Virtualization in Practice: Implementing Active Directory Sites

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ABSTRACT

Virtualization has the potential to revolutionise the way networking is taught in higher learning institutions. This article outlines, through the use of a case study, the way in which VMware Workstation and VMware ESX Server are used so that each student in the class runs his or her own set of seven virtual servers, including a Linux router. The Linux router connects virtual networks within the context of student physical machines to one another as well as a lecturer virtual server, which runs on an ESX server. In this way, a class of twenty-two students can together run an enterprise-like network comprising of some 177 servers and implement Microsoft Active Directory sites and associated services in order to optimize a specific scenario-based replication topology.

Keywords: Active Directory, ESX, Microsoft, Networking, VMware, Virtualization

INTRODUCTION

Virtualization has been described somewhat informally as “the ability to run a full operating system on a software platform in such a way that the OS thinks it is running on a “real” computer” (Minasi, Gibson, Finn, Henry, & Hynes, 2010). To be a little more specific (and formal), virtualization is “A framework or methodology of dividing the resources of a computer hardware into multiple execution environments, by applying one or more concepts or technologies such as hardware and software partitioning, time sharing, partial or complete machine simulation, emulation, quality of service, and many others” (Williams & Garcia, 2007). In a nutshell, though, the essence of virtualization is “the act of abstracting the physical boundaries of a technology” (Wolf & Halter, 2005). All three aforementioned sources are consistent with the concept of virtualization as the technology or perhaps more accurately the set of technologies that enable computers to no longer require dedicated use of physical hardware, whether it be disk, CPU, network adapter or other physical resource. It decouples hardware and software, so that a system may utilise – without its knowledge as Minasi, Gibson et al. (2010) put it—a subset or even superset of hardware resources independently of other systems. In other words, one set of hardware may host a number of virtual machines and one virtual machine may be hosted on multiple sets of hardware. As a result, compared to physical machines, virtual systems do not just make more efficient use of existing hardware resources but are also more flexible in that they are easier to

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provision, maintain and decommission as well as move to alternative physical locations.

Some academics have been slow to embrace these technologies, even viewing these developments in virtualization with some suspicion. Others have adopted it and recognised its value for teaching operating systems, networking and programming, notably McEwan (2002) Correia and Watson (2004) and more recently Dobrilovic & Odadžic (2006), van Aardt and Mossom (2009), and Lunsford (2009). The value of virtualization for providing students with the experience of implementing a variety of “real” systems has gained some level of acceptance in many institutions of higher learning, including polytechnics in New Zealand. One of the reasons for making this a standard approach for providing students with practical ways to implement technologies is that it enables a single physical machine to run many virtual machines with these machines being on the same or different network segments. Much of this is now reasonably well documented but few academics have documented exactly how they use widely available virtualization software to explore a topic or technology with students. This paper aims to do just that.

**Active Directory Sites**

Active Directory Domain Services, otherwise known as “Active Directory Directory Services” or simply “Active Directory” has been adopted in a wide range of organisations, large and small. Like a number of other directories that conform to the Lightweight Directory Access Protocol (LDAP), Active Directory stores information about network entities as objects and makes this available to users and services that require them (Kouti & Seitsonen, 2002, p. 4). The store of users, groups, computers, applications, printers, and other network entities is organised in a hierarchical fashion in a central database on one or more servers and as such provides “centralized and secure management of an entire network, which might span a building, a city, or multiple locations throughout the world” (Microsoft, 2010). It is this centralised record of network resources that makes a large enterprise network manageable. Users can only log onto the network from different workstations because their user account and its associated data, including the password, is stored centrally. In order to avoid a single point of failure, Microsoft recommends that organisations keep multiple copies of this data by making use of at least two servers that store the Active Directory database or “domain controllers” as they are called.

Active Directory comprises of essentially two components: logical and physical (Microsoft, 2003). The logical structure refers to the organization of objects, whereas the physical structure refers to, as Williams and Walla (2003) put it, the communication of those objects. To be more specific, organizational units, domains, forests are objects that form part of the logical structure while sites, subnets and site links for example, objects that provide a means to build “the most efficient replication topology” (Microsoft, 2008), form part of the physical structure. The physical structure is the way in which Active Directory accommodates the geographically dispersed nature of many corporate networks. An enterprise typically has a presence in different cities and its network therefore comprises of a number of local area networks. A site is essentially a “LAN-connected area” (Minasi, Anderson, Smith, & Toombs, 1999), and as such replication of Active Directory data (new users, a new site, a changed password and so on) between domain controllers within sites differ fundamentally to replication between domain controllers between sites. For instance, replication traffic between sites is compressed whereas replication traffic within sites is not. What is important in terms of managing an Active Directory domain is that an administrator cannot manage replication between domain controllers in the same site but can and should manage replication between domain controllers in different sites. The scenario-based practical project on Active Directory sites and services ensures students implement “an efficient replication topology” (Microsoft, 2008).
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