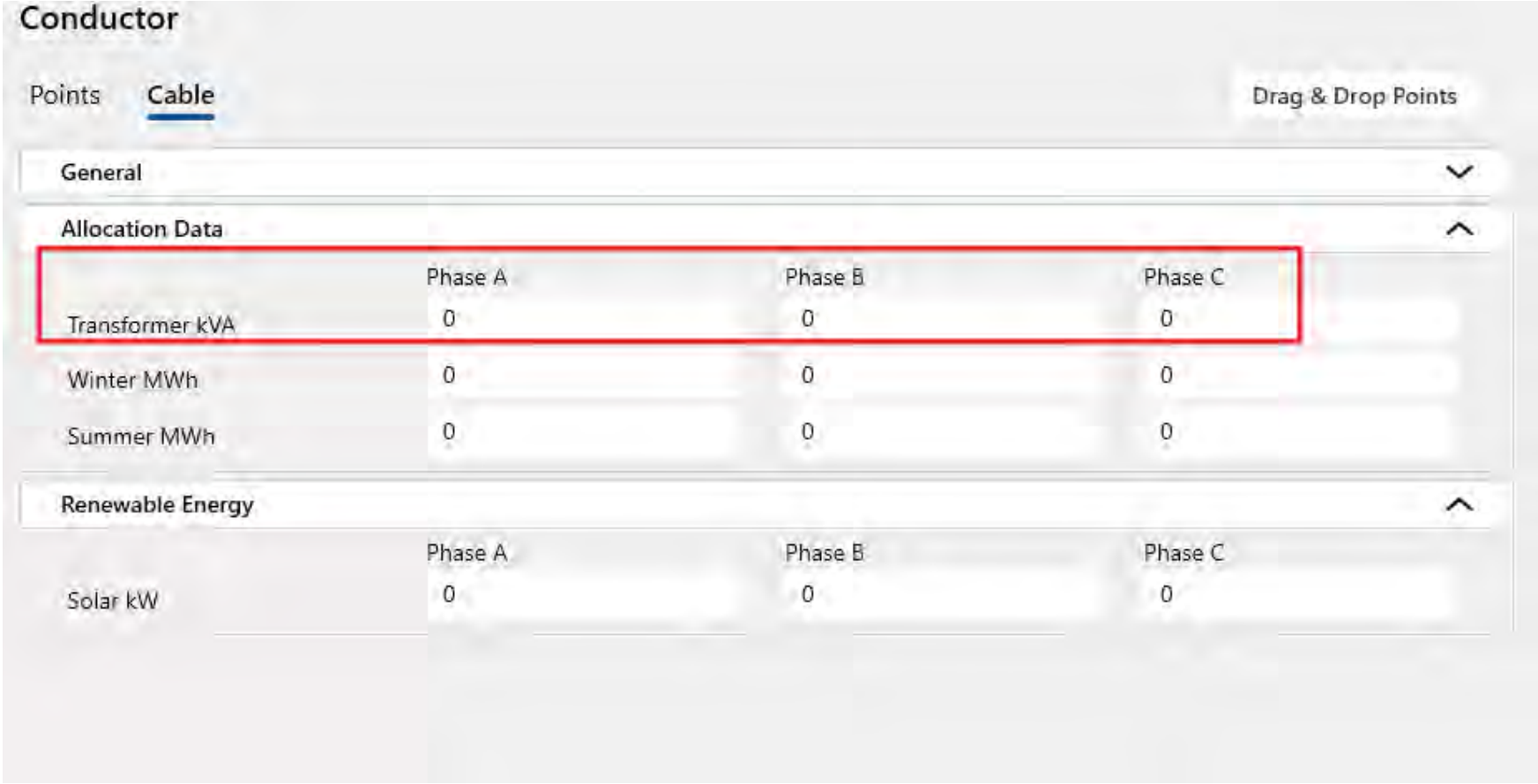
SmartVU Preparation – LS DMS Record – Switch

- Current Rating: For a tie switch, if we are transferring load, the system will check if the current post-transfer is lower than this rating.
- Fault targets Status and Reset
- Device-level FLISR EnDis
- Device-Level FLISR Mode



