



Fault Locator Approach for High Impedance Grounded or Ungrounded Distribution Systems Using Synchrophasors

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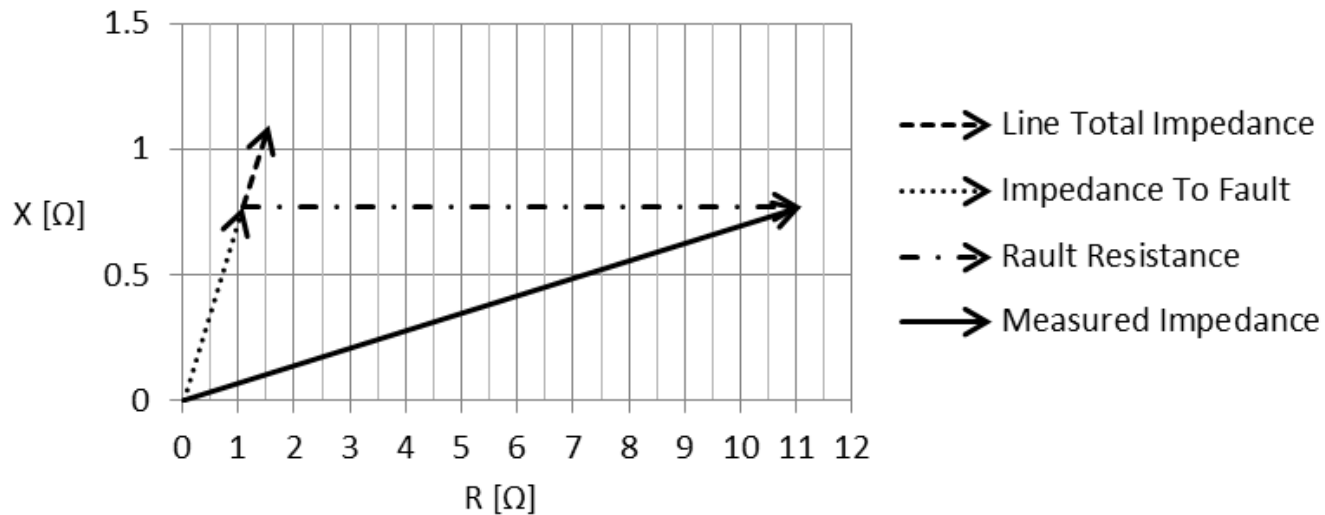
Daniel Patynowski, 01-05.06.2015
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FAULT LOCATION

- Fault location is an important part of the power system protection.
- Most algorithms are based on the line impedance calculations
- Fault location function is usually incorporated as part of line of feeder protection.

FAULT LOCATION PROBLEMS

- High error during faults with fault resistance.



