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1358 Estimating Topologies of Low Voltage Grids from Electric Vehicle Charging Station Measurement Data

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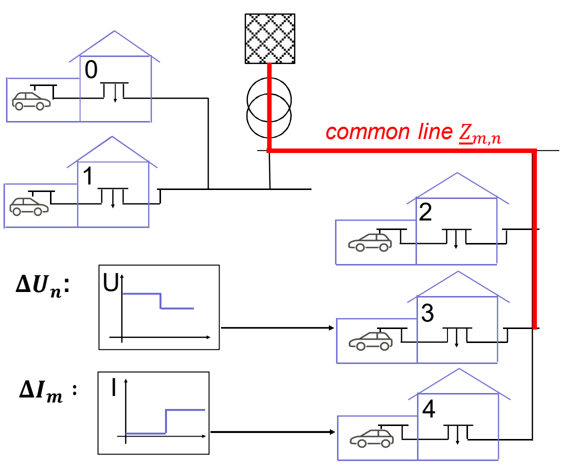
Objectives

Many smart grid applications require knowledge of the topology of the grid they operate in. If such data is not available, here's a solution.

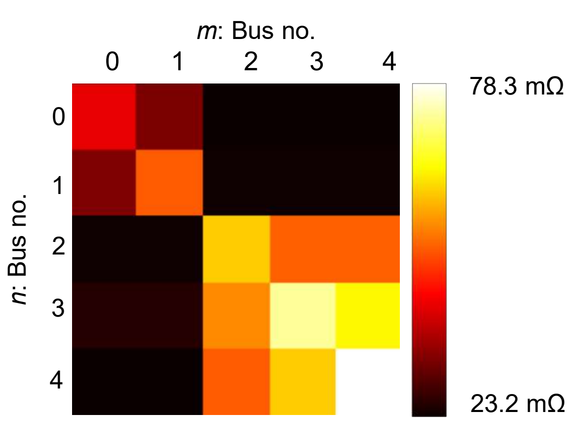
Methodology

We assume a power grid with e-vehicles:



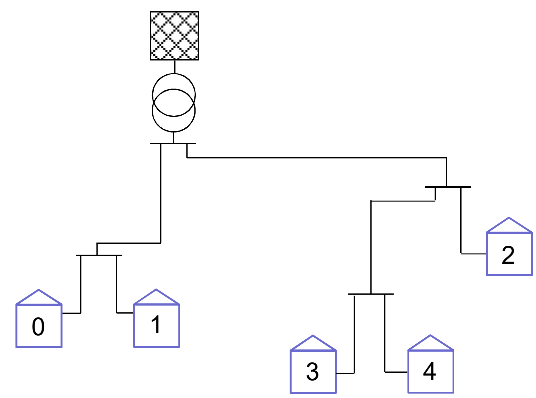
For each start of a charging cycle (Switch Event) on bus *m* we notice a voltage drop on bus *n* and derive the common line impedances:

$$\underline{Z}_{m,n} = \Delta \underline{U}_n / \Delta \underline{I}_m$$



Reconstruction as binary tree:

A recursive algorithm yields a binary tree representation of the reconstructed grid:



Noise and precision:

Estimations of line impedances are subject to noise. Statistical noise cancelling helps improve precision:

Median over n Switch Events	***RMS error: reactance***
4	333%
10	43.4 %
30	10.0 %
60	9.4 %
120	7.9 %
240	7.7 %

Conclusion:

Given sufficient measurement data, a complete and precise reconstruction of a not-meshed low-voltage grid is possible and can pave the way for sophisticated smart grid applications and other low-voltage grid related technology.