Integrated Fault Location System for Power Distribution Feeders

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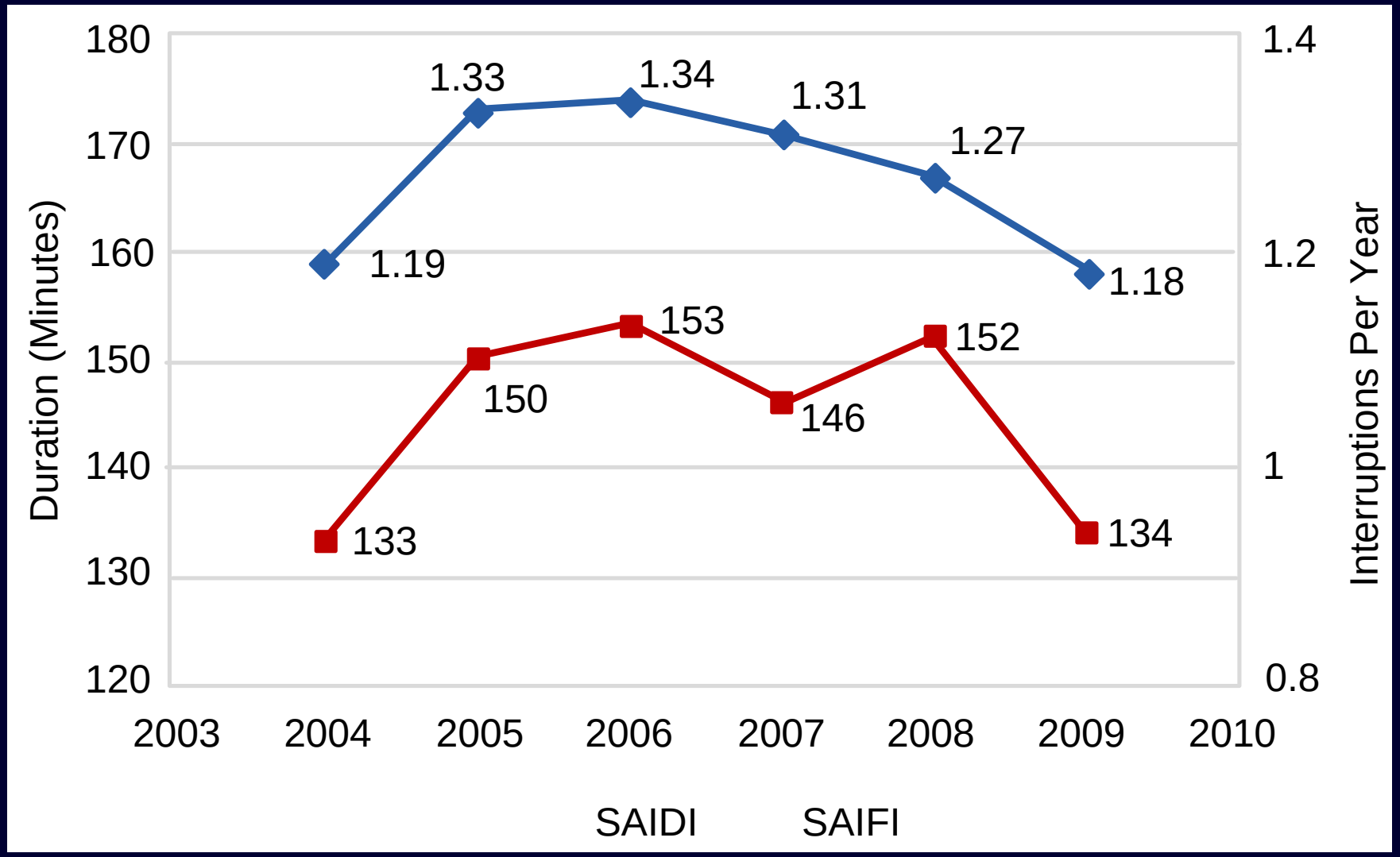
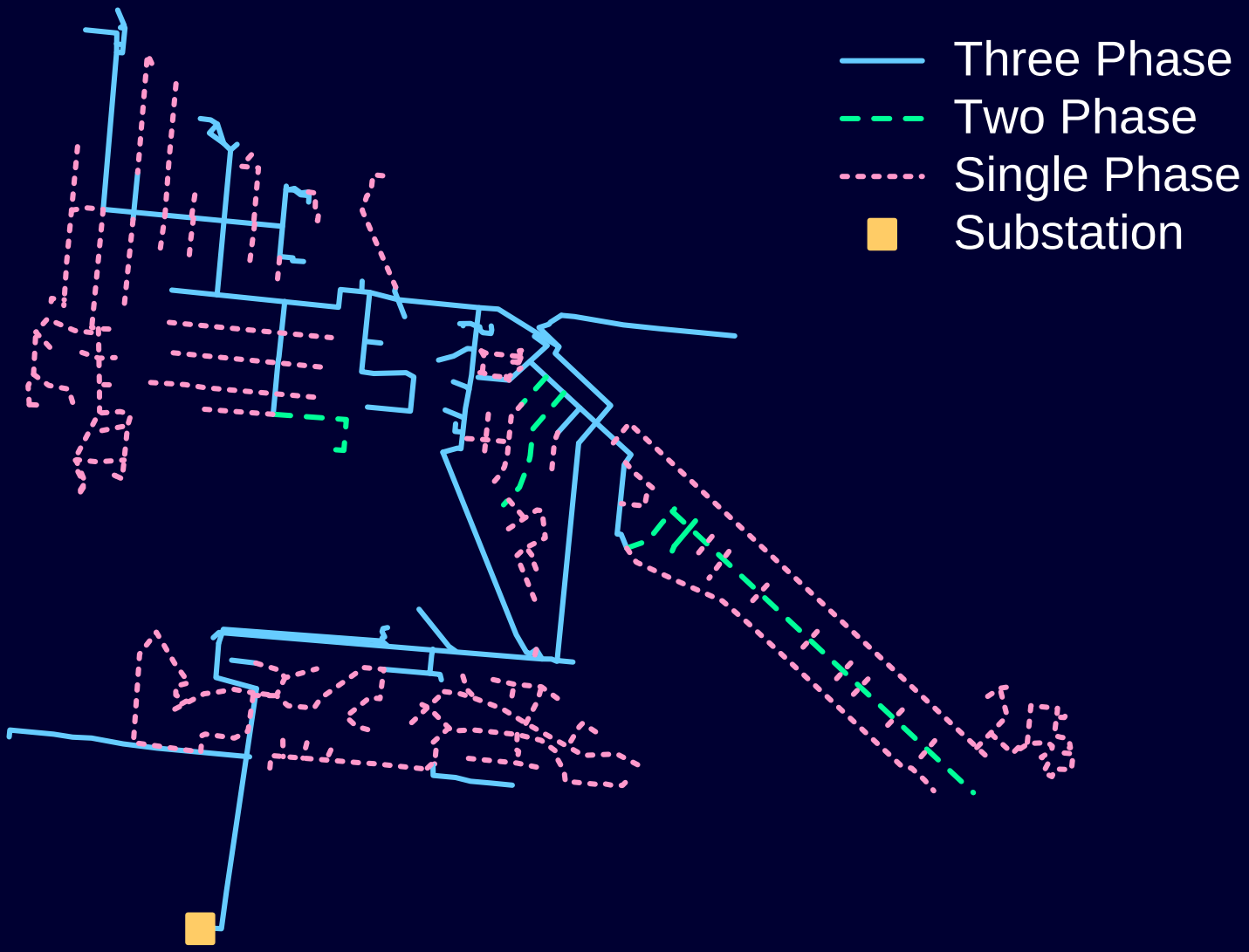
Accurate / Fast Fault Location Information Improves Quality of Service