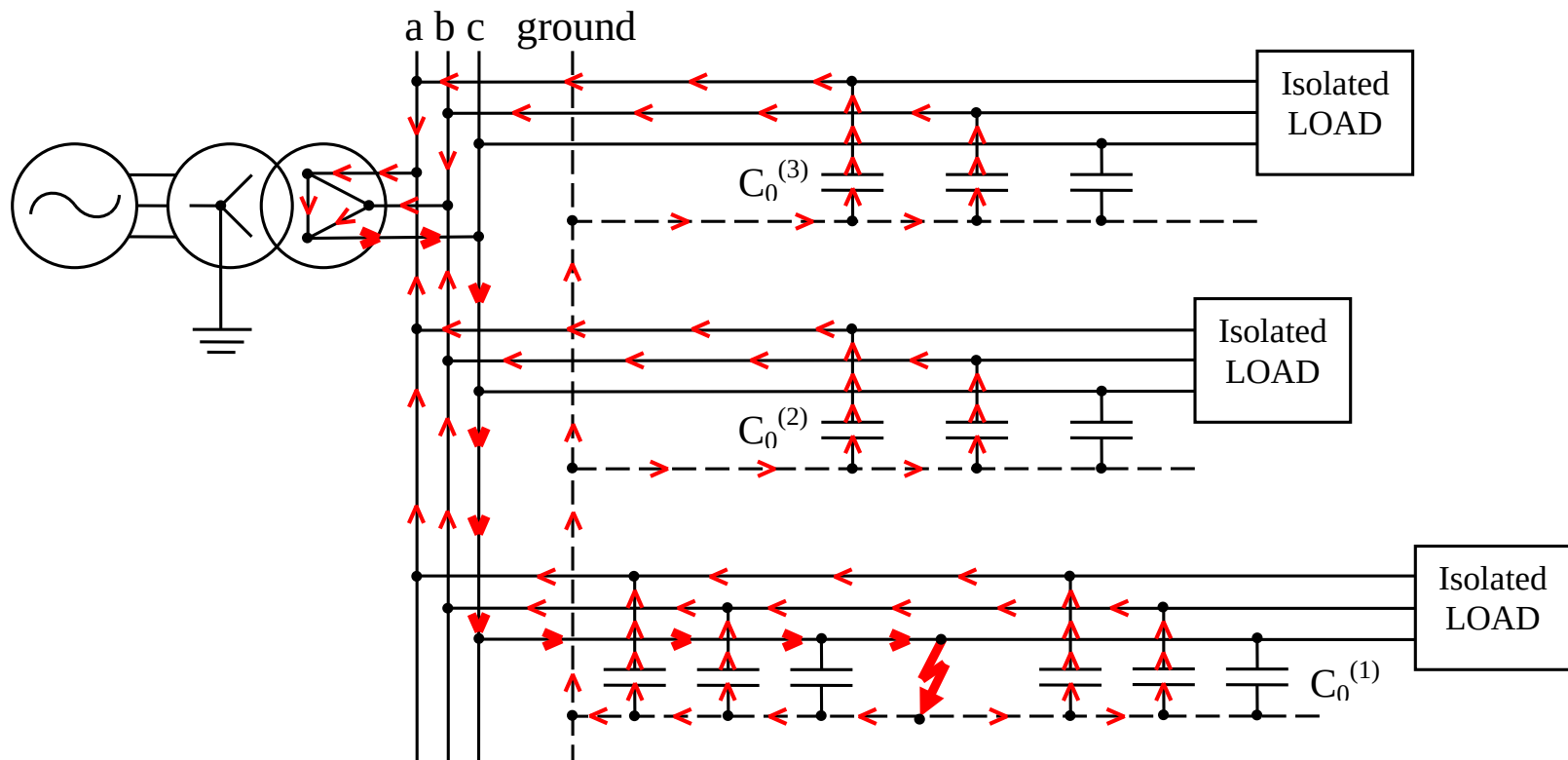
FAULT LOCATION PROBLEMS

- Impedance-based algorithms are fairly accurate only in grounded systems
- In isolated and Petersen-coil grounded systems the fault loop contains zero-sequence capacitance in series.

