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IBRIX Helps Pixar Deliver *Cars* On Time

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Management Summary

When John Lasseter left his animation job at Disney Studios in 1984 to join George Lucas' special effects animation group, he probably did not think he would work for Disney Studios again. Lucas' group, which would be later called Pixar, has developed many critically-acclaimed animated films such as *Toy Story*, *A Bug's Life*, *Finding Nemo*, and their latest movie, *Cars*. Disney Studios recognized the talent and expertise at Pixar and entered an agreement in 1991 to have Pixar produce several animated films that would be marketed by Disney. In June 2006, that agreement became more solidified, when Pixar became a wholly-owned subsidiary of the Walt Disney Company. John is now back working at Disney.

Pixar has received many accolades about the quality of their film design and production. The creation of each new film presented interesting challenges to Pixar's IT department. Most IT organizations plan for the future – they know what new applications are being developed and work closely with the business units to ensure that the right amount of storage and processing power will be available when it is needed. Pixar's IT organization has a different challenge. Film designers continuously use new techniques to develop the next animated film and the IT department at Pixar doesn't always know what the requirements will be until the design process is well underway. *Cars* is the most ambitious movie production that Pixar has ever attempted because techniques like Ray Tracing - which makes shadows and reflections more realistic - required approximately 300x more compute power than that used on *Toy Story*. During the design phase, it became clear that the IT infrastructure could not keep up with the heavy demands. That is when Pixar's IT department had to find a new solution quickly to solve this latest technical challenge.

Many of us have enjoyed watching animated films with our families, but few realize the computing requirements to produce one animated film production. For example, *Cars* took five years to be produced. It is estimated that it took about 2,300 64-bit CPU-years to produce the film. Pixar did not use super computers to generate the graphics, but used over one thousand Dell servers running Linux. During the design process, the system started to 'bog down'. Pixar's IT department determined that the servers were keeping up with the workload, but the file system could not feed the servers fast enough. And that is where IBRIX "entered the picture".

Making A Great Movie

Five years may seem a long time to complete a movie – but many tasks must be completed. The first few stages require little computer processing. Writers pitch the story to get the buy in from the design team and text is written to summarize the main story idea. Artists manually sketch storyboards to illustrate the characters and scenes. Short videotapes of each storyboard are created. After this work is completed, three-

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dimensional models of each character and scene are built. The process of generating a computer image or frame of these three-dimensional models is called rendering. Pixar states that each movie frame - which only lasts 1/24 of a second on the big screen - can take one or more hours to render.

Cars Heads for a Crash

During production of *Cars*, Pixar's IT organization noticed that frames that should have taken one hour to render were taking ten hours. The problem was not the large server farm – the servers were idle waiting for the file system to deliver the data. If IT personnel did not find a way to speed up this process, then *Cars* could not be completed on time. That's when they decided to evaluate the IBRIX solution. Pixar replaced their NFS file system with a 4TB SAN disk and IBRIX. The result – rendering times returned to their previous levels and *Cars* was back on schedule.

The IBRIX Solution

Metadata for traditional file systems are managed by only one server. Applications, such as those in use at Pixar, require file systems that deliver very high performance—in Pixar's case, they needed to access 1 billion 4K reads per hour. This can only be achieved by distributing the management of the metadata across multiple servers, providing multiple concurrent accesses to the file system.

IBRIX offers a distributed or parallel file serving solution suite called *Fusion*. This software only solution runs on standard servers and uses either SAN-attached or direct-attached storage. IBRIX's technology, called *Segmented File System*, differs from other distributed file systems by providing features such as dynamic load balancing, which eliminates "hot spots" on storage. This ensures that performance will always be consistent.

How It Differs

There are several ways to build a parallel file system. One approach organizes the metadata into a hierarchical structure; each server is then responsible for a sub-tree of the hierarchy. However, if one particular segment of the file system is very active, then the server and storage tied to that segment can become very active resulting in performance degradation.

Another approach assigns metadata ownership dynamically at run time. With this approach, a server that needs to access a file must first determine which server owns the metadata. Then it has to request and receive ownership of the metadata before it can proceed. This constant communication between servers degrades performance.

IBRIX uses a segmented approach to achieve performance and scalability. IBRIX's file system is a logical collection of segments. Files and directories are stored within a segment. Each segment can vary in size and files that require high performance can be spread across multiple segments. Servers are assigned the responsibility of managing one or more segments. When additional performance is needed, more servers can be dynamically assigned to the same segment. If additional capacity is required, a new segment can be defined and assigned to existing or new servers.

How It Works

Let's assume that a server requests access to a file. This file can be on the segment owned by the server (the server immediately retrieves the file). It can be on a segment owned by another server within the same SAN (the original server obtains the metadata from the owning server and then retrieves the file over the SAN). Alternatively, the file can be on a segment owned by another server and not accessible through the SAN (the original server sends the request to the owning server, which then transmits the file over an IP network).

Conclusion

Demanding applications, such as the rendering applications at Pixar, require distributed file systems that can deliver consistent high performance. IBRIX's Fusion file system performed as advertised. Its segmented design not only eliminates 'hot spots' but allows one or more segments to be taken offline without impacting the rest of the file system. It allowed Pixar to deliver *Cars* in time for summer vacation, and that's a deadline that Pixar could not afford to miss.

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About the Author

Dianne McAdam **is Director of Enterprise Information Assurance for the Clipper Group**. She brings over three decades of experience as a data center director, educator, technical programmer, systems engineer, and manager for industry-leading vendors. Dianne has held the position of senior analyst at Data Mobility Group and at Illuminata. Before that, she was a technical presentation specialist at EMC's Executive Briefing Center. At Hitachi Data Systems, she served as performance and capacity planning systems engineer and as a systems engineering manager. She also worked at StorageTek as a virtual tape and disk specialist; at Sun Microsystems, as an enterprise storage specialist; and at several large corporations as technical services directors. Dianne earned a Bachelor's and Master's degree in mathematics from Hofstra University in New York.

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