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- Make more effective use of data center electric power
- Use data center floor area more effectively
- Quickly become DCOI compliant

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Nlyte Software

Allen G. Taylor

About Nlyte

Nlyte is the leading software company that automates Data Center Infrastructure Management (DCIM). Many of the world's largest and most sophisticated data centers use Nlyte to become more agile, reduce costs, and operate more efficiently.

Named a leader in Gartner's DCIM Magic Quadrant in 2014, 2015, and 2016, Nlyte is pleased to sponsor this book. With over 30 federal agencies selecting Nlyte as their DCIM vendor, Nlyte is the front runner in helping these sectors understand and manage compliance requirements with the Data Center Optimization Initiative (DCOI) mandated in August 2016. Many of these agencies went through extensive technical evaluations and found Nlyte to be the sole DCIM provider to meet all requirements, particularly with Nlyte's customizable DCOI dashboards.

We hope this book can help you reduce the anxiety, complexity, and costs associated with full DCOI compliance. Ultimately, a modern DCIM solution like Nlyte can empower your data center organization to become more nimble and enable it to respond quickly to the dynamic IT needs of your organization.

Enjoy the book and please feel free to submit comments or questions to **info@nlyte.com**.

We look forward to hearing from you.

The Nlyte Team

Data Center Optimization Initiative (DCOI)

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Introduction

There is a limited amount of time between now and the end of fiscal year 2018. By that time, thanks to the Data Center Optimization Initiative (DCOI), data centers throughout the federal government must comply with the optimization mandates set out in the initiative. This task will not be easy for many of the affected agencies, but it'll be much easier because full-featured data center infrastructure management (DCIM) software will be operating at the agencies' data centers — one of the DCOI mandates is that DCIM software be installed and running. However, not all DCIM software packages are alike. In fact, in many cases, they aren't even close to being comparable. You need to know what to look for in a DCIM package to make sure you get the one that best meets your agency's needs.

About This Book

This book describes what DCOI is looking for in a data center and what data center management needs to do to comply with the requirements that the DCOI lays out. It also outlines the characteristics you should look for when evaluating the offerings of vendors who want to assist you in meeting the goals set out by the DCOI.

Foolish Assumptions

In writing this book, I assumed that at least one of the following applies to you:

- You're involved in making decisions about how to comply with the DCOI.
- You're a senior agency manager, responsible for an agency's data centers.
- You're concerned about how the DCOI will affect your agency.

Icons Used in This Book

Throughout this book, I use icons in the margins to draw your attention to certain kinds of information. Here's a guide to the icons:

When I provide a suggestion or recommendation, I mark it with the Tip icon. This material usually points you to a quick and easy way to get things done or offers a handy piece of extra information.

Anything marked with the Remember icon is something you want to keep in mind even after you set down this book.

The Warning icon alerts you to conditions that require extra care and thinking.

Beyond the Book

I could only fit so much information in 48 pages, but you can find additional information about DCIM and how Nlyte can help you at `www.nlyte.com/federal-government-data-centers`.

Chapter 1

DCOI 101

In This Chapter

- Seeing how the number and size of federal data centers have grown
- Looking at the FDCCI, a first attempt at stemming the growth
- Reducing data center growth
- Complying with the DCOI

The U.S. federal government owns more computing power than any other country or entity of any kind in the world. Most of this computing power is spread throughout the United States in thousands of data centers ranging in size from a rack tucked away in a closet to a massive collection of servers in a building occupying more than a million square feet of floor space.

Due to its place in the world, and the challenges it faces, the federal government needs a lot of computing power. Data centers are the tools that provide that computing power. These data centers have grown over a span of decades, continually adjusting to changing requirements. As they've grown, so too have their inefficiencies. New requirements fail to exactly match existing infrastructure, which causes new purchases to create a mix of equipment that is difficult to efficiently use and maintain.

To rein in costs, and at the same time provide all the computation services that the government legitimately requires, the Office of Management and Budget (OMB) has issued mandates that require improvements in the performance and efficiency of existing computational assets in data centers, as well as redeploying, or even retiring, assets that aren't being used productively.

In this chapter, I walk you through the history of data center proliferation and introduce you to the earlier Federal Data Center Consolidation Initiative (FDCCI). I explain what can be done to minimize the growth of data centers. And I walk you through the basics of how to comply with the Data Center Optimization Initiative (DCOI).

Understanding Data Center Proliferation

Between 1998 and 2009, the number of federal government data centers had grown from 432 to over 1,000. By 2014, the number of federal data centers had swelled to over 10,000!

If you think it seems strange that the need for federal data centers increased by a factor of ten within a mere 5 years, after just more than doubling in the previous 11 years, you're not alone. This trend raised a red flag for the OMB. Even back in 2010, it was clear to the OMB that the trend to more and more data centers was getting out of hand.

Looking at the Federal Data Center Consolidation Initiative

To address the rapid rise and expense of data centers, the Federal Chief Information Office established the Federal Data Center Consolidation Initiative (FDCCI) on February 26, 2010. Not only was this rapid expansion of infrastructure expensive, but much of it was underutilized. The procurement bias was to overprovision rather than to find the most efficient or cost-effective solution to a computing requirement.

The FDCCI had three goals:

- To promote the use of green IT by reducing the energy use and real estate footprint of government data centers
- To reduce the cost of data center hardware, software, and operations, while increasing security
- To shift IT investments to more efficient computing platforms and technologies

Reversing the Rapid Proliferation of Government Data Centers

So, what can be done to reduce the footprint of government data centers, when government needs for computation are constantly expanding as new challenges arise? Read on!

