



Servicing the Animation Industry

HP's Utility Rendering Service Provides On-Demand Computing Resources

Providing rendering as an Internet-based service, HP's URS offers scalability, rapid response and reliable performance.

The global multi-billion dollar industry of 3D film animation is full of increasingly realistic texture, color, expression, and movement. Blockbuster movies like *Shrek* and its sequel have pushed the boundaries of animation technologies and given audiences of all ages a taste of what is possible when an animator's artistic energy meets up with powerful computer algorithms.

As animation technologies have become more and more advanced, however, the resources required to turn an animator's vision into the magic you see on the screen have increased exponentially.

Traditionally, animation's intense resource requirements have translated into expensive infrastructure for large production companies, with advanced data center planning, building, management, and over-provisioning necessary to ensure available resources during periods of peak demand - even if those resources go unused most of the time. For smaller production houses, project scope and viability have been dependent upon in-house resources.

Hewlett-Packard's Utility Rendering Service (URS) is transforming the way animation companies of all sizes approach film production and rendering by ensuring adequate computing power is available to turn an animator's most ambitious models into final frames.

Real-World Research

Chartered with exploring emerging technologies in real-world settings, researchers in HP Labs chose the world of film animation as a backdrop for putting services running on a utility data center to the test. 3D movie rendering - the process of converting computer-generated geometry, character, and scene models into finished frames by adding color, light, texture, and other details - is a resource-intensive process with large computing requirements in terms of processing, storage, and bandwidth.

The necessity to build infrastructure to support animation's variable resource requirements has made quality animation an expensive endeavor. Throughout a film's production, peak demands are often unpredictable. If a small studio can respond rapidly to a customer's project, it has a competitive advantage. When the director of a feature film mandates a major story change, a large studio needs to be able to ramp up resources within hours rather than the weeks it would take to purchase new computing hardware.



Providing rendering as an Internet-based service, HP's URS offers scalability, rapid response and reliable performance. The financial viability of a film project often has to be measured against the combined costs of the estimated resources.

With HP's URS, animators can focus on the big picture without worrying about *not* having enough processing power to bring their vision to the screen. What's possible becomes limited only by the animator's artistry, skill, and creative bandwidth - not lack of computing resources.

Using the URS, filmmakers can remotely manage all aspects of the rendering of animated movies. They can securely upload digital models, render those models, and retrieve the final frames - all via a Web-based interface that makes both rendering and resource planning virtually plug-and-play.

422 and Frame Factory

In 2003, 422, an award-winning production company in Bristol, UK, was given access to Frame Factory, the initial prototype implementation of the URS. HP Labs challenged 422 to create a world-class, innovative short animated film rendered entirely using the Frame Factory service.

A team of animators worked for more than two months to create *The Painter*, a four-minute film featuring a tiny robot whose artistic quest is helped along by a Genie with the right tools.

Rendering of the 18,832 frames (6,000 of which were used in the final animation) was conducted over 17 days, with the final 2,500 frames being rendered in 19 hours. As resource demand fluctuated throughout the project, computing power was seamlessly made available by the URS, with the number of processing nodes in use quintupling at the end of the project.

In total, the rendering of *The Painter* used the equivalent of one Pentium III ProLiant server working 24/7 for 278 days. Without the URS, the rendering would have taken almost three months on 422's in-house data center.

For 422, access to the URS sped up production timelines and let the company work with complex animations beyond the scope of its own rendering resources. For HP Labs, 422's creation of *The Painter* on the URS put its utility computing research to the first real-world test.

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Ogre-Sized Production

Continuing a technology partnership that began in 2001, HP worked with DreamWorks to create a dedicated utility data center at HP's Laboratories in Palo Alto, Calif. to provide a secure, flexible, remote rendering service for the production of *Shrek 2*.

Acting as an extension of DreamWorks' Redwood City facility, the URS increased the filmmaker's peak rendering capacity by 50 percent, enabling DreamWorks to maintain tight production schedules and extremely high creative targets without adding additional infrastructure to meet variable rendering demands. Instead, the URS allowed DreamWorks to dynamically draw on expanded power during peak production, releasing that power when rendering requirements fell back to levels manageable by in-house facilities.

Over 4 Terabytes of storage were provisioned to keep the farm fed with creative input data. In the end, more than a million frames were rendered, consuming more than 100 CPU years.

Connected to the DreamWorks studio via a secure fiber-optic link with a gigabit-per-second bandwidth, the data center consisted of 500 dual-processor HP servers running an industry-standard Linux environment, each configured with 4GB of memory and 72GB of local disk. Over 4 Terabytes of NFS-based storage were provisioned to keep the farm fed with creative input data. In the end, more than a million frames rendered, consuming more than 100 CPU years, approximately 10 percent of *Shrek 2*'s 10 million rendering hours were processed remotely via the URS.