Reduce Duration of Outage

- Fault-monitoring technology can pinpoint fault location
- Personnel respond sooner and reduce outage length

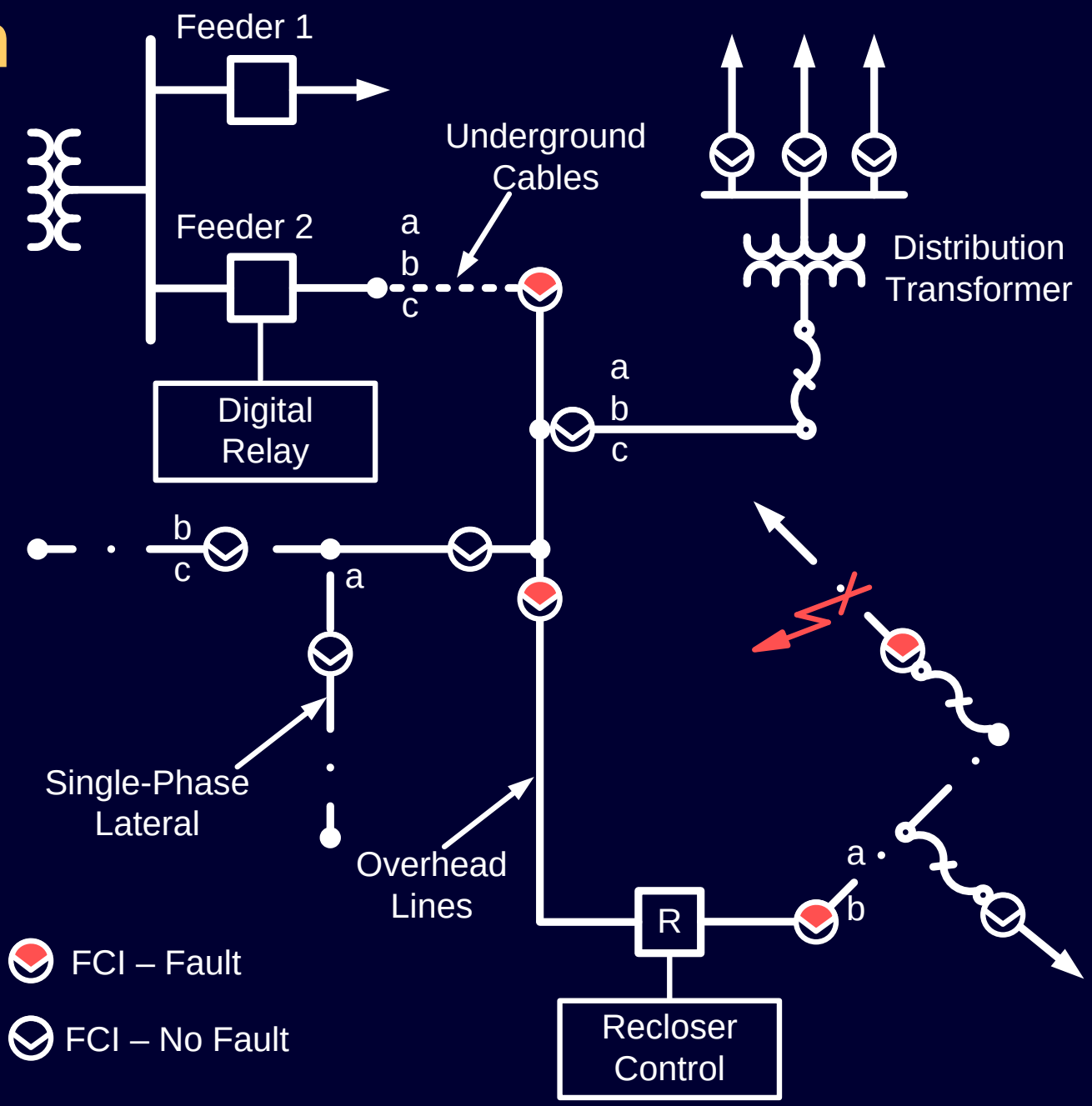
Locating Distribution Feeder Faults Is Challenging



