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Transición energética en la 4ta revolución industrial

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Convex Optimization Methods for the Restoration Topology and the Switching Sequence Restoration in Distribution System

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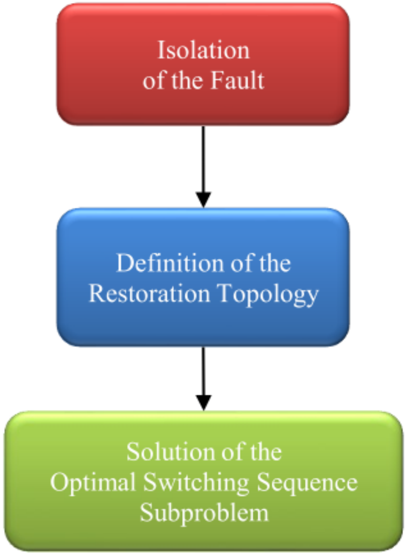
"JÚLIO DE MESQUITA FILHO"

Contents

I. Introduction

After a fault in the Distribution System, Restoration transfers loads between primary feeders through switching operations

Most of the methods define the only the restoration topology (switches to be open or close), while disregards the sequence of operation



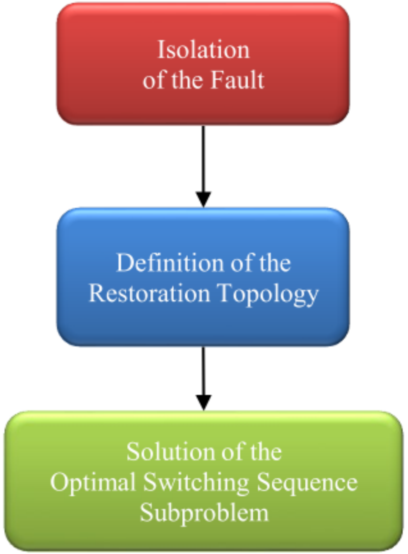
I. Introduction

Convex models for the restoration service subproblems are used:

- Restoration topology (minimization of the power curtailment)
- Optimal switching sequence (minimization of the energy not supplied)

Two convex models were developed for the Optimal switching sequence:

- Mixed-integer conic programming
- Mixed-integer linear programming



II. Proposed Convex Models

Optimal switching sequence problem:

- Original relation between voltage, current, and power flows $V_{n,t}^{sqr} I_{mn,t}^{sqr} = P_{mn,t}^2 + Q_{mn,t}^2$
- Conic formulation $V_{n,t}^{sqr} I_{mn,t}^{sqr} = P_{mn,t}^2 + Q_{mn,t}^2$
- Linearized formulation $\tilde{V}_{m,t}^2 I_{nm,t}^{sqr} = f(P_{nm,t}) + f(Q_{nm,t})$

Piecewise function that approximates the square of a nonnegative variable

II. Proposed Convex Models

Optimal switching sequence problem:

- Objective function: Minimization of the energy not supplied during the restoration process

$$\min \sum_{m} \sum_{t} \Delta_t P_m^d y_{m,t}$$

- Power flow constraints (branch flow formulation)

$$V_{n,t}^{sqr} I_{mn,t}^{sqr} = P_{mn,t}^2 + Q_{mn,t}^2$$

- Voltage and current limits

$$\underline{V}^2 \leq V_{m,t}^{sqr} \leq \overline{V}^2;\ I_{mn,t}^{sqr} \leq \overline{I}_{mn}^2 x_{mn,t}$$