Shutting down data centers

One method of reducing the data center footprint is to shut down inefficient and underutilized data centers. Inefficient data centers are costly in more ways than one. In 2006, federal data centers consumed more than 6 billion kilowatt-hours of electricity. When the FDCCI was rolled out in 2010, it was estimated that by 2011 that number would double to 12 billion kilowatt-hours. That's expensive, not only to the taxpayer, but also to the environment if that electricity is generated using fossil fuels. Using less electricity reduces both operating costs and the costs associated with cooling infrastructure.

Small, distributed data centers tend to host redundant copies of software applications that could more efficiently be run from a single, centralized data center. Not only would this approach save money and electric power, but it would also make it easier to provide effective security for one major data center.

Of course, the data centers slated for shutdown must have been doing *some* useful work. That work will have to be transferred to another facility. One option is to co-locate the work on another agency's data center. This may make sense if that other agency's data center has unused capacity.

Working with third-party vendors

Another way to minimize the footprint of government data centers is to purchase computing as a service from vendors in the business of providing such services. This passes on to the vendor the expense and headaches of maintaining

infrastructure that would otherwise accrue to the government. Such a change is bound to improve overall efficiency, because such work is the core business of the vendor, and maintaining data centers is not the primary focus of most government agencies.

A big advantage of buying computing as a service is that you purchase only as much capacity as you need. As your needs change, you can easily scale up or scale down, without having to make changes to your core installed data center infrastructure. Going to a cloud provider also reduces overall energy consumption and frees up real estate that can be put to other uses, or even disposed of.

Consolidating data centers

The FDCCI identified several actions that would reduce the cost of government data centers. Among them were the following:

- Shifting IT investments to more efficient computing platforms and technologies
- Sharing services across operating units
- Using cloud computing
- Consolidating data centers

Of these, the primary focus of the FDCCI was the consolidation of data centers. For the purposes of the FDCCI, any room that is devoted to data processing servers — whether it's a closet or a million-square-foot building — is considered a data center. The objective was to optimize the utilization of servers, racks, and floor space. The primary method of achieving this optimization was to consolidate the workloads of small, inefficient data centers into larger, more efficient data centers, retiring the small ones in the process.

The FDCCI provided a rationale for closing data centers whose work had been transferred to other facilities, but it didn't constrain the procurement of new data centers. As a result, the total number of data centers continued to grow, and the economic savings attributable to the FDCCI were modest.

Complying with the Data Center Optimization Initiative

Over the five-year period just prior to the initiation of the DCOI, about $2 billion was saved out of a total spend of $80 billion. That comes out to a savings of about 0.5 percent per year.

Several years after the initiation of the FDCCI, it became clear that stronger measures were needed to induce a meaningful reduction in data center expense. This led to the proposing of the DCOI in March 2016. The DCOI mandated specific actions that must be taken and specific objectives that must be met.

Right out of the gate, the DCOI ordered all new federal data center construction to cease. This measure was rather drastic, but it was meant to stem the seemingly inevitable growth in the number of federal data centers. In 2014, for example, the government spent $5.4 billion on physical data centers. The DCOI's goal was to reduce spending by $270 million in 2016, $460 million in 2017, and $630 million in 2018, for a total savings of $1.36 billion.

With the DCOI, if an agency wants to build a new data center or expand an existing one, it must make the case to the Office of the Federal Chief Information Officer (OFCIO) that there is no better alternative, such as using cloud services, leasing colocation space, or using services shared with other agencies.

How DCOI defines a data center

The way the DCOI defines a data center may be different from the way most people think of data centers. According to the DCOI, a *data center* is any room that contains at least one server, regardless of how it is being used. Rooms containing only switching and routing gear or security hardware are not considered data centers, only rooms with servers.

The DCOI recognizes two types of data centers, tiered and non-tiered. A tiered data center is one that has separate space for IT infrastructure, an uninterruptable power supply (UPS) system, an independent cooling system and a backup generator. Any other kind of room with servers is considered a non-tiered data center.

In the following sections, I fill you in on the goals of the DCOI and the key components of a DCOI implementation.

The goals of DCOI

The main goals of DCOI are easy to understand, but not so easy to achieve.

Optimizing existing data centers

A number of things can be done to optimize a data center, but before you can do any of them, you must have a good understanding of the current state of the data center. How much floor space is it taking up? How much electricity is it using? How large is its operations and support staff? How fully is its capacity being used? These questions are an important prerequisite to deciding where optimizations are possible and what they might be.

Software tools to help you record and visualize the answers to these questions can ease the burden of finding the optimizations required by the DCOI. Data center infrastructure management (DCIM) software is the appropriate tool for this job.

Prior to the issuance of the DCOI, federal data centers could use DCIM software, but they didn't have to. After DCOI took effect, that was no longer the case. It's essentially impossible to satisfy the goals of the DCOI without DCIM software. All data centers must have DCIM software in place by the end of 2018. Any new data centers will have to include DCIM software from the outset.

Lowering costs of existing data centers and avoiding new costs

Data centers are expensive to procure and provision, and after they're procured, they're expensive to operate. One goal of the DCOI is to reduce the operating expenses of existing data centers and avoid the costs of expanding those data centers or procuring new ones. This goal is consistent with the goal of optimizing data centers, because optimization should result in lower costs in addition to more efficient operation.

Closing as many existing data centers as possible

If you want to save money on data centers, closing them completely will probably save more than anything you might do to make them more efficient. The DCOI mandates that by the end of fiscal year 2018, at least 25 percent of tiered and 60 percent of non-tiered data centers, across the entire government, must be closed. This will result in the closure of 52 percent of all data centers and will free up 31 percent of the floor space currently occupied by data centers.

When data centers are closed, the work that they've been doing must either be transferred to other data centers or be deemed unnecessary and eliminated. The DCOI mandate has the side benefit of causing agencies to take a close look at all the computation they're doing and determine whether it's still needed. This kind of review should probably be done on a regular basis anyway.