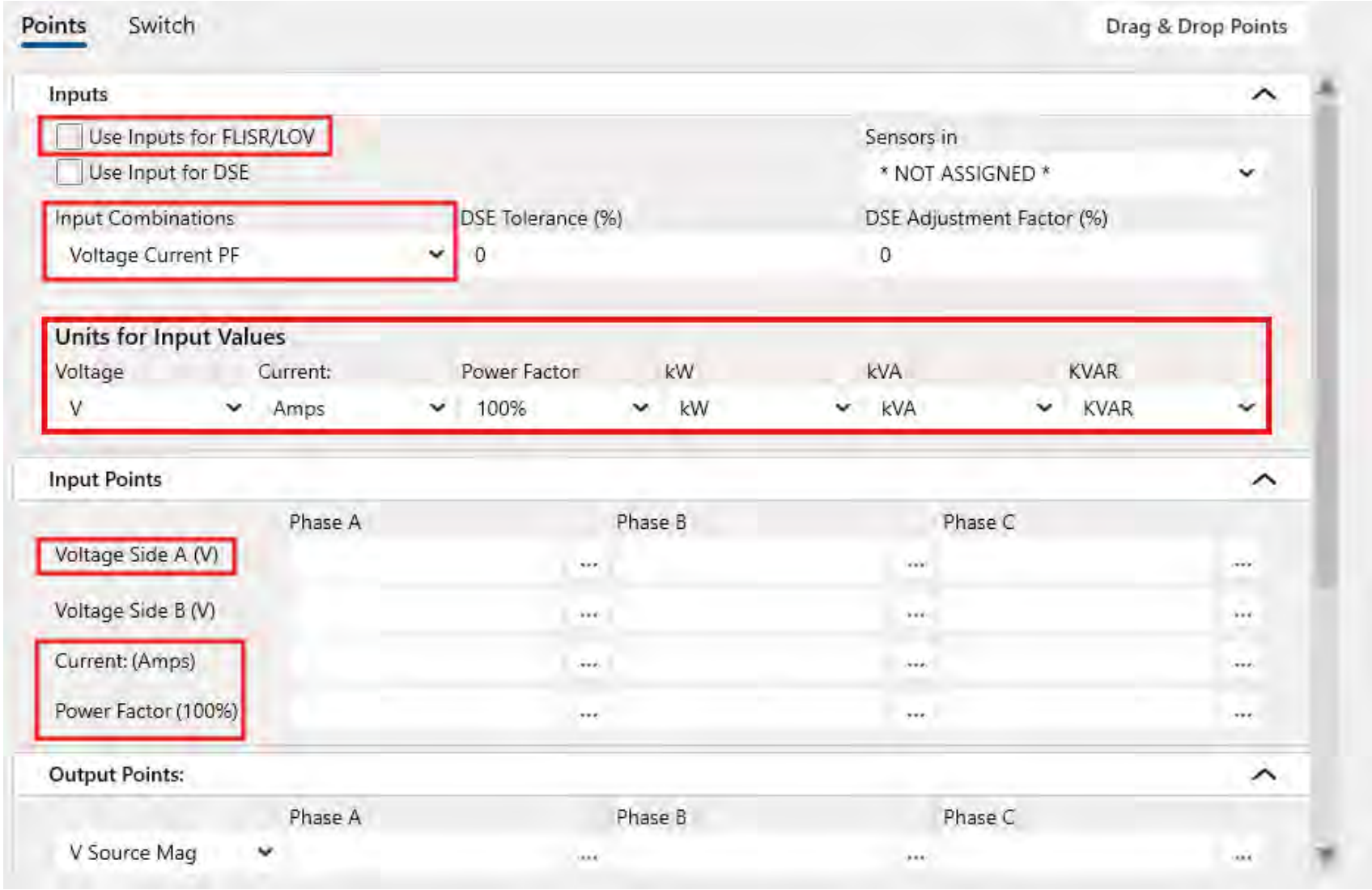
SmartVU Preparation – LS DMS Record – Conductor

- Connected KVA is calculated by a Task in STC explorer and then assigned to every Conductor LS in SmartVU



