

GRID EMT

SIMULATION INITIATIVE

Integrators in RE-INTEGRATE

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Motivation

- Global, uniform integration is still the default.
 - Examples: PSCAD, EMTP, commercial solvers
- Integrator choice does not consider the component's behavior.
 - Example: Differentiating between the fast and slow states – Stiffness
- Accuracy–robustness is handled via damping rather than through principled adaptivity.
 - Example: Large disturbance handling
- Model/tool development remains discretization-driven and labor intensive.
- Limited support exists for heterogeneous/partitioned schemes.



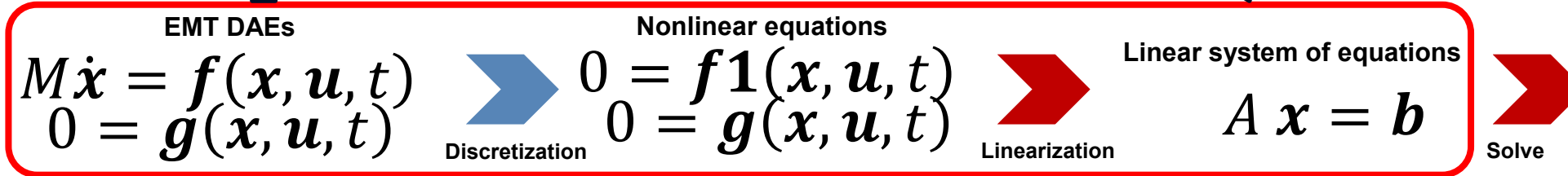
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Approach

Option 1: Manual discretization and linearization

Option 2: Automatic generation of A matrix and b through residual computations

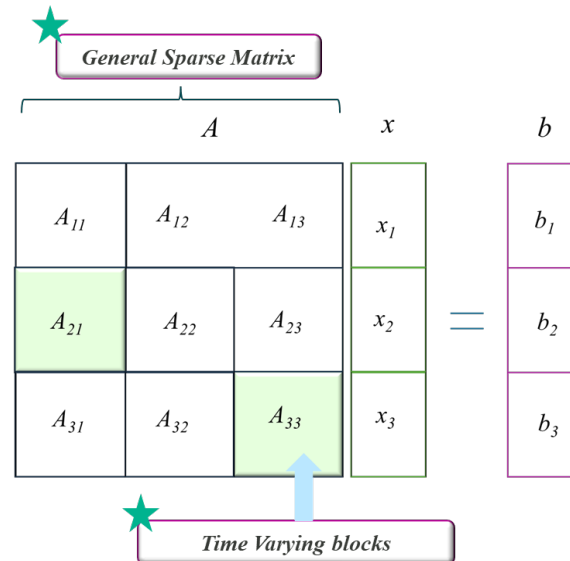
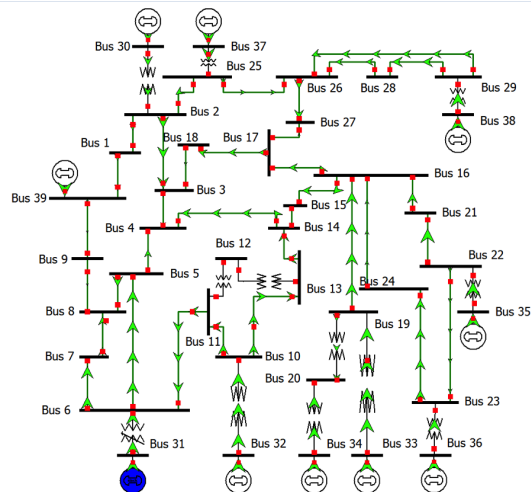
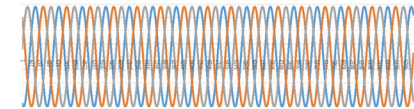