The key components of a DCOI implementation

Although you might think that there are several different ways to optimize a data center, the DCOI is very specific in the optimizations that it mandates. Tiered data centers, in particular, will be judged according to five metrics:

- **Power usage effectiveness (PUE):** A measure of what proportion of a data center's electric power usage is going into powering the IT infrastructure
- **Energy metering:** A measure of the percentage of a data center's gross floor area (GFA) that is being metered for power consumption
- **Virtualization:** A measure of the extent to which physical servers are running multiple virtual machines
- **Server utilization and automated monitoring:** A measure of the percentage of time physical servers equipped with automated monitoring software are busy as opposed to being idle

- **Facility utilization:** A measure of the percentage of GFA that is actively in use, holding racks containing at least one server

Non-tiered data centers will have only one metric to satisfy: server utilization and automated monitoring.

I cover each of these components in greater detail in the next chapter.

Chapter 2

Digging into the Key Components of DCOI

In This Chapter

- Making effective use of data center electric power
- Measuring data center electric power
- Saving money and resources with virtualization
- Making servers more productive
- Using allocated space productively

The federal government spent $5.4 billion on physical data centers in 2014. The goal of the Data Center Optimization Initiative (DCOI) is to reduce that figure to $4.04 billion by 2018, a savings of $1.36 billion. This overarching goal will be achieved by making significant progress on three sub-goals: data center optimization, cost savings and avoidance, and closing data centers.

These three sub-goals are interrelated. In the process of optimizing a data center, you'll save on some of your current operating expenses, and you'll probably at least delay, if not totally avoid, additional expenses. Plus, if you can't meet the targets set by the DCOI for power usage effectiveness (PUE), energy metering, virtualization, server utilization and automated monitoring, or facility utilization, the only alternative is to shut down the data centers that are dragging down the metrics used to measure compliance with the DCOI. So, the metrics used to measure compliance with the data center optimization goal are relevant to the cost savings and data center closing goals, too.

Here are the metrics used to measure compliance with the DCOI:

- PUE
- Energy metering
- Virtualization
- Server utilization and automated monitoring
- Facility utilization

The DCOI mandates that, for all tiered data centers, the target values of all five metrics be achieved by the end of fiscal year 2018, including PUE. The PUE target applies to each data center individually, while the other four metrics are applied agency-wide.

Of the five metrics, only the server utilization and automated monitoring metric applies to non-tiered data centers. High-performance computing (HPC) nodes in tiered data centers are excluded from calculation of both data center virtualization *and* server utilization and automated monitoring.

In this chapter, I walk you through all five metrics in greater detail.

Power Usage Effectiveness

PUE is defined as the total data center energy used divided by the total IT equipment energy used. That ratio is targeted at less than or equal to 1.5 for existing data centers and less than or equal to 1.4 for new data centers.

In order to meet the DCOI's PUE goal, there must be a way to monitor and track the data center's energy consumption by both of the following:

- **The IT equipment:** The denominator of the PUE ratio is the average energy used by the IT equipment in the data center. This is the energy going into the server racks that are doing actual productive computation, as well as the energy used by ancillary equipment that might be present, such as monitors or printers.

- **All the other things that use electricity in the data center:** Any energy consumed in the data center that does not go to IT equipment — for such things as lighting, heating, cooling, air circulation, security, and so on — is added to the energy used by the IT equipment to form the total average data center energy usage.

Software tools designed to make such measurements and associated metering hardware are essential to meeting this goal.

There are two ways to decrease the value of a ratio:

- Decrease the value of the numerator.
- Increase the value of the denominator.

The simplest way to drive down PUE ratio is to reduce the amount of energy consumed by anything that is *not* IT equipment. This reduces the numerator without reducing the denominator, thus reducing the PUE. One such intervention might be to reduce the amount of lighting in the data center. If in the normal course of operation, there is little need for humans to be present, there is little need for artificial lighting.

Newer large data centers are largely run autonomously, so they're already dimly lit, which means you have to look elsewhere for an easy PUE reduction.

Another possible intervention would be to increase the energy efficiency of any assets in the data center that are not classified as IT equipment.

DCIM software can provide real-time monitoring of energy usage and cooling effectiveness. This information gives management insight into where to look for interventions that could reduce the data center's PUE.

Energy Metering

The energy metering metric is a measure of the square footage of an agency's data centers that have energy metering capability divided by the square footage of *all* the agency's

data centers, including both those that have energy metering and those that do not. The ultimate objective is to transition to a state in which all the data centers have energy metering capability.

Although all five metrics are considered vital, the energy metering metric has the highest priority of the five.

In order to calculate this ratio, you need to know the data center's gross floor area (GFA), which — no surprise — has a very strict definition. The GFA is the total square footage available for IT equipment, including all associated corridors, walkways, and required air circulation space. It does *not* include areas that are not available for active IT equipment, such as office space, mechanical rooms, or storage areas.

Total square footage can be calculated from the floor plan of a data center, such as the one shown in Figure 2-1.

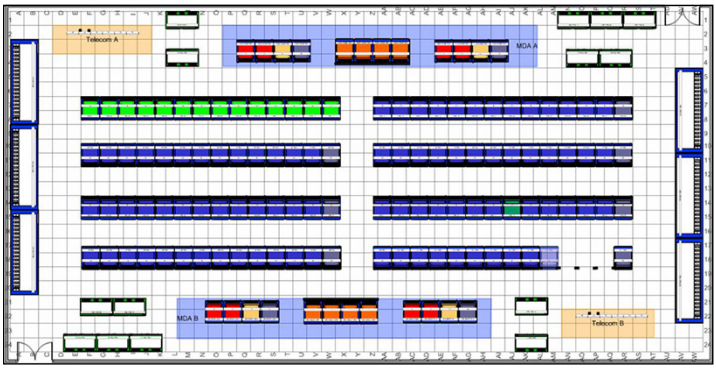

Figure 2-1: A data center floor plan.

