ULTRA-HIGH SPEED TRANSMISSION LINE PROTECTION PERFORMANCE IN TIME DOMAIN DUE TO SEVERAL CONTINGENCY SITUATIONS

Paulo Sergio Pereira Junior
Why Traveling Waves?
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• More **accurate** Fault Location

• **Faster** Protection Performance

• Better Performance in **Hybrid** and **Compensated** Line

• Improved Performance with **IBRs**

• **Faster** Fault Elimination -> **Safety, Stability**
# Approach Comparison

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<th>FEATURE</th>
<th>CE-TW1</th>
<th>PULSE GENERATOR</th>
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<td>Simulation fidelity</td>
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<td>Injection level</td>
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<td>IED input test</td>
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<td>Portability</td>
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<td>Test on site</td>
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<td>Investment</td>
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<td>COMTRADE with TW</td>
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<td>Sensitivity test</td>
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<td>Number of reflections</td>
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<td>Transmission line models</td>
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*Why not test using the best of solutions?*
• Brazilian software for simulation of electromechanical and electromagnetic transients
• Developed since 2009
• Friendly interface
• + 400 components
• Allows the reproduction / acquisition of the simulated signals by the test set
• Closed Loop Test
PS Simul + CE-TW1 solution allows:

- **Importing** COMTRADE:
  - Analysis (Bewley-Lattice)
  - Reproduction (Secondary Levels)

- **Exporting** COMTRADE:
  - Reproduction (Playback)
Remote Generation

- Controlling **multiple test sets** on the same screen
- **Local** Network or **Cloud**
- Centralized Control
- **Report Concentration**
- Application:
  - **End-to-end** testing
  - **Distributed** testing
Case Study

- Power System (230 kV class) modeled in **PS Simul**
- Test cases changing: **Fault type, fault location, incidence angle**
- Running **76** test scenarios repeated **3** times each -> **228 tests**
- Injection into **commercial IEDs**
- BC-G Fault
- Location: 45%
Results

Trip Times
- 21: average of 12ms
- TW: average of 0.9ms

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<tr>
<th></th>
<th>SS1</th>
<th>SS2</th>
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<tbody>
<tr>
<td>TW</td>
<td>0.646</td>
<td>0.646</td>
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<tr>
<td>21 (Z1)</td>
<td>8.355</td>
<td>8.250</td>
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<tr>
<td>Avg</td>
<td>0.929</td>
<td>0.918</td>
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<tr>
<td>Max</td>
<td>1.341</td>
<td>1.306</td>
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<tr>
<td></td>
<td>26.757</td>
<td>27.035</td>
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Fault Location [%]
Trip Time x Fault Location

- The further away from the terminal, the longer the operating time
Conclusion

- 228 Contingency scenarios tested
- Most Trip times less than 1ms
- Min = 646 us
- Importance of testing the IED in conditions close to real ones
- PS Simul -> reliable models -> realistic waveforms
- CE-TW1
  - Powerful tool
  - Secondary level
  - Megahertz
THANK YOU!

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