Correcting GIS Using AMI Data

Big Data Fixing Big Data

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GIS Interest Group
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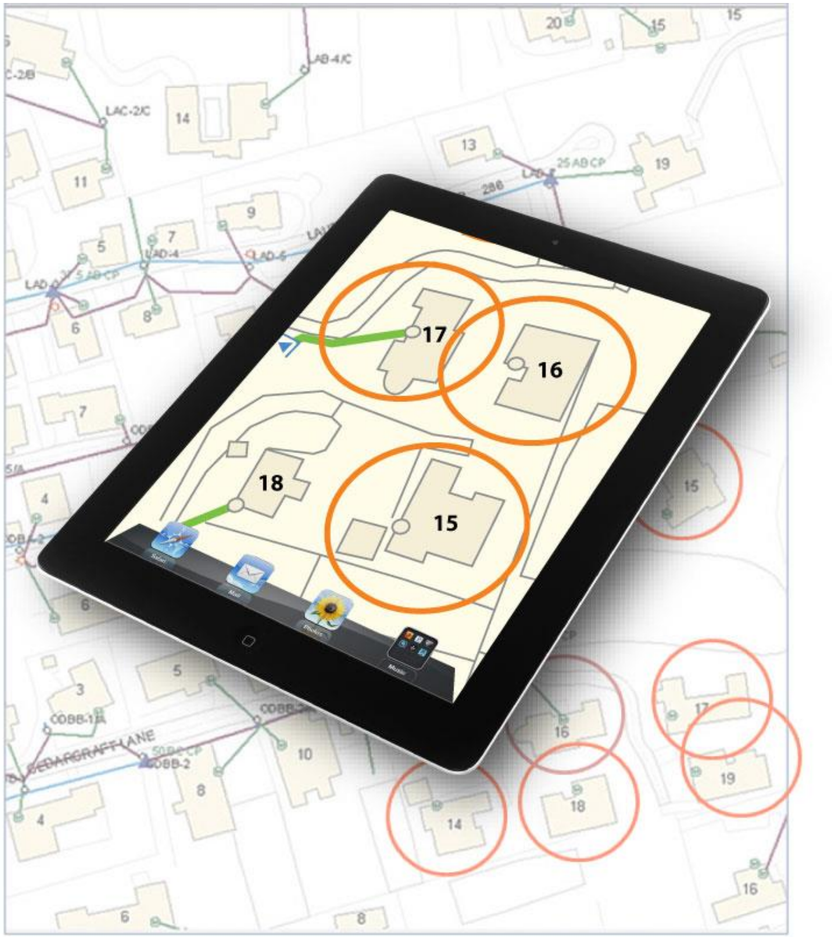
Agenda

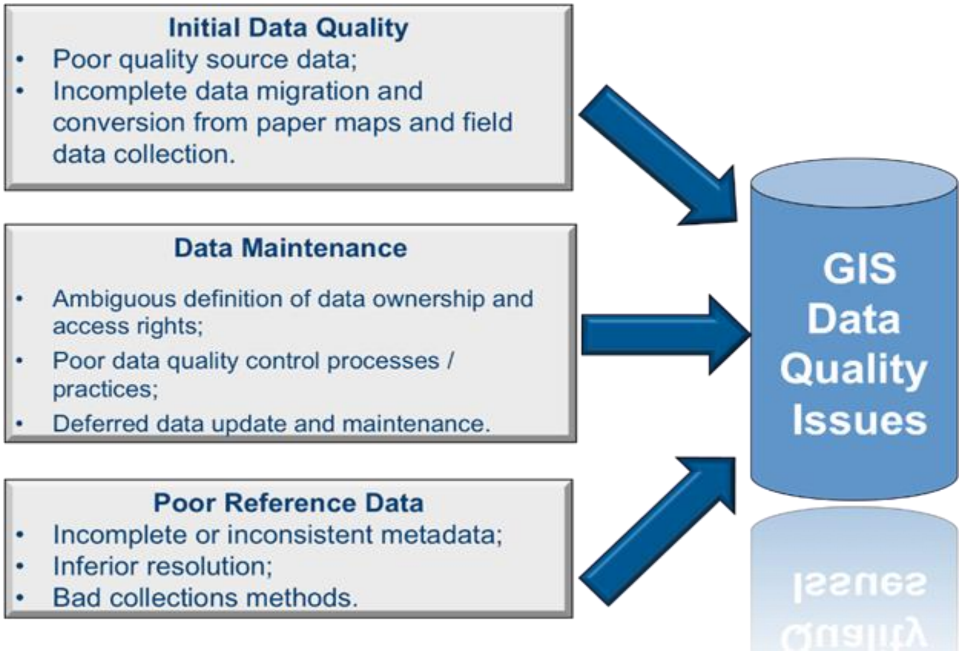
- GIS Data Quality.
- Finding the feeders.
- Finding the transformers.
- Finding the secondaries.

Quotes.



GIS Errors

- Types of Errors
  - Lineage (metadata) – information about the data.
  - Logical consistency – discrepancies in data.
  - Completeness – thoroughness, data gaps.
  - Accuracy (positional and attribute) – lost validity of data or inaccuracies.
- Sources of Errors
  - Initial data quality.
  - Poor reference data.
  - Maintenance-induced and ongoing deterioration.
  - Policy.



What Might be Possible with AMI Data?

- Phase identification
- Transformer identification
- Theft detection
- Mapping connectivity of secondaries
- Auto-generation of secondary models, including impedances
- Finding meters on the wrong circuit (addressing errors)
- Identification of open points on loops
- Identifying transformers with off-nominal taps or ratios
- Quantifying lighting and other unmetered load
- Plotting profiles of primary line voltage at any instant in time
  - Circuit model verification
  - Identification of switched capacitors with blown fuses
  - Identification of misoperating voltage regulators

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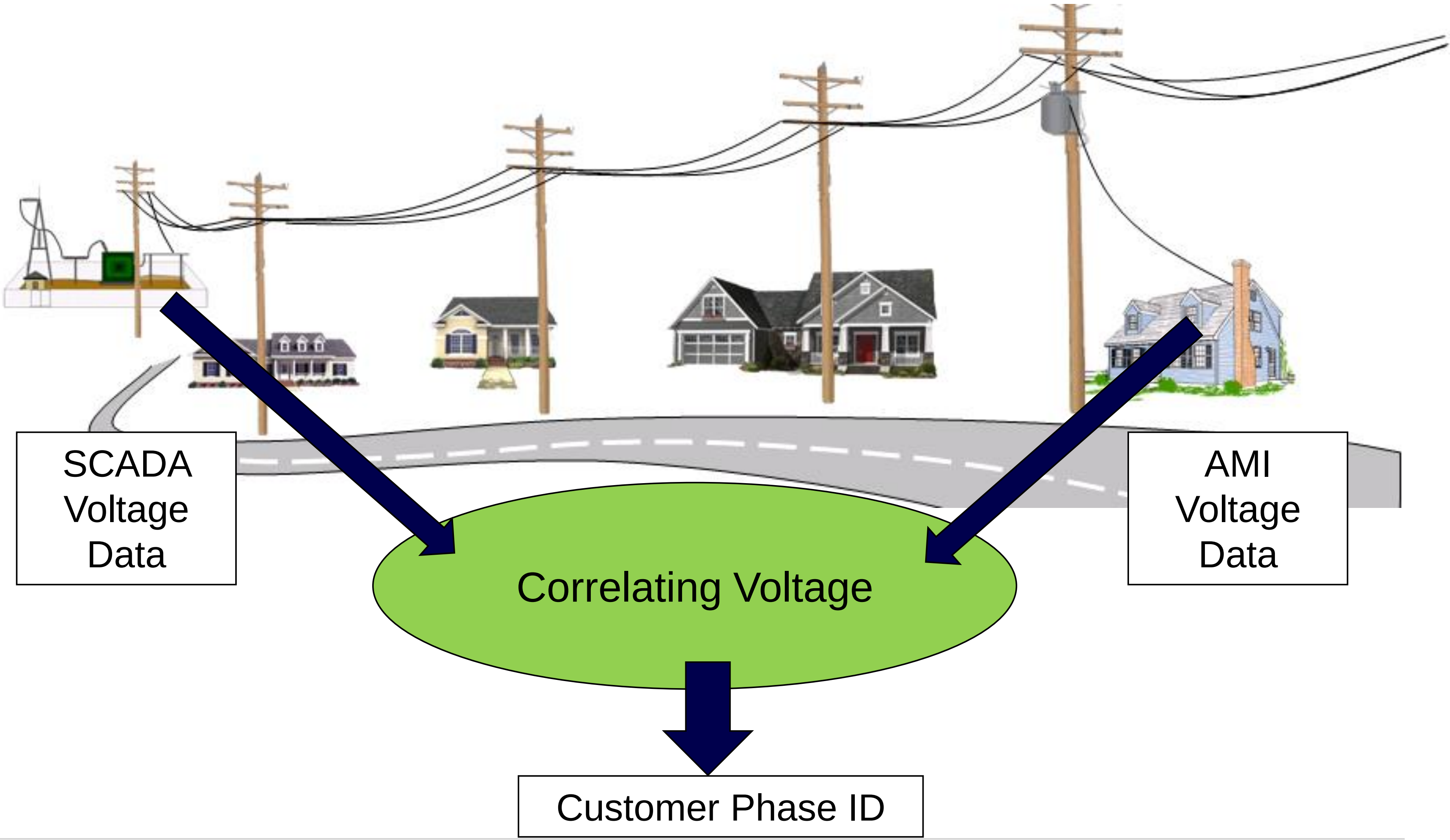
Circuits on the Wrong Phase from the Substation

- Problem
  – The correct circuits (taps) are not always on the correct phase.
  – GIS is wrong.
- Impact
  – Poor designs.
  – Impacts on loading.
  – Impacts with DR and DER.
  – Outage management impacts.