DreamWorks' use of the URS for *Shrek 2* represents the first time the company has relied on external infrastructure for the rendering process. A hallmark of the success of the project was HP's ability to address critical issues of security and trust.

HP and DreamWorks are continuing their joint exploration of utility computing services and the Adaptive Enterprise. DreamWorks is using HP's URS technologies for production of their upcoming film, *Madagascar*.

In addition, DreamWorks' forthcoming feature film *Shark Tale*, as well as the NBC computer-animated TV series, *Father of the Pride*, scheduled for debut in fall 2004, will utilize HP technologies in their production pipelines.



SE3D Sparks New Talent

As a next step in the study of utility computing services in the context of media production, HP will launch SE3D, a unique 3D animation showcase, at the 2004 Brief Encounters film festival. Combining cutting-edge technology, creative residencies, and public events, the SE3D animation showcase has been developed to support 3D animation talent.

Ten SE3D participants will be given free access to the URS to create a 3D animated short to be unveiled at international film festivals in 2005. Access to the URS, which runs Alias Maya 6, and participation in a series of animation workshops and events will give showcase participants an unprecedented opportunity to produce high-quality, innovative films that might be impossible without URS resources.

The creative vision behind the SE3D will be overseen by an artistic board comprised of representatives from top animation companies, including Alias, DreamWorks, Aardman Animations, Watershed, South West Screen, EM Media, and 422 South.

With its combination of training and cutting-edge technologies, SE3D represents an unparalleled creativity accelerator for up-and-coming talent in the animation industry and will help push forward HP Labs' research on utility computing, allowing it to broaden its research focus to include multiple customers using the URS simultaneously.

Utility Computing

Shifting the focus away from building massive data centers and infrastructure to handle projected or "what if" resource requirements, utility computing treats computing power as an on-demand, pay-per-use resource, much like electricity. Instead of over-provisioning by buying more and more hardware, companies can temporarily access globally distributed resources, paying only for what they use at any given time.

The virtualization of resources ensures dynamic scalability and enables businesses to quickly and cost effectively respond to fluctuations in computing needs. This adaptive model has the potential to realign businesses, allowing them to focus on core competencies - not on the computing power needed to support the varying resource requirements of business processes and cycles.

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Adaptive Technologies

Central to HP's adaptive computing model are technologies that control the utility, provide Web-based interfaces for managing services, and accurately allocate and monitor resources.

Service descriptions used to launch a service are deployed using HP's SmartFrog (Smart Framework for Object Groups) framework. SmartFrog technology provides a language for describing services, a deployment infrastructure, and a component model to manage the complete lifecycle of utility services. HP's Anubis distributed group membership protocol is used for resource management and allocation.

SmartFrog, which HP has released in part into Open Source, is influencing the standardization process within the Configuration, Description, Deployment and Lifecycle Management (CDDL) activity of the Global Grid Forum (GGF).

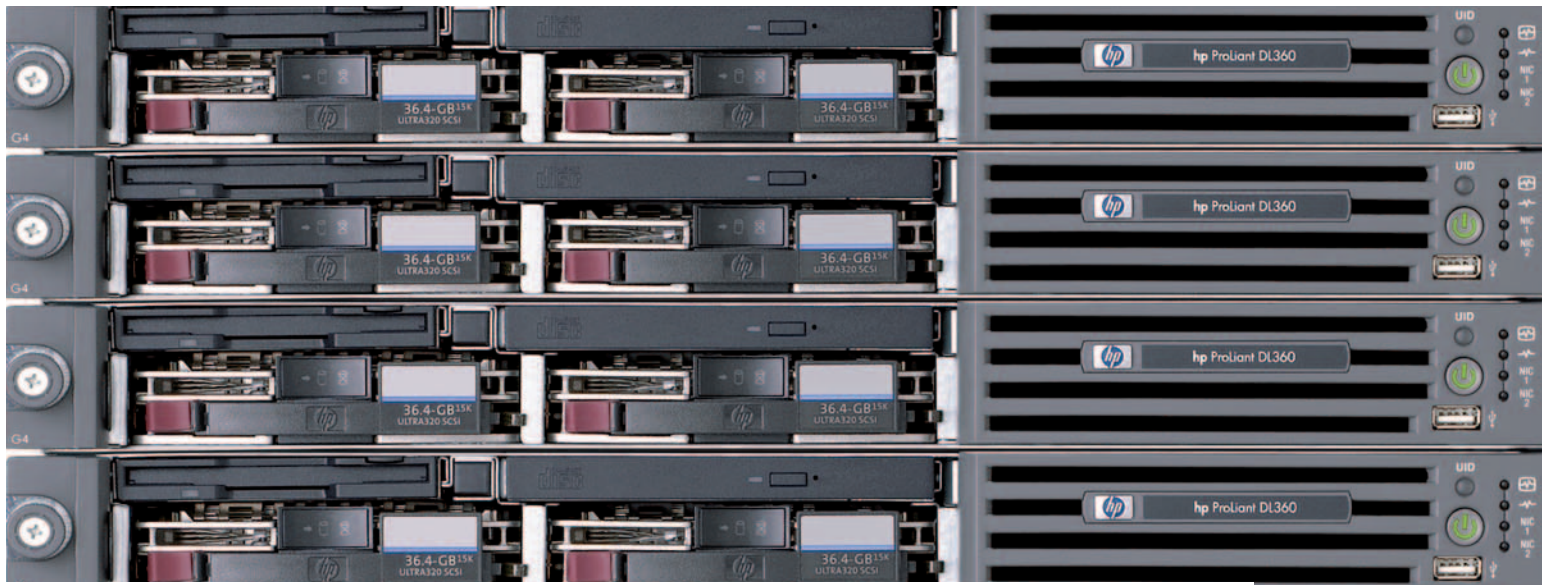
Modern render farms have become large-scale data centers with thousands of high-performance processing nodes, densely packed into ever-smaller physical spaces. As computer speed and density increase, power dissipation can exceed 30KW in a standard rack footprint. Thermal management and power consumption have become critical considerations for cost, component reliability, and system uptime.

