

# Virtualizing OpenLab CDS Client/Server Systems

## Introduction

This guide specifies how to virtualize Agilent OpenLab CDS client/server systems. Although based on VMWare vSphere and uses VMWare terminology, the requirements also apply to other virtualization software such as Microsoft Windows Hyper-V. Agilent expects system administrators to be proficient with the virtualization technology they have selected. For less proficient users, Agilent recommends contracting a virtualization specialist. There are online references in the footnotes that have been found to be helpful.

Note: This guide does not address virtualization in a cloud environment.

In order to have a reliable, fast performing system, it is mandatory to follow the requirements in this guide. Agilent cannot provide support for reliability or performance problems when the virtualization software is not configured as specified in this document.

This guide is written for the OpenLab CDS software but also applies to OpenLab EZChrom and OpenLab ChemStation client/server systems. Where EZChrom and ChemStation have unique requirements, they are called out separately.

## System Architecture

Figure 1 is a simplified illustration of the architecture of an OpenLab CDS system. Larger systems supporting multiple laboratories include additional servers and different network topologies.

Requirements for each component of the system can be found in the requirements documents. The virtual machines (VMs) used for your virtual OpenLab CDS system must provide the required resources specified for physical machines.

OpenLab Servers and Agilent Instrument Controllers (AICs) can be virtualized with hardware virtualization software such as VMWare vSphere or Microsoft Windows Hyper-V. OpenLab CDS Clients can be virtualized with application virtualization software such as Microsoft Remote Desktop Services (RDS) or Citrix Xenapp. The OpenLab requirements documents include the virtualization software used in Agilent's testing.

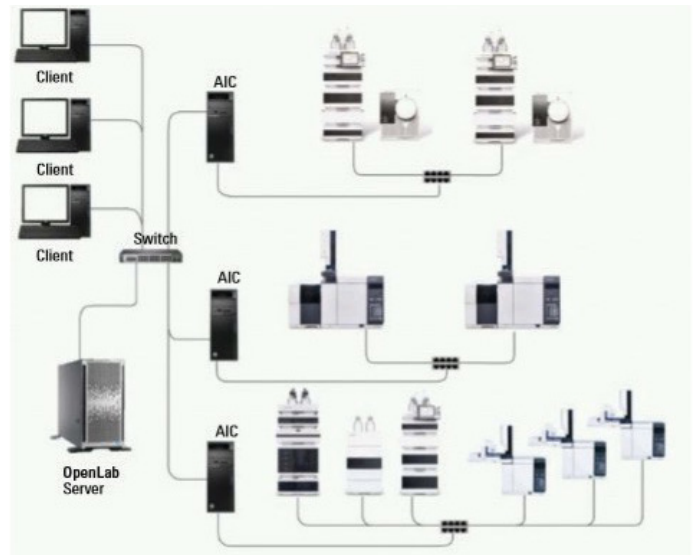


Figure 1. Agilent OpenLab CDS Client/Server system architecture.

## General Requirements

For all components of an OpenLab CDS system, the following general requirements apply. See later sections for additional requirements for individual components.

- **Resource reservations** – Reserve CPU cores and memory for each virtual machine according to the requirements guides<sup>1</sup>.
- **Host hardware** – Ensure that each host server is adequately provisioned. Each host must have more hardware than the total reserved CPU cores, CPU sockets, and memory for all the VMs (including any VMs that are hosted for other software applications on the same server). Overcommitting the host hardware will significantly impact system stability and performance.
- **Snapshots** – Take snapshots only when the system is idle. Do not use snapshots for backups and do use more than 2 or 3 at a time<sup>2</sup>.
- **Machine migration** - Do not migrate running virtual machines between servers (for example, using VMWare VMotion.)

- **Disk storage** – Distribute disk storage for the servers to separate storage devices to avoid bottlenecks. For best performance, use SSD storage devices, especially for servers. Regularly check performance counters such as disk read and write queue length to identify bottlenecks<sup>3</sup>.
- **Optimize VM configuration** – Follow the virtualization software vendor recommendations for optimizing the VM configuration vis-à-vis the host hardware. For example, the virtual machines must not be configured for more CPUs than the number of sockets in the host machine<sup>4</sup>.

**Virtual router/switch** – Configure a virtual router/switch for VMs on the same host so communications occur locally instead of going out to the network and back. See [Virtual router/switch](#) later in this document.

Unlike other software systems, OpenLab CDS operates laboratory instruments that acquire and process data in real time. Reliable operation always depends on sufficient resources – especially under peak load when the lab is very busy.

