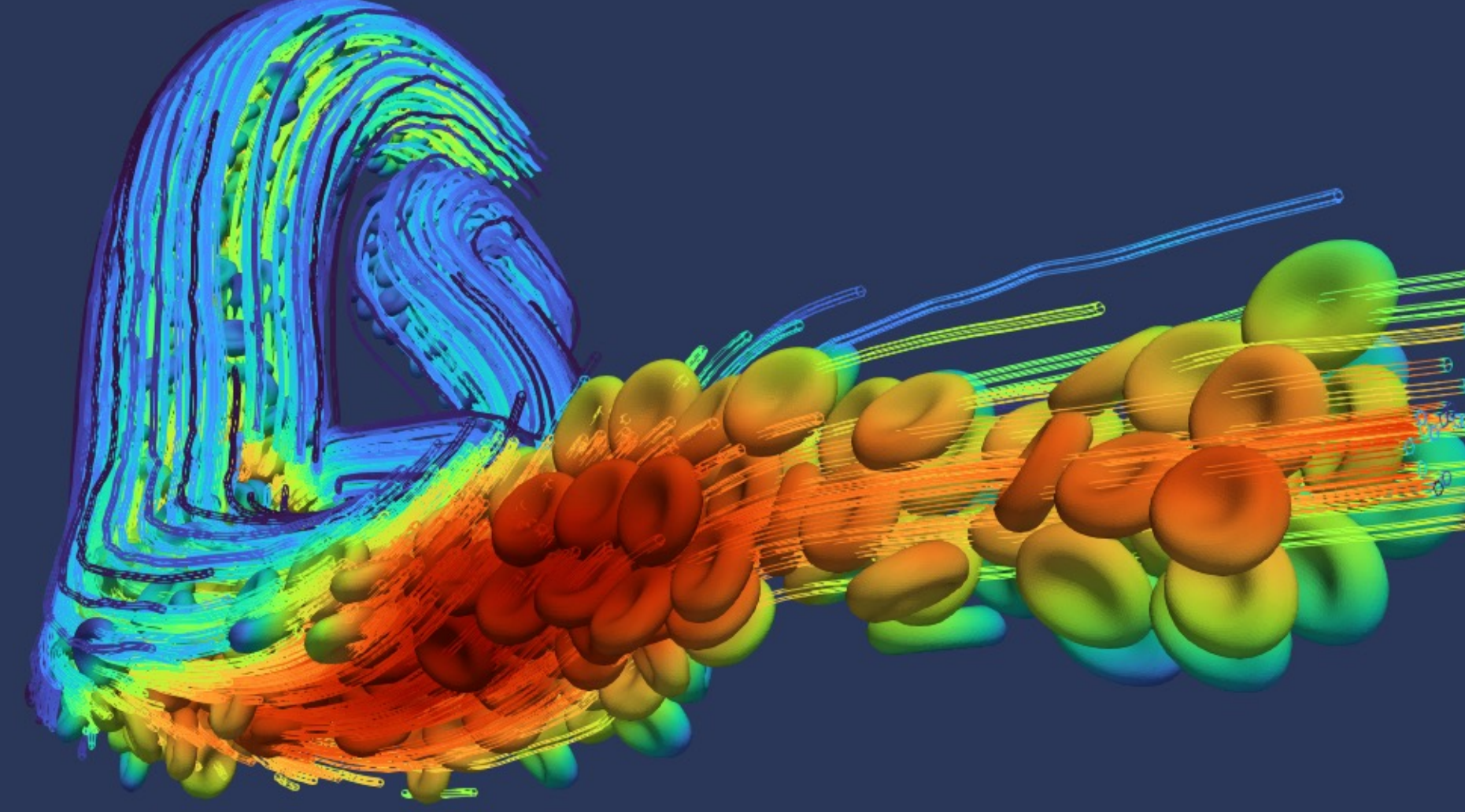


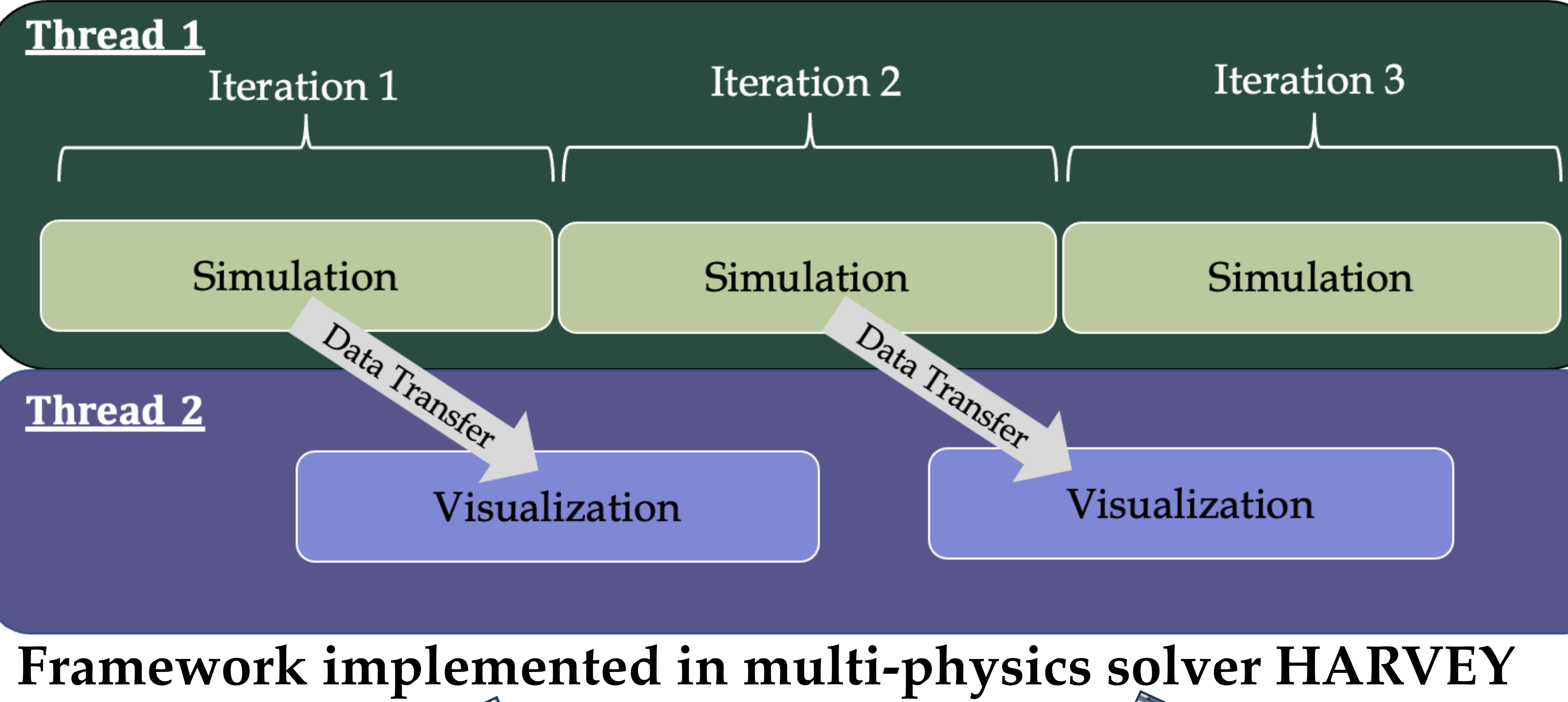
# A Heterogeneous In Transit Approach for Large Scale Cellular Modeling



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## Introduction

- Cellular modeling has paralleled advancements made in computational power, necessitates proper analysis routines<sup>1</sup>
- I/O advances lag behind processor speed counterpart<sup>2</sup>
- In situ methods help solve this, but introduce complications<sup>3,4</sup>
- In-transit methods can help resolve these limitations<sup>4</sup>
- We developed method that launches simulations concurrently on separate MPI threads, separately executing two key components:
  - Record and Replay**