"Missing data, definitely. We are missing whole feeders and in some cases, whole substations and the feeders from them."

Automating Phase Identification

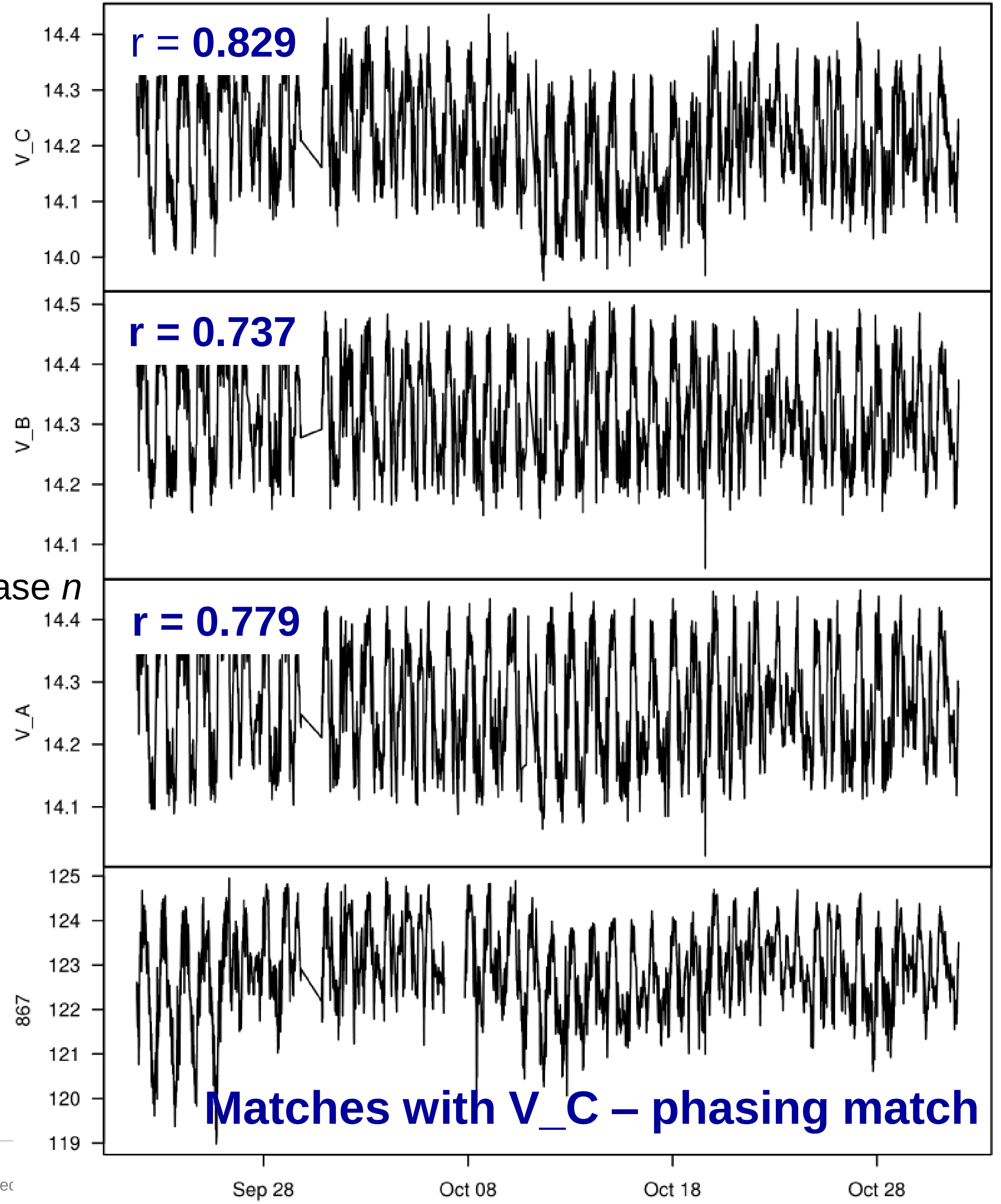


Basic Correlation Algorithm

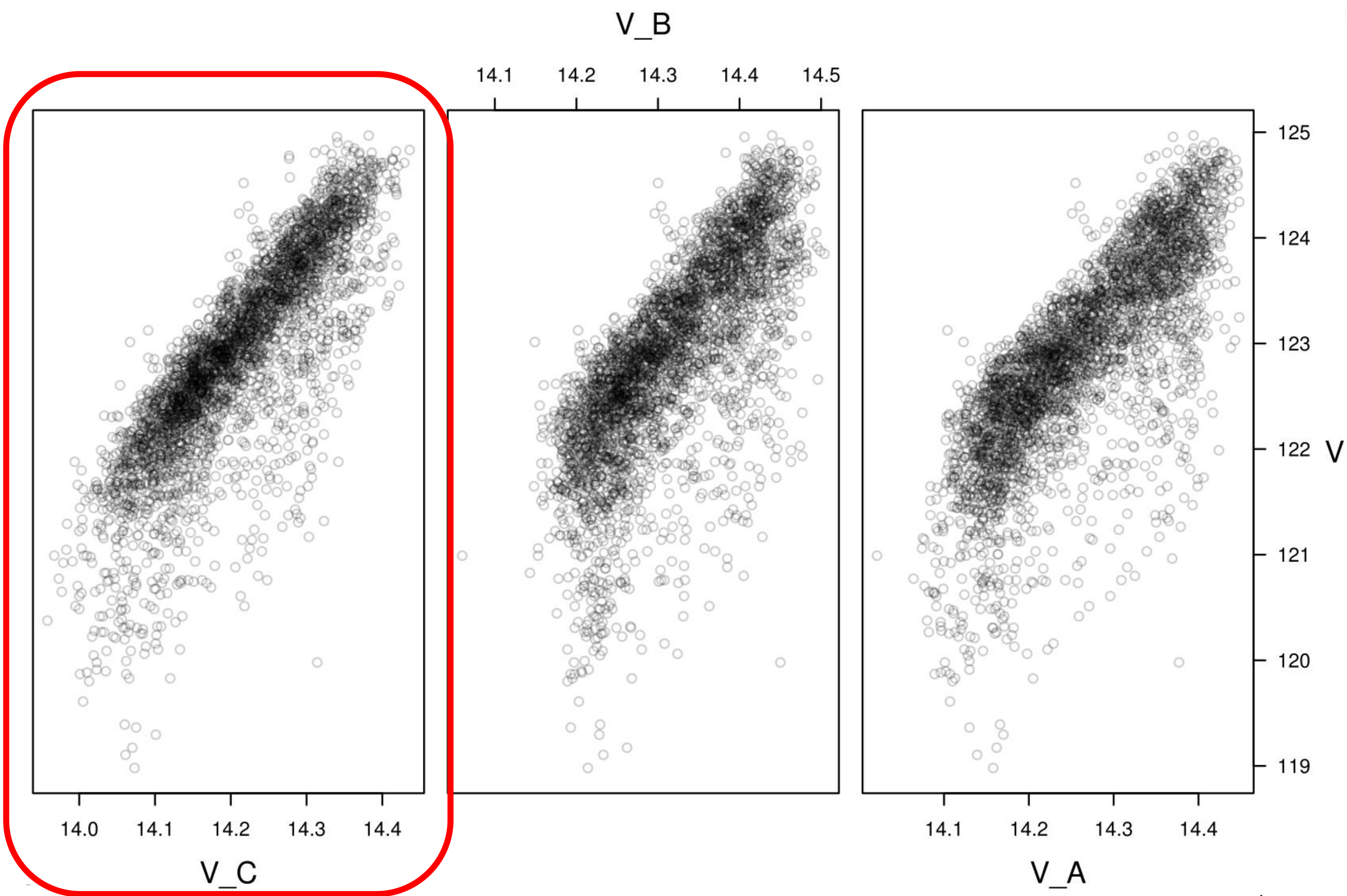
$$V_n = k_0 + k_1 V_m + k_2 W_m + k_3 W_n$$

Where:

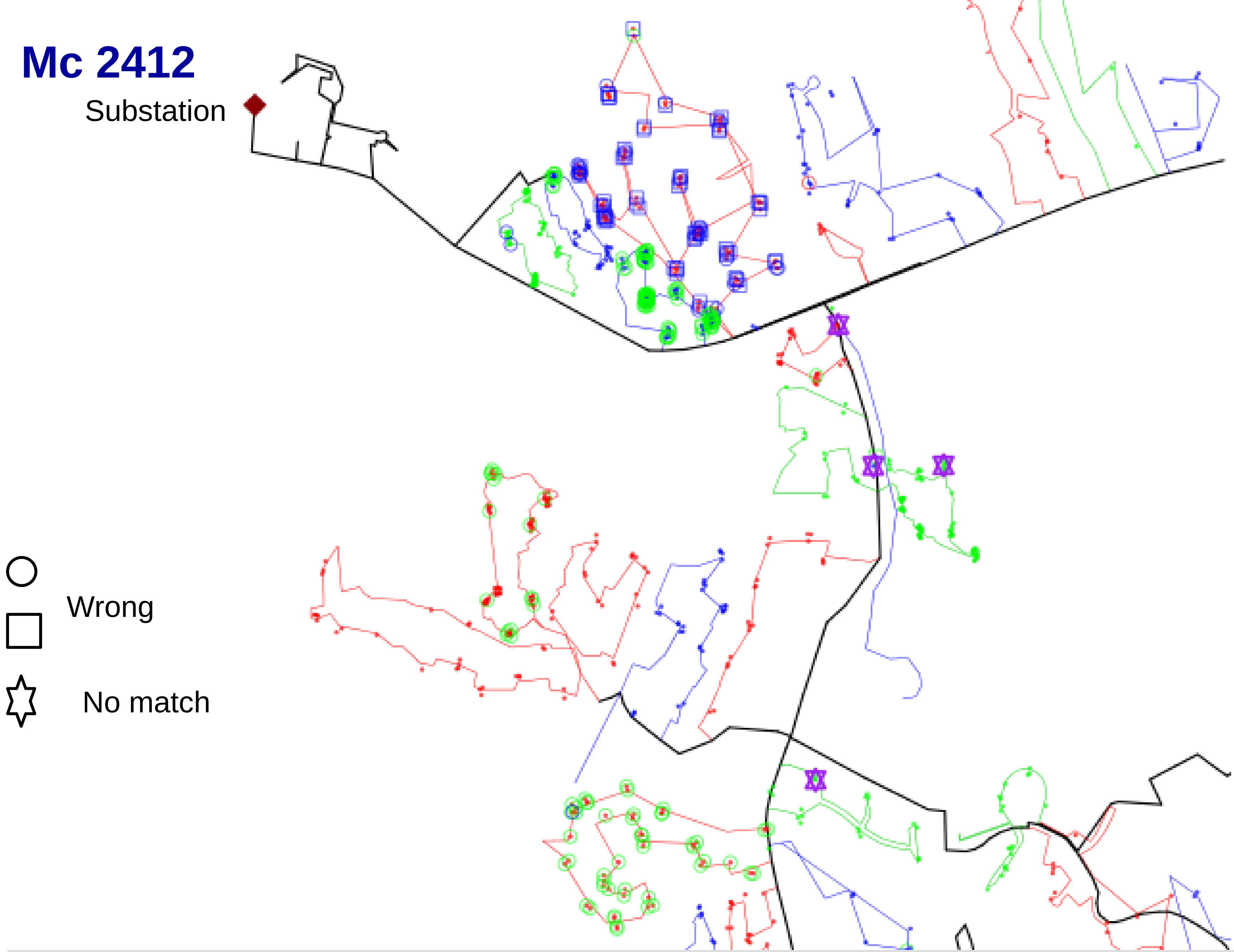
k_i = regression coefficients
V_n = substation voltage on phase n
W_n = substation average power on phase n
V_m = voltage at meter m
W_m = average power on meter m



Same Data as X vs. Y



Mc 2412

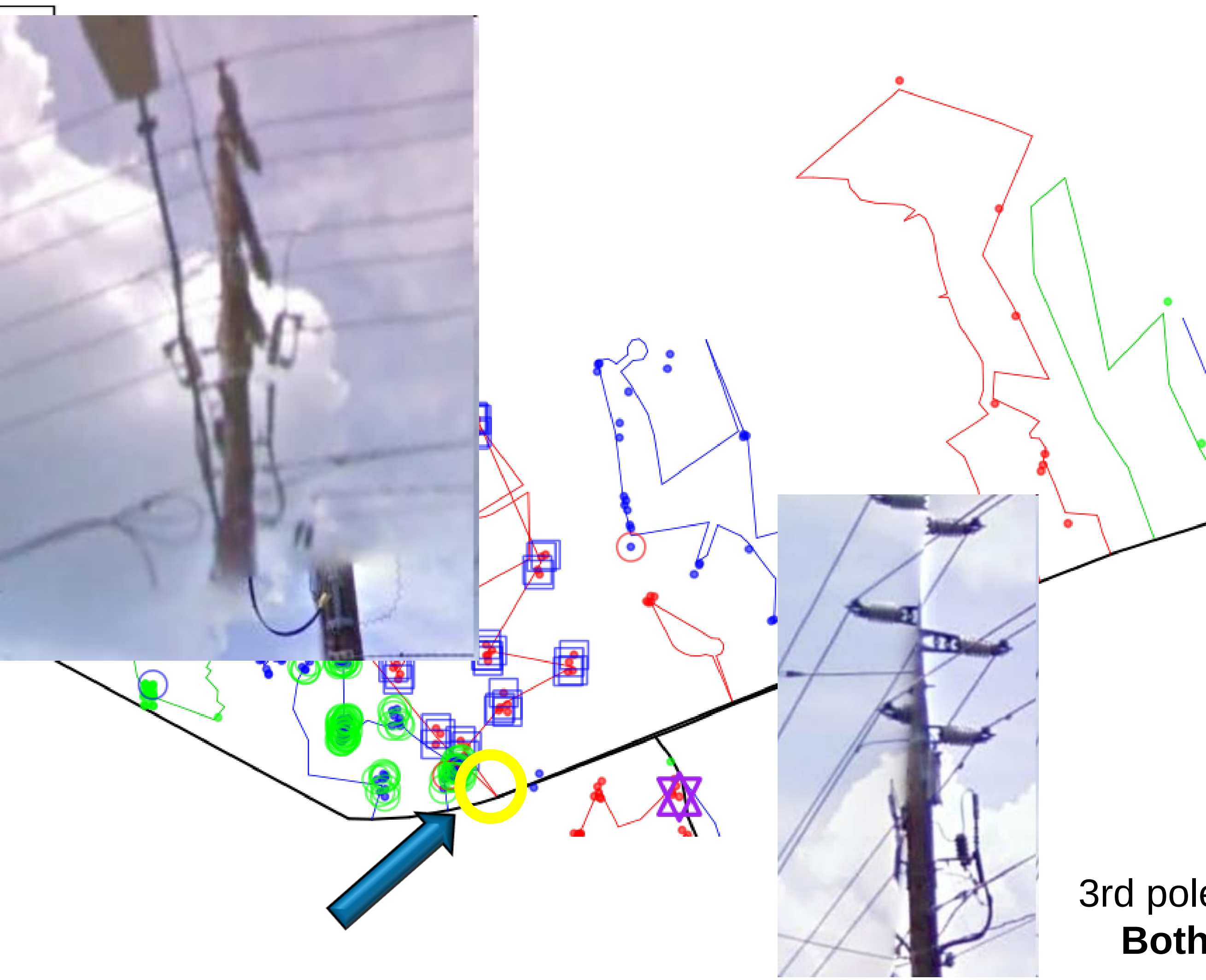


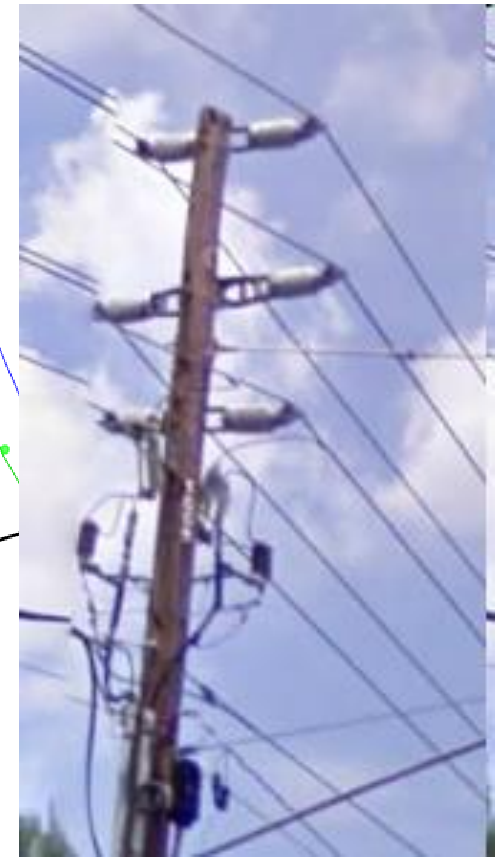
Mc 2412 Google Maps Verification

5th pole east of Carswell Ln

Bottom (blue) phase to transformer

Mc 2412





3rd pole east of Carswell Ln

Both bottom (blue) phase to riser

Seems to confirm the phasing mismatch

Transformer Identification

- Problem
  - The correct premises are not always on the correct transformer.
  - The trans-premise relationship is not always in GIS.
- Impact
  - Poor transformer maintenance.
  - Impacts with DR and DER.
  - Outage management impacts.

