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Online gamma-ray spectroscopy acquisition

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ABSTRACT

This work develops a centralized network solution for gamma-ray spectroscopy online acquisition, and could potentially eliminate the client computers from the equipment inventory to reduce cost and maintenance efforts, ideal for teaching laboratory development. The three-ways communication among the server, detectors, and client devices are carried over Internet. The Osprey digital signal processing instrument is switched to network mode and powered by the Power over Ethernet injector. The ProSpect gamma spectroscopy software is hosted as a RemoteApp on Windows Server 2016. It accepts connections from various operating systems supporting Microsoft Remote Desktop protocol with or without additional software. The client devices do not need to install the data acquisition software, and the users can bring their personal laptop or log on any general purpose lab computers to perform data acquisition. In addition, this development demonstrates remote data acquisition of several gamma-ray sources using Windows, LINUX, MAC, iOS, and Android systems as the clients.

1. Introduction

Nuclear experiment is an essential part in nuclear engineering education providing hands-on experience to students. Each experiment set may contain measuring device such as gamma-ray spectrometer, data acquisition software, computers, and sources. During the class, multiple students must use multiple computers to control multiple detectors to perform data acquisition. At Texas A&M University-Kingsville (TAMUK), the undergraduate nuclear experiments are conducted with four sets of Canberra LABKIT-Basic (Cocks et al., 2017). Each LABKIT-Basic mainly contains an Osprey multi-channel analyzer (MCA), a NaI detector, and a Cs-137 source. The ProSpect gamma spectroscopy software (Canberra Inc., 2012) of each equipment set is license locked to a user provided Windows PC. This restriction would be an obstacle preventing the expansion of the number of equipment to accommodate the growing enrollment in the nuclear program, because it is difficult to purchase, maintain, and store a dozen of computers for this purpose, especially in a regional university. In addition, restricting the ProSpect software on a certain computer may cause the entire LABKIT unusable, if the computer or software fails to start. That would take weeks to coordinate between the manufacturer and the university IT department to transfer the software license to another computer. This situation motivates us to develop a centralized server solution to host the ProSpect software and enable remote data acquisition by using the existing campus network infrastructure. This work will eliminate the client computers from the inventory of the equipment, which means the nuclear lab does not need to invest, maintain, or keep them. When operating all experiment equipment is needed, the users may use any computer to connect to the server to manipulate the detector. They can either bring their own laptops or log on the general purpose computers available in the lab. The client computers do not need the data acquisition software installed. The developed solution will support client devices with various operating systems (OS) including mobile devices. This solution presents an easy and low-cost method to manage the nuclear lab and greatly reduce the workload of the lab administrator, as there is only one server that needs cares. It also allows the ProSpect to run on other OS that are not natively supported by the Windows-based software. The central idea presented by this manuscript can be applied to other similar scenarios to bring revolutionary network solution to nuclear education. To the best knowledge of the authors, the literature survey shows no relevant existing work, and this research is extended from the authors previous efforts (Garcia et al., 2016).

2. Methodologies

The hardware used in this work includes a Dell Optiplex 7020 (Intel i5-4590, 16 GB memory), four Canberra LABKIT-Basic (Osprey, NaI detector, detector holder, power over Ethernet injec-

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tor, and Ethernet cables), gamma-ray disk sources, campus wired and wireless network, and five client devices with different OS. The PC elected as the server does not have to be enterprise level equipment, but it should be able to simultaneously run several ProSpect instances. The minimum system requirement is estimated to be 2 users per CPU core, and 2 GB memory per user plus 2 GB for the OS. The server, client devices, and the detectors are interconnected by internet, through either campus network or a private wireless router. Fig. 1 illustrates the setup of the interconnection of all devices.

The software used in this research is Microsoft Windows Server 2016 Datacenter, 5-users Client Access License (CAL), and ProSpect. Other editions of the Windows Server 2016 can achieve the same functions described in this manuscript. PCs with any version of Windows 7 or 10 can be used as client devices without additional software. Linux, Mac, iOS and Android systems requires additional utility applications to connect to a Microsoft Windows server.

The decision of choosing the abovementioned software is primary based on two requirements. First, ProSpect only supports Windows system, so the server OS must be Windows, otherwise ProSpect could not be installed. Second, it is preferred that no or minimum modification is needed for the client systems. All Windows systems natively support Remote Desktop Protocol (RDP) and no additional software is required to connect to an RDP server. Therefore, the most popular Windows system is ideal for this development, and clients with other OS could utilize some light utility software to establish the connections.