SmartVU Preparation – Points Tap

- Units for Input Value: we assume all the readings coming from the field are in these units
- Input Points: these are the telemetered points coming from the field
  - These points will be used if the check box for “Use Measurements if Available” is checked on the Feeder main



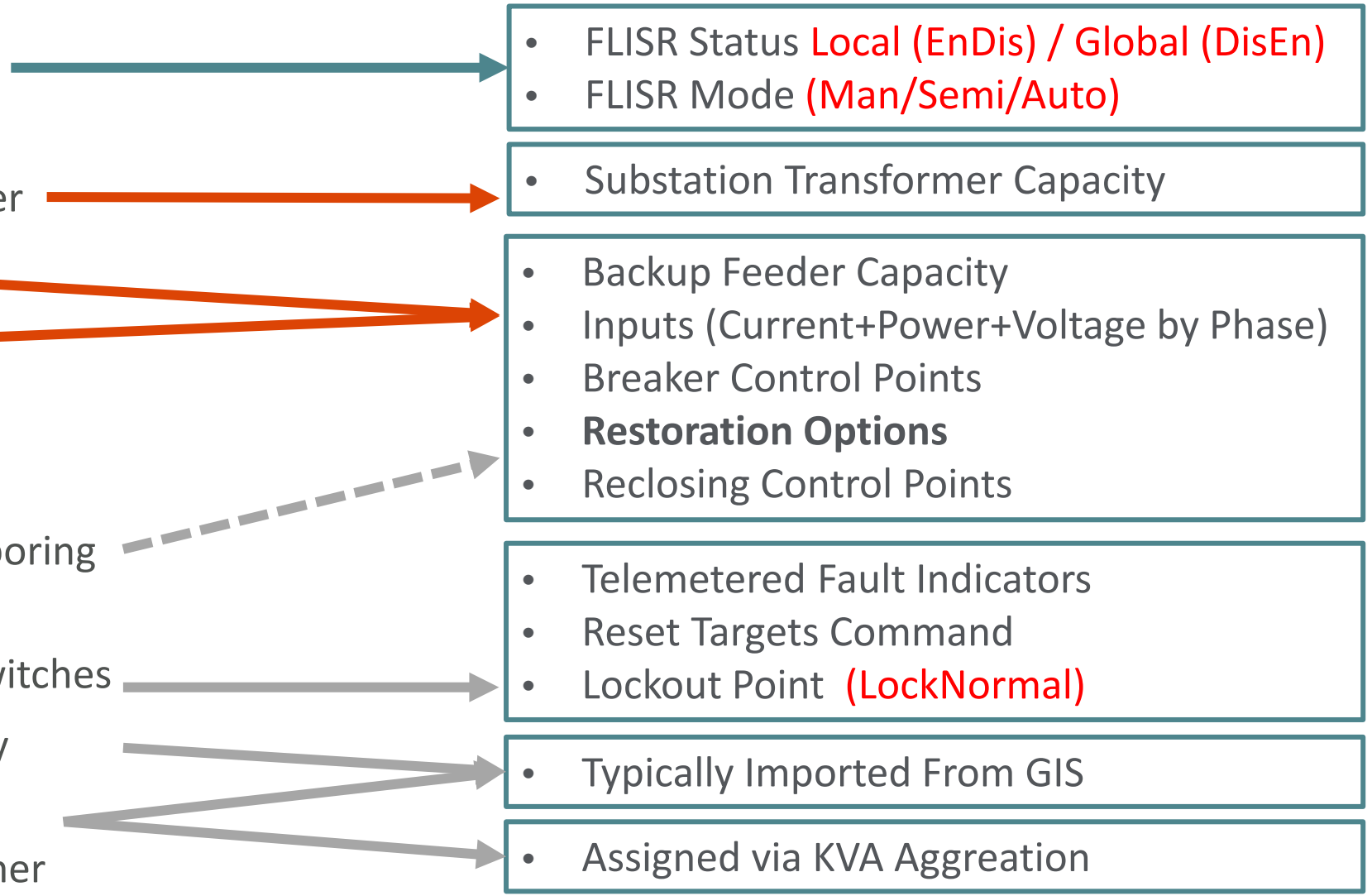
Database Preparation – Summary

- ✓ DMS Catalog
  - ➢ FLISR
  - ➢ Application Data
- ✓ LS DMS Record
  - ➢ Substation Transformer
  - ➢ Feeder Main
  - ➢ Switches/Breakers
  - ➢ Conductor