"I would say that linking the customer to the right transformer and to the right phase is our number one priority. If conflation wasn't so expensive, we would do that first."

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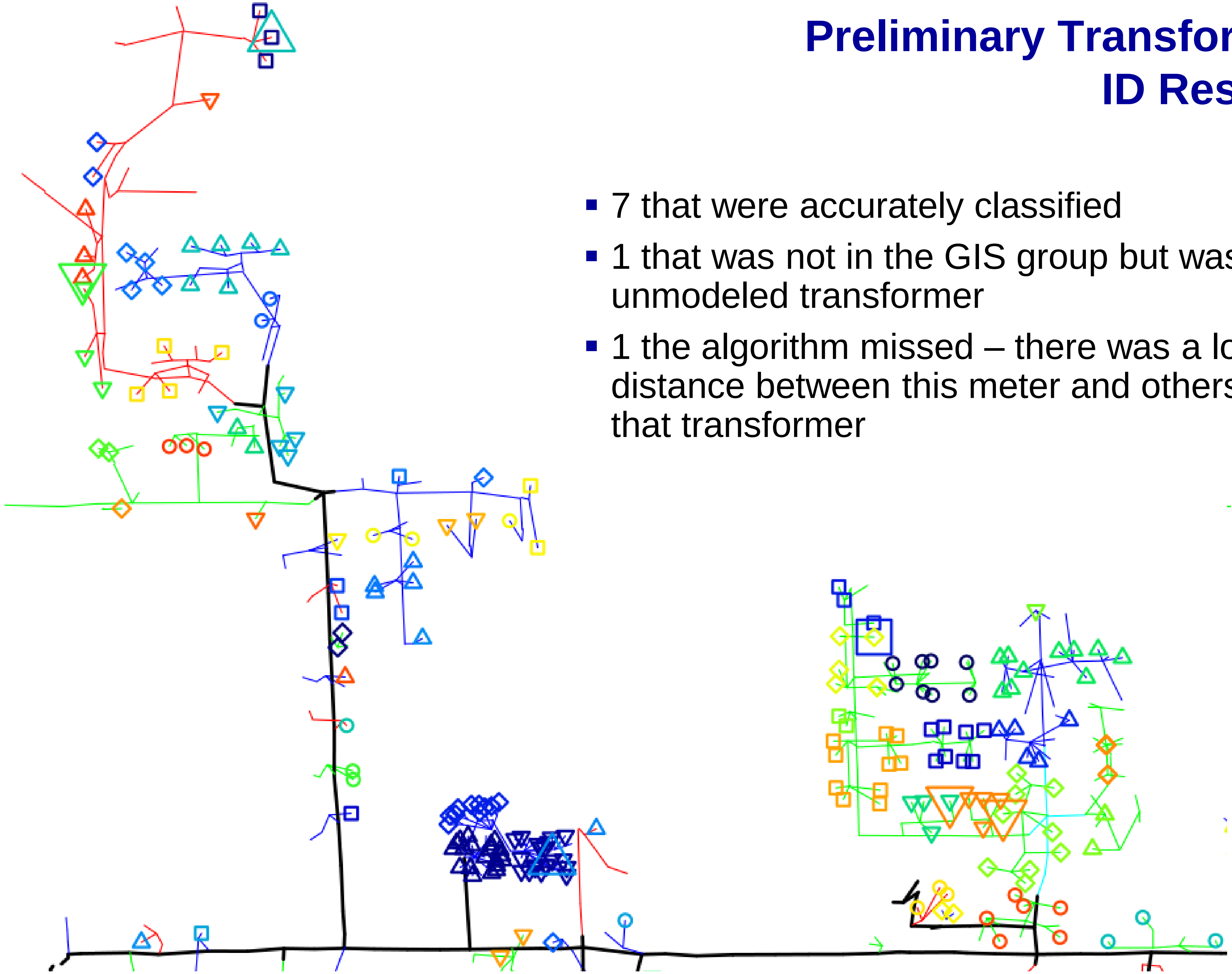
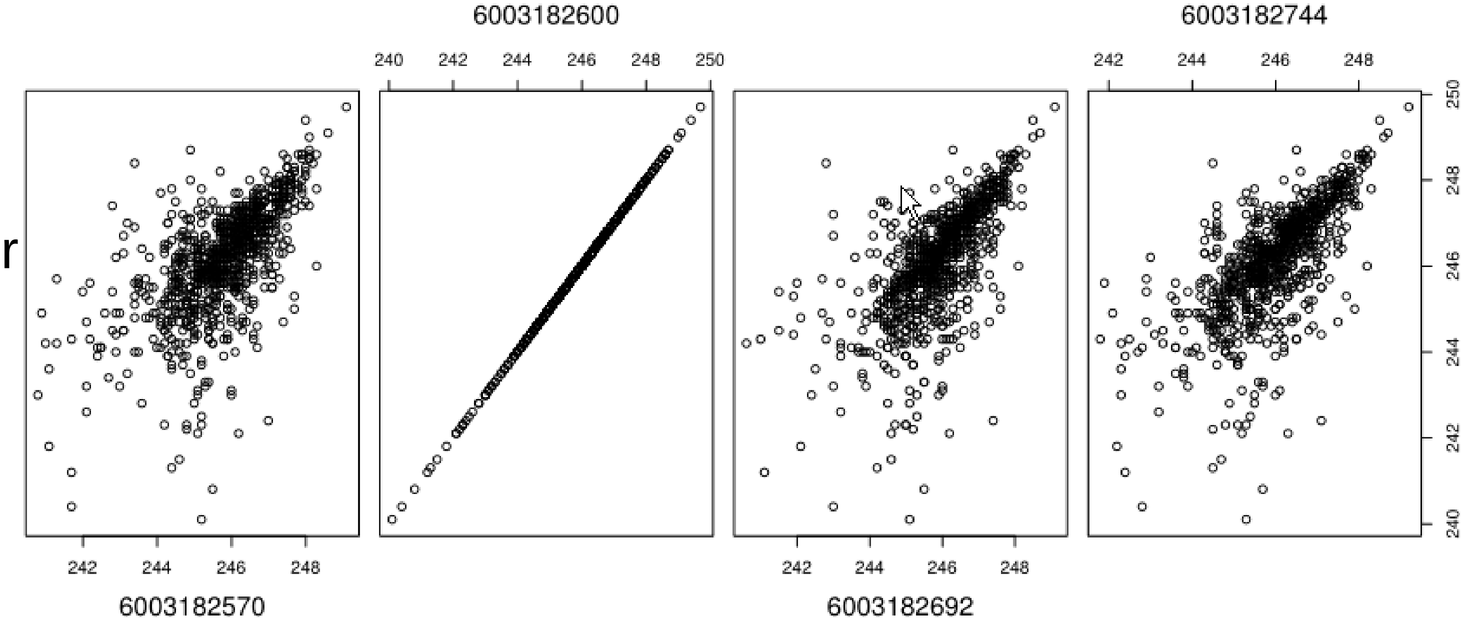
Preliminary Transformer ID Results