The energy metering target value is the ratio of the GFA of all energy metered data centers in an agency divided by the GFA of all data centers in the agency, both metered and non-metered. This gives an idea of the extent to which energy metering has been implemented across all the data centers in an agency.

The target value for the end of fiscal year 2018 is 100 percent. In other words, by the end of fiscal year 2018, all the data centers in an agency must have energy metering. If even one data center in an agency does not have energy metering, the agency is out of compliance with the DCOI.

Virtualization

Government agencies run applications that require different operating system versions and application releases. Maintaining a physical server for each of these is costly. Virtualization provides a flexible and lower-cost alternative. It consolidates multiple virtual servers on a single physical server, providing efficiencies and decreasing both capital expenses and operating expenses.

When applications are running in a virtual environment, IT personnel can deploy services rapidly. Administrators can provision new applications quickly to meet emerging requirements and to respond to shifts in application demand. For example, if you can run four different applications, which require four different operating environments, on a single physical server rather than four physical servers, you've saved more than money. You've also relieved staff from having to maintain multiple different operating platforms.

The thrust of the DCOI initiative is to do more with less. Reducing the amount of hardware also lowers the need for support infrastructure and staff. Virtualization is a key method for achieving hardware reductions that will help meet not only the virtualization target, but also the PUE target.

The virtualization ratio mandated by the DCOI is greater than or equal to four by the end of fiscal year 2018. This means that, on average, across all the servers in an agency, they must be running at least four operating systems for every active physical server in the inventory. Some servers will have to run more than four to compensate for any that are running fewer than four. For all practical purposes, it will not be possible to maintain any servers that are not virtualized.

Server Utilization and Automated Monitoring

The purpose of the server utilization and automated monitoring metric is twofold:

- To increase the percentage of time that government servers are engaged in productive work
- To increase the percentage of government servers that are equipped with automated monitoring capability

When you identify servers that are not being productive, it's easy to determine which ones are ripe for decommissioning. Sending unproductive servers out to pasture brings a reduction in electricity usage and floor space occupancy on the data center floor. By fostering an increase in the percentage of servers that are being monitored by an automated monitoring system, poorly producing assets can be more readily identified and dealt with appropriately.

An operating system running applications on a server knows when it's busy and when it's idle. In a virtualization environment, the underlying native operating system knows when it's busy and when it's idle based on the activity (or inactivity) of the virtual machines it's hosting. That knowledge of busy time versus idle time must be surfaced to an application that monitors activity for DCOI purposes. This is a task performed by data center infrastructure management (DCIM) software, provided by vendors such as Nlyte.

The amount of time that a server is actually engaged in doing productive work is important for determining how efficient a data center's operation is. However, accurately measuring this value in the absence of automated monitoring is a challenge. To have a high ratio of busy time to idle time *and* have high confidence that the value you arrive at is accurate is the purpose of the server utilization and automated monitoring metric. With automated monitoring, you can have high confidence that the utilization value that you report accurately reflects actual usage of the servers in your data center.

The target value for server utilization and automated monitoring is greater than or equal to 65 percent by the end of fiscal year 2018. This figure is obtained by multiplying the percentage of time that the servers in an agency are busy by the percentage of servers that are equipped with automated monitoring. To drive this figure above 65 percent, server busy time must be at least 65 percent, even if *all* the servers in the agency have automated monitoring. In the likely situation that not all servers have automated monitoring, the busy percentage of nearly all the servers in the agency must be higher — perhaps much higher — in order to satisfy the DCOI requirement.

Both tiered and non-tiered data centers must achieve the target value of greater than or equal to 65 percent for this metric by the end of fiscal year 2018. The one exception is that HPC nodes are not to be included in the calculation. In contrast, the PUE, energy metering, and facility utilization metrics specifically *do* apply to HPC nodes.

Facilities Utilization

Facilities utilization measures how efficiently the floor space of a data center is being used. The facilities utilization metric is the ratio of the number of active server racks multiplied by 30 divided by the total GFA of the data center.

For each rack, including its associated corridors, walkways, and air circulation space, an area of 30 square feet is assigned as a reasonable footprint for that rack. When the product of two numbers (the number of racks times 30) is divided by the GFA of the entire data center, the target value by the end of fiscal year 2018 should be greater than or equal to 80 percent. That means that at least 80 percent of the floor space of a data center should be occupied by server racks and their associated corridors, walkways, and air circulation space.

This metric has the effect of discouraging the building of data centers that include extra space for future expansion beyond current needs. Any such extra space would drive this metric away from its target value. This will motivate managers to look into cloud and colocation possibilities instead of expanding physical data centers.

Chapter 3

The Current State of Federal Data Centers

In This Chapter

- Recognizing that the current data center growth is unsustainable
- Identifying the limitations of efficiency
- Digging into the three goals of DCOI

Many federal data centers have grown haphazardly over a period of years, or even decades, as new requirements have brought new equipment that sits alongside older equipment running legacy apps. Often, new equipment was located wherever there was space for it, instead of reconfiguring the data center to the most efficient layout, based on the currently active racks. The trend has been toward continual growth, as new equipment is acquired much more frequently than old equipment is retired.

Looking at the Growth and Proliferation of Data Centers

In recent years, the growth in the number of federal data centers and, thus, their overall cost, has risen to an unsustainable level. As recently as 1998, there were no more than 432 federal data centers in existence. Over the next 11 years to 2009, that number more than doubled to about 1,100 data centers. At that point the Office of Management and Budget (OMB) initiated a reduction and optimization effort. Despite that,

two years later in 2011, there were 2,100 data centers. In 2014, there were more than 9,000, and by November 2015, there were more than 11,700. Clearly, this astounding rate of growth could not continue. In response, in March 2016, the OMB rolled out a new program with some real teeth in an effort to stem the tide — the Data Center Optimization Initiative (DCOI).

