Consolidating Servers in Three Phases

Approach a server consolidation project in stages to maximize savings and keep mistakes at a minimum.

BY MALCOLM HAMER
VIRTUALIZATION HAS EMERGED as a principal enabler of data center efficiency. Using virtualization, an organization can consolidate many servers into few, dramatically improving hardware utilization and lowering the corresponding power, cooling and physical space demands that have stunted long-term data center growth. But virtualization is not a turnkey process; it requires careful consideration and planning to ensure successful (and cost-effective) deployments.

Throughout the Virtualization Essentials e-book, our experts give advice on four key elements of a server virtualization deployment: consolidation, storage, desktop virtualization and network virtualization. In this chapter, we'll focus on the planning aspects of server virtualization in three distinct phases.
even more difficult to verify their value after installation and deployment, especially since there is no standard method to measure this value. Direct savings are easier to quantify and are generally sufficient to justify a move to a virtualized environment or an expansion of an existing virtualization project. A systematic and phased approach to server consolidation—data collection and analysis as well as migration preparation and implementation—will ensure that your data center reaps all the benefits of virtualization.

PHASE 1: DATA COLLECTION
The first step in planning a server consolidation project is to get a complete and accurate picture of the contents of your data center. This should include not just a physical inventory of all servers but also an exact description of what is installed on each server—the operating system, middleware, and the application or database that the server supports. The data collection phase typically accounts for about 75% of the total planning efforts.

Some data collection can take place concurrently, and you’ll be gathering it from three work-streams:

1. Compile information about the current data center environment, including the following:
   - An inventory that covers each server’s make and model, serial number, physical location in the data center, date of manufacture, hostname and IP address. You should also include server resources such as CPU details, memory and network interface speed.
   - A software inventory for each server listing the installed OS and version as well as middleware, including database management systems like Oracle or Microsoft SQL Server, and Web server software such as Apache or Microsoft Internet Information Services.
   - A catalog containing a complete list of all applications and databases the data center supports. This should include apps developed in-house, purchased enterprise-specific software and generic apps like email. The catalog should also have contact information for members of software development and support teams who are responsible for each application and database.
   - Application/server mapping and database/server mapping for each app and database, as listed in the aforementioned catalog. Include a list of all instances of the application/database and associated details. In some cases, data center records may not include all necessary instance-mapping informa-
An APPLICATION INSTANCE or DATABASE INSTANCE is a copy of the application/database that exists on a particular server. The instance’s role and “green zone” details should be recorded for each instance. Each instance has one of four roles: production, quality assurance, testing or development. The instance’s green zone is the exact period each week, typically on the weekend, when the application is not being used. Server or network changes and maintenance can occur during this time.

2. Interview application and database owners. For each application and database in the catalog, conduct interviews with appropriate development and support staff. Ask questions that will help you do the following:

- Update information about the application and/or the database, which is often incomplete.

- Become aware of plans for the application or database. For example, a database may be scheduled for decommissioning, replacement or a major overhaul.

- Understand if the application or database can run in a virtualized environment, including any ways in which an app can “behave badly” or be the subject of special regulatory requirements.

- Find out which versions of the OS the application should run on and which versions it has been tested for. Admins may try to move as
QUANTIFYING VIRTUALIZATION’S GOALS

PHASE 1: DATA COLLECTION

PHASE 2: DATA ANALYSIS AND APPLICATION ASSIGNMENT

PHASE 3: THE MIGRATION PLAN AND ENVIRONMENT MONITORING

PREPARING FOR END-STATE OPERATIONS

CONSOLIDATING SERVERS IN THREE PHASES

many applications as possible onto the same version of each OS for manageability. This is not an essential part of server consolidation because you can build VMs that run several versions of an OS, but it is an opportunity to reduce the complexity of data center operations.

- Obtain details of application-to-application and application-to-database dependencies.

- Learn if the license keys for purchased software are tied to the server and how to obtain updated keys when moving the application to a new server, particularly to a VM.

Enter all of these results into a project database—ideally Microsoft Access, SQL Server or Oracle. An Excel workbook is also adequate for smaller workstreams. Table 1 illustrates the structure of a typical database for a server consolidation project. It gives you an idea of the number of data elements that are typically collected for each server, application and database. For larger data centers containing 1,000 servers that support numerous

<table>
<thead>
<tr>
<th>TABLE (OR WORKSHEET)</th>
<th>KEY COLUMN(S)</th>
<th>NO. OF ROWS</th>
<th>TYPICAL NO. OF COLUMNS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Servers</td>
<td>Server ID—server host name or other unique ID</td>
<td>One per server</td>
<td>20</td>
</tr>
<tr>
<td>Applications</td>
<td>Application ID—generated by the project team if there is no unique naming scheme in place</td>
<td>One per application</td>
<td>15</td>
</tr>
<tr>
<td>Databases</td>
<td>Database ID—generated by the project team if there is no unique naming scheme in place</td>
<td>One per database</td>
<td>15</td>
</tr>
<tr>
<td>Application/server mapping</td>
<td>Application ID, server hostname</td>
<td>One per application instance</td>
<td>5</td>
</tr>
<tr>
<td>Database/server mapping</td>
<td>Database ID, server hostname</td>
<td>One per database instance</td>
<td>5</td>
</tr>
<tr>
<td>Daily server performance</td>
<td>Server ID—server hostname or other ID</td>
<td>One per server per observed day</td>
<td>20</td>
</tr>
<tr>
<td>Monthly server performance</td>
<td>Server ID—server hostname or other ID</td>
<td>One per server per observed month</td>
<td>20</td>
</tr>
</tbody>
</table>
applications and databases, the consolidation database could contain more than 30,000 data points—not including server performance data.