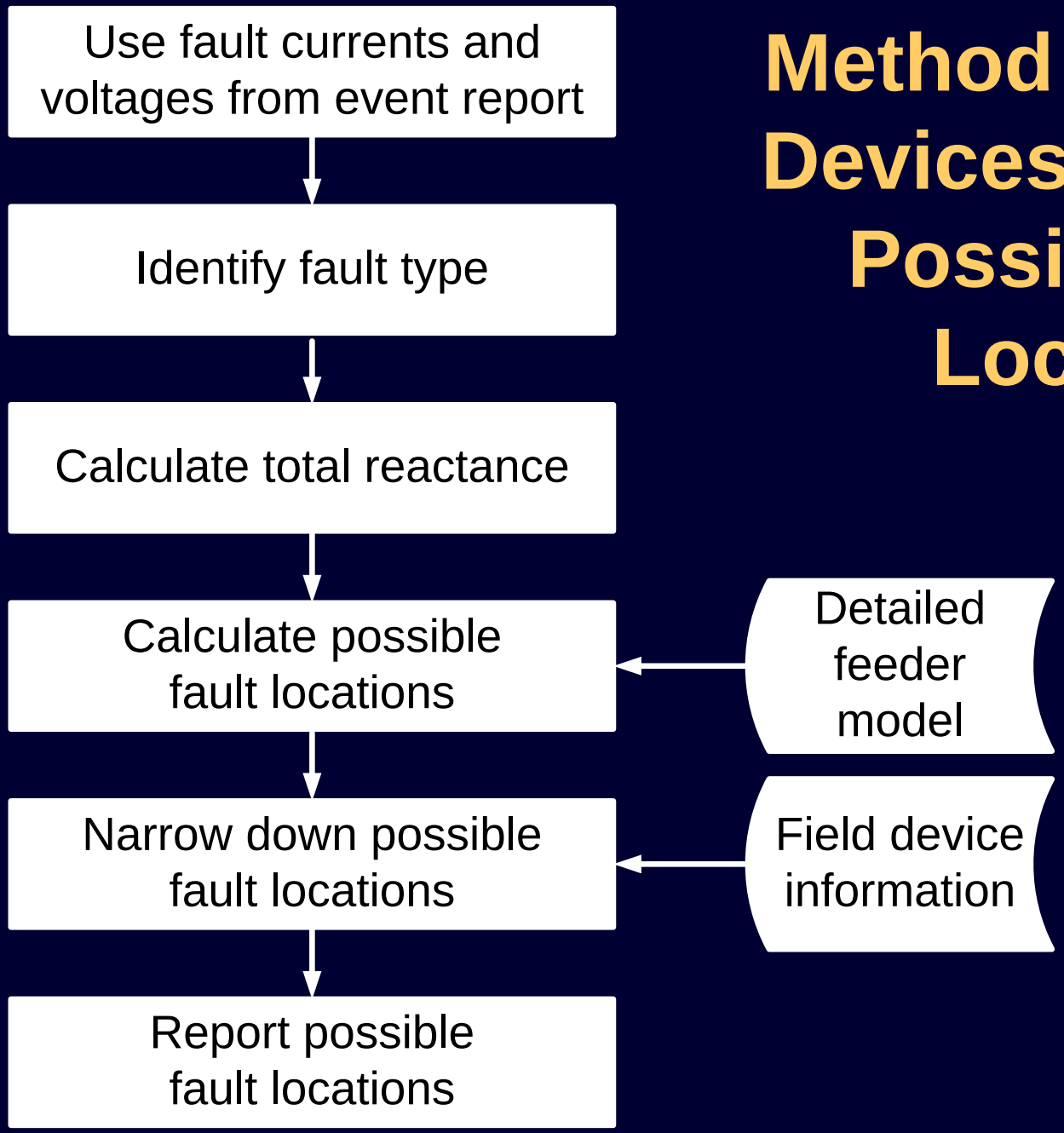
Existing Distribution Feeder Fault Location Method

- Traditional relay
- Fault current only
- Automatic meter reading or trouble call