GROUND FAULT IN ISOLATED NETWORK

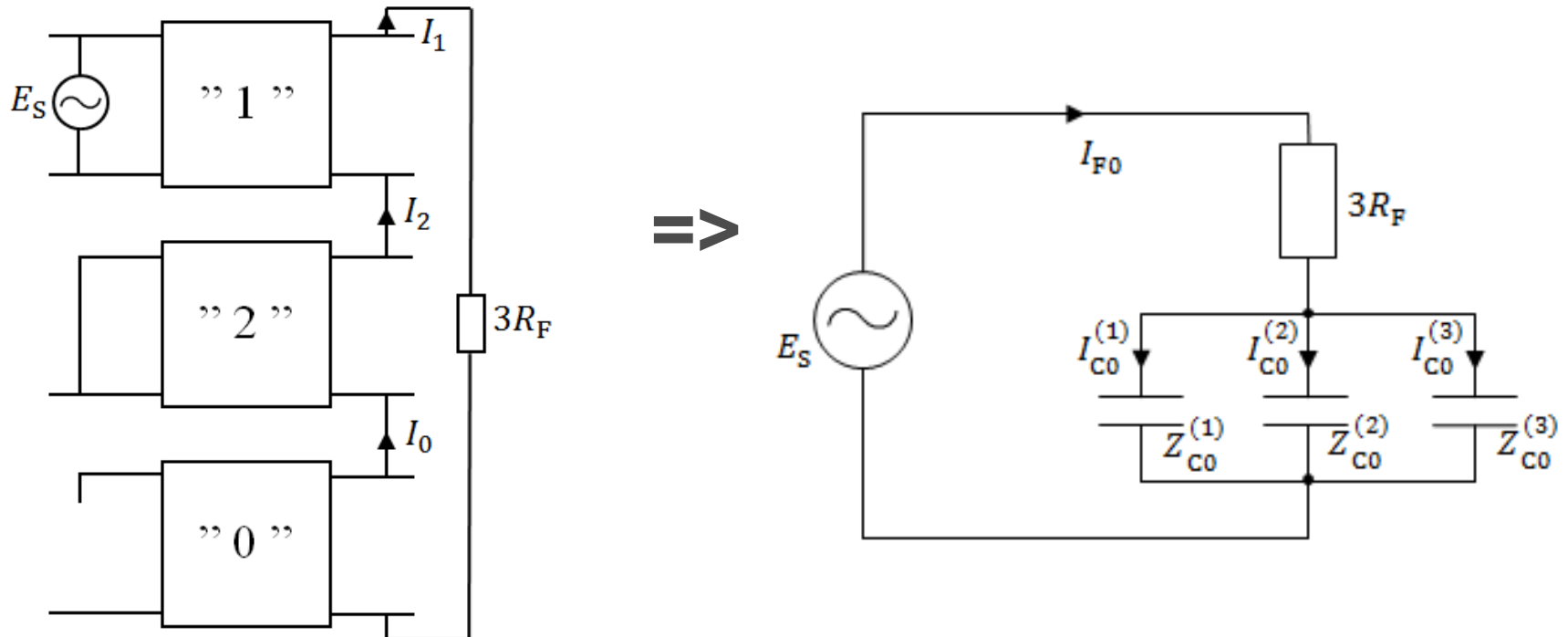
Fault current limited by grid capacitance

- Isolated systems – typically $IF < 50\text{ A}$
- Petersen-coil grounded systems $IF \approx 0\text{ A}$