Note that the number of application instances or database instances appearing in the application/server mapping or database/server mapping tables is typically four to five times the number of applications or databases in the environment. Generally, there are three or four instances of each application and database within production and test and development roles.

It’s common to discover that a few applications and their underlying databases co-reside on one server. In these cases, the same server will appear under both application/server mapping and database/server mapping. It may be useful to flag these cases by including a “combo server” column in the mapping tables, where a value of “Y” in that column indicates this co-residency. In addition, if some servers have been virtualized previously, include columns to record this.

PHASE 2: DATA ANALYSIS AND APPLICATION ASSIGNMENT

The goal of the analysis phase is to create a complete definition of the consolidated end state. The target end state will be represented in the following ways:

- A list of all servers that will exist after consolidation, including servers that will be retained and new ones that will be purchased.
- The number of VMs that will be created on each server. Some servers may remain as standard servers, without virtualization software installed on them. These servers will host a single application, a single database or a combination of the two.
- The exact placement of each application and database instance in this virtualized environment, including the physical server and, except when a dedicated nonvirtualized machine is used, the VM where the application or database will reside.

Your first task in the analysis phase is to identify which servers to retain in the new environment. Base this on a review of the characteristics detailed in the consolidation project table—CPU, memory, network interface.

You might decide to upgrade some servers by, for example, adding memory. Once you have listed the servers that will be retained, you can assign simple codes to them (E1, E2, E3 and so on) to facilitate subsequent steps.

Then you can begin the main analysis task: assigning each application instance and database
instance to a physical server in the end state. If you have several hundred, or even thousands, of servers listed in the project database, this may seem like a daunting task. Certain assumptions, however, can help you dramatically reduce the number of choices. It’s not unusual to complete the analysis in as little as three hours for a project that involved two months’ of data gathering.

When choosing applications or databases to consolidate on the same physical server—in separate VMs, of course—here are the objectives:

- Do not exceed a reasonable number of VMs on each physical server. For example, you may need 10 VMs for production servers but fewer VMs for test and development instances.

- Virtualization software can support more than 200 VMs per server. However, you should avoid such a concentration of production instances on one physical server because this would create a single point of failure.

- Do not overload physical servers. Be sure that the sum of the demands of the individual applications on CPU, memory and network connectivity is within the machine’s capabilities.

To meet the previous two objectives, mix heavy-load and light-load applications or databases on each physical server. Placing several light-load applications that efficiently use server resources would go against the first goal. And if you use a few heavy-load applications, you would run the risk of poor performance during peak usage times across applications.

Utilities like the Application Consolidation Tool (ACT) from Indus IT Valley in St. Louis can help you streamline application-instance tracking. Other third-party services can help you plan for application consolidation. If you approach the identification process without tools, the traditional method is to extract this data to a Microsoft Excel spreadsheet that contains one row per application/database instance. You’ll want to omit all apps and databases that are scheduled for decommissioning during the server consolidation project. Your spreadsheet should contain the following column names:

- Application ID/database ID
- Current server ID
- Role
- Green zone (start day/time and end day/time)
- Workload factor
- Workload class
- Special cases
- Physical server assignment
- VM number

The first two columns uniquely identify each application/database
instance on its current server. Items from the Role column onward are attributes of that application/database instance.

**Workload Factor** is a percentage that describes the load that an application instance or database instance will place on the end-state server on which it resides. **Workload Class** is a broad classification of an application/database instance that you derive from the calculated workload factor and other similar measurements.

The **Special Cases** column should contain critical information about the application or database. This data comes from the data center’s records or previous interviews; you’ll need to take any special cases into account before making final decisions about your virtualization project.

In the **Physical Server Assignment** and **VM Number** columns, you’ll enter a code (such as “E3”) to identify the physical server where a group of applications or databases will reside. **VM Number** identifies the specific virtual machine on that server. Once you designate all existing servers that will be retained in the end state as E1, E2, E3, etc., you can assign new servers with codes like N1, N2, N3 and so on.

To easily determine which instances to assign to each physical server in the end state, combine the application/database instance review table and some sorting and manual row selection. You can adapt these five general steps to suit your organization.

1. Sort the instances according to special cases to separate application/database instances that must go on a dedicated server. Enter the server designation for each instance (E1, E2, E3, etc.) in the **Physical Server Assignment** column. There is no value for the VM Number column, so put “NV” to indicate that it’s a nonvirtualized server.

2. Sort the remaining instances according to workload class, and assign dedicated servers to any instances that are “unsuitable.”