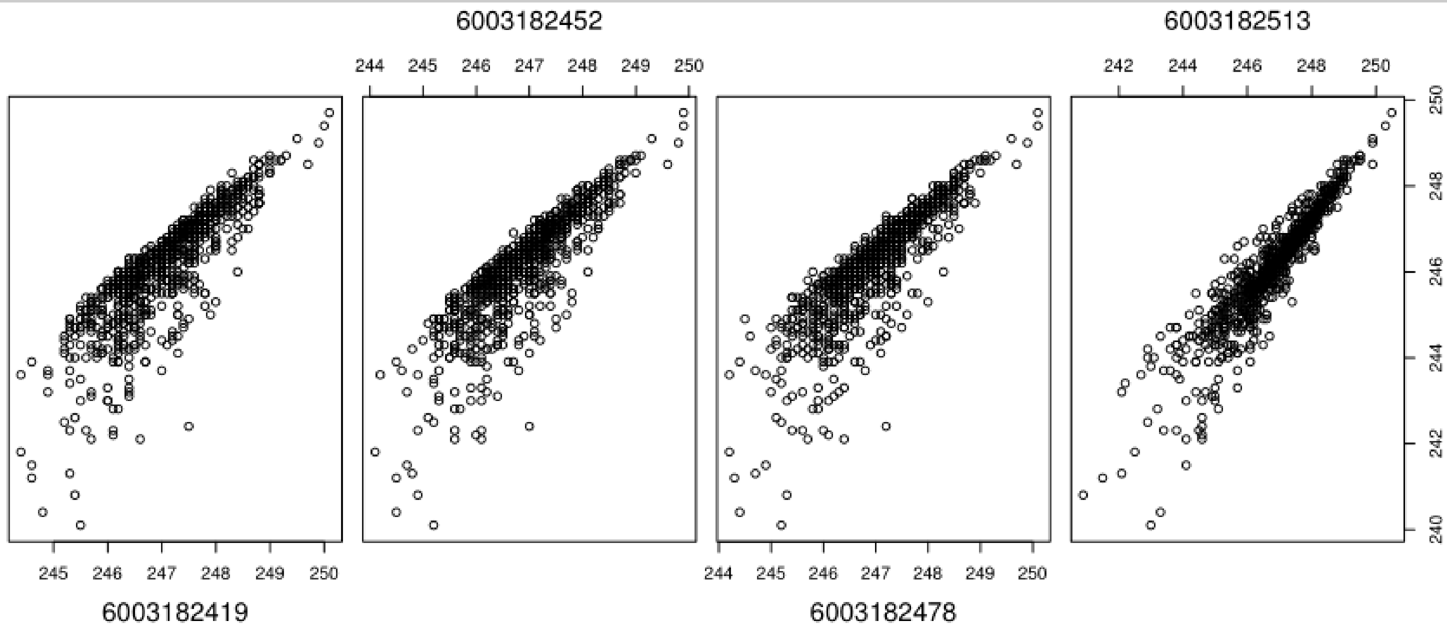
- 7 that were accurately classified
- 1 that was not in the GIS group but was on an unmodeled transformer
- 1 the algorithm missed – there was a lot of distance between this meter and others on that transformer

Transformer Error ID

GIS Transformer Grouping



Transformer grouping with the best correlation

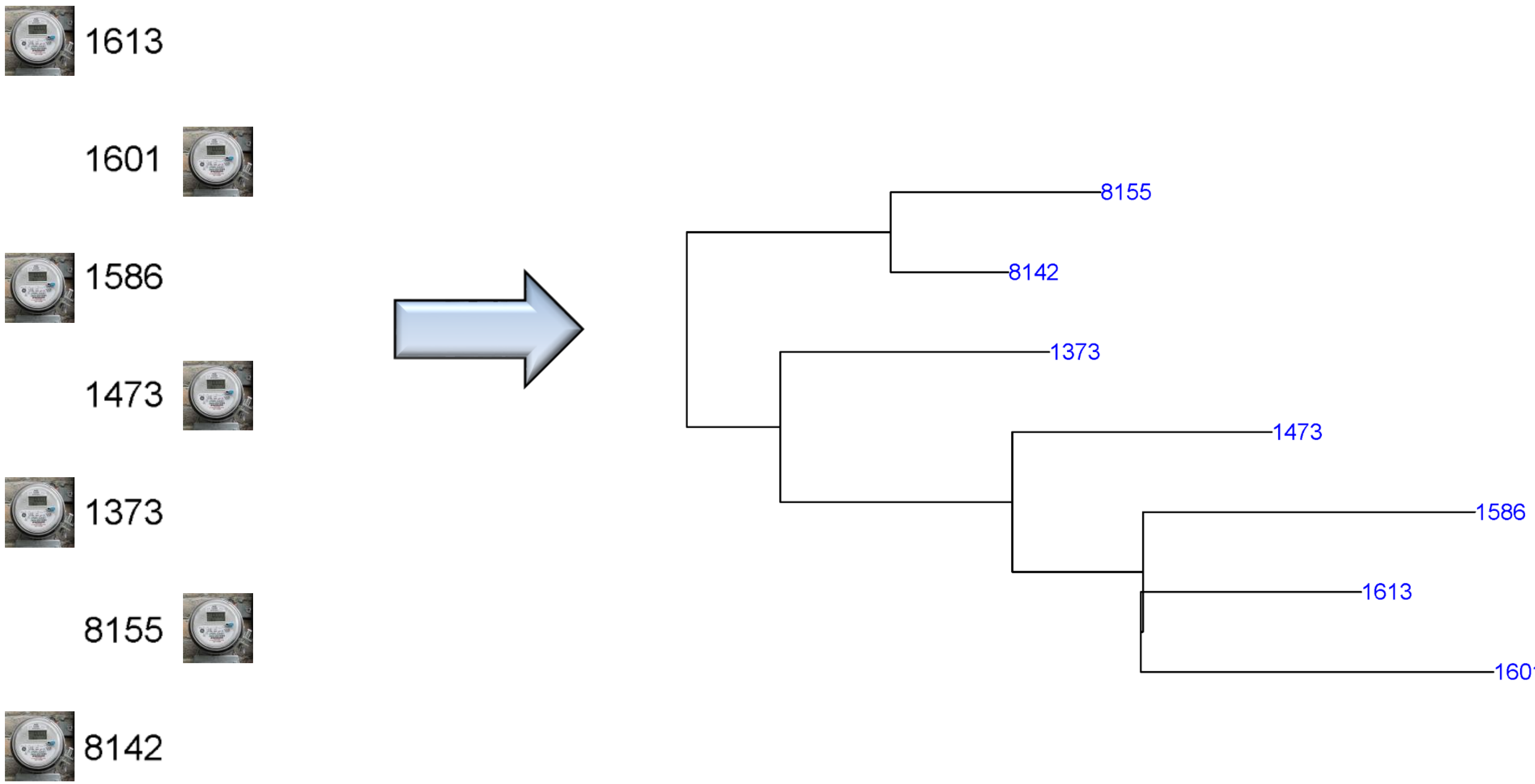


Gaps in Secondary Model

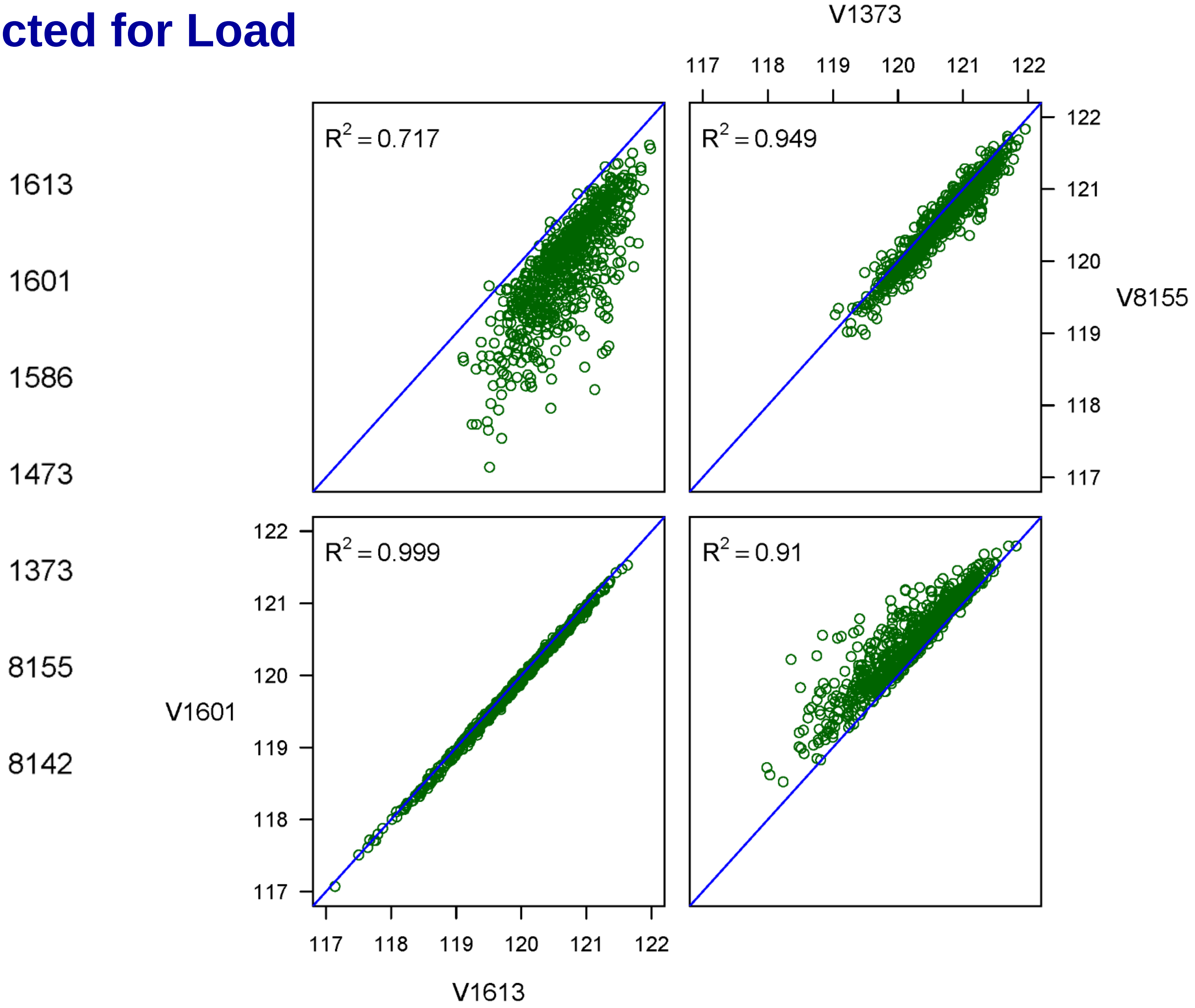
- Problem
  - Secondary circuits are missing.
  - Trans-premise relationship missing.
- Impact
  - Poor transformer maintenance.
  - Impacts with DR and DER.
  - Outage management impacts.
  - Poor planning.