GROUND FAULT IN ISOLATED NETWORK

- Fault current limited by grid capacitance



PROPOSED SOLUTION

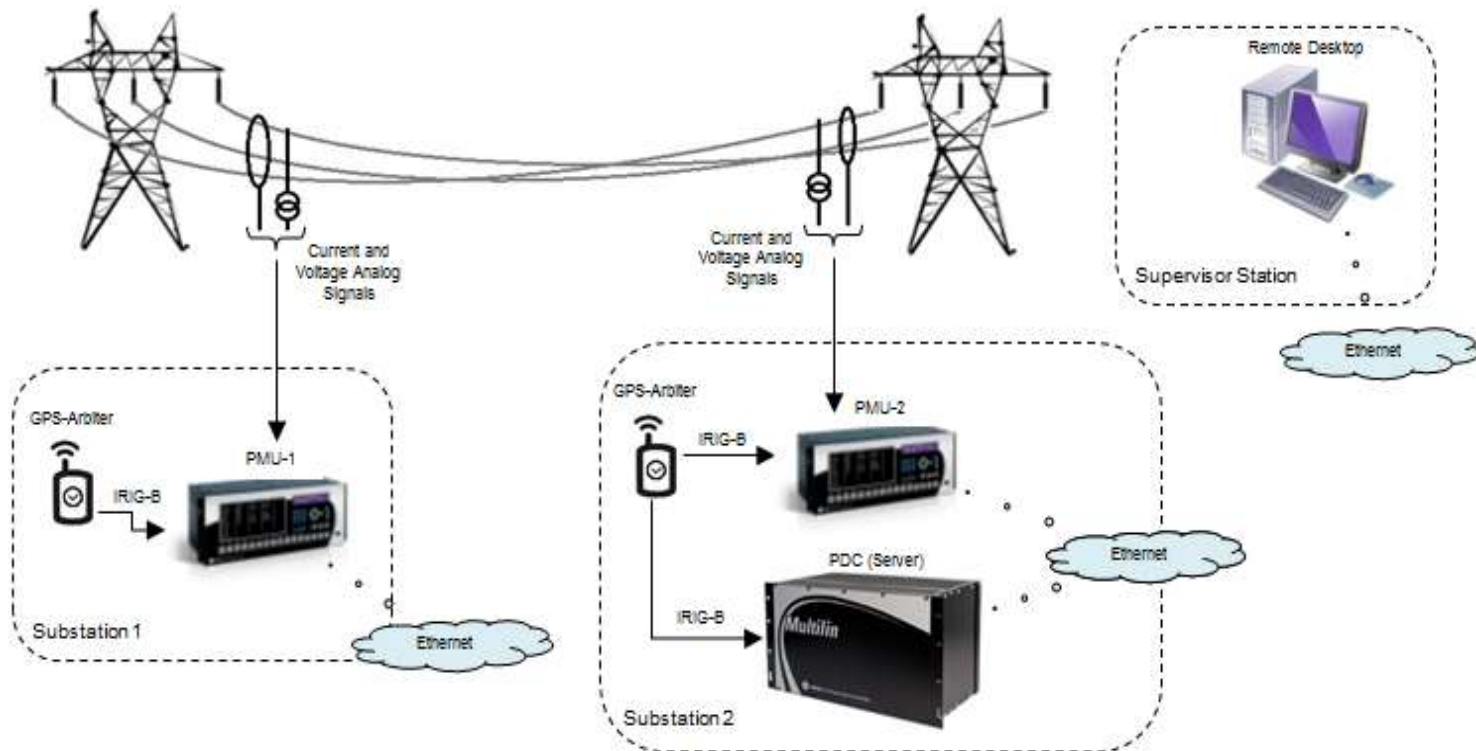
Synchrophasors
+
Algorithm with capacitance included

SYNCHROPHASORS APPROACH

- The same timestamp for all measurement devices – PMUs.
- The synchrophasors technology gives the possibility of direct comparing measurements from different geographical locations.
- Standardized and specified by IEEE C37.118 and IEC 61850.

SYNCHROPHASORS APPROACH

- The Phasor Measurement Unit can be incorporated within the protection relay
- All devices - PMUs are synchronized with external clock and send the data to the server - PDC