<sup>1</sup> "Agilent OpenLab CDS Requirements Guide" and "Agilent OpenLab Server Hardware and Software Requirements Guide" on the media for the software and on the product page at <https://www.agilent.com> under Support/User Manuals

<sup>2</sup> "Best practices for using snapshots in the vSphere environment (1025279)", January 21, 2021, <https://kb.vmware.com/s/article/1025279> (accessed February 17, 2021)

<sup>3</sup> "Detecting bottlenecks in a virtualized environment", October 17, 2017, <https://docs.microsoft.com/en-us/windows-server/administration/performance-tuning/role/hyper-v-server/detecting-virtualized-environment-bottlenecks> (accessed February 17, 2021)

<sup>4</sup> "Virtual Machine vCPU and vNUMA Rightsizing – Guidelines", March 9, 2017, <https://blogs.vmware.com/performance/2017/03/virtual-machine-vcpu-and-vmnuma-rightsizing-rules-of-thumb.html> (accessed February 17, 2021)

## OpenLab Server (Shared Services and Content Management) virtualization requirements

OpenLab Server is used to store data collected from your instruments. OpenLab Server can be deployed as a one server or as a scalable server system.

Shared Services is a set of administrative services that control, for example, the security policy and the central configuration of OpenLab CDS, and is accessed through the Control Panel.

Content Management is a database used to manage your analytical data. The database is provided as a component of OpenLab Server.

### Virtualization requirements

In addition to the General Requirements specified earlier, OpenLab Server or OpenLab ECM XT requires the following:

- **Network adapter** - Provide a network adaptor to which the OpenLab Server license can bind. Do not use a dynamic MAC address which, for example, has been the default option for Hyper-V. It is not recommended to use a Windows Server virtual machine with the Windows Server network teaming feature. With this configuration, OpenLab Server cannot retrieve the MAC address of a network team interface. If you must use this configuration, an additional virtual network adaptor is needed to which the OpenLab Server license can bind.

### External database server

A separate external database server is required for larger systems as specified in the *Agilent OpenLab Server Hardware and Software Requirements Guide*.

The General Requirements specified earlier apply also to separate database servers. For virtualizing Microsoft SQL Server, follow the VMWare best practices guide<sup>5</sup>.

## OpenLab ECM 3.x virtualization requirements

OpenLab ECM 3.x is also available as for data storage with OpenLab CDS, ChemStation, and EZChrom systems. In this configuration, there is a separate OpenLab Shared Services Server that has the same virtualization requirements as specified for OpenLab Server above.

The OpenLab ECM 3.x system itself can also be fully virtualized with a similar approach. This is not covered in this guide. Contact your Agilent representative for more information.

## OpenLab Agilent Instrument Controller (AIC) virtualization requirements

The Agilent Instrument Controller performs CPU and memory-intensive tasks such as data acquisition, data processing, data reprocessing, and reporting. Since each AIC is directly communicating with a laboratory instrument, sufficient CPU cores and memory are essential to maintaining reliable communication.

### Virtualization requirements

In addition to the earlier General Requirements, OpenLab AICs must be virtualized with the following requirement.

- **Configure** the host server with multiple storage devices (disk drives, spindles, or LUNs) each of which must be assigned to a different VM. During operation, AICs produce heavy disk I/O because many log and data files are simultaneously read and written. For more information, see the vSphere Storage reference<sup>6</sup>.

**Caution:** Failure to adequately provision the AIC will have a negative impact on system performance, stability, and may result in data loss.

<sup>5</sup> "Architecting Microsoft SQL Server on VMWare vSphere", November 2018, <https://www.vmware.com/content/dam/digitalmarketing/vmware/en/pdf/solutions/sql-server-on-vmware-best-practices-guide.pdf>, (accessed February 19, 2021)

<sup>6</sup> "vSphere Storage", August 15, 2020, <https://docs.vmware.com/en/VMware-vSphere/7.0/vsphere-esxi-vcserver-70-storage-guide.pdf> (accessed February 19, 2021)

## Physical AIC versus virtual AIC

A *physical* AIC connected directly to your instruments provides the benefit of uninterrupted execution of submitted samples when network communications with the OpenLab Server are interrupted for an extended period of time.

A *virtual* AIC may be unable to provide uninterrupted execution of submitted samples if a network interruption prevents instrument communications. Note that some older instruments do not communicate via a LAN connection and cannot be used with a virtualized AIC. Devices that convert non-LAN connections to LAN are not supported.

Evaluate the laboratory use patterns of instruments and the AICs, as well as the risk of controlling instruments over the network, before attempting to virtualize AICs. Consider the value proposition of virtualizing AICs that require the same dedicated CPU and similar memory physical resources as a physical AIC server. While AICs can be virtualized, the benefits need to be weighed against the loss of the data-protection value provided by non-virtual AICs and the processing demands on the host server, in addition to introducing a single point of failure.

Be aware of Network Proximity to instruments. A physically isolated instrument network is strongly recommended. Routing instrument communications traffic is unreliable and not supported (instruments must be on the same vlan as the AIC).

## Multiple AIC VMs

Multiple Network Interface Cards (NICs) are required for multiple AIC VMs. For more information, refer to the online VMware Knowledge Base<sup>7</sup>. If NICs are teamed, a virtual router is required. LAN cards should not be teamed for instrument communications. The number of instruments using the same LAN or NIC, and how often OpenLab CDS clients will be used to view data in real time, will drive LAN card requirements. In particular, when instruments are connected, the physical network connection to the host is shared by all the virtual AICs, and must have sufficient capacity. As a rule of thumb, there should be a physical NIC for every 5 virtualized AICs for OpenLab CDS and every 2 virtualized AICs for OpenLab ChemStation.