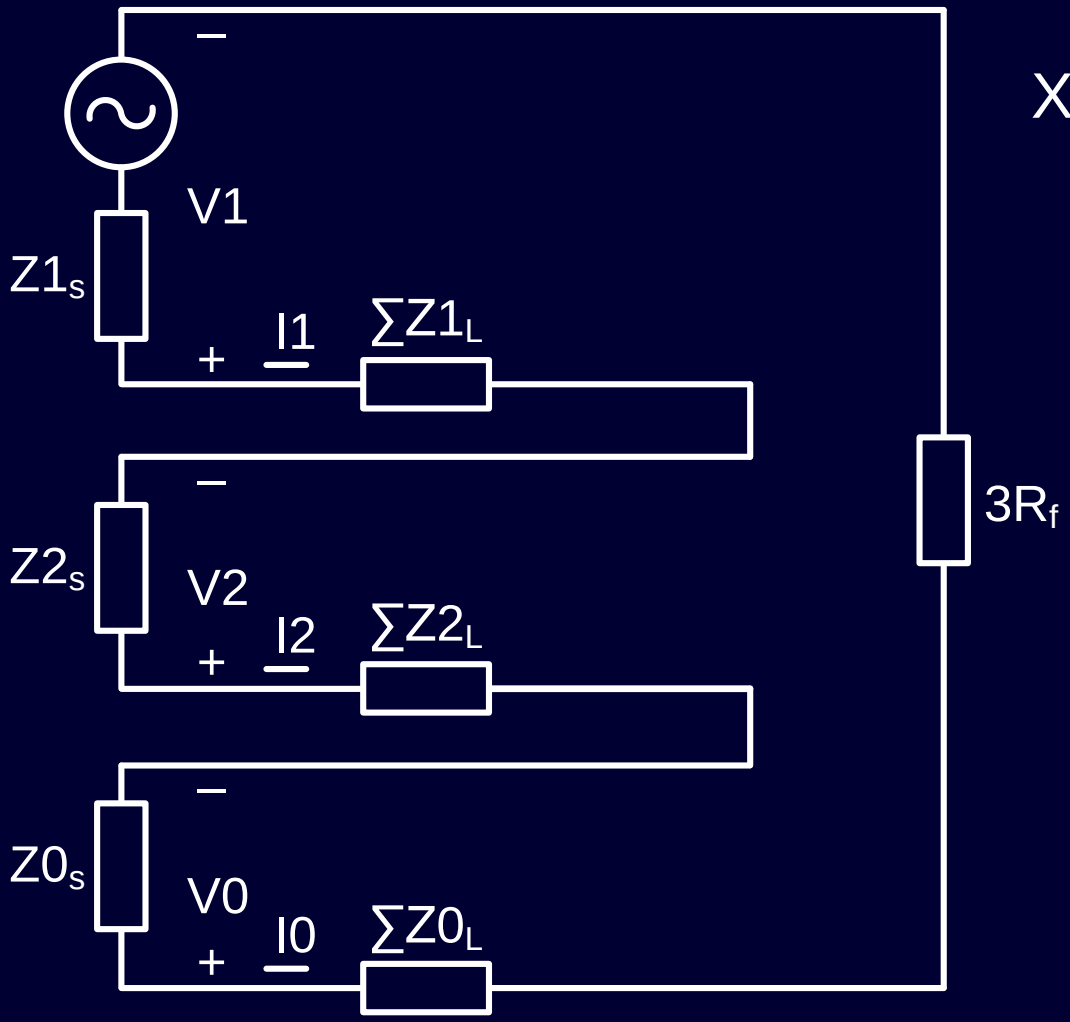
Distribution Feeder



Method Uses Field Devices to Reduce Possible Fault Locations



Reactance Calculation Using I2 for Single-Phase-to-Ground Faults

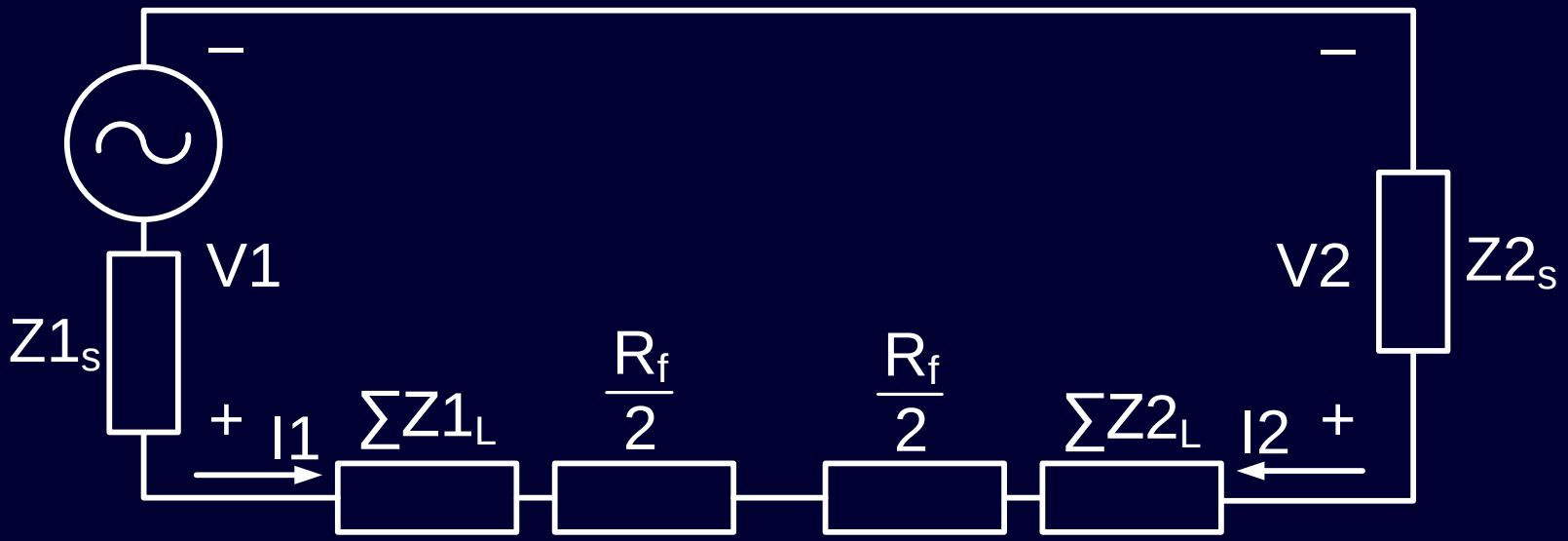


$$X_{total} = \sum_{i=1}^{k} \left(X1_i + X2_i + X0_i \right)$$

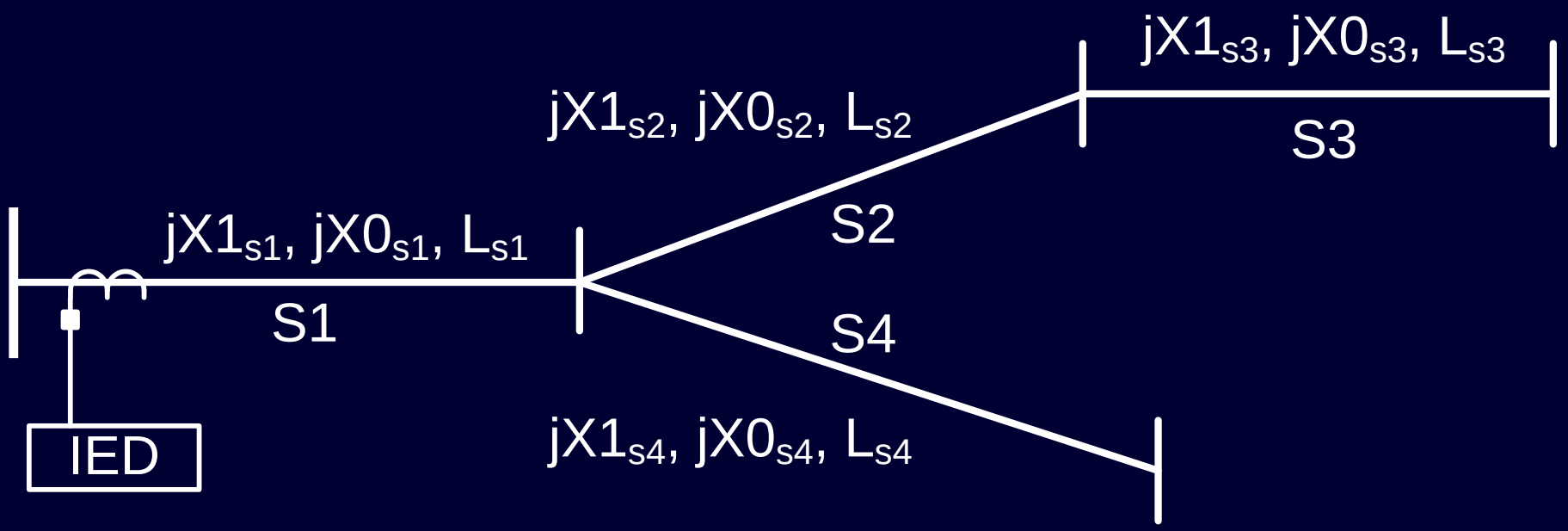
$$= \frac{\mathrm{Im}\left(V_{phase} \bullet I2^{*} \right)}{\left| I2 \right|^{2}}$$

Reactance Calculation Using I2 for Phase-to-Phase Faults

$$X_{total} = \sum_{i=1}^{k} X1_i = \mathrm{Im}\left(\frac{V2 - V1}{2 \bullet I2}\right)$$



