National Aeronautics and Space Administration

Panel: Future Advanced Computing Ecosystem

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Entry Systems Modeling Project

Plume-Surface Interaction Project

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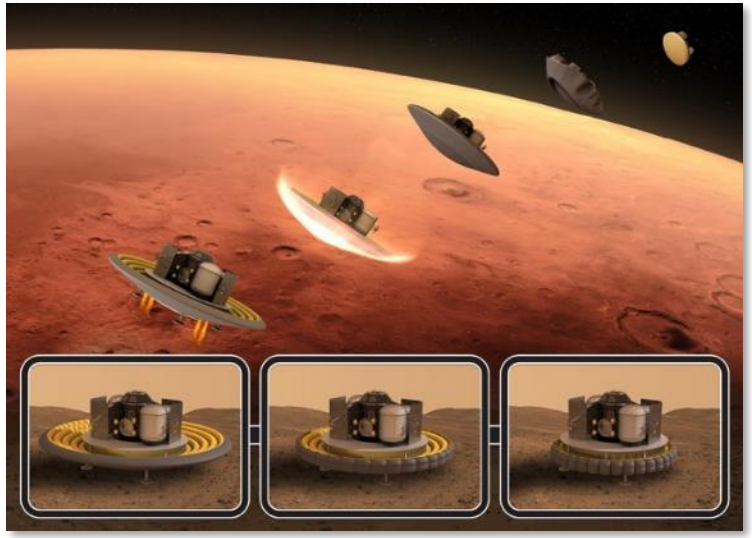
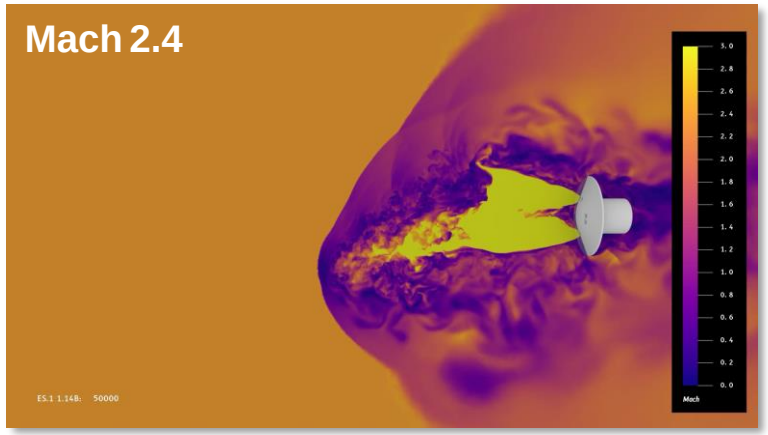
Use Case: Retropropulsion for Human Mars Exploration

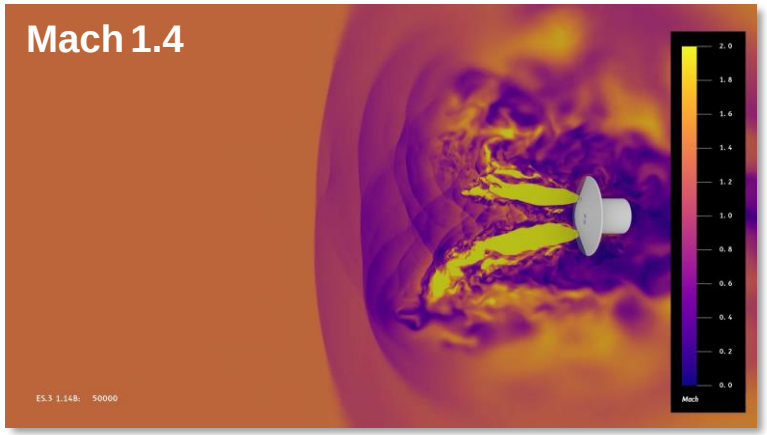
- 2019 Summit Early Science and INCITE awards
- Equivalent of 1,000,000 Xeon core-hours burned daily
- Agency, industry, and academic collaboration

