

ALTAIR® HPCWORKS™ : A COMPREHENSIVE SOLUTION FOR HIGH-PERFORMANCE COMPUTING MANAGEMENT OVER OPEN-SOURCE JOB SCHEDULERS

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Abstract

The Altair® HPCWorks™ high-performance computing (HPC) and cloud platform offers a solution that's superior to open-source job schedulers by providing advanced capabilities in resource management, scalability, job scheduling, multi-cluster management, customizable hook systems, and user friendliness. Capabilities such as an intuitive user portal, cloud bursting, I/O profiling, and license asset management enable a more integrated, more efficient approach to handling diverse computational tasks. Enhanced job submission and management, in-depth usage analytics, and comprehensive application monitoring mean tight alignment between compute use and business needs. Altair HPCWorks also offers superior budgeting and allocation tools to ensure high return on investment and controlled costs. Professional support guarantees swift resolution of critical issues, improving system utilization and productivity. The Altair HPCWorks platform is a robust, adaptive, one-stop solution for managing complex HPC environments.

Altair® PBS Professional®

Altair® PBS Professional®, a solution that's part of the Altair HPCWorks platform, is the trusted leader in HPC workload management. PBS Professional efficiently schedules HPC, artificial intelligence (AI), and machine learning (ML) workloads across all forms of computing infrastructure. Easily scaling to support systems of any size — from small and mid-sized clusters to the largest supercomputers — PBS Professional ensures users maximize the value of their hardware and software investments. It's a fast, powerful workload manager designed to improve productivity, optimize utilization and efficiency, and simplify administration for supercomputers and cloud computing. PBS Professional automates job scheduling, management, monitoring, and reporting. It's the trusted solution for the majority of top automotive companies, and it's also used throughout the aerospace, energy, weather, and life sciences industries, including in many complex Top500 systems.

"Altair really knows HPC. They understand the challenges of maintaining complex systems and know how to deliver reliable solutions that work. PBS Professional proved its superiority as the most flexible and reliable workload manager, and Altair gave us the confidence and comfort level we need in a long-term partner." — Dr. Ben Evans, deputy director for HPC and data innovation, National Computational Infrastructure (NCI) Australia [1]

1.1 Architecture and Scalability

PBS Professional is built with a robust, adaptable architecture and designed with multi-cluster, multi-level, and multi-tenant operations in mind, enabling efficient management of complex, heterogeneous workloads. As a system with capabilities designed for exaflop HPC platforms, PBS Professional handles workload management for Aurora, the exascale supercomputer at Argonne National Laboratory. Aurora is among the world's most powerful supercomputers, with the ability to perform two exaflops (two billion billion calculations per second). Argonne chose PBS Professional because they needed a robust, scalable solution with commercial support.

“It was with a hint of nostalgia that Argonne Lab’s Bill Allcock described the Argonne Leadership Computing Facility’s (ALCF) decision to switch to a commercially supported workload management suite after 20+ years spent developing and using ALCF’s custom workload manager, Cobalt. Argonne National Laboratory announced today that it is deploying Altair PBS Professional across the organization’s HPC systems and clusters.” — HPCwire [2]

1.2 Job Scheduling and Resource Management

PBS Professional has the flexibility and customizable APIs necessary to implement the scheduling policies and resource allocation that best suits each organization’s unique needs. Notable features include efficient and highly customizable scheduling, preemption, and backfilling policies, power management capabilities, and topology-aware scheduling to ensure that the right job runs in the right place at the right time. Resource management and allocation are equally important. PBS Professional has tight cgroups integration and a node health-check framework, alongside advanced GPU management and easy support for launching jobs into containers. These capabilities are an essential part of AI/machine learning workload management, and all provide a comprehensive approach to handling diverse computational tasks for both HPC and AI. PBS Professional also supports running jobs on Windows execution hosts for customers with mixed environments.

1.3 Multi-Cluster Management

PBS Professional shines in its ability to manage multiple clusters from a single access point, streamlining administration for expansive environments — a task with which open-source workload managers (WLMs) often struggle.

1.4 Customizable Framework with Hook System

The robust, adaptable PBS Professional hook system allows administrators to add custom scripts to be executed at various points in the job lifecycle to seamlessly implement site-specific requirements. This system helps enforce policies and add functionality, an area where open-source WLMs typically only offer limited events like prologues and epilogues.

“One of the key issues is ensuring workload and resource management obey our own policies, for which PBS Professional gives us a good solution. The highly customizable nature of PBS Professional is a key feature enabling more productive cluster management.” — Dr. Hiroshi Nakashima, professor, Academic Center for Computing and Media Studies, Kyoto University [3]

1.5 Hybrid Cloud Bursting

PBS Professional delivers dynamic cluster extension by bursting to public cloud platforms. Its vendor-agnostic approach ensures users aren’t locked into a single solution. Partnerships with top-tier cloud providers like AWS, Google Cloud, Azure, and Oracle ensure rapid and secure resource mobilization to meet real-time demand. With connectors to all the major vendors and automation for scaling machines up and down based on demand, moving to the cloud is accelerated from months to weeks, cutting costs dramatically and reducing user disruption.