Module 3: Operation & Demonstrations

FLISR Operations – What Is Considered

- FLISR Control Points
- In the Substation
  - Substation Transformer
  - Feeder
  - Breaker
- On the Circuit
  - Tie switches to neighboring feeders
  - Reclosers, isolation switches
  - Network and Topology Model
  - Distribution Transformer data



FLISR Operations - FLISR Steps

- **Detection**
  - A device has locked out
  - Fault targets are active
- **Verification**
  - Make sure that data is up to date
  - Poll all the devices in the circuit where the fault was detected
- **Confirmation**
  - Check for tagging, failed telemetry, and updated statutes after polling devices
- **Localization**
  - What is the last devices that saw the fault (has Active Fault Targets)
- **Isolation**
  - Generate and execute OTO to isolate faulted area
- **Restoration**
- **Load transfer**
  - Calculate KVA and determine the candidate backup feeder/s

FLISR Operations - Operation

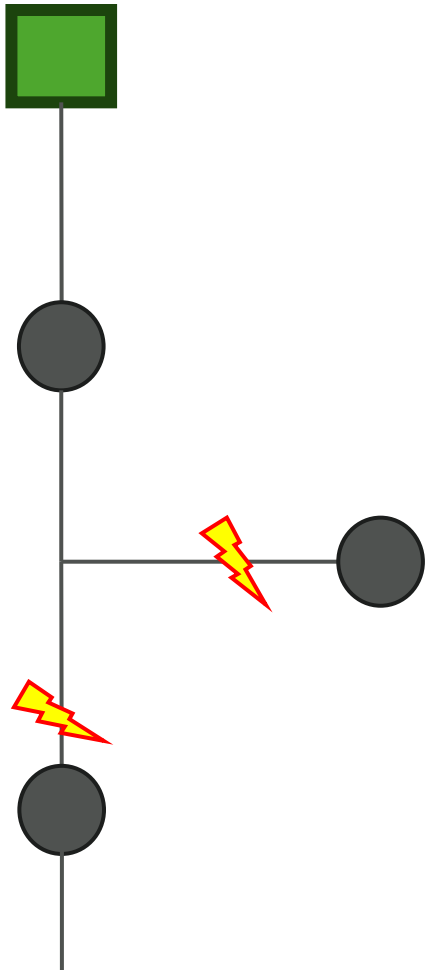
DEMO

- Initial fault
  - DMS Dashboard; FLISR Report
- Cascading fault
- Second pass

Bonus

DID YOU KNOW!

- If we send a control and it fails, FLISR will switch to semi-auto, and create the SO (the SO will have all the operations, the ones where the control was successful will be marked as executed and the following ones will be marked as not executed.
- FLISR will abort under these conditions:
  - If a tie is closed and the protection in the backup feeder trips. We will backtrack the operation (open the tie and close the device that trips) and send an alarm with the abortion
  - Fault found in 2 different branches of the same feeder. Before abortion, FLISR will open the switch before the branching. The Alarm will clarify the reason for the abortion
  - If after the verification step a control command is sent to a device and the device doesn't respond (no status change is detected)
  - If the reclosing point is missing or disabled on the faulted feeder (the device that triggered FLISR)



Common Questions

- **Can we prioritize one backup feeder over another?**

No, we work on the current configuration with the data that we get from the field at the time of the fault.

- **Do we take into account the transformer margins at the transmission level?**

No, just at the distribution level.

- **If FLISR is disabled on a Feeder, can it still consider it as a backup option?**

No. If FLISR is disabled on a feeder, it will not be considered at all in the isolation or restoration.

- **Can we have FLISR with different Modes (Semi-auto, Auto) on different feeders?**

You can have different segments of the system working in different modes and using different load transfer calculations. However, for neighboring feeders (those that FLISR is to consider for isolation and restoration) they need to have the Mode and the Load Transfer Calculation method.

Survalent.

Questions?

Thank You