



March 2026

EMT Webinar Series

North American Electric Reliability Corporation
Oak Ridge National Laboratory



U.S. DEPARTMENT
of **ENERGY**

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EMT Webinar Series: Agenda (03/10)

Time (in ET)	Event	Lead
1:00 – 1:05 pm	Quick Overview	Suman Debnath, ORNL
1:05 – 1:20 pm	Requirements in EMT from Industry	Aung Thant, NERC
1:20 – 1:55 pm	Ongoing EMT Research & RE-INTEGRATE EMT Simulation	Suman Debnath, ORNL Rahul Mishra, ORNL
1:55 – 2:00 pm	Wrap-Up	



March 2026

EMT Activities: Overview

Suman Debnath, Rahul Mishra
Oak Ridge National Laboratory



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EMT Simulation: Current Challenges

Some of the challenges

- Limited understanding of usage of EMT simulations – what applications are of interest?
- No standard models are available or no guidelines on model usage (and no models in some cases)
- Simulation is not portable – not transferable
- Slow nature of simulations
- Limited scalability feasible with simulations
- Translating reliability to EMT simulation studies (e.g., PRC-029 standard) – how to do it?
- Difficulty with processing tremendous amount of data from simulations
- Difficulty with using the existing simulators with limited support tools
- Challenges with limited access to grid models by developers
- Challenge expressed by utilities, system operators— not having access to good plant models, load models

EMT Activity: Overview

EMT Activity

- Bring together national labs, academia, and industry partners under one platform to accelerate the development and use of electromagnetic transient (EMT) simulation software.

Vision

- Create an ecosystem that assists industry with realizing the transition needed to perform EMT simulations for ensuring the reliability and security of the future power grid.

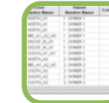
Overall Goal

- Develop a backbone that integrates models, data, validation processes, and standards and that educates/trains individuals to analyze new applications in EMT.

Impact

- In the near-term, accelerate the process of interconnection studies, increase deployment of large loads (e.g., data centers without reliability challenges in the power grid) and generation, increase return on capital, and reduce capital expenditure.

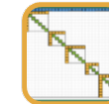
EMT Simulation Capability



Input Data Layer: Input data files (network connectivity, power dispatch, power flow information)



Model Layer: Inverters, generators, lines, transformers



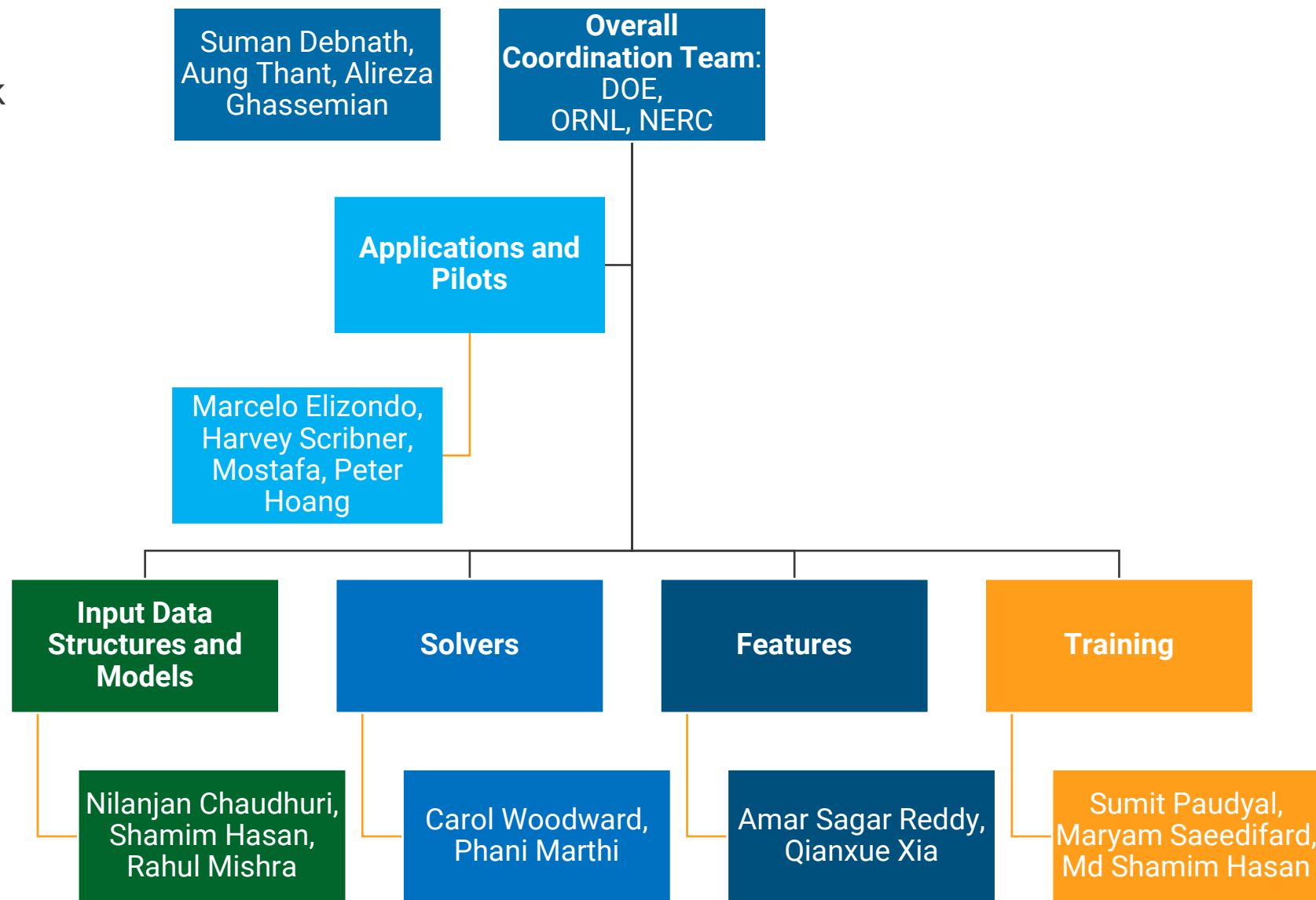
Solver Layer: DAE solvers, linear solvers, non-linear solvers