Burning a Lot of Watts without Processing Many Bits

The incremental growth over time of data centers and of the equipment racks within a data center applies relentless pressure, pushing square footage used and electricity burned continually upward. When a data center is in place and running, it's difficult to get rid of it, even if the original reason for its existence has disappeared. The same applies within a single data center. When a rack is installed and operating, it tends to remain in operation even if its workload is substantially decreased.

When an asset such as a server rack or even an entire data center exists, there is strong organizational resistance to giving it up. As a result, efforts to reduce data center spending prior to the DCOI have had limited success.

The CIO's lament

After a data center has been around for several years, growing in one direction and then another as requirements change, the person responsible for it may cry in frustration, "I don't even know what I have, let alone what it all does." The lack of accurate tracking over a period of years makes it difficult for management to retire assets that are no longer doing enough work to justify the cost of retaining them. It's easier to just let things ride and continue to make budget requests that support the infrastructure you have, regardless of how useful it is.

Considering the Three Goals of DCOI

To address the recent explosive growth in the number of new federal data centers, and the poor operational efficiency of existing data centers, the OMB set out three goals for data centers in the DCOI:

- To make existing data centers more efficient in their use of electricity, equipment, and real estate
- To reduce current costs and avoid adding new costs
- To close data centers entirely

In this section, I examine these goals and show you what are likely to be the most effective strategies to achieve them.

Optimizing existing data centers

Data centers can be "optimized" in several ways. What is optimal to one person might not be very desirable at all to another. That's why it's very important that the definition of *optimal* be definite and easy to understand. The DCOI does this with the five metrics. The target values for the metrics are based on comparisons to the existing state of the data centers belonging to each of the agencies that are subject to the DCOI.

Before any substantial effort is put into DCOI compliance, some agencies are bound to already be more efficient and cost effective than others. Even within one agency, some data centers are sure to be more efficient and cost effective than others. So, it wouldn't be fair to mandate some across-the-board number, such as a 30 percent reduction in usage of electric power, because that would penalize the agencies and data centers that are already doing a better job of running an efficient shop.

A fine balance must be achieved in management's approach to complying with all five metrics. As you look more closely at the five metrics, you'll see that in some cases, improving a data center's position with regard to one metric may actually decrease compliance with another. The important thing to keep in mind is reaching the target values for all five by the target date.

Life cycle asset management

The life of a data center passes through the following stages:

1. **Concept and design.**

   Ideally, consideration of all the subsequent stages is included with the formation of the concept, and the fleshing out of the design occurs here. Planning early on for situations that might arise and preparing for them in advance is much cheaper than dealing with them only after they've arisen.

2. **Construction.**
3. **Commissioning.**
4. **Certification.**
5. **Production.**
6. **Decommissioning.**

   With the DCOI in effect, some data centers are likely to hit the decommissioning stage earlier than was anticipated when they were conceived and designed. Any active workload will have to be transferred to another data center that is not itself scheduled for decommissioning to meet the end of fiscal year 2018 target deadline.

7. **Disposal.**

   When a data center is turned off for the last time, equipment must be properly disposed of and any needed site remediation must be performed.

The extent to which a data center may be considered optimized depends on the five metrics stipulated by the DCOI. Each of these metrics deals with a different quantity that can be driven to a better, if not an optimal, value. The metrics are shown in tabular form in Figure 3-1. I walk you through each of them in the following sections.

Whereas the power usage effectiveness (PUE) metric is applied to each data center in an agency individually, the other four metrics, including the energy metering metric, are applied across the board to all the data centers in an agency.

Power usage effectiveness

The goal of the PUE metric is to assure that as much of the electric power consumed by a data center as possible is going into data processing. The idea is to minimize or eliminate any power draws that are going to anything else.

Metric	Definition	Calculation	FYE 2018 Target Value
Energy Metering	(%) Percent of total gross floor area (GFA) in an agency's tiered data center inventory located in tiered data centers that have power metering.	$\frac{\text{GFA of Energy Metered Data Centers}}{\text{GFA of All Data Centers}}$	100%
Power Usage Effectiveness (PUE)	(Ratio) Proportion of total data center energy used by IT equipment.	$\frac{\text{Total Data Center Energy Used}}{\text{Total IT Equipment Energy Used}}$	≤ 1.5 (≤ 1.4 for new data centers)
Virtualization	(Ratio) Ratio of operating systems (OS) to physical servers.	$\frac{\text{Total OS}}{\text{Total Physical Servers}}$	≥ 4
Server Utilization & Automated Monitoring	(%) Percent of time busy (measured as 1 – percent of time spent idle), measured directly by continuous, automated monitoring software, discounted by the fraction of servers equipped with automated monitoring.	$\text{Average Server Utilization} * \text{Percent of Physical Servers Equipped with Automated Monitoring}$	≥ 65%
Facility Utilization	(%) Portion of total gross floor area in tiered data centers that is actively utilized for racks that contain IT equipment.	$\frac{\text{Total Active Rack Count} * \text{30 sq. ft.}}{\text{Total Gross Floor Area}}$	≥ 80%

Only the Server Utilization & Automated Monitoring optimization metric shall apply to non-tiered data centers. Additionally, high-performance computing (HPC) nodes shall be excluded from calculations of data center Virtualization and Server Utilization & Automated Monitoring. The Facility Utilization, PUE, and Energy Metering metrics shall not exclude HPC nodes in tiered data centers from the calculation.

Source: M–16–19–Data Center Optimization Initiative, Memorandum for Heads of Executive Departments and Agencies, U.S. Office of the Federal Chief Information Officer (August 1, 2016)

Figure 3-1: DCOI metrics.