Detailed Feeder Model Provides Accurate Results

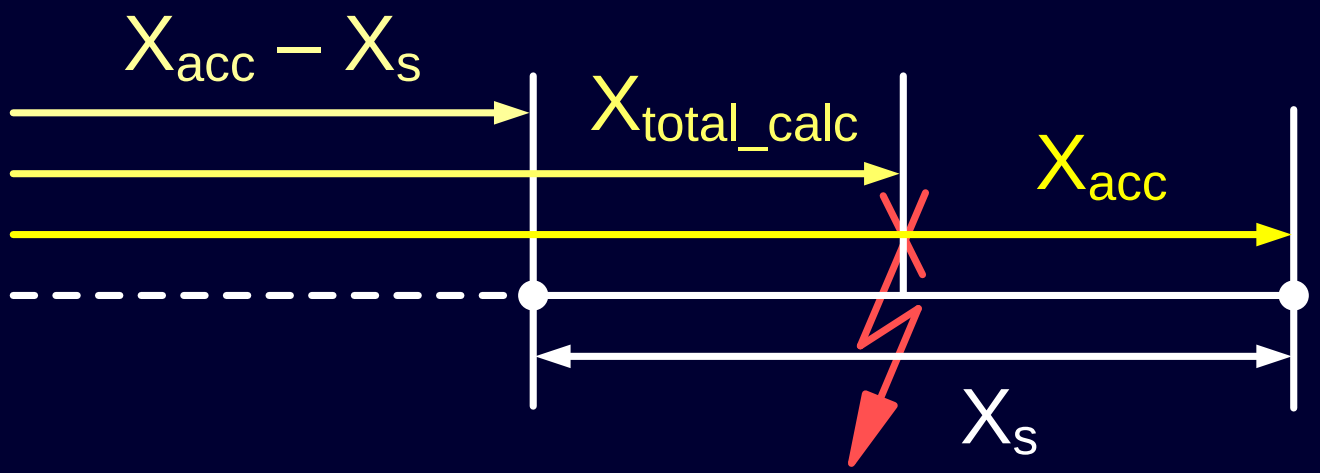


Available Feeder Data Simplify System Configuration

Use feeder models available in popular distribution system analysis software

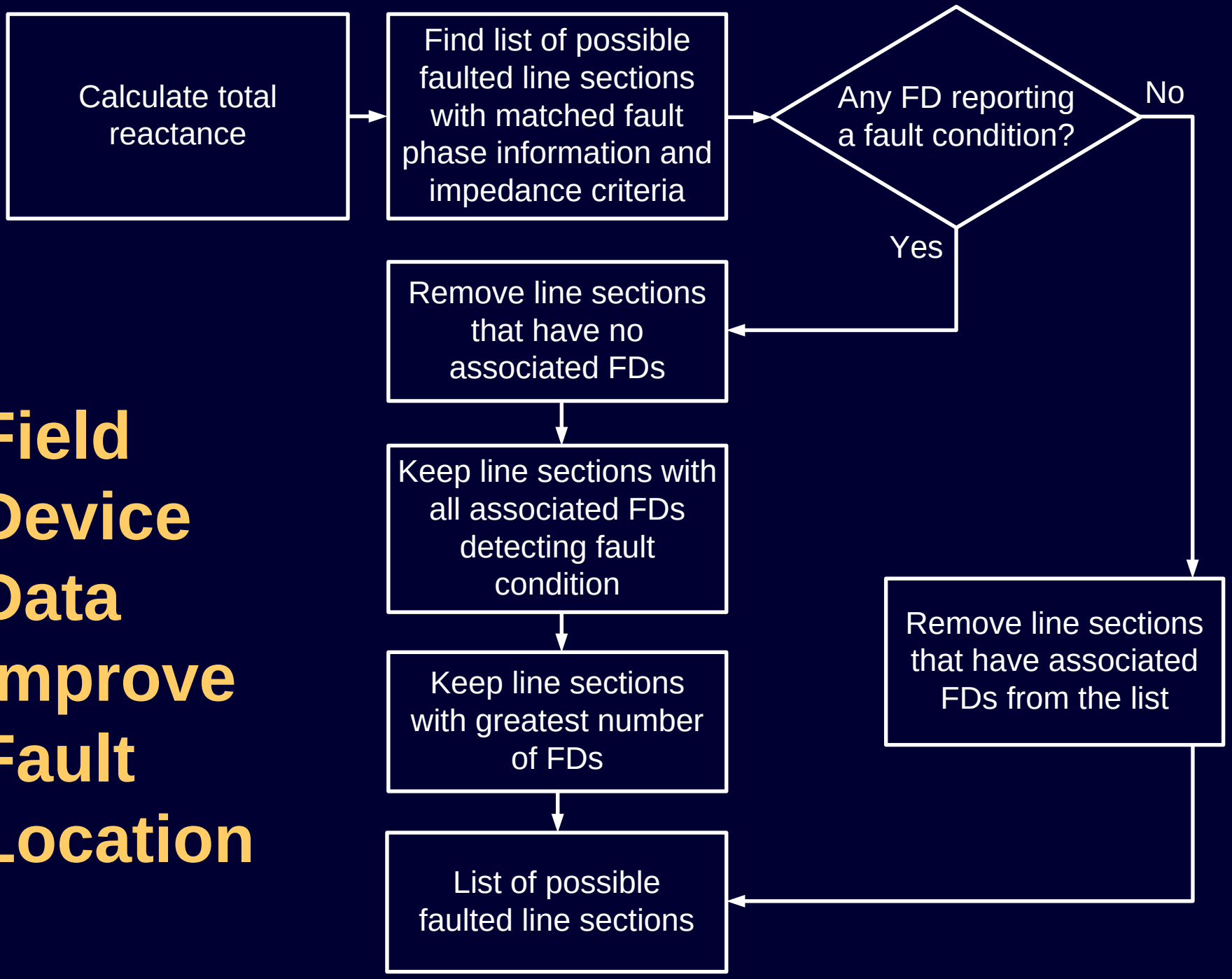
Section ID	From Node ID	To Node ID	Phase	Length (ft)	R1 (Ω)	X1 (Ω)	R0 (Ω)	X0 (Ω)
Fd01	Fd0001	Fd0002	ABC	506	0.0662	0.755	0.2497	2.0687
Fd02	Fd0002	Fd0003	ABC	424	0.0452	0.558	0.2140	1.2560