- Radial topology at each step

- Only one switch can be maneuvered at each step

$$\sum_{mn \in L} |x_{mn,t} - x_{mn,t-1}| \leq 1$$

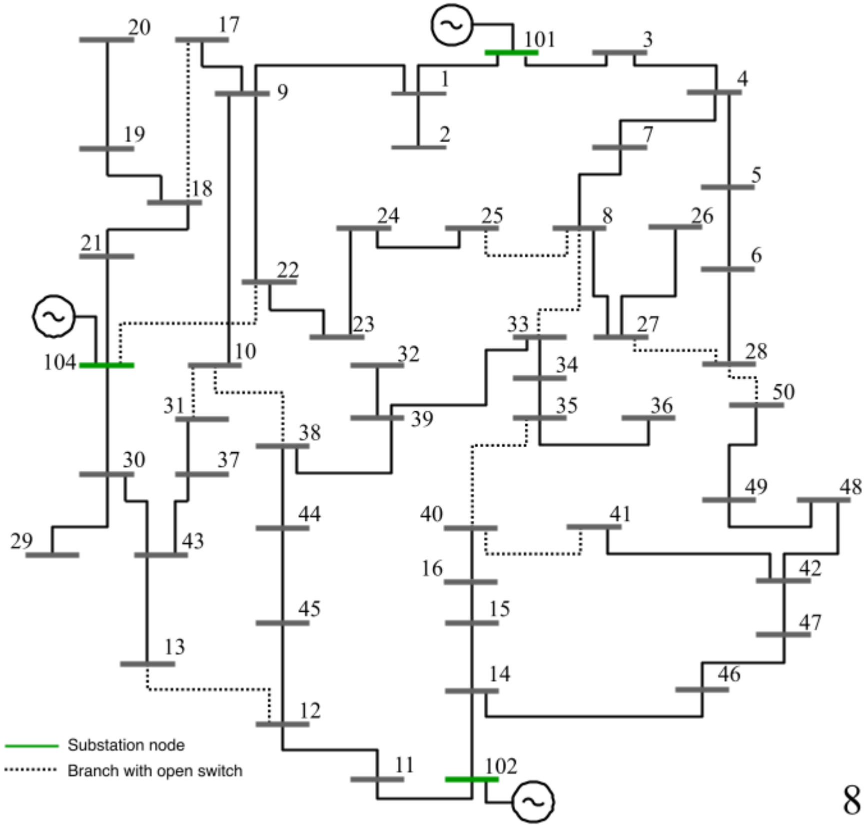
III. Results

- 3 substations (13.8kV)
  at nodes 101, 102, and 104

- 50 load nodes

- Dashed lines represent open circuits than can be used to restore loads

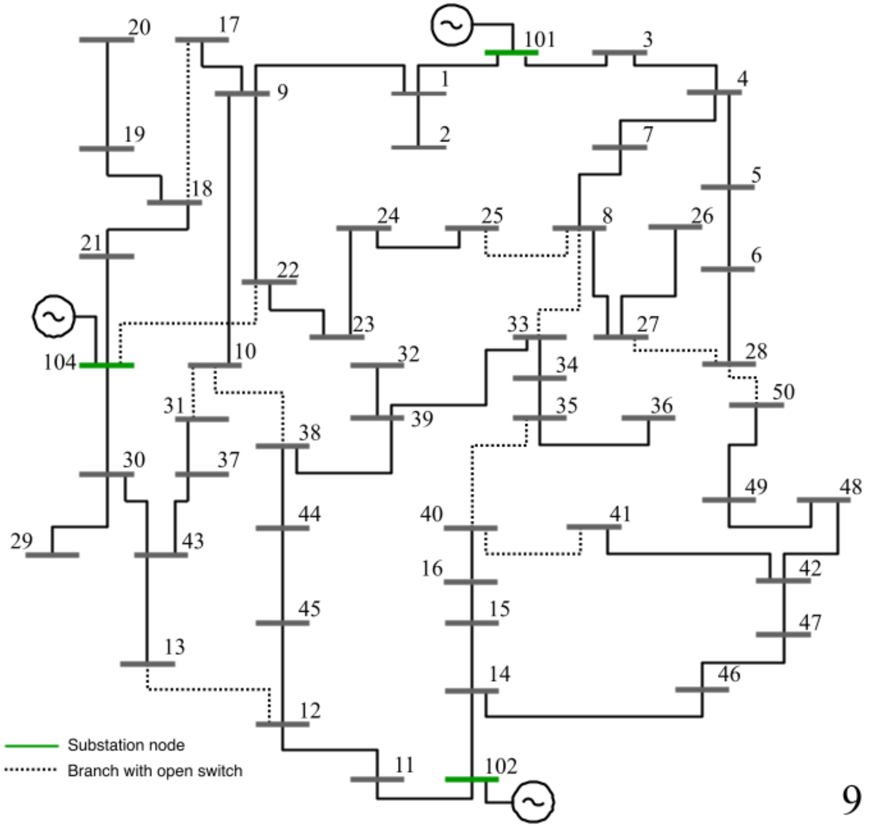
- Models formulated in AMPL and solved with CPLEX