Switching hybrid analog-discrete systems

Discrete nonlinear systems

Structure-specific formation

Results



Features of Option 2

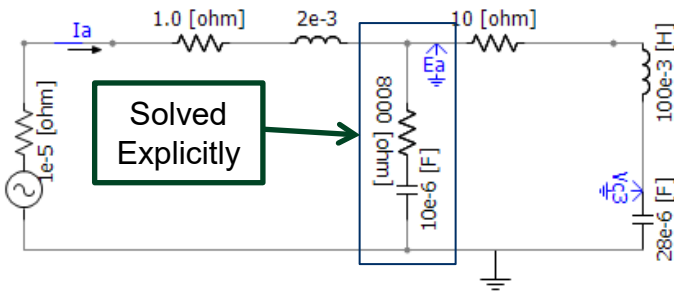
- Ease of component development
- Support for state-specific solver choice of { Forward Euler (FE), Backward (BE), Trapezoidal(TZ) }
- Multiphase representation by design
- Noniterative for EMT solver



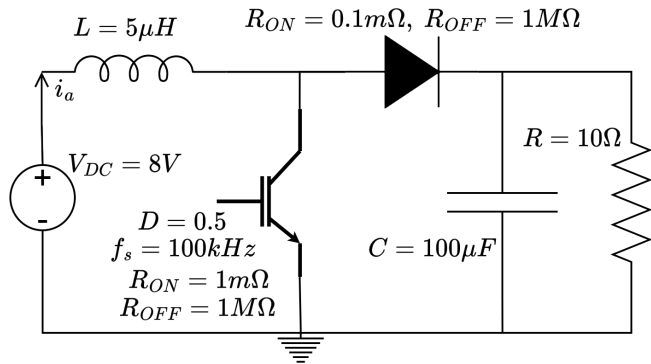
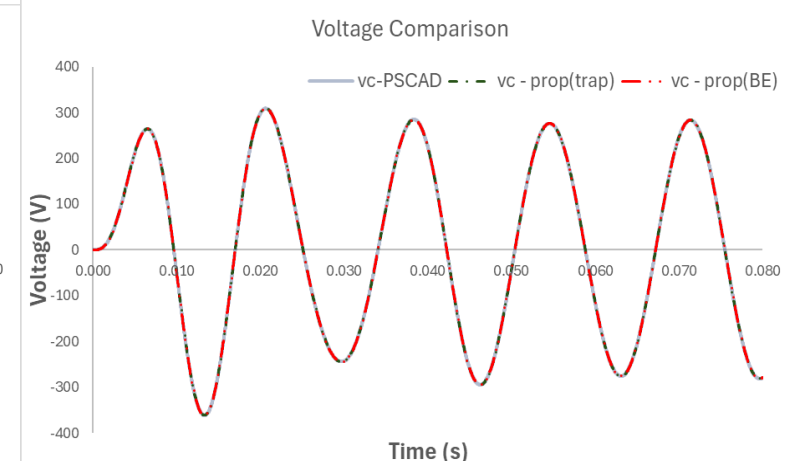
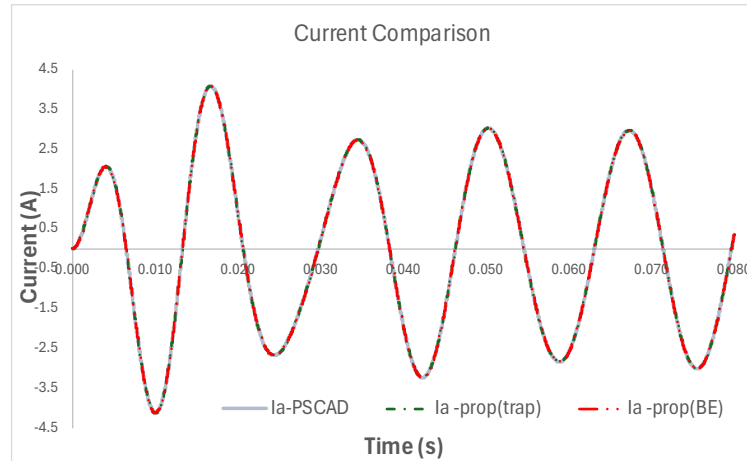
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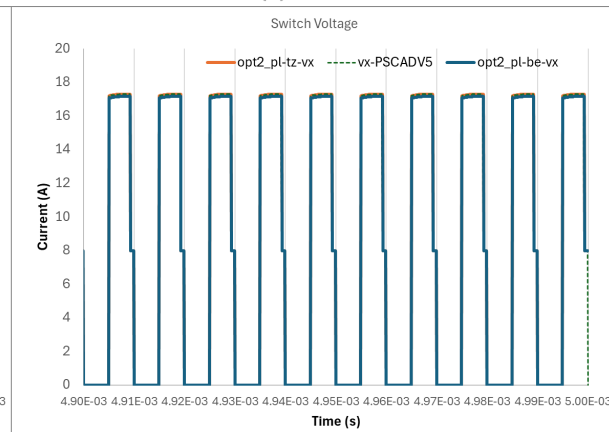
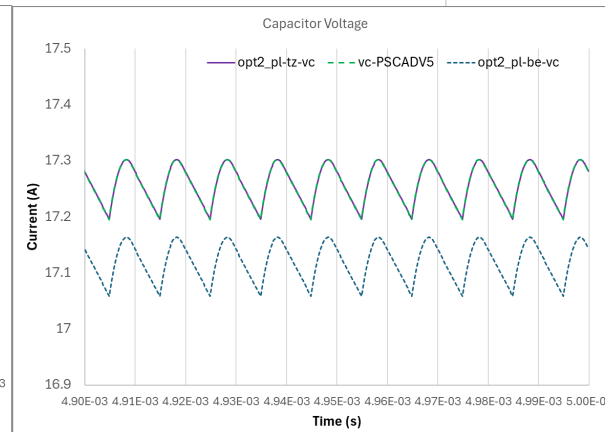
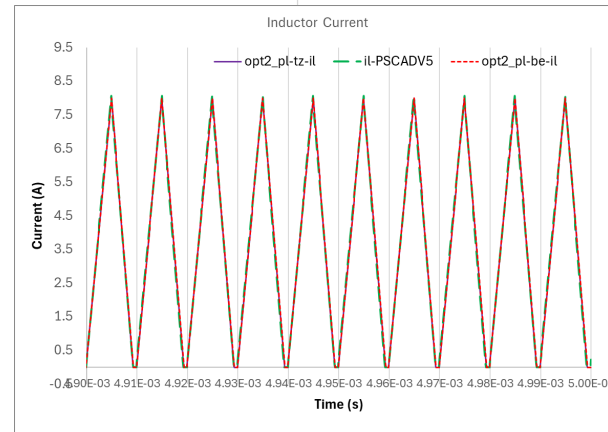
Results/Observations