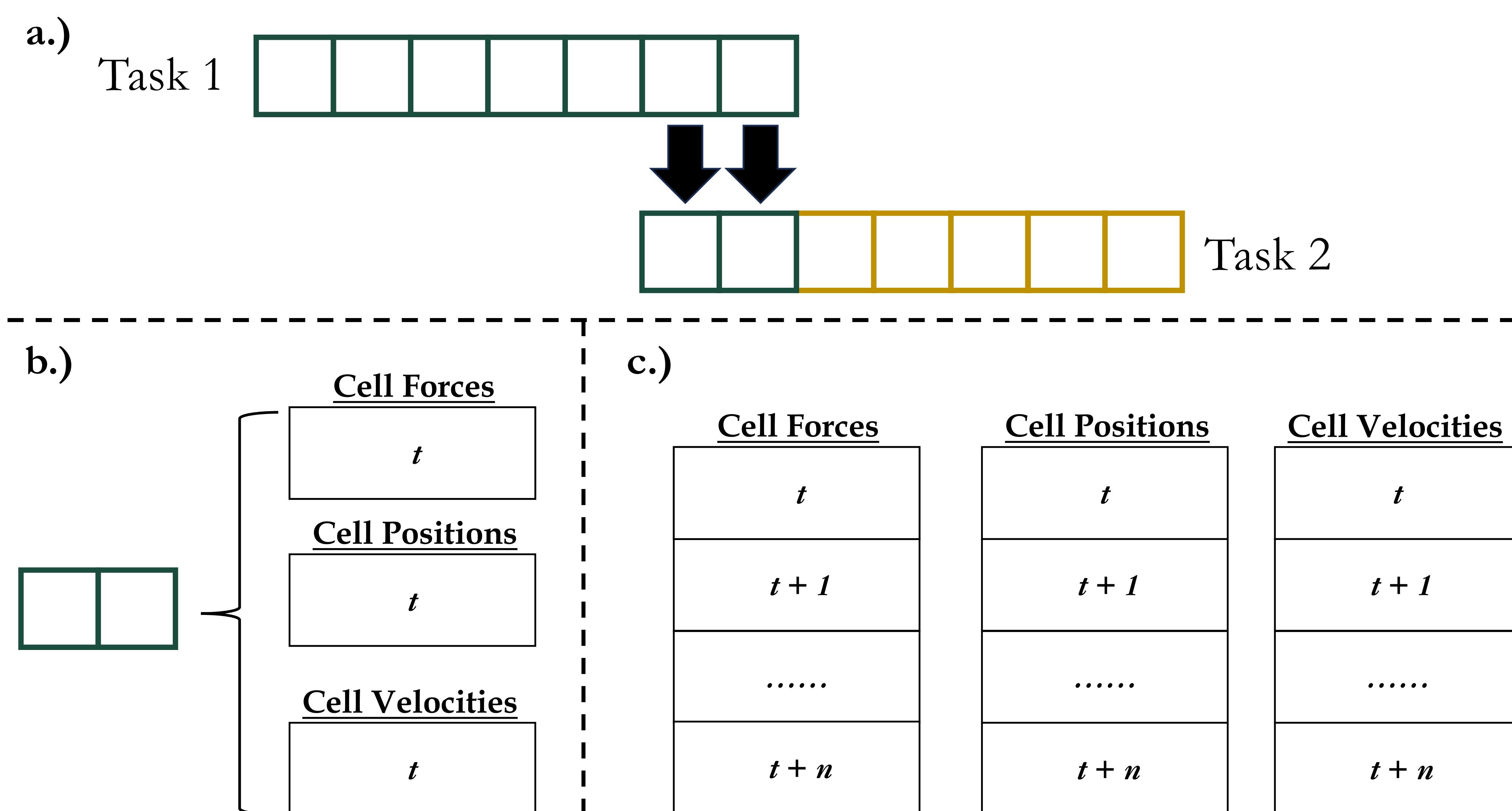


Framework implemented in multi-physics solver HARVEY

## Objectives

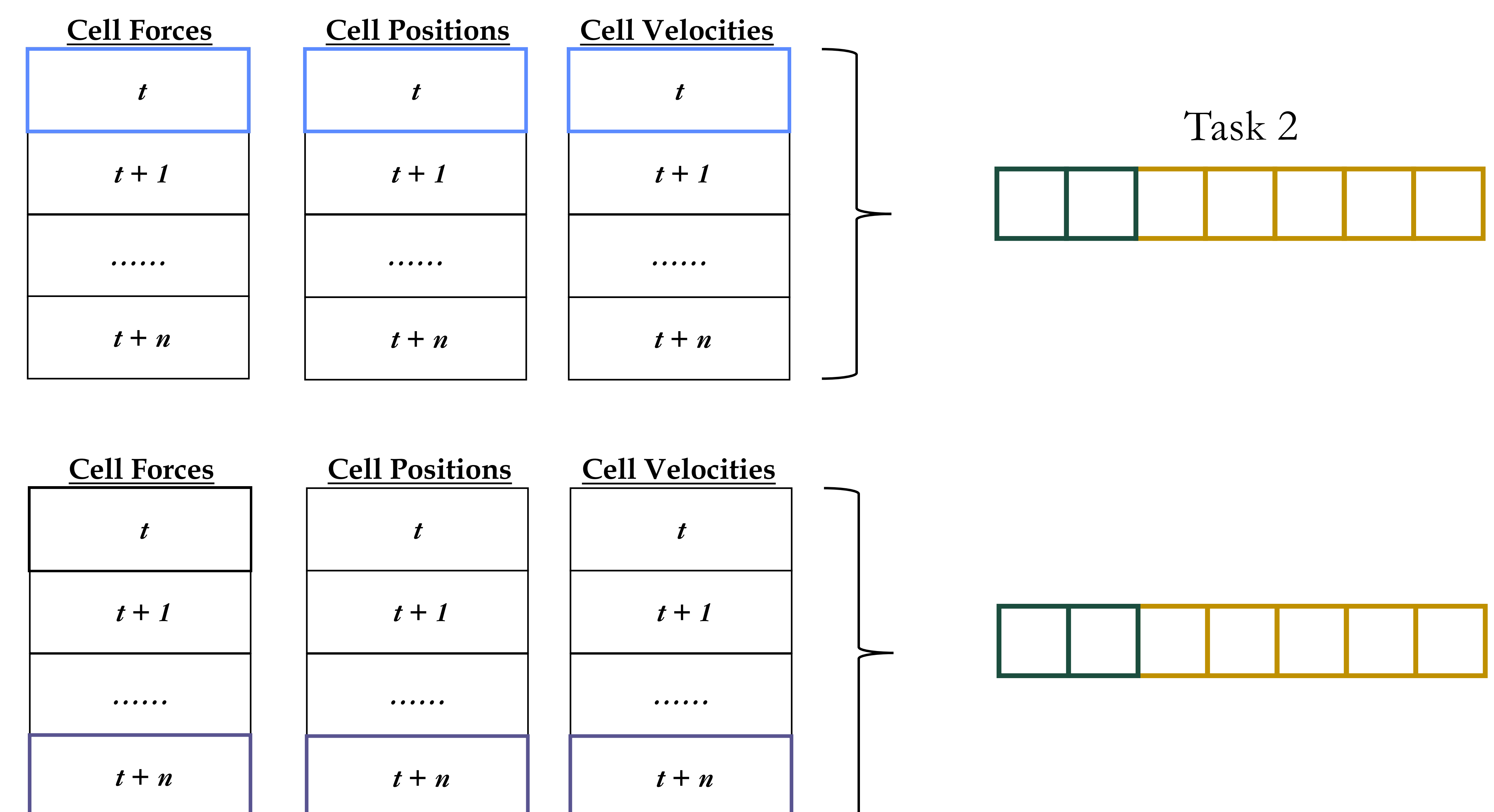
- The establishment of a new in-transit methodology aimed at:
  - Enabling analysis for large scale computational fluid dynamics
  - Better utilization of hardware
  - Data movement reduction
- Delineation of integration into existing massive scale code base
- Analysis on methodology's limitations