Features Layer: Dynamic Phasors, Impedance Scan, Screening Methods, AI/ML

EMT Activity: Working Groups

Working groups created to work on problems identified with EMT simulations and provide solutions to the community!



Working Groups: Goals & Ongoing Activities

Applications and Pilots

- **Goal:** List of applications identified – integration, planning, operational assist, operational decision-making
- 2026 focus – large load integration

Input Data Structures and Models

- **Goal:** Input data structure and models that help with portability, standardization, details, and ease of usage
- 2026 focus – design standard input data structure, process multiple input data structures, develop large load models and testing capability

Solvers

- **Goal:** Integrators and solvers that help with near-real-time simulation for 10 millions of power grid with millions of inverters
- 2026 focus – achieve speed-up for large load integration case

Features

- **Goal:** Enhance ease of usage using tools, automation, and foundational capabilities needed
- 2026 focus – automate processes in large load integration with allying tools

Training & Workforce Development

- **Goal:** Educate, train, and create next-generation workforce working with academia and training institutes
- 2026 focus – create basic course materials in EMT for Universities

Working Group Activities: Status

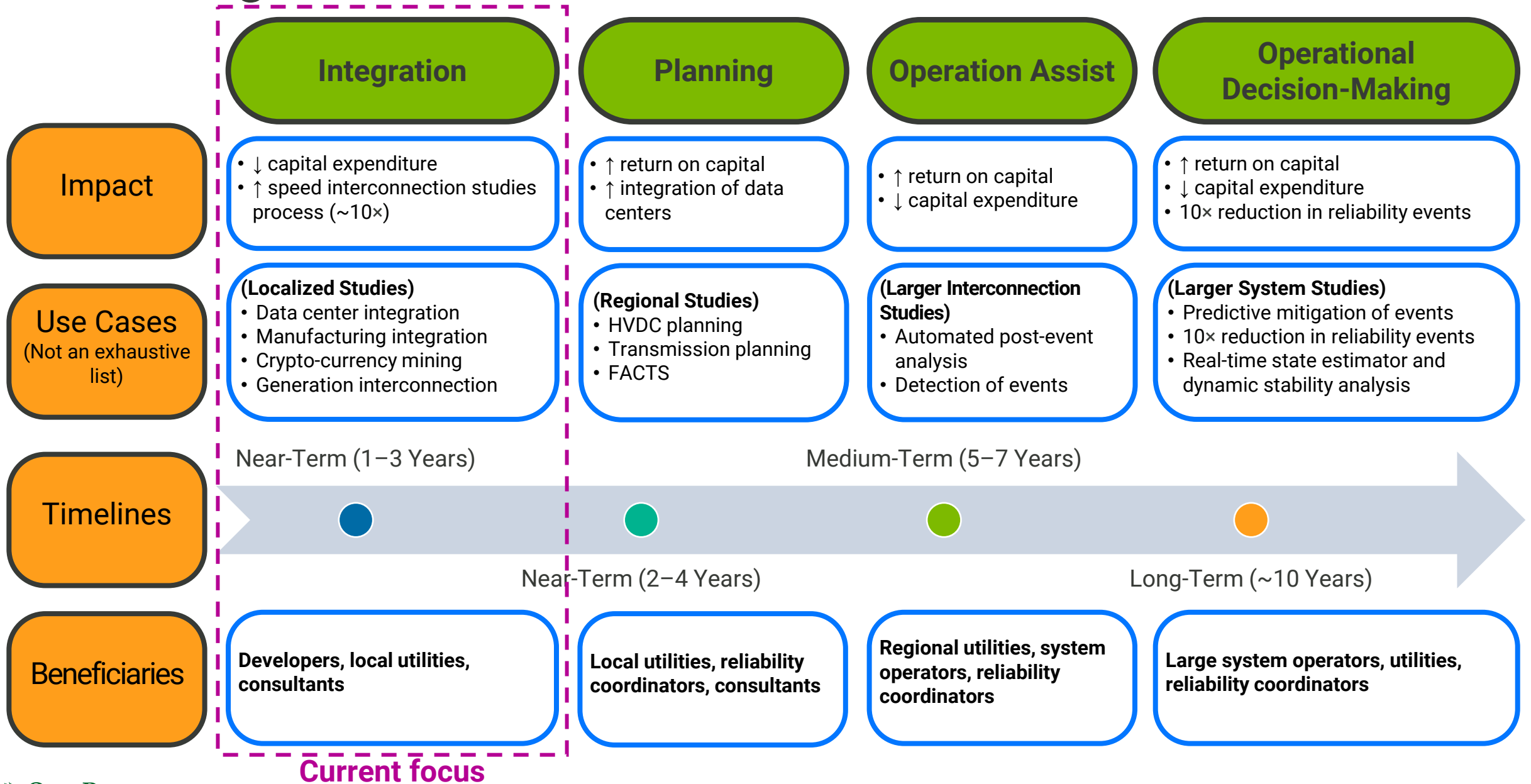
2025

- Roadmap prepared – industry, national labs, academia (w/ feedback during workshop 2025)

2026

- Monthly webinar series
- Progress tracked for roadmap
- Ongoing R&D based on roadmap
- Work with industry to provide solutions together

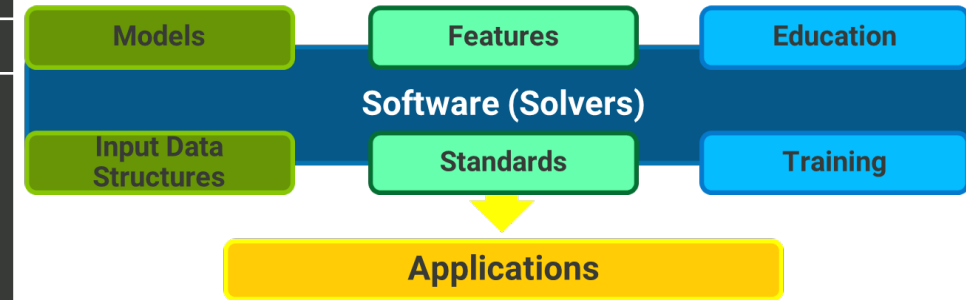
EMT: Long-Term Timeline