Current and voltage waveforms are **matching**.
Solved using trapezoidal + forward Euler and
backward Euler + forward Euler



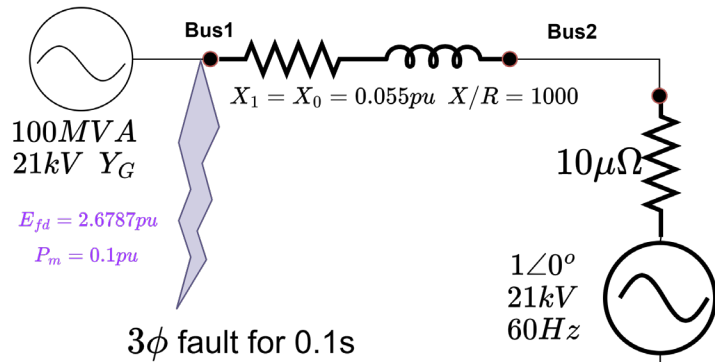
Current and voltage waveforms
are **matching**. Solved using
trapezoidal and backward Euler



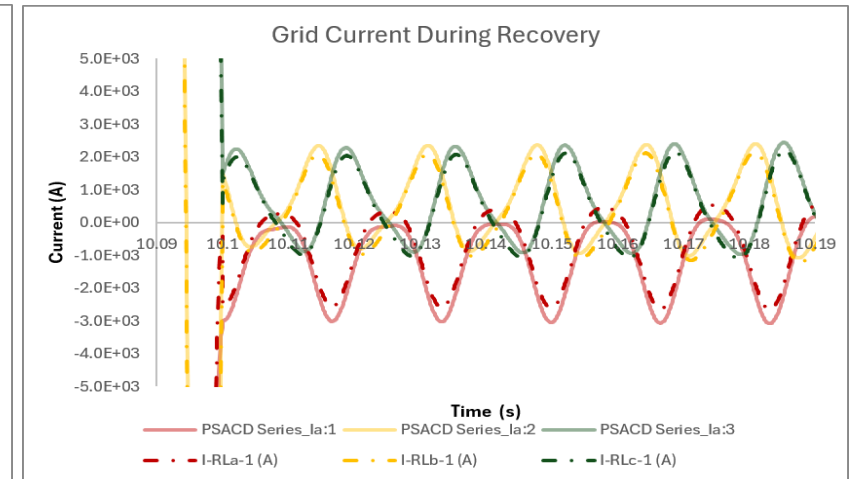
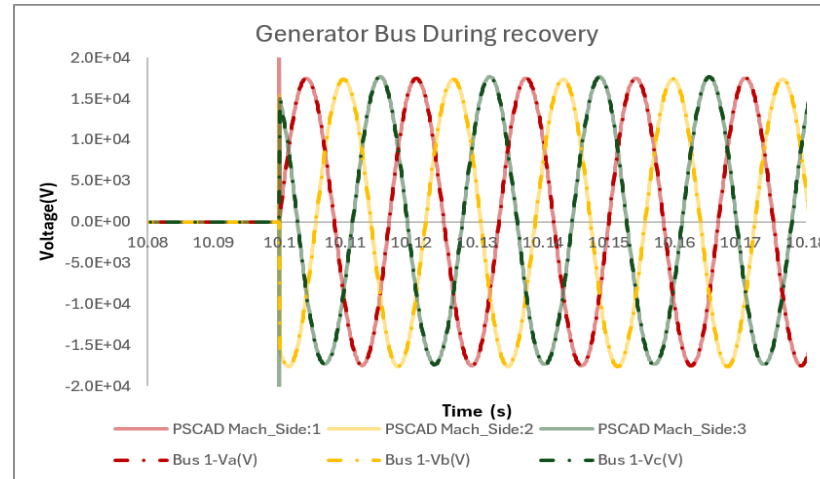
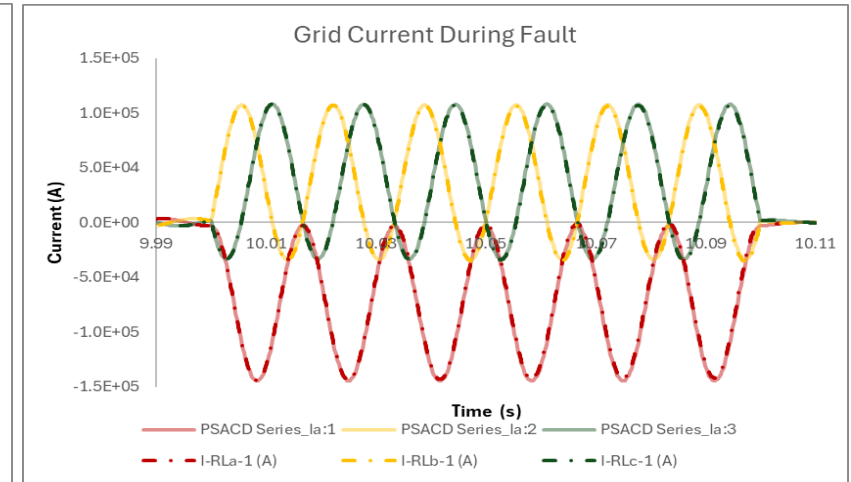
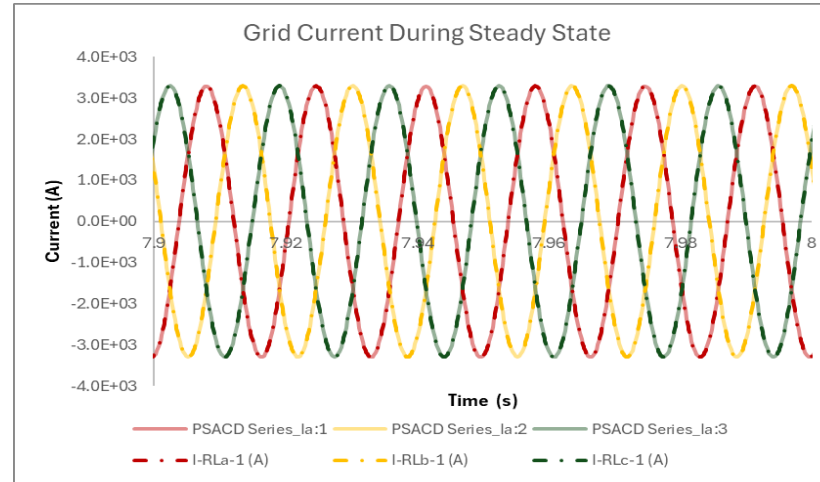
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Results/Observations