“By partnering with Altair, we implemented a brand new HPC cloud architecture in just a few weeks without impacting users’ work. The new infrastructure enables our team to get critical engineering work done quickly and efficiently without the headaches of operating an on-premises data center.” — Mauro Bigli, CIO, PUNCH Group [4]

1.6 Reliability and Security

The PBS Professional release cycle allows sites to plan updates reliably and be assured that they will be getting fully end-to-end QA-qualified releases, including critical bug fixes and security updates as required.

PBS Professional has many security-focused features including, but not limited to, TLS-encrypted communication, SELinux MLS support, and multiple user authentication options.

Lockheed Martin needed to manage HPC resources across 20 security levels and compartments, ensuring full system utilization. *“We chose Altair thanks to PBS Professional’s rich set of queuing, managing, and reporting capabilities and the company’s willingness to innovate with us.” — Joseph Swartz, program chief scientist, Lockheed Martin [5]*

1.7 Open-Source Ecosystem

PBS Professional has been released as an open-source project called OpenPBS. OpenPBS allows users to experiment with PBS at the source code level, which maintains compatibility with commercially supported PBS Professional. Members of the open-source community contribute bug fixes and improvements to OpenPBS that are later incorporated into the commercially supported solution. Many labs, including NASA and Argonne National Laboratory, work with OpenPBS for HPC research and run PBS Professional on production systems to get the best of both worlds.

PBS Professional maintains compatibility with the OpenPBS scheduler, allowing experimentation with scheduling policies and hooks. To access advanced capabilities such as cloud bursting, budget control, and GPU scheduling, users can upgrade to PBS Professional.

Budgeting and Allocation

Altair's budgeting tool offers granular control over HPC resource allocation and facilitates project and user-quota management. It surpasses the allocation management features found in open-source alternatives by providing greater detail and control. For on-premises systems, budget allocation ensures that the right teams have access to the right resources and that compute is divided fairly between stakeholders. In the cloud, PBS Professional's budget capabilities ensure that cloud computing is a business decision, not a user choice.

"While the systems are diverse, we needed centralized resource budgeting and accounting software, a web portal for users and admins, and remote 3D visualization technology. Altair solutions make it possible to use our supercomputers effectively and efficiently, which in turn helps accelerate the research and innovation of our users. Altair's workload management tools can cater to our requirements and future demands." — Stephen Wong, technical director, National Supercomputing Centre (NSCC) Singapore [6]

Altair® Access™ – Ease of Use and Integration

Altair's Access portal enhances user interaction with HPC resources by simplifying job submission and management tasks and enabling secure data management and remote 3D visualization. Its web-based interface for job submission, monitoring, and secure data management allows researchers and engineers to concentrate on their core tasks rather than on crafting HPC scripts.

Altair® Control™ – Monitoring and Analytics

Control outshines open-source alternatives by providing real-time cluster workload monitoring and in-depth historical usage analytics and reporting capabilities, which aid in data-driven decision-making.

Altair Mistral™ – I/O Profiling of HPC Applications

Altair Mistral™, designed specifically for HPC scientific computation, offers extensive application monitoring. With a lightweight yet flexible design, Altair Mistral helps quickly identify rogue jobs and storage bottlenecks and delivers comprehensive I/O, CPU, and memory usage monitoring.

Total Cost of Ownership

Although HPC centers using open-source workload management solutions may pay less for L2 support, they often incur higher costs in hiring on-site administrators for deployment, maintenance, and support. They also may face delays in fixing critical bugs and security issues while awaiting community-developed solutions. In contrast, Altair promises swift resolution in such cases. The reliability, robustness, and efficient management of HPC resources with Altair HPCWorks significantly enhance system utilization, improving return on investment. Altair's team of engineers and specialists is readily available for consultation and expert advice.

"PBS Professional provides the job resource management and scheduling on our HPC system. It's critical to the system such that if that service were to go down, then we'd consider that a whole-system outage. Altair understands the criticality of that." — Tim Pugh, supercomputer programme director, Australian Bureau of Meteorology [7]

In summary, while open-source solutions offer competent workload management, Altair HPCWorks provides a more comprehensive, robust, and user-friendly solution. It not only delivers advanced resource management, user experience, and analytics capabilities, but also presents a broader set of tools for addressing various HPC needs, making it a one-stop solution for managing complex HPC environments.

Acknowledgements

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Scott Campbell, product manager, Altair HPCWorks

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- [5] [Lockheed Martin Improves Security Capabilities and Reduces HPC Costs with Altair PBS Professional](#)
- [6] [NSCC Delivers HPC in Singapore – Petascale Computing Resources Support Education and Research Nationwide](#)
- [7] [Cylc & Altair's PBS Professional Power Weather Modeling at Australia's Bureau of Meteorology](#)