Faulted Line Section Criteria

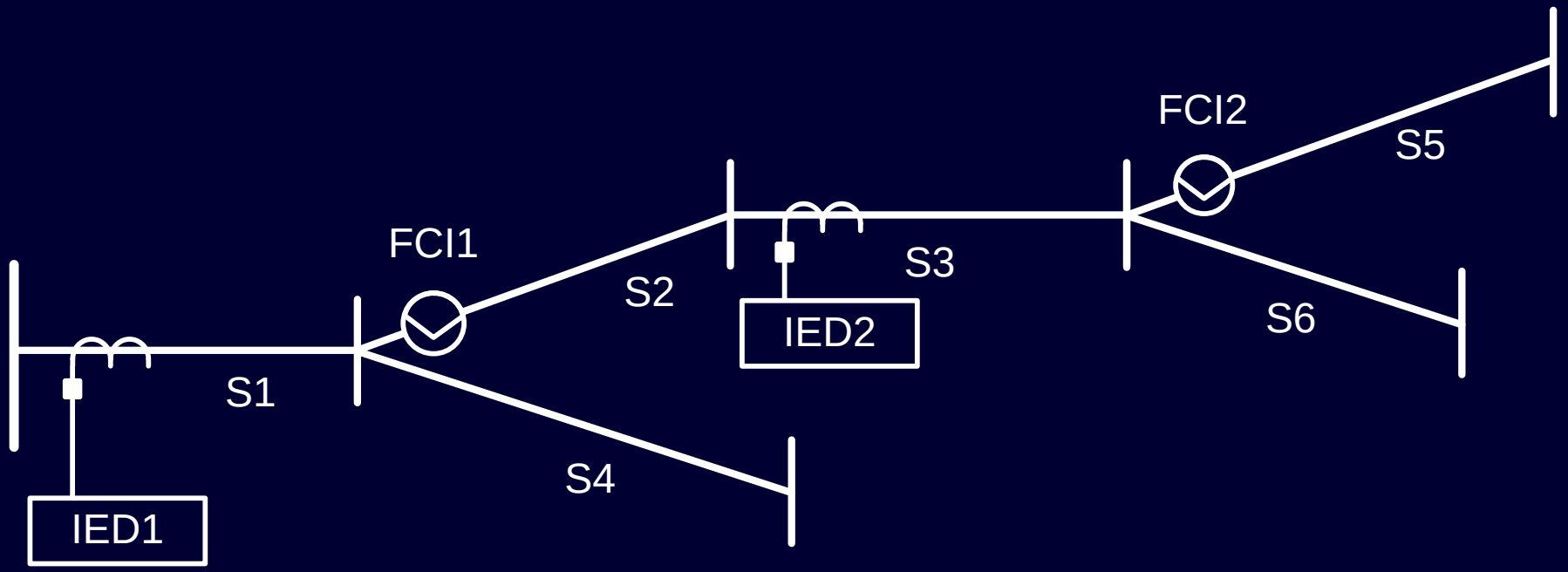


Line section phase contains identified faulted phase

$$X_{acc} \geq X_{total\_calc} > X_{acc} - X_s$$

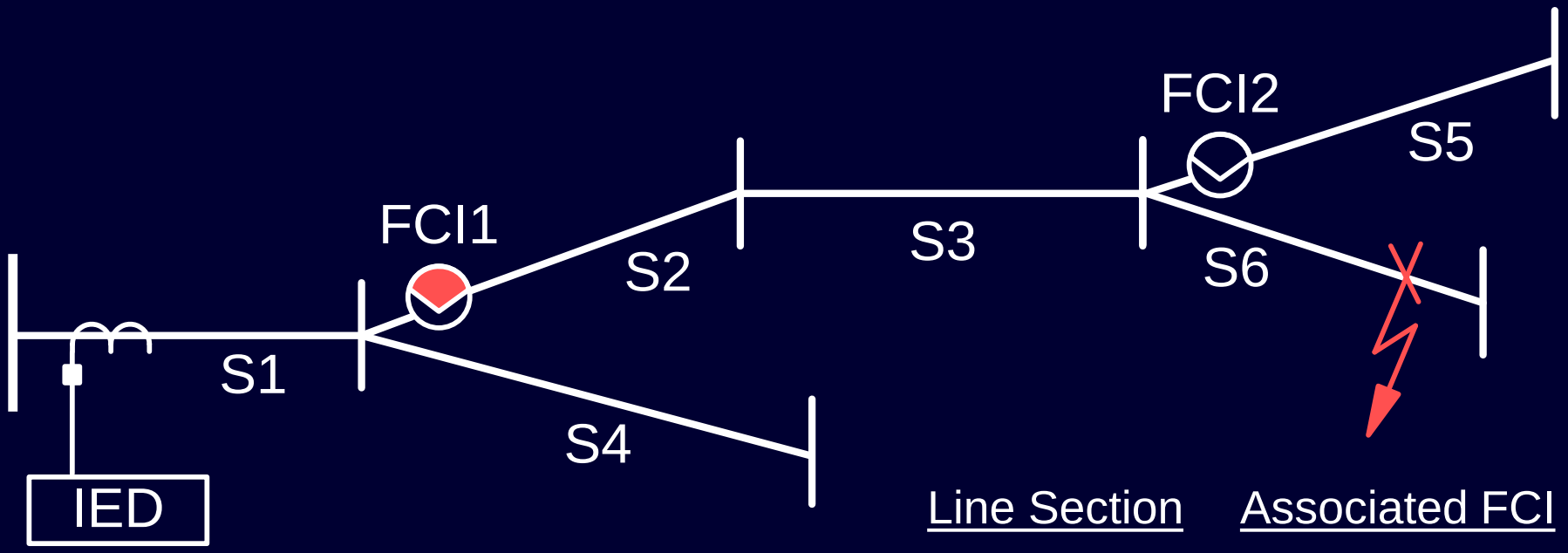

Calculate total reactance
Find list of possible faulted line sections with matched fault phase information and impedance criteria
Any FD reporting a fault condition?
No
Yes
Remove line sections that have no associated FDs
Keep line sections with all associated FDs detecting fault condition
Keep line sections with greatest number of FDs
List of possible faulted line sections
Remove line sections that have associated FDs from the list
Field Device Data Improve Fault Location

Recloser Control Data Improve Fault Location



- Use recloser control as FCI
- Calculate reactance with current / voltage measurement from recloser control