3. Group any instances that aren’t assigned to dedicated machines in previous steps according to role and the green zone. It’s a good idea to keep instances with the same role together on physical machines so that it’s easier to apply different standards and support procedures.

4. Select instances to go on each physical server from within each group of rows that share the same role and green zone. Your selection should contain a balanced combination of workload classes—two high, three medium and five low, for example. Verify that the sum of the workload factors adds up to at least 30%, but no more than 50% of the total workload.

Once your selection looks accept-
able, enter the code for the next available server in the Physical Server Assignment column. Then assign VM numbers (starting at 1) to each of the selected instances.

5. Repeat this process until you have assigned all instances within a common green zone. Continue assigning instances (roles and green zones) to physical servers and giving each a VM number.

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**Five things that can ruin a consolidation project**

1. **The goals of server consolidation have not been clearly articulated, and the use case hasn’t been proven based on realistic assertions.** Be clear about reasons for moving to server consolidation. If your ultimate goal is to reduce costs, make sure that the gross savings are realistic and that all costs are taken into account.

2. **Critical information about the present environment—servers, applications, databases, the location of application/database instances and their roles—is inaccurate and incomplete.** Devote adequate time and resources to current-state data collection and data reconciliation/cleaning, including structured interviews on line-of-business applications with database development and support teams.

3. **Staff is inadequately trained and generally unprepared to support the migration process or handle postconsolidation operations.** Make sure staffers receive adequate training. Don’t expect them to “pick it up” from on-site vendors and contractors. Recruit a few staff members with hands-on server consolidation experience to act as point people for others.

4. **There is no storage area network, or your SAN can only support a few servers.** Complete a full SAN implementation before you attempt a server consolidation project.

5. **There are no adequate data center management tools, such as a configuration management database (CMDB), to handle a consolidated environment.** Examine current processes and the tools that support them to determine if they can handle regular use of virtual machines. Add some test data to the CMDB and include upgrades or new software purchases in your plan.
**PHASE 3: THE MIGRATION PLAN AND ENVIRONMENT MONITORING**

Your server consolidation migration plan will vary depending on the number of servers you start with and the number of new servers you intend to add to the environment. Here are some general guidelines to follow when formulating a migration plan:

1. Divide the migration process into several manageable segments or waves, and allow time between each wave for the IT staff to deal with any problems.

2. The analysis phase may show that there are enough servers for the end-state environment. However, your migration plan must take into account the purchase of a sufficient number of “swing” servers to accommodate the first wave of migrations.

3. Plan the wave sequencing so that you can free up existing servers that are part of the end-state environment first. Use performance-monitoring tools to measure and track application performance as the consolidation proceeds. If performance problems exist, you may have to adjust computing resources that have been assigned to the troubled VM. You can also adjust the consolidation plan and shift the troubled VM to another server.

4. You don’t need to move application and database instances if the present server’s performance is adequate.

- Import the details needed to finish each VM into the completed application/database instance review sheet. Then divide that sheet into separate pages for each wave. Each sheet must include the OS and OS version, where the instances can be found, and whether license keys are needed.

- Include all network changes needed to support planned migrations for each wave, particularly if you are unable to reassign current server IP addresses to new VMs.

- For each migration wave, create a fallback plan in case something goes wrong.

**PREPARING FOR END-STATE OPERATIONS**

Migration plans should also include end-state preparations for the entire data center and its staff. Give each of the following factors adequate attention:

- **Staff training:** All staff should be trained before the migration begins; senior staff members should be involved in the planning process.

- **Management tool selection, purchase and installmment:** The
products you use will depend on the virtualization software that you have purchased. For example, organizations using Microsoft Hyper-V will probably use System Center Virtual Machine Monitor; VMware users will likely choose vCenter.

- **Storage area network (SAN) capacity:** Ensure that your SAN has enough storage capacity. If current servers are using the SAN, you may need to expand its capacity. Performance bottlenecks may occur when smaller servers with higher read/write activity place high demands on the SAN.

- **Data backup plan:** Determine if you need to update backup procedures and tools.

- **Disaster recovery plan:** Update your disaster recovery (DR) plan to take into account the virtualized environment.

- **Configuration management database:** You may need to update the data center’s configuration management database (CMDB) to include the new virtual machines. After consolidating servers, the CMDB needs to reflect relationships between VMs and servers. If your CMDB doesn’t have an underlying database design that recognizes these new relationships and attributes, your configu-
ration management process will quickly unravel.

- **Containing VM sprawl**: Build specific procedures into the data center’s operational process to avoid VM sprawl—the accumulation of unnecessary VMs created at the request of development teams or other groups. VM sprawl is wasteful in several ways, particularly in that it requires software licenses, which sit unused on machines. All requests for temporary VMs should include an expiration date. Once that date arrives, take steps to decommission the VMs and remove all software.

  Closely monitor your newly consolidated environment after each migration wave and throughout the first few weeks of operation. Make sure that all servers have the proper mix of application or database instances. If problems occur during this process, one or more of the application/database instances should be moved to an underutilized VM to balance the load.

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