NASA Advanced Computing Services (NACS)
NNA15NACSL
Questions and Answers
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Q1. What key challenges do NAS users face?

A1. High End Computing (HEC): NAS users face the challenge of effectively using a complex and powerful tool (supercomputing) to enable and accelerate their NASA mission impact. They are experts in their scientific or engineering discipline, but they are typically not experts in how to program or use supercomputers. Key pieces of this challenge include improving their simulation and analysis codes, dealing with the complexities and continual evolution of a leading-edge supercomputing environment, and getting the resources they need at the same time as hundreds of other users. NAS experts routinely assist users in addressing these and other challenges. As NAS transitions to more energy-efficient architectures in the future, users face the additional challenge of migrating their codes, and they must pioneer the effective use of the new architecture even while the associated systems, support services, and knowledge base mature.

Other Advanced Computing: The challenges here are similar to that of moving to a new HEC architecture, and the evolution of the systems and services is even more rapid, as these take shape. Users of these services must be more resilient and resourceful, since they will help determine how the systems and services evolve and mature.

Q2. What key challenges will NAS face over the next 10 years?

A2. HEC: Key challenges in achieving maximum NASA mission impact with HEC include funding constraints, facility constraints, and technology limitations. Because funding is limited, NAS must balance and optimize system upgrades, user services, and maintenance and operations (e.g., power). For example, migrating to more energy-efficient accelerator architectures is a long-term goal, since it should improve total computing at reduced power, but it will require strategic effort to become system experts and to migrate user codes. To mitigate facility constraints, we are exploring options for new facility space with lower PUE (power usage effectiveness), additional power headroom, and more configuration flexibility. The challenge in user services is to operate cost-effectively with rapid problem resolution for all users. Technology limitations in a world-class HEC facility result in occasional job and system interruptions, and these problems are expected to get worse as systems increase in scale and complexity, unless better system and application resilience can be achieved.

Other Advanced Computing: Here the challenge is to help NASA assess which technologies are worth strategic investment, to help define a path for exploring and advancing these technologies in the absence of roadmaps, and to enhance and apply NAS expertise in support of new areas of computing for the agency.

Q3. What is the vision for NAS?

A3. NAS' vision is to broadly enhance and enable NASA mission success through world-class delivery of advanced computing services. Indeed, NAS achieves this vision every day, even as we seek to employ advanced computing to enable the agency to achieve more. In this vision, HEC continues to be NAS' core service, with migration towards accelerated/energy-efficient architectures, innovation in value-added services such as application and visualization support, and expansion into emerging mission applications such as planetary defense, life sciences, and in-situ resource utilization for exploration into the solar system.

Included in the vision are increasing capability and mission application of other NAS-provided advanced computing services, including data-intensive, collaborative, and quantum computing. These are often used in conjunction with HEC, ensuring that the NAS-provided service is unique and unmatched in the agency.

Q4. Where do you expect to find users?

A4. HEC: There is no shortage of HEC users and associated resource demand. Generally users find NAS, whether by referral from other users or NASA managers, mention of NAS services in NASA requests for proposals, NAS' web presence, NASA news articles or press releases/events, hosting a booth at conferences where NASA has a significant presence, or other means. Periodically, we conduct outreach events at other NASA Centers, to better engage with existing and new users.

Other Advanced Computing: For emerging advanced computing services, early outreach efforts (e.g., tours, technical summaries) at the Division, Directorate, and Center level will build awareness and interest in potential users. Once a user base and some awareness develops, the user base will grow on its own, in the same ways that the HEC user base continually expands.

Q5. What is the timing for quantum computing?

A5. Quantum computing is currently in the exploratory stage, and mission impact is not certain. NAS operates an early-generation quantum annealing machine, and it will take researchers a few years, and another generation or two of technology advancements, before notable mission impact is anticipated. Within 5 years we should know if quantum annealing will have significant mission impact, and that impact could begin another 5 years beyond that. For other quantum computing approaches, the timeline is at least doubled.

Q6. Are you involved in the SST (Structural Simulation Toolkit) framework?

A6. NAS is aware of the SST project, but is not currently involved in its development or use.

Q7. What challenges do you face with the next generation of users?

A7. HEC: The next generation of users will be experts in their domain area, just like their predecessors. The primary differences will be the programming languages that the users have experience with and the system architectures that NAS will likely be operating for them. Whereas past generations wrote supercomputer applications mostly in FORTRAN and more recently in C and C++, languages which are amenable to efficient execution on supercomputers, next generation users are more likely to have programmed in Java, Matlab, perl, or other languages where achieving efficient execution on supercomputers is extremely challenging. These new users will be challenged to work with and carry on development of NASA's wealth of validated heritage codes, and the migration of old and new codes to accelerator-based, many-core architectures. Another difference of next generation users is their expectation to engage with NAS through mobile devices and social media. Recognizing the value of these tools, NAS is continuing to advance its mobile app, and has been using twitter and other social platforms for several years to engage with users and the public.

Other Advanced Computing: In contrast to HEC, next generation users often have an advantage over their predecessors, in that they are more likely to have greater familiarity with the technologies and techniques of mobile and collaborative computing, big data, and other areas of advanced computing. They may even have an expectation that such technologies should be the norm for pursuing modern science and engineering, and they may bring ideas for advancing NAS' services in emerging advanced computing areas. The challenge for new users may be in convincing more veteran colleagues of the value of investing in the use of these new technologies.

Q8. What facility challenges does NAS face?

A8. HEC: The NAS facility is approaching 30 years of age. While the facility has shown remarkable flexibility and upgradeability over this time, NAS currently faces facility-related constraints that are slowing the growth in HEC capacity that NAS provides. Specifically, NAS is operating at the limit of electrical power and cooling in the facility. As a result, when new HEC systems are installed, an equivalent amount of older systems (with lower but still useful compute power) must be removed. Further, the NAS facility's PUE (power usage effectiveness), while competitive with modern HEC facilities, is still higher than that of state-of-the-art data centers in industry, meaning that NAS may be using more electrical power than necessary for cooling and other overheads. NAS is challenged to determine and pursue the most cost-effective approach to create electrical and cooling capacity headroom at a lower PUE, to enable NAS to continue to provide the maximum computing capacity within facility and funding constraints.

Other Advanced Computing: Each advanced computing capability—quantum, collaborative, data-intensive, etc.—involves unique facility challenges. Quantum computing requires extreme system isolation from the outside world, so installing and operating the existing quantum annealing machine involved extensive facility modifications and new processes to ensure uninterruptible power and cooling. Data intensive computing involves extensive storage systems, which must be protected from power interruptions; the NAS UPS system ensures that data integrity is maintained. NAS addresses these unique facility challenges as they become clear.