“The biggest issue with our GIS data is mapping out the secondary network. This is an ongoing issue and we don’t have a good solution.”

Using AMI to Map the Secondary – Bottom-Up Grouping



Corrected for Load



Corrected for Load

1613

1601

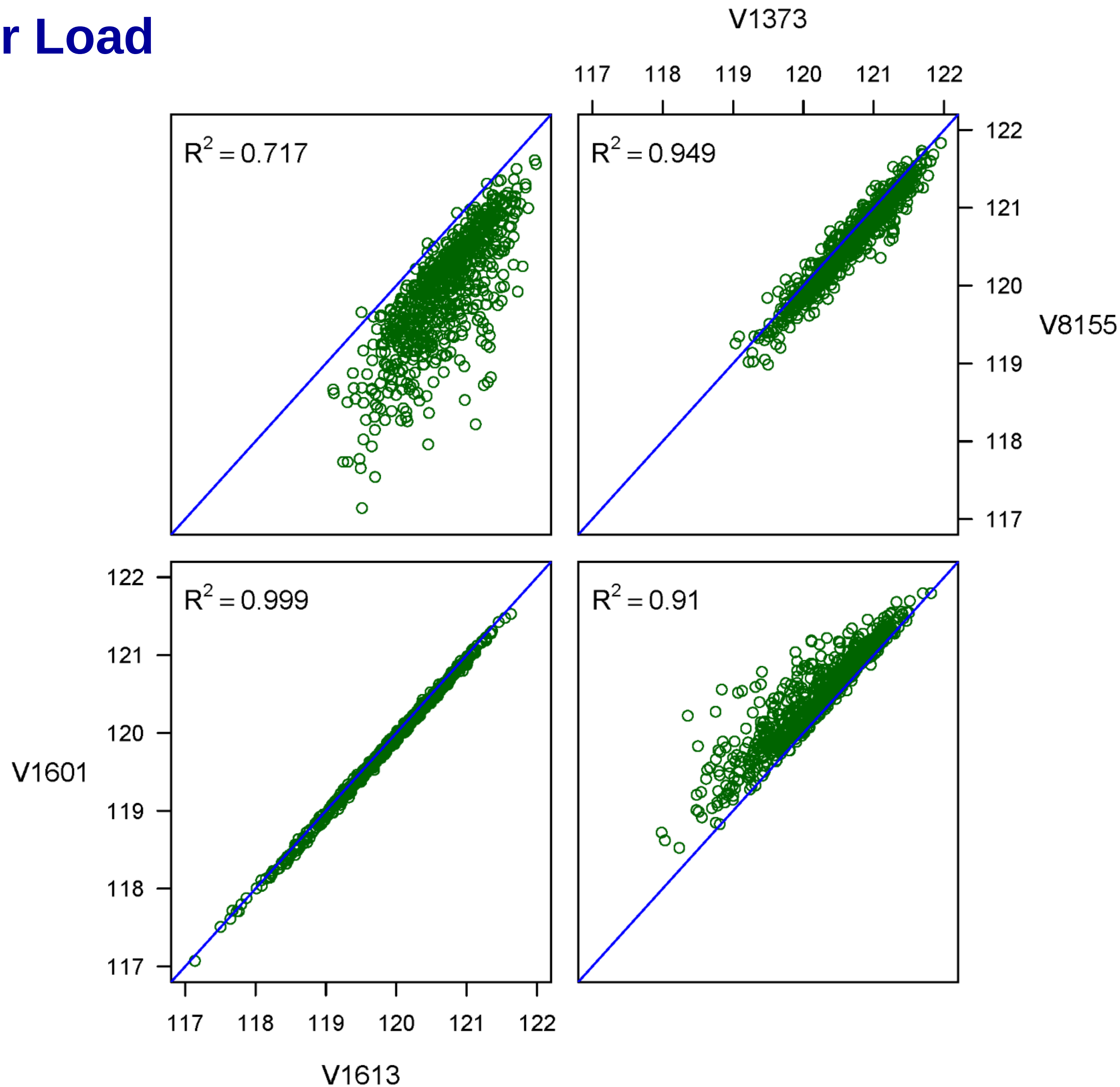
1586

1473

1373

8155

8142



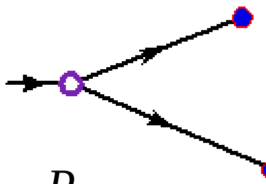
Basic Algorithm

- Start with a set of meters to be grouped (set *A*), each meter having series of voltage, watt, and var averages captured simultaneously.
- For each meter *i*, solve the regression model paired with every other meter in set *A*.
- Pick the meter *j* that has the highest R^2 value in regressions with meter *i*.
- For the new meter pair of closely coupled meters *i* and *j*, store the line resistances and reactances for each branch from the regression model. Also find the voltage and real and reactive power at the common point. This forms a new metering point *k*.
- Remove meters *i* and *j* from set *A*. Add the new meter point *k* to set *A*.
- Repeat starting with step two until all meters have been paired together.

$$V_{\text{drop}} \approx R \cdot I_R + X \cdot I_X$$

$$V_0 = V_1 + R_1 \cdot I_{1,R} + X_1 \cdot I_{1,X} = V_2 + R_2 \cdot I_{2,R} + X_2 \cdot I_{2,X}$$

$$V_1 = \beta_0 + \beta_0 \cdot V_2 + R_2 \cdot I_{2,R} + X_2 \cdot I_{2,X} + R_1 \cdot \left(-I_{1,R}\right) + X_1 \cdot \left(-I_{1,X}\right)$$

