Autonomous Multiscale Simulations – Turning Synchronous MPI into Asynchronous Workflows

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LLNL-PRES-842204

This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under contract DE-AC52-07NA27344. Lawrence Livermore National Security, LLC

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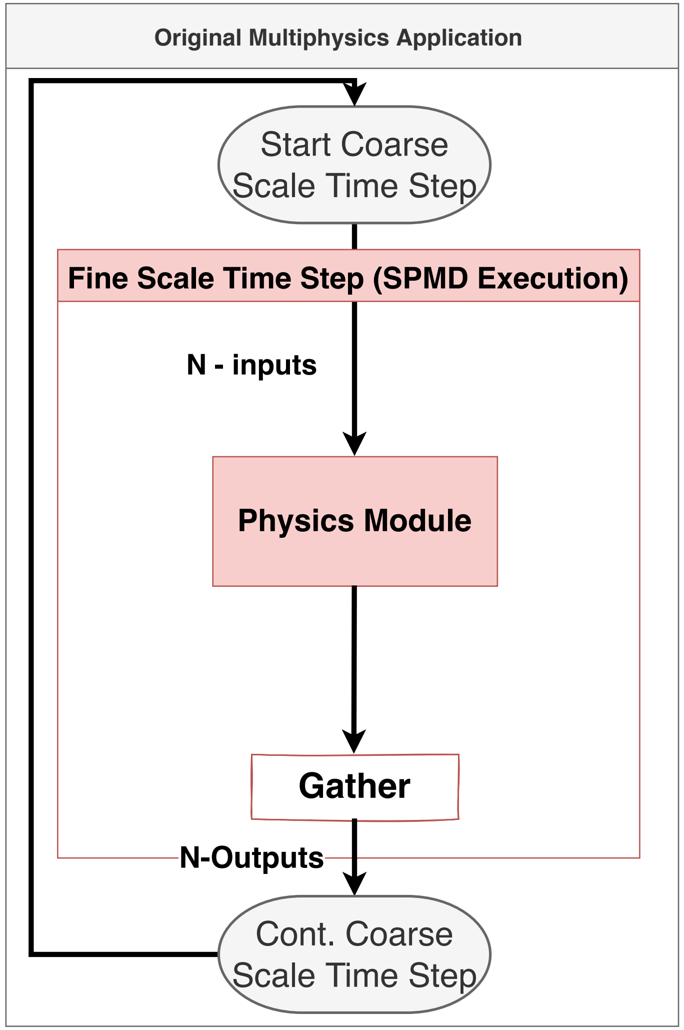
Many Physics Simulations Directly Couple Either Multiple Scales or Multiple Types of Physics to Improve Accuracy

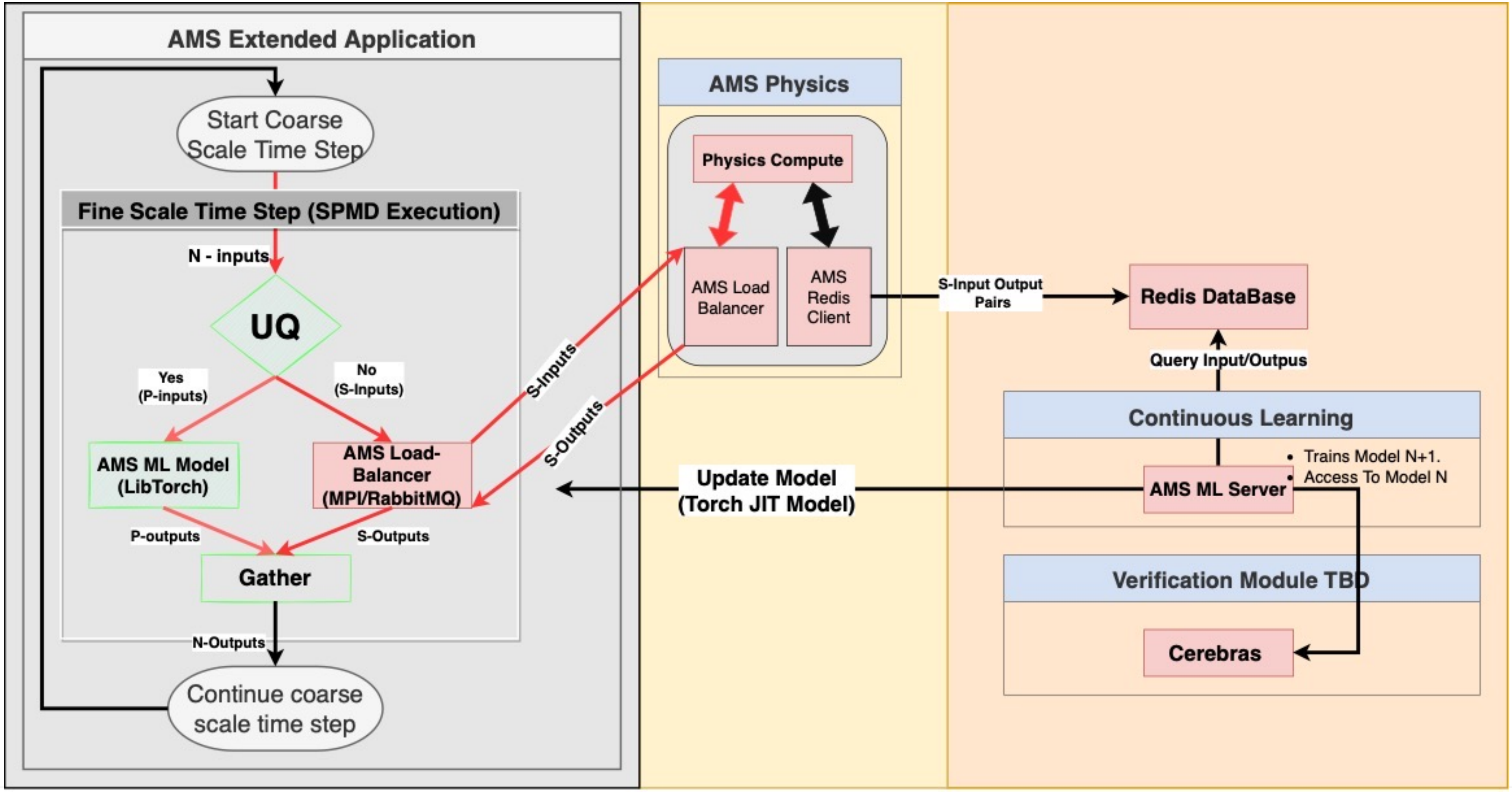
- Hydrodynamics vs. radiation transport
- Transport vs. reaction
- One particularly common pattern are “subgrid” models:
  - At each coarse time-step
  - At each mesh point
  - Call fine-scale physics (EOS, kinetics, rad. transport , …)
- Depending on the fidelity subgrid models quickly dominate the run time



One Attractive Solution is to Replace the Subgrid Model with a (Deep Learning) Surrogate Model

- Advantages:
  - Massive expected improvements in performance
- Challenges:
  - Collect training data
  - Guarantee sufficient accuracy
  - Report potential failures
- Existing Solution
  - Execute a simulation of interest with the original physics to collect data
  - Train reliable surrogate model
  - Execute new simulation with surrogate model
  - Check for coverage and accuracy of the model
    - If problems are found – REPEAT until convergence

Autonomous Multiscale Aims to Break this Pattern by Directly Integrating Simulation, Data Collection, and Training



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