## Record



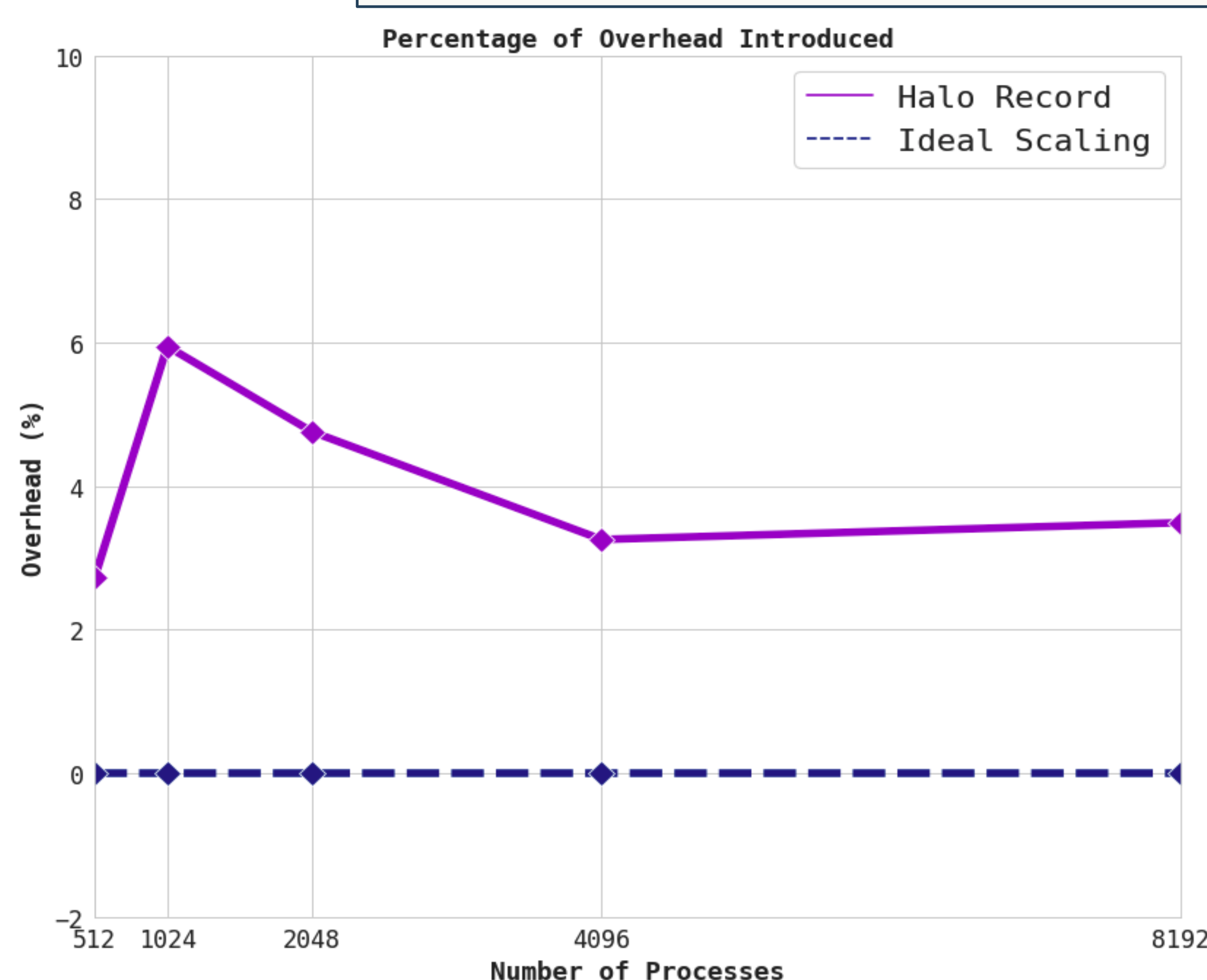
- Two threads maintain separate copies of a simulation simultaneously
- GPU and CPU co-opted for primary thread
- "Halo" data is exchanged between compute processes on primary thread and cached in memory

## Replay



- "Halo" data is loaded in from memory by secondary thread
- Communication avoided on secondary simulation by pulling from "halo buffers"
- Analysis is performed with full range of data on secondary simulation

## Results



- Overhead comparable to similar in situ methodologies
- Enables in situ-based visualization due to availability of data
- Low overhead combined with threading enables efficient usage of compute resources

## Conclusion

- New in-transit framework integrates into HARVEY fluid solver
- Utilizes heterogeneity of leadership-class systems, reducing resource "waste"
- Enables in situ analysis and reduces costly data movement by mirroring simulation

## Acknowledgements



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[1] Grinberg, Leopold, et al. "A new computational paradigm in multiscale simulations: Application to brain blood flow." Proceedings of 2011 International Conference for High Performance Computing, Networking, Storage and Analysis. 2011. [2] James Ahrens, Sébastien Jourdain, Patrick O'Leary, John Patchett, David H Rogers, and Mark Petersen. 2014. An image-based approach to extreme scale in situ visualization and analysis. In SC'14: Proceedings of the International Conference for High Performance Computing, Networking, Storage and Analysis. IEEE. [3] James Kress. 2020. In-line vs. in-transit in situ: Which technique to use at scale? (2020) [4] Ames, Jeff, et al. "Low-overhead in situ visualization using halo replay." 2019 IEEE 9th Symposium on Large Data Analysis and Visualization (LDAV). IEEE, 2019.