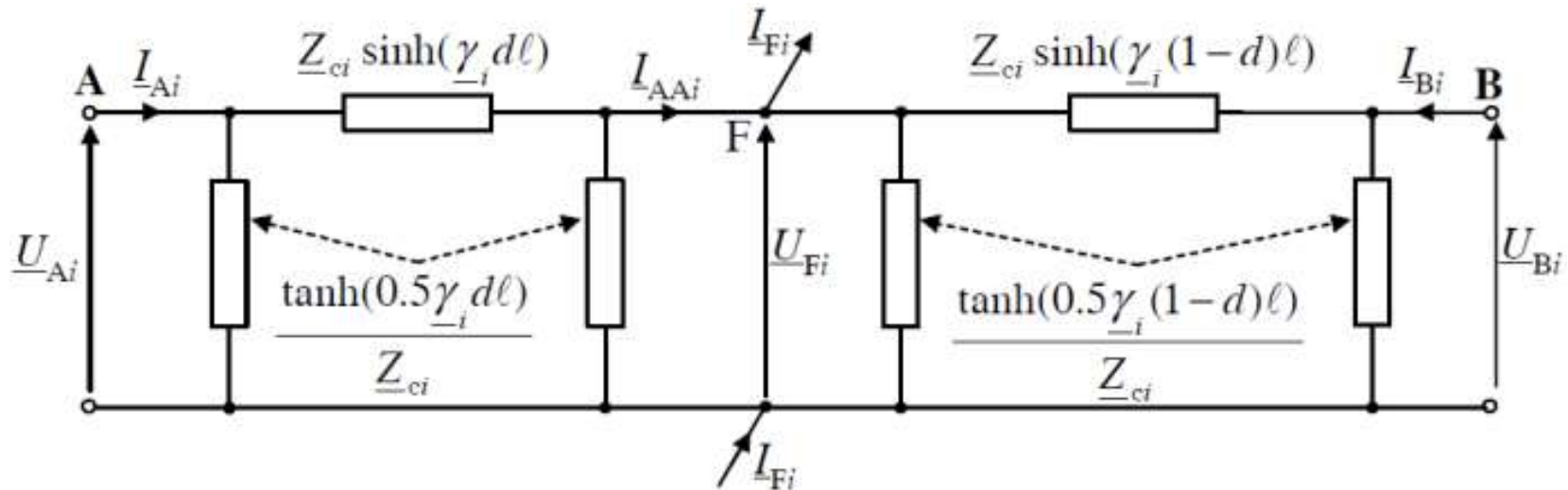


NEW FAULT LOCATOR PROPOSAL

- The new proposed approach is an application of the fault locator based on the multi-ended synchrophasor measurements
- The use of different algorithms for different systems types and faults in order to get accurate result

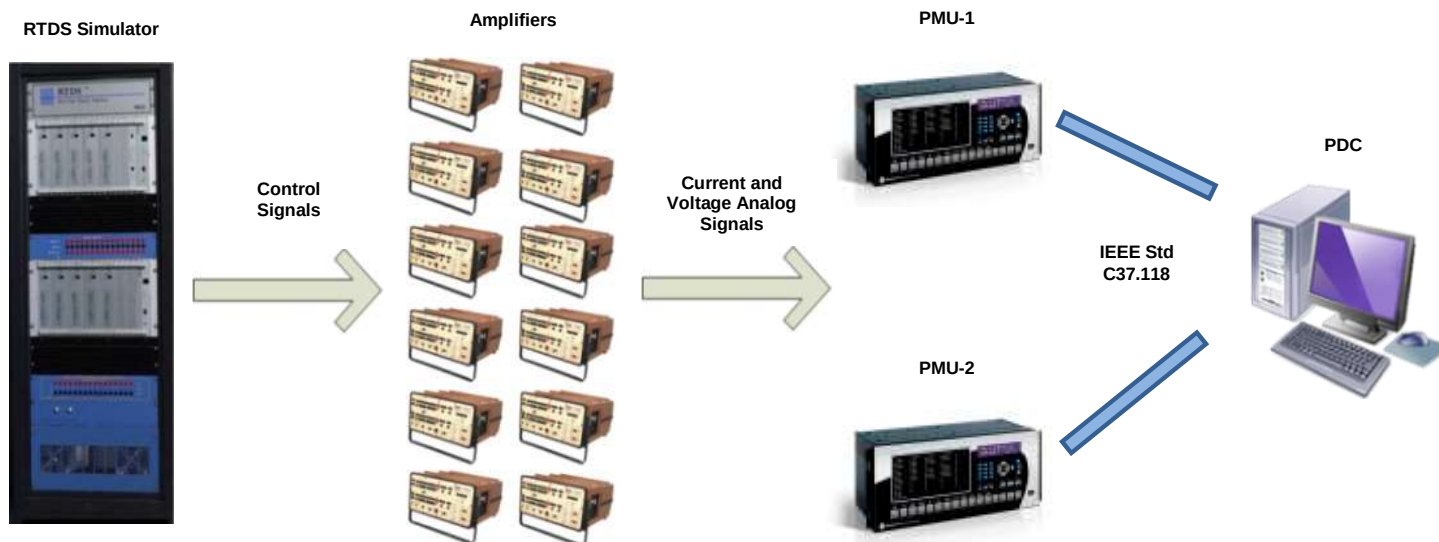
NEW FAULT LOCATOR PROPOSAL

- The use of distributed-parameter model based algorithm, which includes shunt capacitances in case of not solidly grounded systems