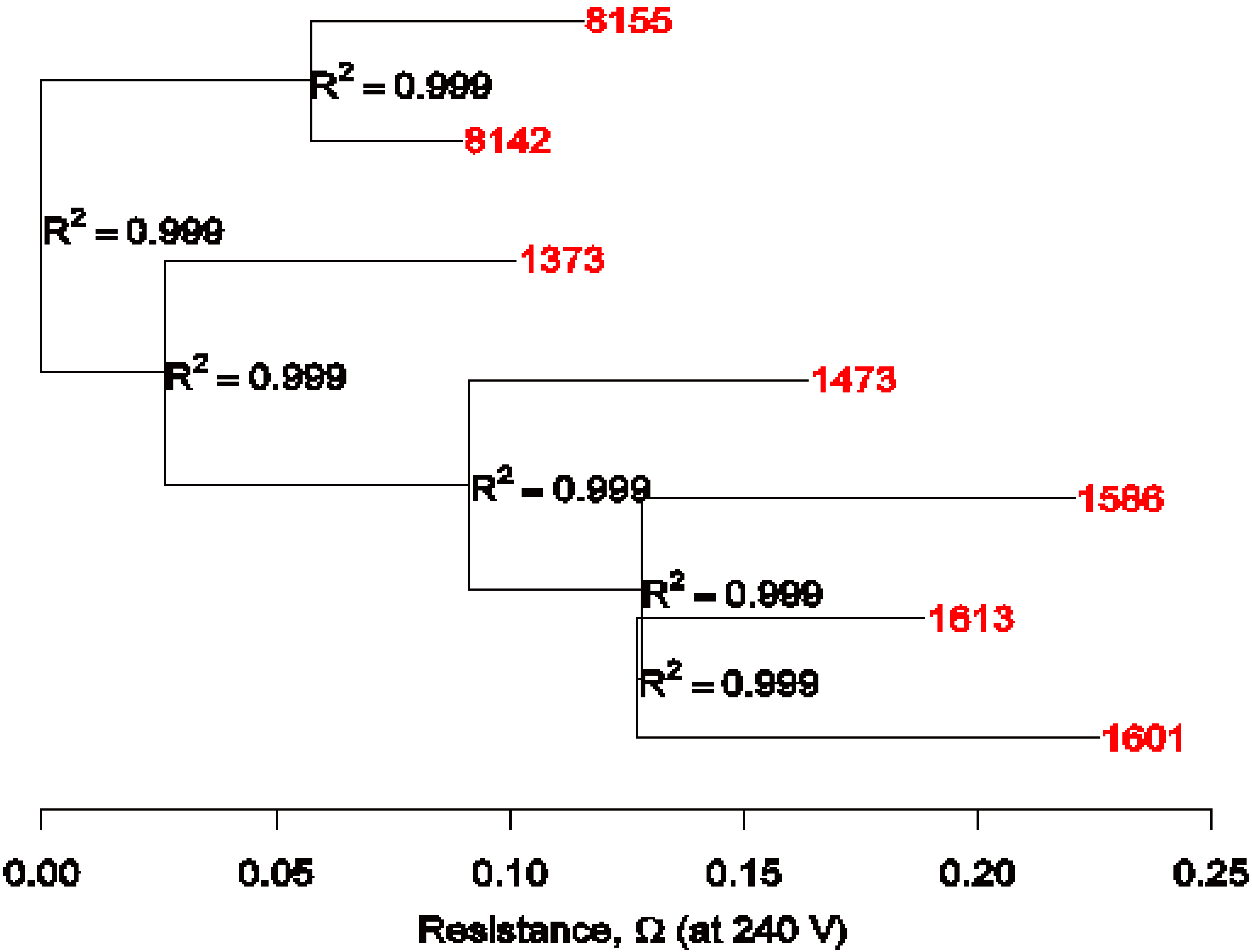


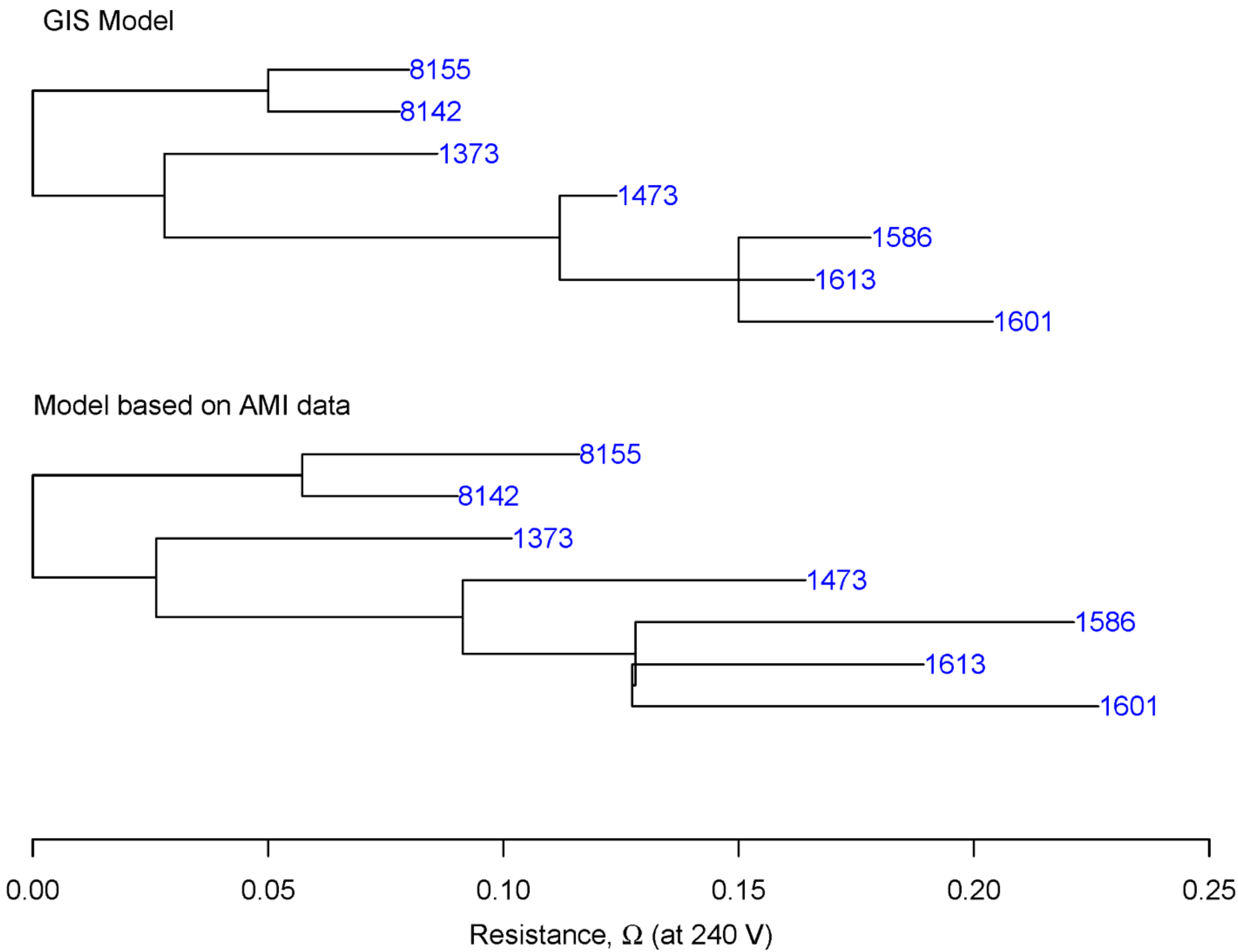
$$I_{i,R} = \frac{P_i}{V_i} \qquad I_{i,X} = \frac{Q_i}{V_i}$$

$$V_{0,\text{estimate}\,1} = V_1 + R_1 \cdot I_{1,R} + X_1 \cdot I_{1,X}$$

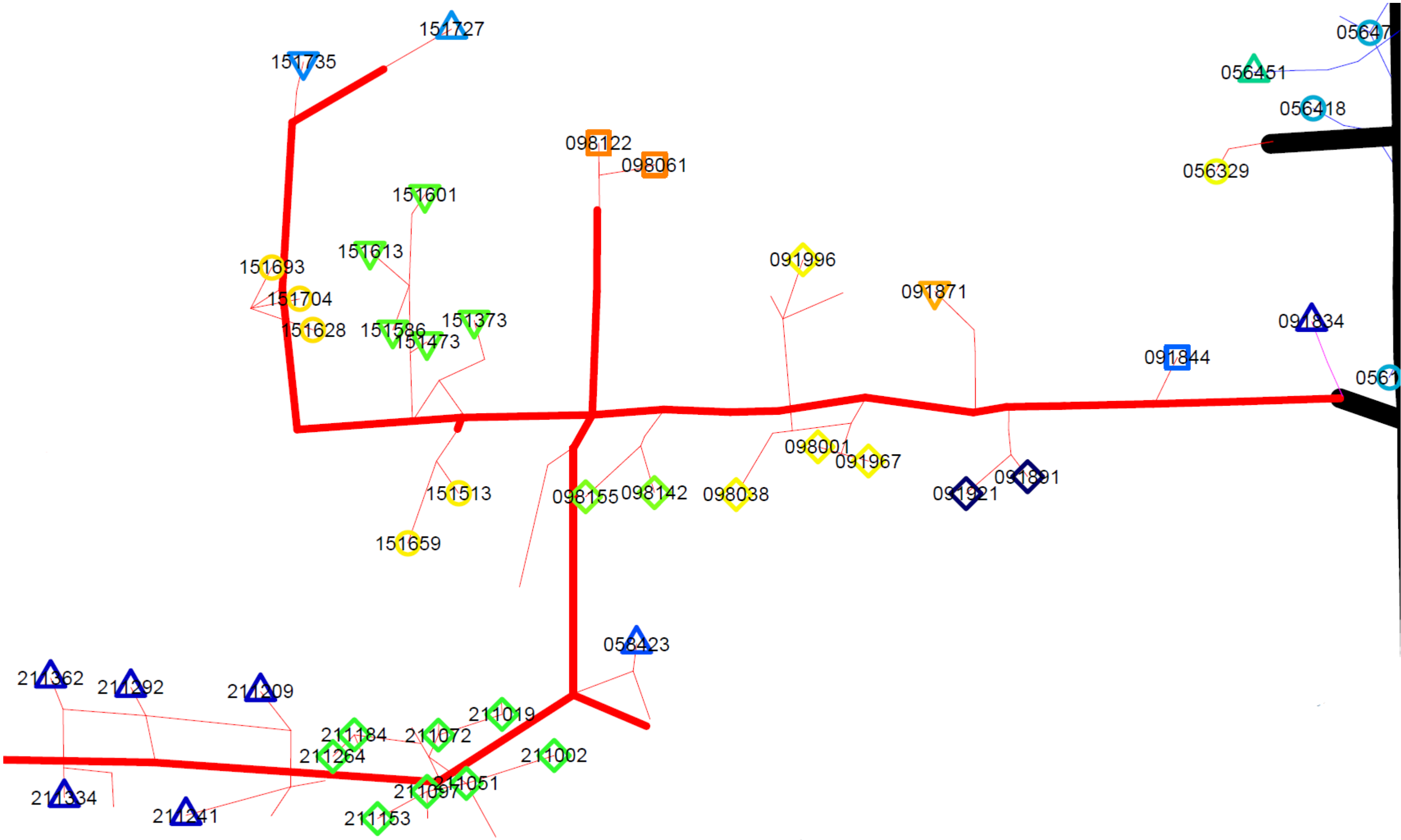
$$V_{0,\text{estimate}\,2} = V_2 + R_2 \cdot I_{2,R} + X_2 \cdot I_{2,X}$$