## OpenLab CDS Client virtualization requirements

An OpenLab CDS client application contains the OpenLab Control Panel, the Acquisition client module, and Data Analysis. The Acquisition client communicates with the Acquisition server that is running on the AIC. When an OpenLab CDS Client is disconnected, it no longer receives updates but the Acquisition server continues to run on the AIC.

### Virtualization requirements

In addition to the earlier General Requirements, OpenLab CDS clients have the following virtualization requirements:

- With Citrix XenApp, the port for communications must be changed from the default 27000 as this conflicts with the port required for the OpenLab CDS License Manager.

### Additional Note for OpenLab ChemStation Clients

An OpenLab ChemStation client contains the OpenLab Control Panel and is used to access the ChemStation instance on an AIC. The connection between the CDS Client and the AIC is transparent using Remote Desktop Services. When you disconnect the CDS Client, you disconnect the Remote Desktop Connection. ChemStation continues to run on the AIC.

ChemStation clients should be provisioned according to the earlier General Requirements including memory and CPU reservations per the OpenLab ChemStation Hardware and Software Requirements Guide<sup>8</sup>.

<sup>7</sup> VMware Knowledge Base, <https://kb.vmware.com/selfservice/microsites/microsite.do>, (accessed February 18, 2021)

<sup>8</sup> OpenLab CDS ChemStation Edition Requirements\* on the media for the software and on the product page at <https://www.agilent.com> under Support/User Manuals

## Additional Information and Recommendations

### Virtual router/switch

Configure a virtual router/switch when virtual guests on the same host communicate with each other. For more information on virtual router, refer to the online VMware Knowledge Base<sup>6</sup>. When using a virtual router, traffic between guest VMs on the same virtual switch is typically transferred locally across the system bus instead of across the network. This helps to lessen the amount of traffic that travels in and out of the network interface and over the LAN. This can be used for AIC communication with the OLSS and the OpenLab Web server when configured on the virtual switch. The only traffic that traverses the network infrastructure is that which is needed for instruments, clients, and other servers that are not virtualized. For more information, see the VMware vSphere Networking Guide<sup>9</sup>.

Consider using NIC with TCP Segmentation Offload<sup>10</sup> (TSO) to offload the packetization of data from the CPU to the NIC. For more information, see the topic on TCP Segmentation Offload. TSO is supported by the E1000, Enhanced VMXNET, and VMXNET3 virtual network adapters (but not by the normal VMXNET adapter). In ESXi, TSO is enabled by default in the VMkernel, but is supported in virtual machines only when they are using the VMXNET3 device, the Enhanced VMXNET device, or the E1000 device. TSO can improve performance even if the underlying hardware does not support TSO.

For more information and recommendations regarding deployment of VMWare products, refer to the online VMware Knowledge Base<sup>5</sup>.

### Virtualization optimization strategy

Up to this point, the instructions in this guide are proven to provide a reliable, high-performance system. This section discusses a strategy that system administrators can follow to optimize the virtualization resources while maintaining acceptable performance.

When optimizing virtualization resources, system administrators must track the system performance and be ready to adjust resources when needed. Agilent recommends the following steps:

1. Set up the initial configuration of a new system according to all the previous instructions in this guide for the first set of instruments and users when the system goes live.
2. Thoroughly document the system configuration and establish a baseline of system performance. Work with users to measure response times for a set of common operations. For example:
  - a. Acquisition startup time for an instrument that is not currently connected
  - b. Data Analysis startup time
  - c. Reprocessing time for a large Result Set
  - d. Time to return a search result from Data Analysis
  - e. Etc. – add others as appropriate
3. As the system load increases, check that the response times remain acceptable. Keep a spreadsheet of the measures with the date, time, client, and AIC used. Take measurements during peak load times when many instruments are running and many users are processing data.
4. When the virtualization host hardware is not sufficient to reserve all the resources required:
  - a. Prioritize resource reservations for the database and OpenLab servers first.
  - b. For ChemStation, AICs should also be prioritized for resource reservations.
  - c. Reduce reserved resources for all other VMs so there are not more total reserved resources than exist in the virtualization host hardware. Clients are lower risk than AICs so start with the client resources.
  - d. Do not reduce reservations for OpenLab CDS AICs to less than 50% of what is required.
5. Check the response times in step 2 whenever making virtualization configuration changes and revert any change that results in unacceptable performance.

By following a controlled process as described, system administrators can maintain acceptable performance for the OpenLab CDS users while realizing the benefits of virtualization.

<sup>9</sup> "VMware vSphere Networking Guide", 2017, <http://pubs.vmware.com/vsphere-65/topic/com.vmware.ICbase/PDF/vsphere-esxi-vcenter-server-65-networking-guide.pdf>, (accessed February 18, 2021)

<sup>10</sup> "TCP Segmentation Offload", May 31, 2019, <http://pubs.vmware.com/vsphere-60/index.jsp?topic=%2Fcom.vmware.vsphere.networking.doc%2FGUID-E105A601-9331-496C-A213-F76EA3863E31.html>, (accessed February 19, 2021)

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