SIMULATIONS – RTDS INJECTIONS

- The application was tested using Real Time Digital Simulator by analog injections in the feeder relays



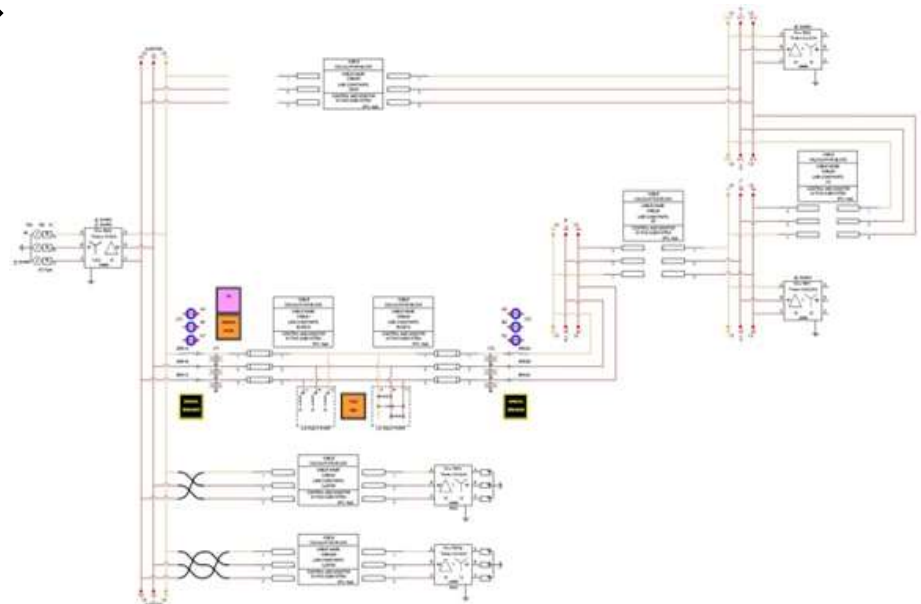
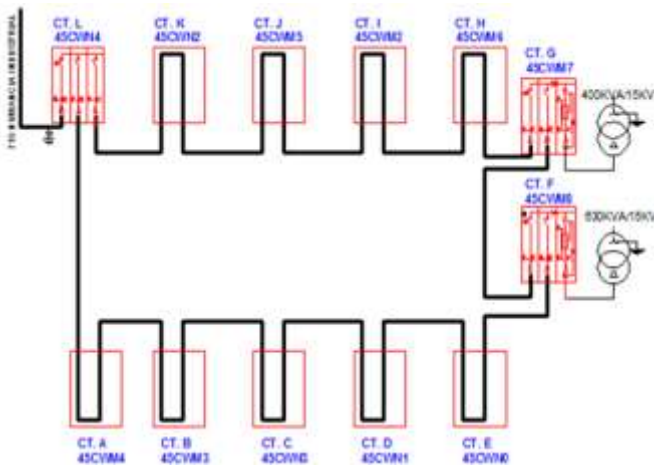
SIMULATIONS – RTDS MODEL

- RTDS test model was created based on real grid data. The project was performed in cooperation with the Spanish power distribution company which provided existing grid topology and data.