III. Results

Time required to solve the restoration problem

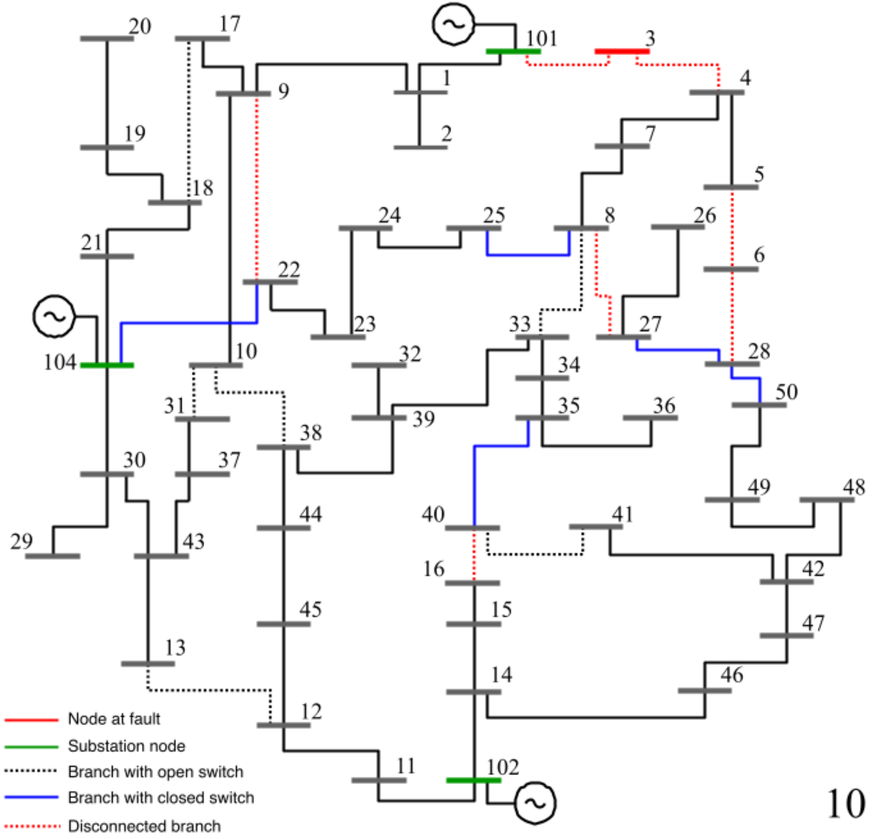
	Model	Restoration topology (s)	Sequence model (s)	Total time (s)
Fault at node 3	Conic	56	239	277
	Linear	38	43	81
Fault at node 44	Conic	6	52	58
	Linear	2	4	6



III. Results

Switching sequence for fault at node 3:

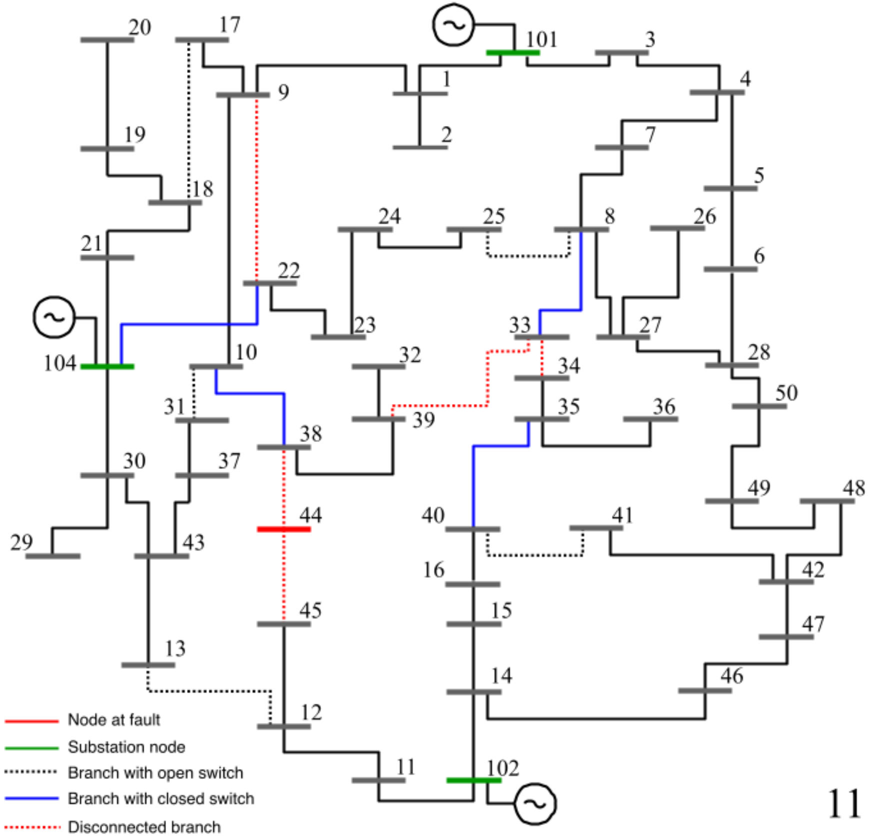
- Open 22-9
- Close 104-22
- Open 27-8
- Open 6-5
- Close 8-25
- Close 28-50
- Open 16-40
- Close 35-40
- Open 28-6
- Close 28-27



III. Results

Switching sequence for fault at node 44:

- Open 34-33
- Close 35-40
- Open 33-39
- Close 8-33
- Open 22-9
- Close 10-38
- Close 104-22



III. Conclusions

- Proposed models provide the switching sequence for the restoration in a reduced time
- Linearized model is 70-90% faster than the conic model
- Future works: impact of distributed generation in the restoration service,
  improved representation of the distribution system unbalance