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Autonomous Multiscale Simulations – Turning Synchronous MPI into Asynchronous Workflows

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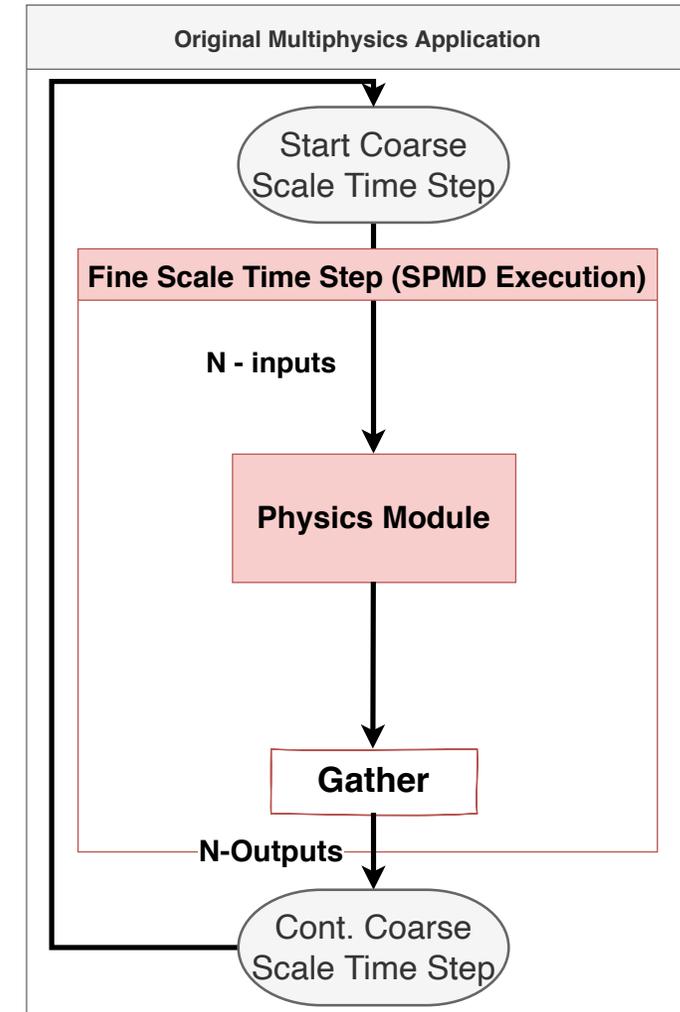
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Many Physics Simulations Directly Couple Either Multiple Scales or Multiple Types of Physics to Improve Accuracy

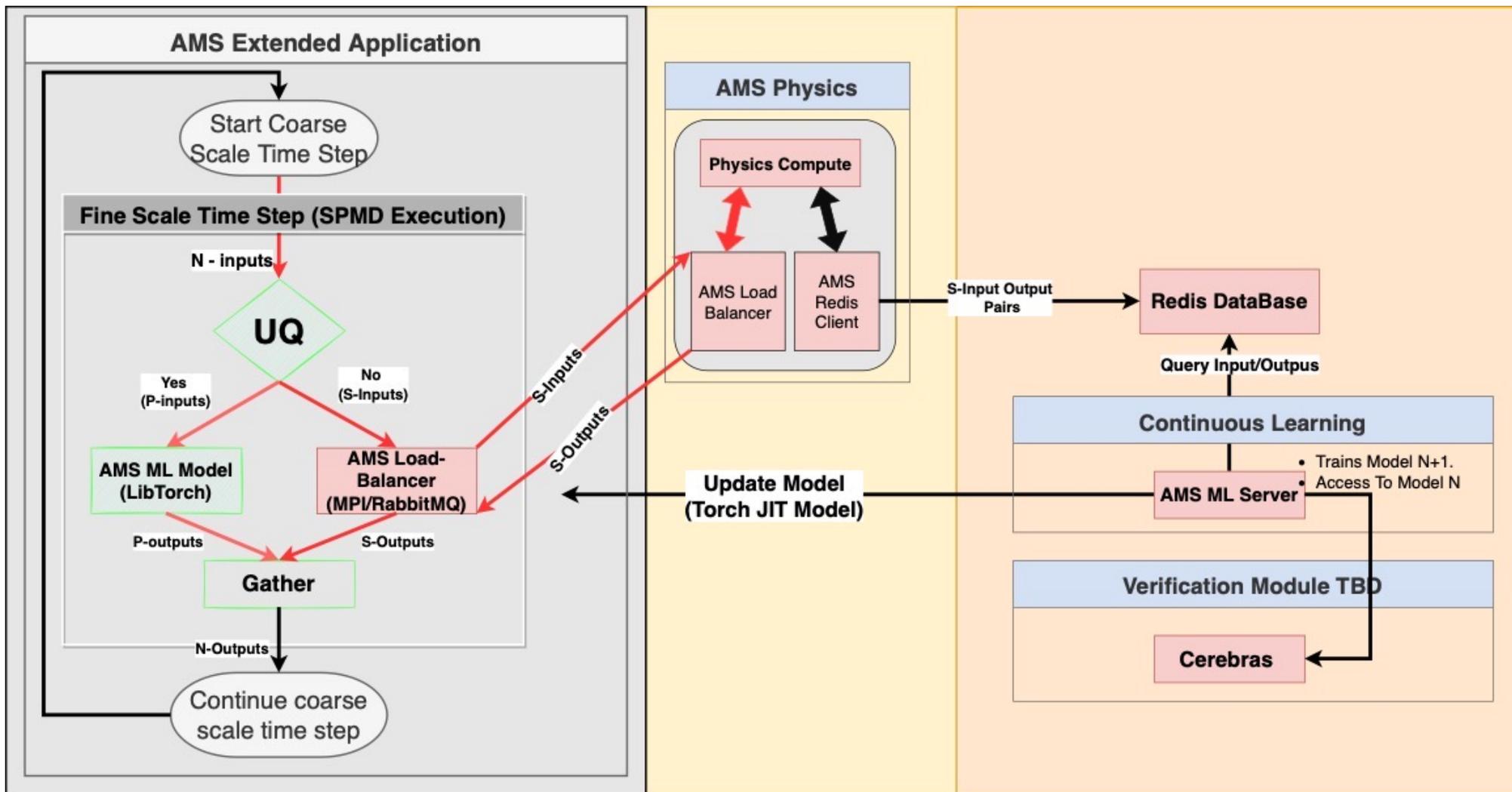
- Hydrodynamics vs. radiation transport
- Transport vs. reaction
- One particularly common pattern are “subgrid” models:
 - At each coarse time-step
 - At each mesh point
 - Call fine-scale physics (EOS, kinetics, rad. transport , ...)
- Depending on the fidelity subgrid models quickly dominate the run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

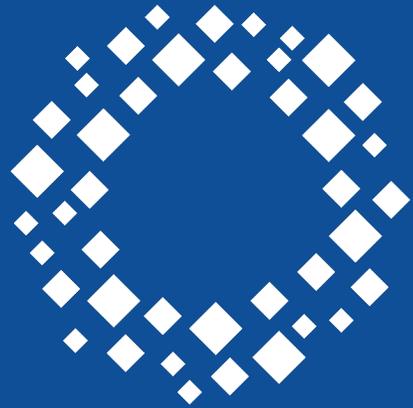


One Attractive Solution is to Replace the Subgrid Model with a (Deep Learning) Surrogate Model

- 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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