In order to meet the target of the PUE metric, you must be able to tell where the power entering the data center is going. This means you must be measuring the power going into all the IT equipment, as well as the total power consumption of the data center. The difference between those two numbers is the quantity you want to minimize. Doing this type of monitoring is one of the things that a full-featured DCIM package will perform for you.

When you know the total power consumed by the data center and can deduce the amount that is not feeding IT equipment, you can start working on replacing non-IT items with more energy-efficient equivalents or on removing them from the data center. In some cases, this may just entail moving something to another room.

You need to drive PUE to less than 1.5 by the end of fiscal year 2018.

Energy metering

It's hard to know whether you're making progress in reducing the amount of energy your data centers are consuming if you don't measure it. Some of the data centers in an agency are going to be equipped to measure energy consumption and some are not. The goal of this metric is to reduce the number of data centers that are not equipped for energy metering.

It's possible to monitor and measure the amount of electricity entering a data center. That energy will either be used to perform useful computations, dissipated as heat, or used to power equipment that is not involved in communication. The purpose of the energy metering metric is to provide visibility of where the energy is going. If too much is going to waste heat or non-IT functions, knowing that fact gives management an opportunity to take remedial action.

The ultimate goal of the energy metering metric is to have *all* data centers in an agency equipped with energy metering by the end of fiscal year 2018. To achieve that goal, the agency will either have to provide energy metering to every data center it has, or to decommission any that, for whatever reason, cannot be equipped with energy metering.

If energy metering is facilitated by DCIM software, it may not be cost effective to provide very small data centers (which could be no more than a single rack sitting in a closet) with DCIM software. This is an argument for consolidating whatever work those small data centers are doing at a larger data center already equipped with DCIM software. This strategy would have the effect of eliminating many inefficient and redundant non-tiered data centers and replacing them with more efficient data centers that are fully equipped to monitor and track energy consumption.

Virtualization

Most data centers have to host a variety of applications. These applications may run under different operating systems or different releases of the same operating system. As time goes on, the number of different operating environments that must be supported grows. As the number of different

operating environments grows, the number of servers they run on grows, too. This is a major cause for the ever-increasing need for new equipment. Old equipment must be retained in order to continue running critical legacy apps, and new equipment must be acquired to accommodate the needs of new apps that require the features of later operating system releases or different operating environments altogether.

There is a way out of this dilemma: installing virtualization environments on servers so that multiple operating environments can be simultaneously hosted on a single server.

Virtualization environments are provided by companies such as VMware, Citrix, Oracle, and Microsoft. Within these environments, operators can spin up multiple virtual machines on a single physical server, each running a different operating system or operating system variant.

To take advantage of virtualization, a server's DCIM software must be able to integrate smoothly with whatever visualization software is being used. If the management of a data center has standardized on a specific virtualization software implementation, the DCIM package that they select should work seamlessly with it.

Across all the data centers in an agency, on average, for each active physical server, at least four virtual machines must be in use by the end of fiscal 2018.

The net effect of this metric is to cause IT management to roll applications running under the native operating system of their physical server onto a more capable server running a virtualization environment compatible with the applications. Following this, the original server can be retired.

Server utilization and automated monitoring

As long as the servers in a data center are turned on, they're using electric power, regardless of whether they're doing productive work. When a processor is turned on, but idle, it isn't using as much electricity as it uses when it's performing heavy computations, but it is using some, running background processes, and just keeping the operating environment live and ready to do work, should an application be launched.

The objective of this metric is to, across all the servers in use in the agency, minimize the amount of energy essentially wasted by keeping the equipment warmed up even though no actual work is being done. In order to determine how much electricity is being used by servers that are not doing useful work, the percentage of time they're spending in idle mode must be measured.

Automated monitoring tools, such as those that comprise a part of a full-featured DCIM suite, record the amount of time a server spends "spinning its wheels" in idle mode. Such tools are necessary to gain an accurate picture of the energy efficiency of a server.

Some servers in a data center may have automated monitoring and others may not. In calculating compliance with this metric, only those servers that have automated monitoring can accurately measure idle time, and thus enable assessment of the level of productive server utilization.

The net effect of this metric is for agencies to either add automated metering to essentially all their servers or to retire them. The calculation of this metric is to multiply the average percentage of time the agency's servers are busy by the percentage of physical servers that have automated monitoring. The product of these two values must be greater than 65 percent by the end of fiscal year 2018.

Suppose the servers in an agency have an amazing average busy percentage of 90 percent, but only half of those servers have automated monitoring. The product of 90 percent and 50 percent is 45 percent, far less than the 65 percent target. Even if 70 percent of the servers have automated monitoring, the agency would still fall short of the 65 percent target.

In some cases, automated monitoring may be provided by the hardware vendor, such as Intel, but in others, a DCIM suite can provide the needed capability.

Facility utilization

The facility utilization metric deals with how effectively the data centers in an agency are using the real estate that they're occupying. How much of the footprint of the data center is occupied by actual computing equipment along with the space around it dedicated to corridors, walkways, and needed air circulation?

The DCOI requires that by the end of fiscal year 2018, across all the data centers in the agency, the amount of floor area occupied by equipment racks and their associated corridor, walkway, and air circulation space make up at least 80 percent of the gross floor area (GFA) of the data center. The DCOI considers 30 square feet to be the footprint of a single equipment rack. Multiplying the number of racks in a data center by 30, and then dividing that product by the GFA of the data center, gives the percentage of floor area dedicated to computation. That percentage must be equal to or greater than 80 percent by the end of fiscal year 2018.

One way to work on complying with this metric is to make more efficient use of the floor space you have in your data centers. Floor space dedicated to equipment racks is helping to satisfy this metric. Space used for desks, shelves, or equipment that is not directly related to data processing is not helping. If the space for these ancillary items can be reduced or eliminated, there would be more room for equipment racks that were performing computations.