FCI Data Reduce Possible Fault Locations

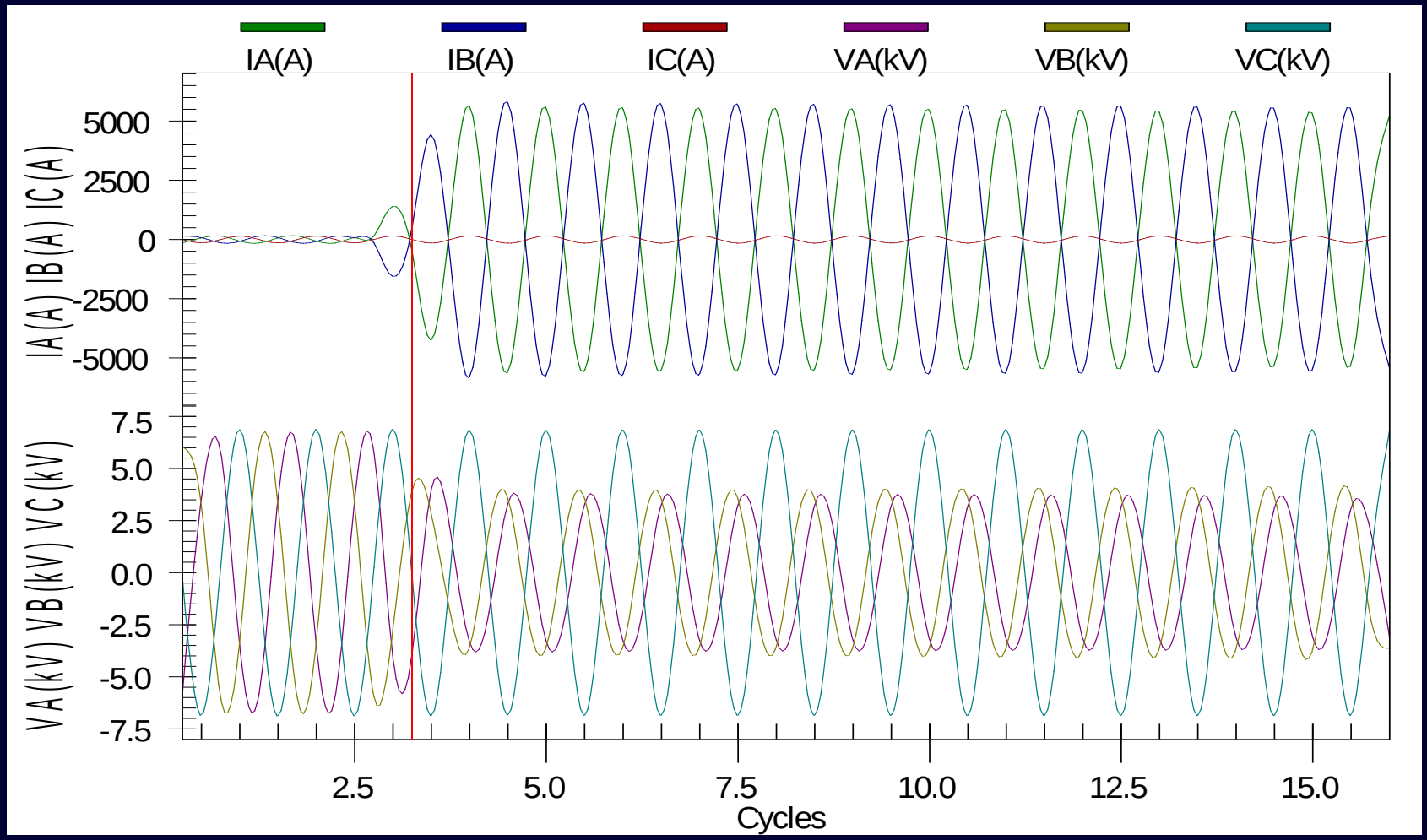


Line Section	Associated FCI
S1	{ }
S2	{FCI1}
S3	{FCI1}
S4	{ }
S5	{FCI1, FCI2}
S6	{FCI1}