Grid Topology



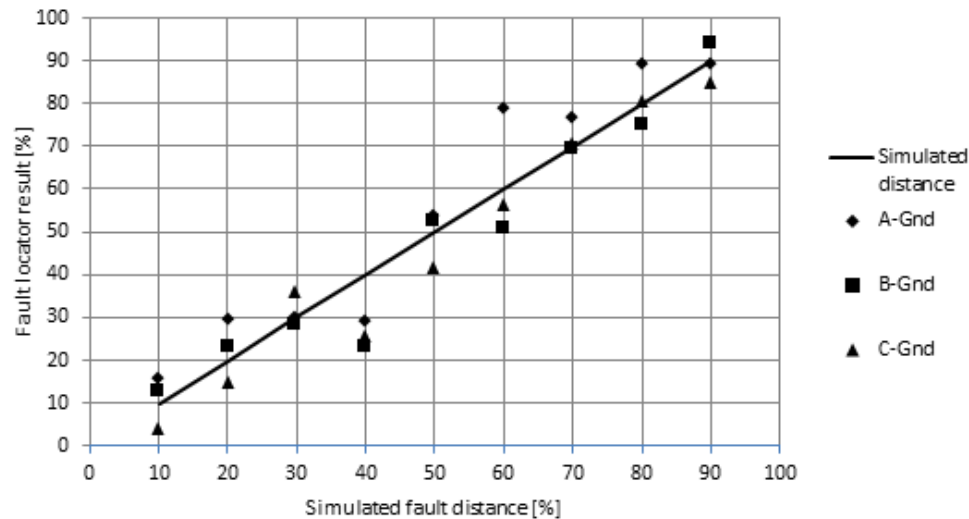
RTDS Model



SIMULATIONS - RESULTS

- The article contains tests results. Tests were performed for different fault locations, with different phases faulted and with different fault resistances.