Current and voltage waveforms are **matching during both fault and steady state**. Solved using backward Euler



Demonstrated Option-2 using Linear, Switching and Non-Linear circuits



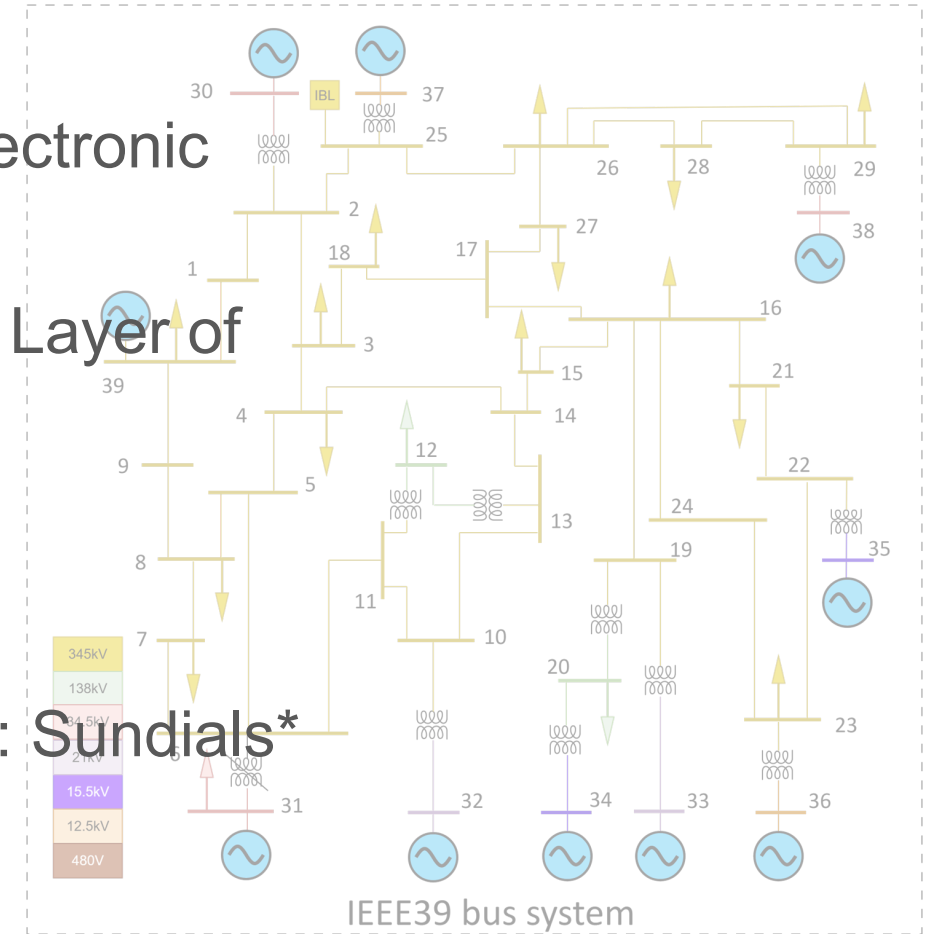
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Conclusions/Next Steps

- Addition of new components including Power Electronic Simulation and Large Networks*
- Integration to Automation Layer and Intelligence Layer of Option 1*
- Stiffness-based solver selection*
- Plug-and-play control systems framework
- Plug-and-play with other ODE solvers packages: Sundials* and odeint

*Ongoing



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Thank You

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