HP's Smart Data Center technologies employ computational fluid dynamics, thermo-mechanical control systems, and advanced sensor networks to maintain correct operating temperatures, optimize cooling and power consumption costs, and maximize the operating life of system components. HP's URS takes full advantage of these unique capabilities to provide a consistently high level of service availability in the face of extraordinary resource demand.

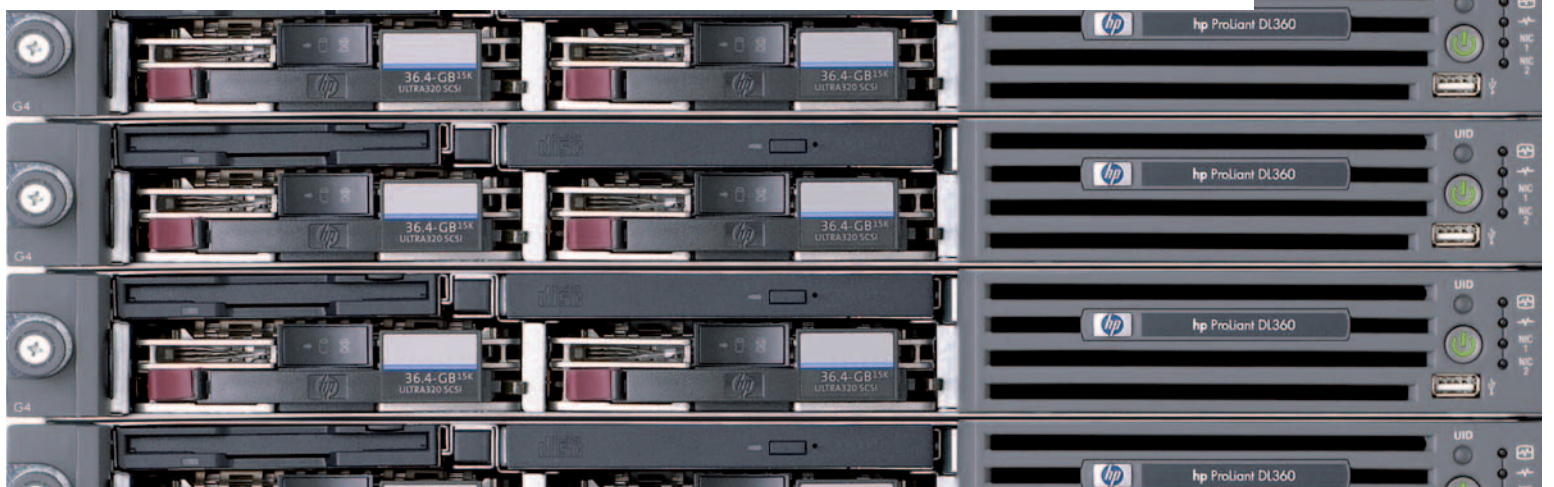
Ongoing Research

For HP, adaptive technologies represent the future of computing, and resources like the URS have the potential to forever transform business practices, infrastructure planning, and cost structures.

Future HP Labs research and customer trials will explore multiple customers using multiple services simultaneously in a utility environment. With companies moving to offload critical computing tasks to HP as a utility provider, these trials will continue to look closely at questions of security and trust as they relate to utility-based services.



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Additional Information:

Adaptive Enterprise

<http://www.hp.com/enterprise>

Data Center Architecture

<http://www.hpl.hp.com/research/dca>

HP's SE3D

<http://www.hpl.hp.com/SE3D/>

SmartFrog

<http://www.smartfrog.org>

Utility Computing

<http://www.hpl.hp.com>

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