Fault resistance = 10 Ω

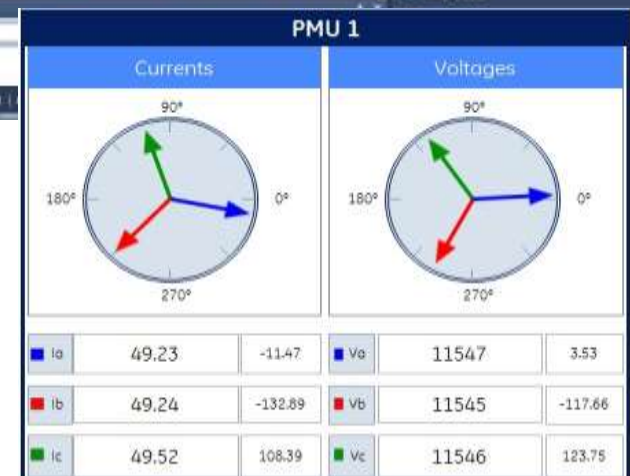
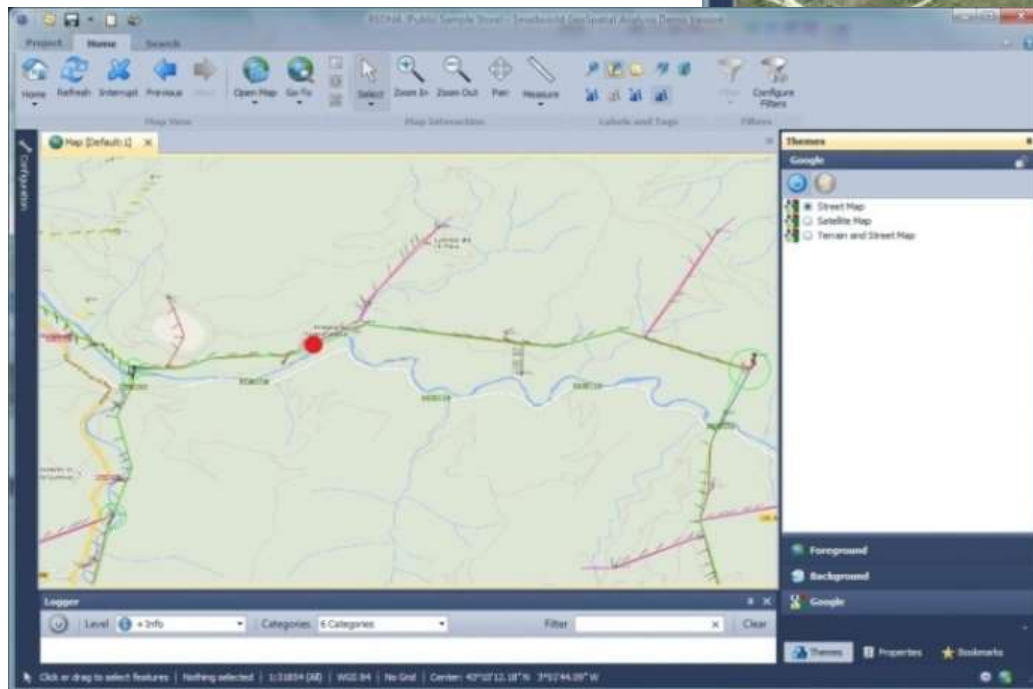
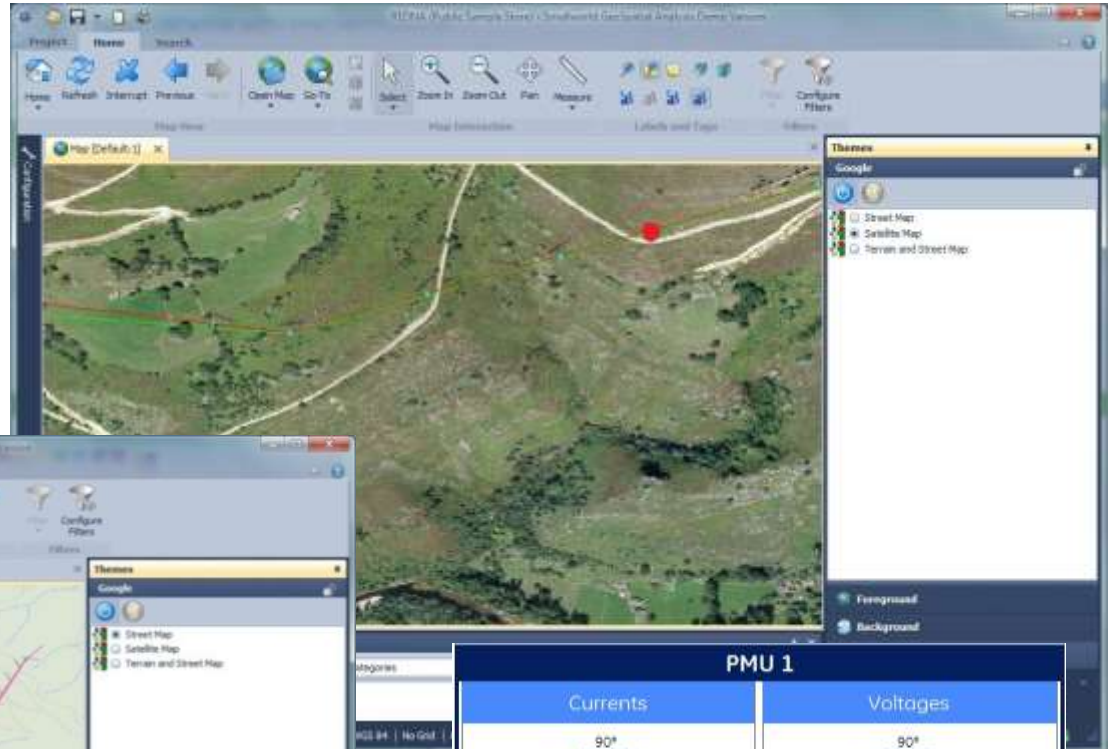


GIS INTEGRATION

- Having accurate fault locator result and powerful PDC it is possible to integrate Fault Locator and Geographic Information System (GIS) environment within the same device and visualize fault location.

GIS INTEGRATION

Grid topology
+
Satellite
background



CONCLUSION

- The article introduces new fault locator approach based on synchrophasors technology
- Based on isolated network example, the article shows how we can improve fault locator performance using the multiended measurements
- The article shows how combining the synchrophasors and GIS technologies we can create advanced and powerful grid monitoring



Thank You



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