$$V_0 = \left(V_{0,\text{estimate}\,1} + V_{0,\text{estimate}\,2}\right)/2$$

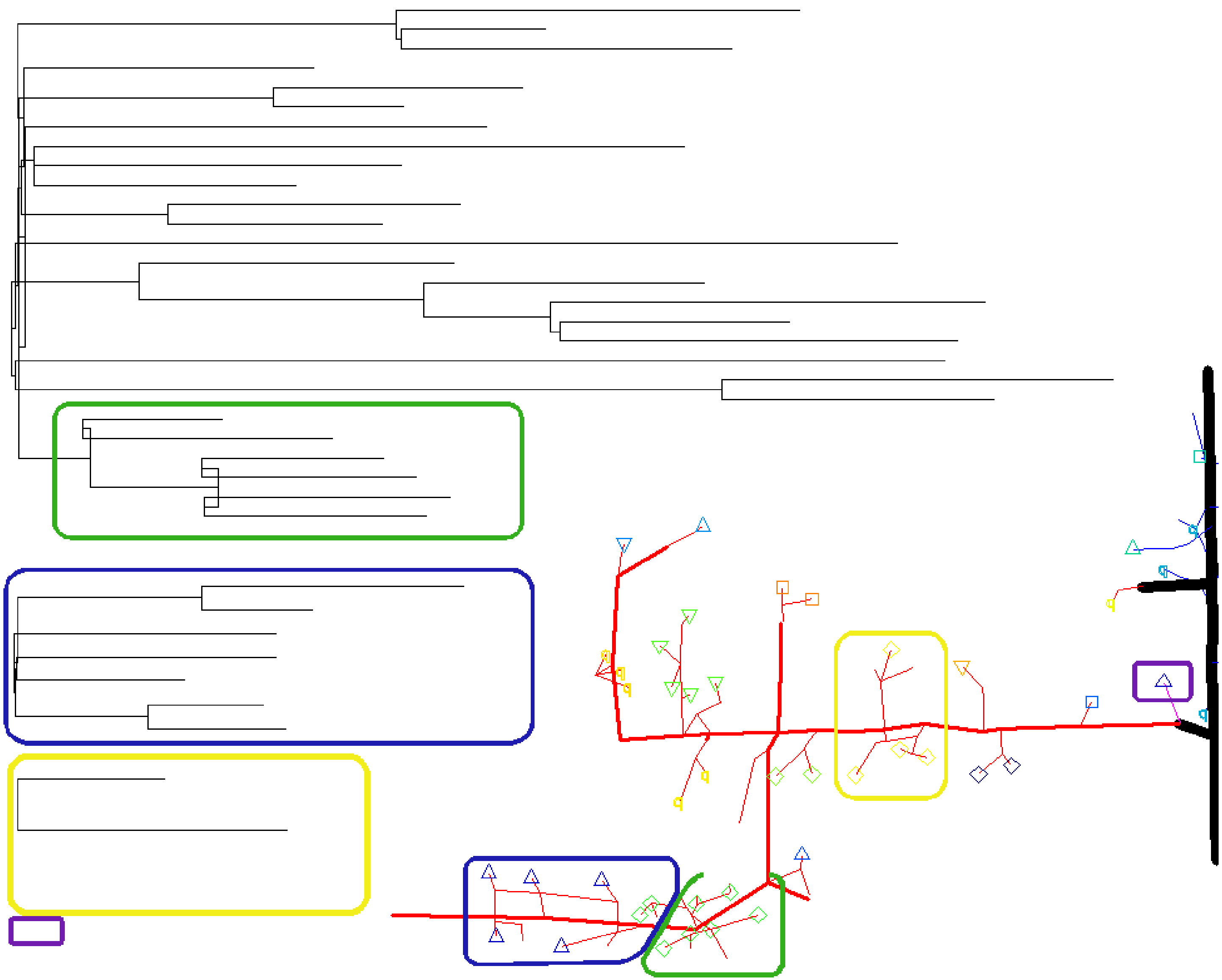

8155
R2 = 0.999
8142
R2 = 0.999
1373
R2 = 0.999
1473
R2 = 0.999
1586
R2 = 0.999
1613
R2 = 0.999
1601
0.00
0.05
0.10
0.15
0.20
0.25
Resistance, Ω (at 240 V)


GIS Model
8155
8142
1373
1473
1586
1613
1601
Model based on AMI data
8155
8142
1373
1473
1586
1613
1601
0.00
0.05
0.10
0.15
0.20
0.25
Resistance, Ω (at 240 V)

A Whole Tap


151727
151735
098122
098061
151601
151613
151693
151704
151628
151586
151473
151373
091996
091871
091834
091844
056451
056418
056329
151513
151659
098155
098142
098038
098001
091967
091921
091891
058423
211362
211292
211209
211019
211184
211072
211264
211002
211334
211241
211097
211051
211153

A Whole Tap



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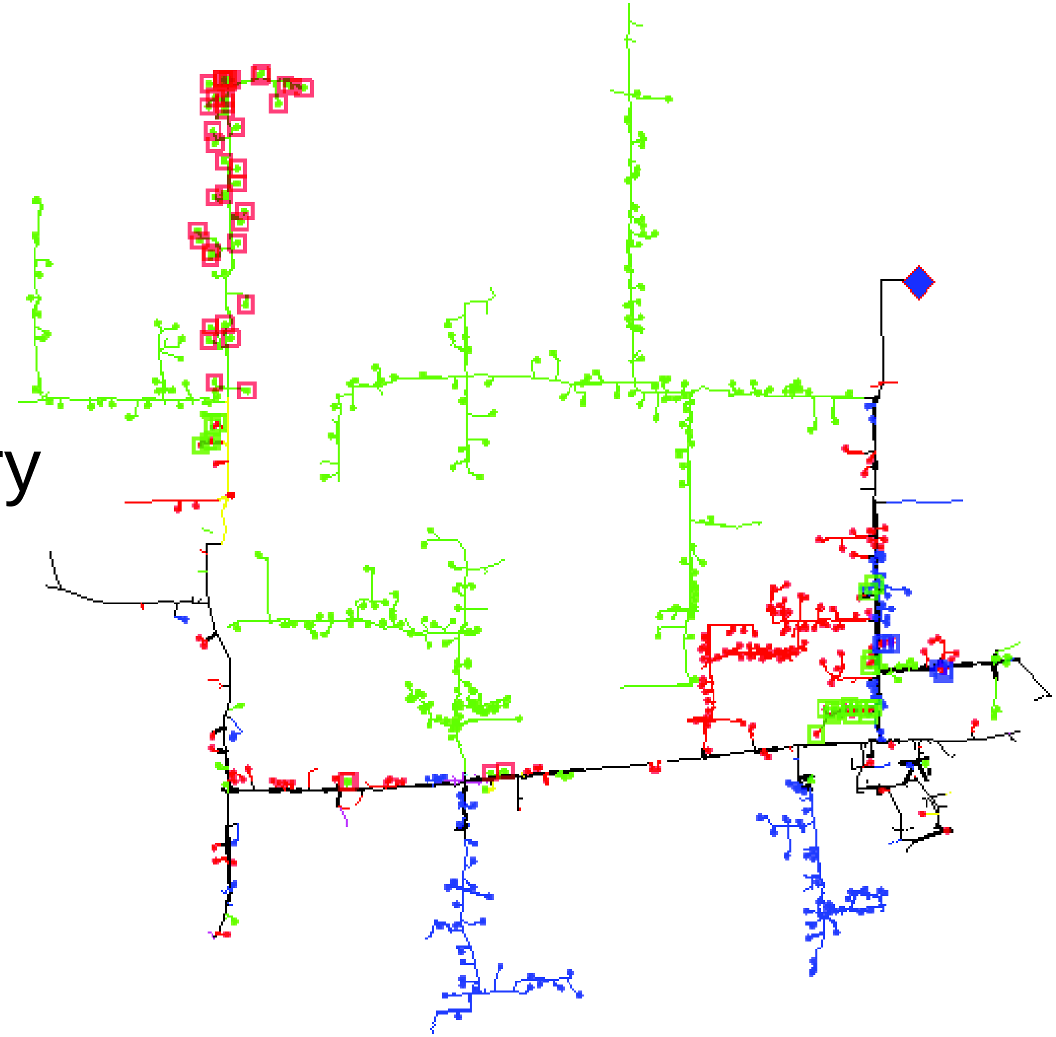
Using AMI Data You Can:

- Identify which phase a premise is on.
- Identify which meter a premise is on.
- Build out the secondary both electrically and spatially.
- And much, much, more…..



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