2.1. Server configuration

RemoteApp, part of the Remote Desktop Service (RDS) on Microsoft Windows Server 2016 will be used to present the ProSpect software to multiple users simultaneously. It requires three services: Active Directory Domain Service (AD DS), RDS, and RDS licensing server. In an enterprise environment, usually three different servers realize those services separately, but for small-scale applications, all services can be integrated into one single server. The configuration starts from the installation of the Windows Server 2016 Datacenter with desktop experience.

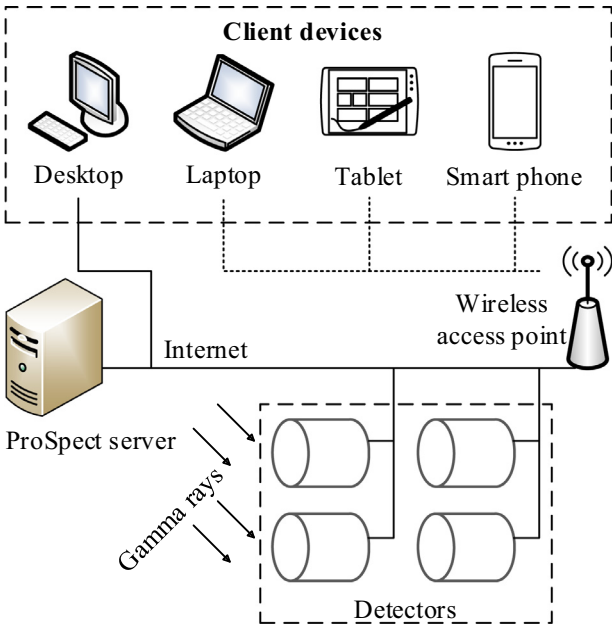

Fig. 1. Online gamma-ray spectroscopy acquisition system connection diagram.

Before adding the AD service, it is wise to modify the computer name, which will be the subdomain name of this server, otherwise it would take many more steps to change it once the server is promoted to an AD server. Changing the computer name can be achieved by selecting "Local Server" in the left panel of the "Server Manager", and then click the current computer name in the right properties windows. In the following "System Properties" dialog, change the randomly given computer name to a short name, so that the users do not have to memorize or type the long name. In this work, the computer name is changed to "NE", and the computer is rebooted to apply the change.

2.1.1. Active Directory Domain Services (AD DS)

AD DS centralizes and authenticates logon and access information. It allows the users to log on a domain instead of a single computer, just like students can log on any computer in the library using the same university assigned username and password. AD DS can be added to the server from the "Server Manager" window by choosing "Add roles and features" and "Role-based or feature-based installation" in the following dialog. Then, select the only server listed in the server pool, noting that the server name has been changed to "NE". In the server role window, check the second role "Active Directory Domain Services", and follow the prompt to complete the installation.

After rebooting the system, the server needs to be promoted to a domain controller. As illustrated in Fig. 2, this action can be initiated in the "Server Manager" dashboard. Then, choose "Add a new forest" and specify the domain name, as depicted in Fig. 3. If a domain (either acquired from the IT department or purchased elsewhere) is available for this server, the domain name can be entered here. In this case, a dummy domain name `nuclear.local` is entered. In the next page, choose a password for the "Directory Services Restore Mode". This password can be the same as or different from the administrator password. It is only used for repairing or recovering the AD database. Accept all default options for the rest of the configurations to complete the AD DS configuration wizard. After the reboot, note that the logon window is changed to domain logon and the user will logon as `NUCLEAR\Administrator` instead of just `Administrator`.

2.1.2. Remote Desktop Service (RDS)

The RDS allows multiple clients to connect to the server remotely through remote desktop protocol (RDP). This feature can be added from "Server Manager" – "Add roles and features". In the following dialog, choose "Remote Desktop Services Installation". This installation is not available until this server joins or becomes a domain controller as explained in the previous section. In the deployment type dialog, choose "Quick Start", and in the deployment scenario dialog choose "Session-based desktop deployment". Then, in the "Server Selection" window select the current and the only server in the server pool. Accept the default options in the following pages to complete the installation.

2.1.3. RDS licensing server

Similar to the AD DS installation, in "Server Manager" choose "Add roles and features" then select "Role-based or feature-based installation". In the server roles dialog, check "Remote Desktop Licensing" as shown in Fig. 4, and complete the installation with default options.

The installed RDS licensing server needs to be activated. In the menu of the "Server Manager" (Fig. 2), click "Tools" – "Remote Desktop Services" – "Remote Desktop Licensing Manager". The RD licensing manager will list the server activation status as not activated. Right click the server name and select "Activate Server". Use the default "Automatic connection" in the connection method and enter the required Company Information in the next page. In