Field Case 1: Phase-to-Phase Fault Location Within 20 Feet

Existing relay: 1,636 feet

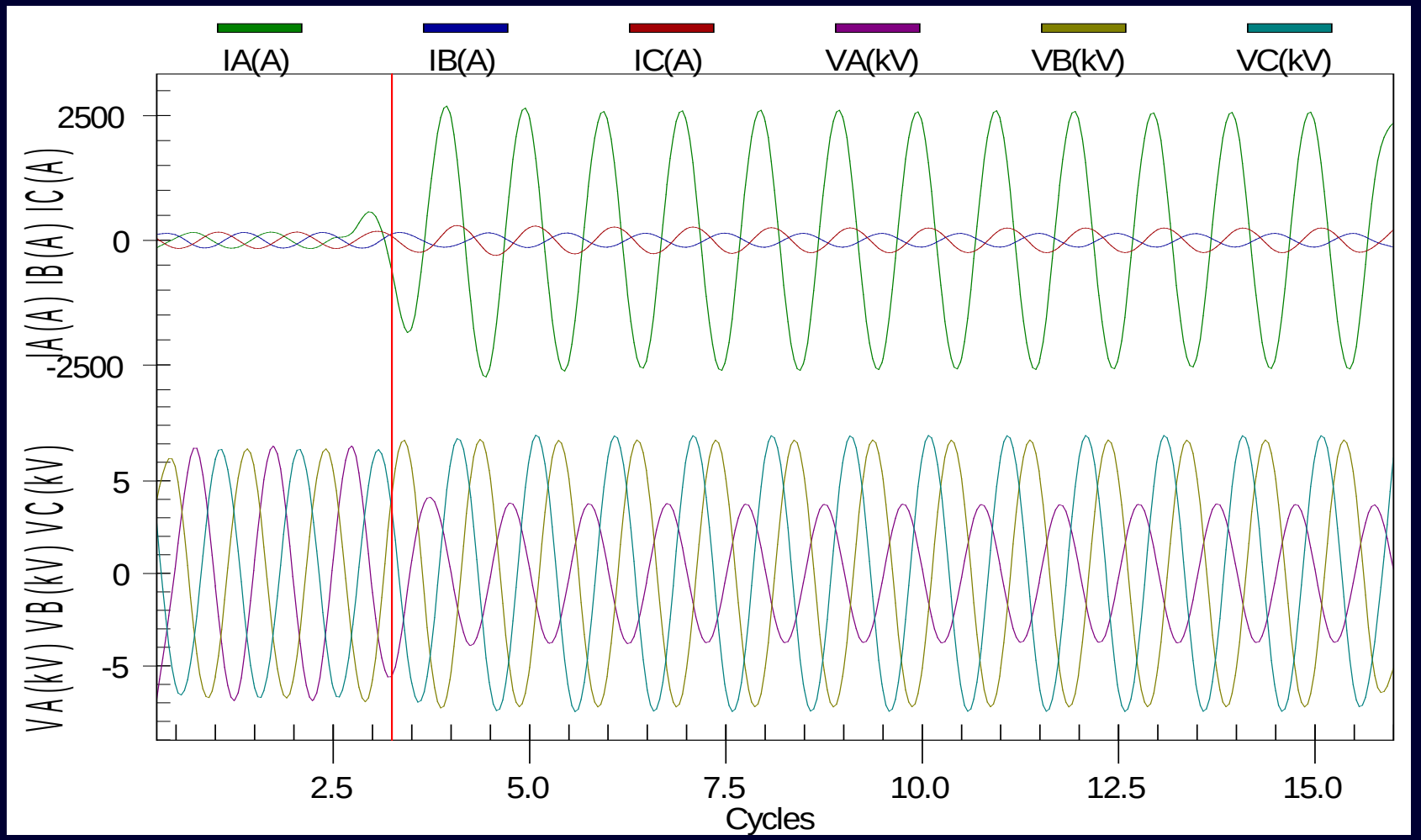
Proposed method: 20 feet

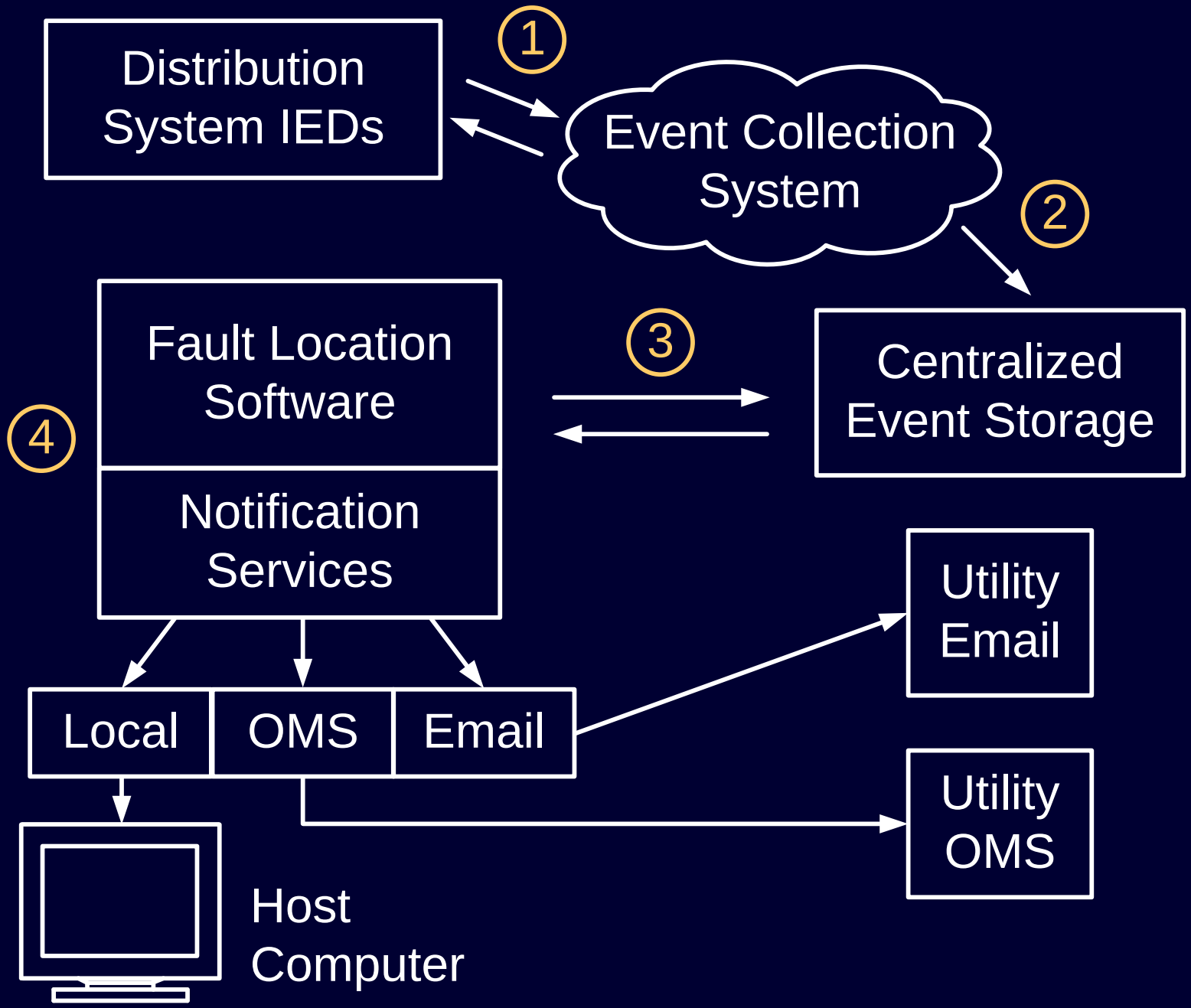


Field Case 2: Single-Line-to-Ground Fault Location Within 24 Feet

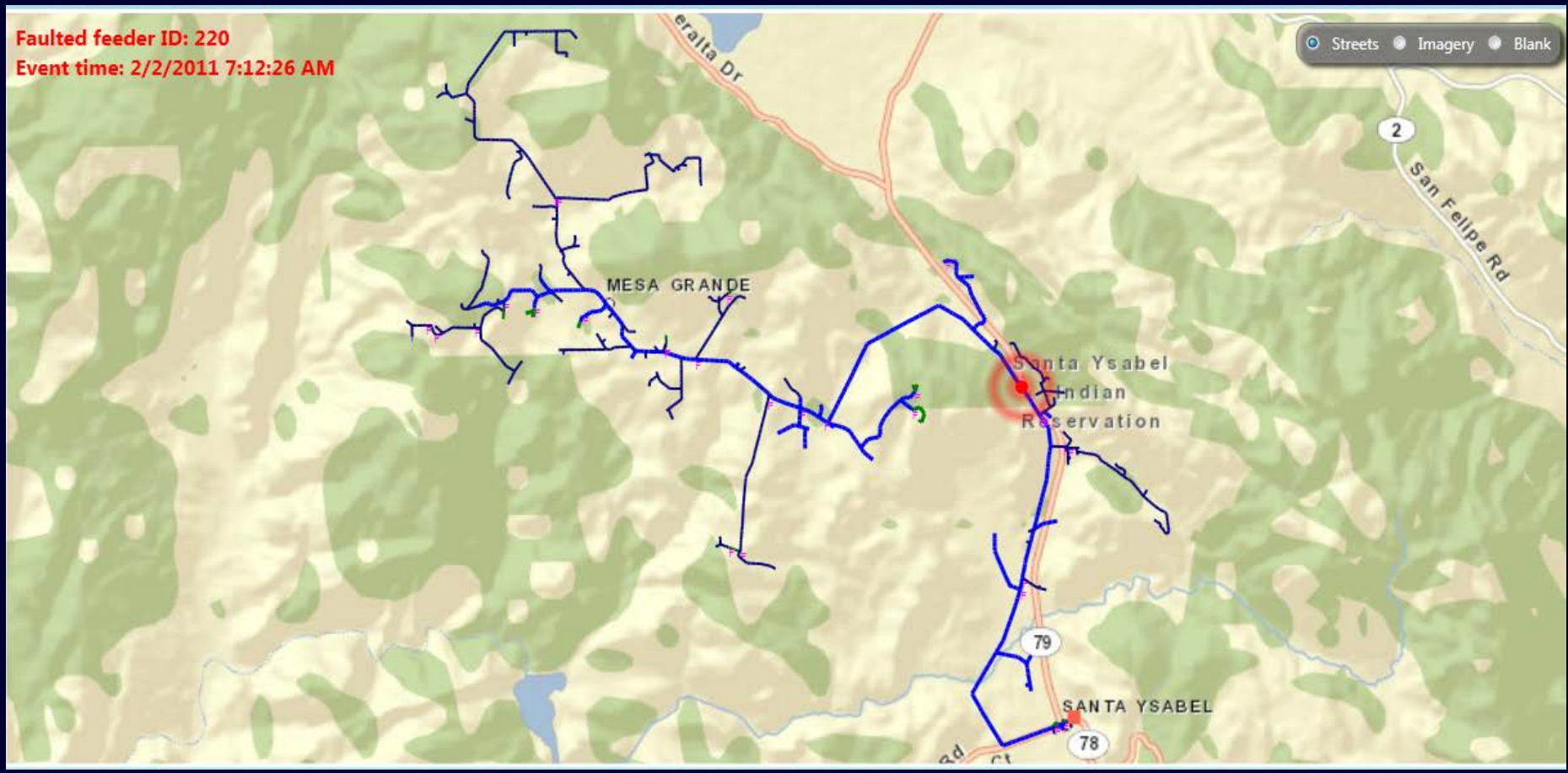
Existing relay: 1,697 feet

Proposed method: 24 feet




Distribution System IEDs
1
Event Collection System
2
Fault Location Software
3
Centralized Event Storage
4
Notification Services
Utility Email
Local
OMS
Email
Utility OMS
Host Computer

Fault Location Results



Conclusions

- Use detailed feeder model to accommodate nonhomogeneity of feeder
- Minimize impact of fault resistance using reactance method

Conclusions

- Use negative-sequence current only for single-phase-to-ground and phase-to-phase faults to minimize impact of mutual coupling
- FCI and recloser control data improve fault location accuracy

Thank you to Oncor for providing the feeder model and field events for this paper

Questions?