Another way to comply with the metric is to reduce data center GFA. Consideration should be given to shrinking data centers to enclose equipment racks and very little else.

Lowering costs of existing data centers and avoiding new costs

A way to generate cost savings on existing data centers is to perform the optimizations mandated. Those optimizations should result in savings on electricity, staffing, consumables, and other operating expenses. Costs can be avoided completely by not expanding existing data centers or building new data centers. Instead of doing either of those things, work can be moved to colocation facilities or to the cloud.

To be able to tell whether you are saving or avoiding costs, you need a baseline that you're comparing against. That can only be done if you're monitoring what it costs to operate before you start the cost reduction program. This requires an accounting of everything that you spend on behalf of the data centers in your agencies, as well as software monitoring tools, specifically DCIM tools, that show you where that money is

going. This is why the DCOI requires that every data center acquire and use DCIM software as one of the mandates of the DCOI.

In order to know whether you're saving money, you need to know where your money is going to begin with. This means that costs can't be hidden, but must be readily available to all authorized personnel. That kind of instant availability is one of the hallmarks of a full-featured DCIM package. When more is known, better decisions are made.

Closing as many existing data centers as possible

The DCOI's third goal is that 25 percent of existing tiered data centers and 60 percent of existing non-tiered data centers be closed by the end of fiscal year 2018. This represents a massive reduction in hardware and the costs, overhead, and staffing that go along with it. This will be disruptive — remaining staff will have to learn new procedures and take on new tasks. Moving work to colocation facilities and the cloud will require significant changes in the way agencies conduct their IT work.

IT staff members who have been performing business as usual for years will have to recognize that the way they've been operating and the way that data centers have been growing is not sustainable. Coming to terms with this reality will make it easier for staff members to adjust to an environment where there are fewer and larger data centers and where they may even be sharing resources with other agencies. They may even find that a substantial fraction of the agency's workload will now be performed in the cloud rather than in a physical data center on their agency campus.

Due to changes in plans and responsibilities, some data centers in an agency may find themselves over-provisioned with equipment for their current workload. In that case, such data centers could take on additional work from data centers that are closing down, or they could be closed down themselves, because they're costing more than is warranted by their productivity. Either action would prompt the agency toward satisfying the facility utilization metric.

Some data centers in an agency are bound to be newer, more efficient, or more productive than others. Those are the ones that are prime candidates for taking over the work of older, less efficient, or less productive data centers that are closed down. They may also host work from other agencies if they have excess capacity, thus saving money for all agencies involved. DCIM software can be valuable in planning the migration of work and consolidation of data centers that the DCOI is promoting.

The DCOI strongly encourages agencies to migrate work to the cloud as a best practice. Any computation done in the cloud is not using government infrastructure. This saves electricity, real estate, staffing costs, and management overhead. This is a big win for the federal government and for the taxpayers who support it.

Chapter 4

Tackling DCOI with DCIM

In This Chapter

- Knowing what you need to do to comply with the DCOI
- Defining DCIM
- Seeing how DCIM can help you comply with DCOI

The Data Center Optimization Initiative (DCOI) is complicated, but you don't have to go it alone. Data center infrastructure management (DCIM) packages can help you comply with the DCOI and take a lot of the stress out of the whole process. In this chapter, I show you what you need to know in order to comply with the DCOI, introduce you to DCIM, and explain how DCIM can help.

Knowing What You Need to Know

The DCOI makes a number of stringent demands on the people who administer federal data centers. A large number of those data centers probably don't currently comply with the DCOI's mandates. In fact, in many cases, administrators don't even know how far out of compliance they are.

Among other things, data center administrators need to know the following:

- **The gross floor area (GFA) of all their tiered data centers:** This is required for both the energy metering and facility utilization mandates of the data center optimization goal.

- **The GFA of all their tiered data centers that have energy metering:** This is required for the energy metering mandate.
- **The total amount of energy used by each of their tiered data centers:** This is required for the power usage effectiveness (PUE) mandate.
- **The total amount of energy used by IT equipment in each of their tiered data centers:** This is required for the PUE mandate.
- **The total number of physical servers they have in their tiered data centers:** This is required for the virtualization metric.
- **The total number of virtual operating environments running on their tiered data centers:** This is required for the virtualization metric.
- **The average percentage of time that physical servers in both tiered and non-tiered data centers are powered on but not running applications (idle time):** This is required for the server utilization and automated monitoring metric.
- **The percentage of physical servers in both tiered and non-tiered data centers that have automated monitoring:** This is required for the server utilization and automated monitoring metric.
- **The total number of server racks in data centers across the agency:** This is required for the facility utilization metric.
- **The portion of GFA in tiered data centers that contains server racks:** This is required for the facility utilization metric.

Some of the required information can be obtained by doing surveys of the data centers and taking inventory of the equipment. Satisfying other metrics requires continuous monitoring of the operation of the data centers. For that, you need instrumentation to measure key parameters such as energy consumption, as well as software to record and present that information in a readable and actionable form.

Complying with the DCOI Mandates

There are physical things that people responsible for federal data centers can do to move toward the targets set by the DCOI. For example, any applications running on a server's native operating system can be moved to a virtual operating environment on a server that supports virtualization. This will help with the data center optimization goal. As a bonus, the original server can then be retired, reducing costs in the process.

Another change, which just involves the placement of physical assets, is to eliminate anything from the data center that does not need to be there, along with the square footage of real estate occupied. Shrinking the data center down to the immediate vicinity of the server racks moves a data center toward the facility utilization goal.

Aside from moving work from less efficient data centers to more efficient ones and then shutting down the ones that have now been rendered redundant, and reducing the physical footprint of data centers, to meet the rest of the metrics and other mandates of the DCOI will require monitoring and measuring. In most cases, this is best performed by software specifically designed to perform those tasks — DCIM software. In addition to the data center optimization metrics, the DCOI specifically mandates that DCIM software be installed in all federal data centers that fall under the DCOI by the end of fiscal year 2018.