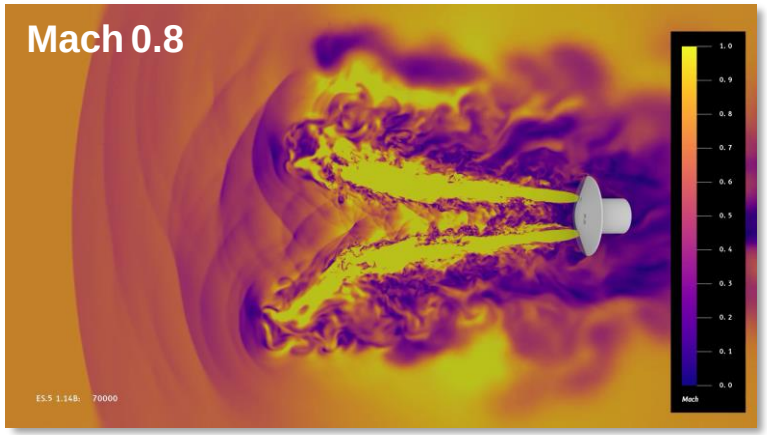
Learning Cycle Reduced from Years to Days

Conventional Capacity-Based Computing	**Summit**
One run in ~9 months using 5,000 x86 cores (10-day waits for 5-day jobs)	Six runs in 5 days using 3,312 GPUs







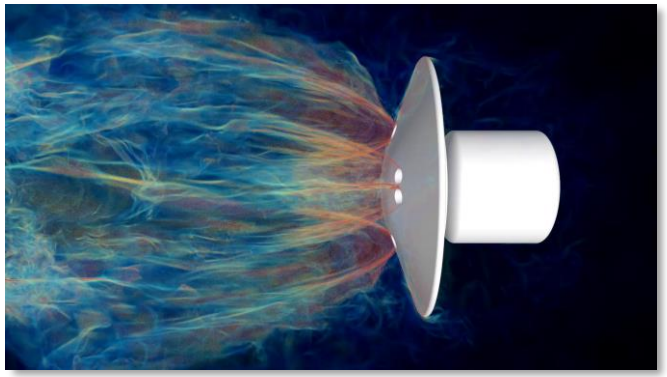


Demonstrated efficient, scalable, production-level computational fluid dynamics capability with GPU computing, reducing the learning cycle from *years to days*

Ecosystem Experience

- Decade-long, grassroots effort required to position for these proposals
- Reliance on computing is rapidly expanding with 1) loss of facilities, 2) increase in application complexity, 3) lack of ability to test
- Pathways:
  - External opportunities for access through other agencies
  - Government-sponsored Research Institutes
  - SBIR, STTR, grants

- Software: Performance-portable mapping of data/implementations to diverse architectures; revolutionary algorithmic advancements required to enable future breakthroughs at exascale and beyond
- Hardware: Broader government-wide availability of diverse hierarchy of systems; transitions to emerging, heterogeneous platforms
- Workforce: Diversification of critical skills, recruitment and retention of top talent, agile and competitive hiring mechanisms, ability to engage non-US talent
- Infrastructure: Data movement, storage, and processing
  - Several PB of data generated, with ~40 TB of data moved from ORNL to NASA *every day* (Library of Congress is ~20 TB)



The Future Ecosystem

Access to exascale and beyond is critical to multiple agencies

- Government, industry, and academia each have differing needs and missions, bringing complimentary strengths in leveraging this national capability
- National competitiveness and technological superiority require an integrated computing ecosystem to be more efficient, more agile, and more responsive from research through operational practice and mission infusion
- Data and networking infrastructure investments are critical for integration across platforms and geographic location
- Substantial, sustained investment in basic research for simulation-based analysis is required for game-changing advances in simulation capability
- Collaboration requires finding workable solutions to leverage advancements elsewhere but directly feed into maintaining and growing national competitiveness and strategic national capabilities in computing
- Workforce, education, and diversification of skills required to develop and utilize these next-generation computing capabilities are as critical as hardware, software, and data

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