RE-INTEGRATE EMT Simulation: Current Capabilities



Characteristics	RE-INTEGRATE
Solvers	RE-INTEGRATE's structure-aware solvers, hybrid integrators Multicore/GPU-compatible/Multi-node <i>Further optimization, solvers, and integrators exploration ongoing</i>
Input Data Structures	.raw, .dyr, .dss, .xml, .seq, .con, .fau <i>Additional expansion of data structures ongoing for ease of usage</i>
Component Models	Generation (synchronous), HVDC, transmission lines, transformers, loads, inverters – ~36 models available <i>New model developments ongoing</i>
Programming Language/Platform	C++, CUDA
Simulation Speed	<ul style="list-style-type: none"> Real-time with IEEE 39-bus with 375 inverter system (demonstrated at workshop) Speed-up of differing magnitudes with existing software (multiple publications) Speed-ups observed of the order of 10,000s <i>Further significant speed-up being evaluated</i>
Largest System Tested	118,000 bus 125,000 inverters <i>Further scalability being evaluated</i>
Test Systems Examples	IEEE 39-bus, IEEE 39,000-bus, IEEE 39,000 w/ 125,000 inverters, IEEE 118-bus, IEEE 118,000-bus, IEEE 123-bus, 1,000 IBRs, IBRs, IBLs, Inverters (2LC, NPC, MMC), MTDC system (four terminals) <i>Additional applications ongoing</i>
Commercial Software Dependencies	None



Long-Term Research Goal: Simulate 10+ million nodes with 1+ million inverters in near real-time

Target: Plug-and-play approach to perform interoperable research on individual modules with ease of usage, aligning tools, standard models/data structures, advanced integrators/solvers, AI-infused capabilities

RE-INTEGRATE Demos

Next Webinar

March 24, 2026

- Large-scale EMT simulation – Sebastien (RTE)
- Applications of EMT simulation – Marcelo Elizondo (PNNL)

Thank you

