SHARC: A scalable 3D graphics virtual appliance delivery framework in cloud

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ABSTRACT

Recent advances in virtualization technology and wide acceptance of the cloud computing model are having significant impact on the software service industry. Though cloud computing and virtualization technology have been widely applied in supporting the information processing needs of conventional enterprise and business applications, there has been a little success to-date in enabling realtime 3D virtual appliances in the cloud. This paper aims to address this deficiency by presenting SHARC, a solution for enabling scalable support of realtime 3D virtual appliances in a cloud computing environment. The solution uses a scalable pipelined processing infrastructure which consists of three processing networks according to the principle of division-of-labor, a virtualization server network for running 3D virtual appliances, a graphics rendering network for processing graphics rendering workload with load balancing, and a media streaming network for transcoding rendered frames into H.264/MPEG-4 media streams and streaming the media streams to a cloud user. The paper describes a prototype implementation of SHARC and reports test results that demonstrate the viability of this approach.

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1. Introduction

Cloud computing is emerging as a viable alternative to premise-based deployment of hardware and software solutions. The economies of scale and elasticity that cloud computing offers in an increasingly dynamic and competitive business climate has garnered rapid adoption and as a consequence is quickly altering the landscape of the information technology service industry. Cloud computing as a disruptive technology, derives its power in part from recent advances in virtualization technology. Virtualization turns traditional software into *virtual appliances*[1] and allows software with its execution environment to be deployed and delivered as services in ways that are both massively scalable and elastic.

Though virtualization has existed long before the emergence of cloud computing, it is the recent introduction of low cost many-core processors combined with the power of virtualization that makes cloud computing especially effective. Many-core processors have increased virtualization densities to the point at which large numbers of virtual servers can be ran concurrently on a single physical server.

To-date cloud computing has been primarily concerned with delivering the software and application services required by the conventional business enterprise, such as web servers, transaction processing, business applications, email services, etc. Beyond the enterprise, cloud computing has also been commonly leveraged by nascent startup companies who offer consumer facing applications and services, and need to be positioned to rapidly scale up their offerings just in time should demand suddenly materialize. Yet these endeavors also involve the same types software services and application categories as the established enterprise.

One application category that has up until now not been actively pursued in the context of cloud computing is multimedia applications, and especially those that involve 3D graphics. This is perhaps due in part to the fact that conventional enterprise software services and application have been the low hanging fruit and thus far received the most attention, but more likely due to the default perception that the technical obstacles are insurmountable. Nevertheless multimedia and 3D graphics functionality is becoming more and more preponderant in many application categories, well beyond the obvious "fast twitch" video games where the technology has been most widely applied. Interactive situated displays are beginning to be deployed in bricks and mortar retail establishments to allow shoppers to visualize what they might look like in a new outfit, or as information kiosks in public places. Many enterprises are now using online 3D virtual worlds for training and collaborative purposes. In such situations, the computing needs of the typical

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