Defining DCIM

DCIM is a suite of software tools that provides a structured approach to managing a data center. It bridges between the facilities aspects and the IT aspects of the data center. In the specific case of a federal data center that is working toward complying with the mandates of the DCOI, the suite should include purpose-built modules that are specifically tailored to help agencies report and validate their data center optimization efforts.

What DCIM provides

A well-deployed DCIM solution quantifies the costs associated with moving, adding, or changing equipment on the data center floor. It understands the cost and complexity of operation of those assets, and clearly identifies the value that each asset provides over its lifespan. The views provided by DCIM bring together the IT and facilities worlds.

Figure 4-1 shows how DCIM stands between IT and facilities and joins them together. The physical assets of the facility, such as floor space, electrical power, environmental control, and cooling are monitored and control by the DCIM processes, which, in turn, interface with the virtual infrastructure overseen by the IT function. The DCIM suite provides an overview of system health and functioning, and enables drilling down to any desired level of detail for fine-grained control of operations.

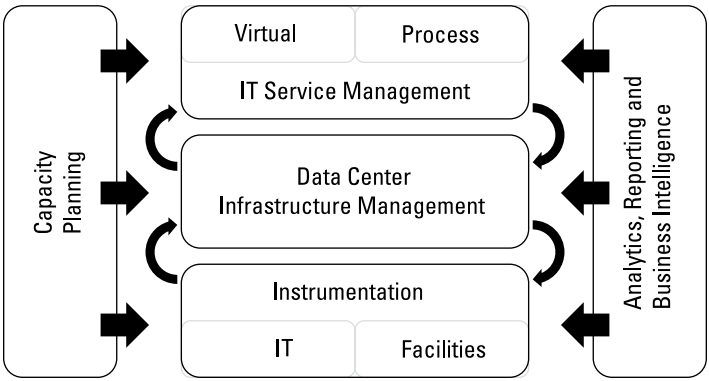

Figure 4-1: DCIM is the layer of infrastructure that supports the agency's IT function.

How DCIM relates to the mandates of DCOI

Commercially available DCIM packages were originally developed for enterprise data centers, which have much in common with federal data centers but without the need to comply with the DCOI. In many cases it would probably be

good for them to do so, as it would save them considerable money.

Full-suite DCIM vendors, such as Nlyte, are addressing the federal market with products that are specifically aimed at helping federal data centers comply with the DCOI mandates. Some of these products are designed to help with data center optimization, while others concentrate on cost reduction. Some even provide guidance as to which data centers should be closed.

Optimizing data centers

Before you can implement procedures to optimize a data center, you must have a clear idea of its current state. DCIM software with asset life cycle management functionality can give you that insight. Ideally, asset life cycle management will be in place from the inception of the data center all the way to its ultimate decommissioning and disposal.

When you have a clear idea of a data center's current state, you'll understand what can be easily done, what can be done with more difficulty, and what cannot be cost-effectively done to bring the data center into compliance with the facilities utilization metric within the time available before the end of fiscal year 2018 deadline.

A DCIM package with power metering capability will address both the DCOI's energy metering and PUE metrics. Installing the package on all data centers in the agency meets the energy metering metric. It also gives you visibility of your current PUE, which is necessary in order for you to see where you stand relative to the less than or equal to 1.5 target value that you'll be required to meet by the end of fiscal year 2018.

Beyond mere visibility, if your DCIM package enables you to run "what if" scenarios where you eliminate or replace some of the assets you have, and then see what effect those changes have on PUE, you'll be able to make effective interventions and avoid making changes that will not help you to reach the target. Figure 4-2 shows a view of one of the screens of the Nlyte Energy Optimizer, which monitors and tracks energy consumption. The PowerView feature provides power chain analysis, giving fast and accurate insight into power capacity and availability.

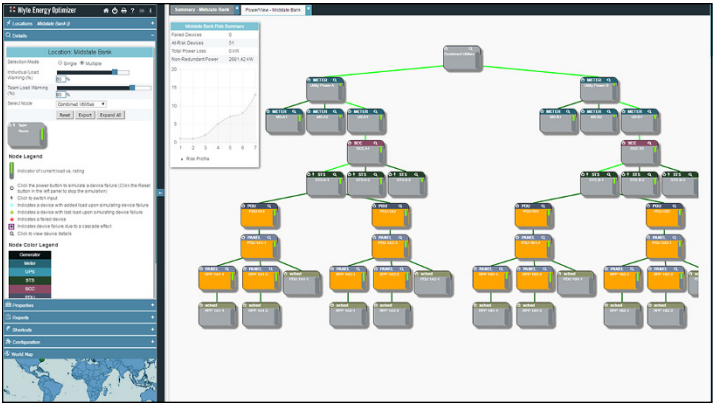

Figure 4-2: The NIyte Energy Optimizer.

To address the server utilization and automated monitoring metric, you want a DCIM product that is capable of reporting on the percent of time a server spends idle. Continuous and automated monitoring is the only accurate way to do this. Some system monitoring tools that you already have may do this. If so, you want your DCIM package to be one that integrates smoothly with what you have.

Virtualization software is a major specialty and probably not a product that you would find in the portfolio of a DCIM software vendor. That being the case, you want to select a DCIM vendor that has a prebuilt integration to the virtualization product that you're using. By the end of fiscal year 2018, your ratio of virtual machines to physical servers must be at least four.

In order to keep track of all these things in an easy-to-comprehend way, you also want a DCIM product that provides customizable dashboards that can track all the DCOI mandates and compare them against the actual state of the data center. This will give you insight into where you'll be relative to the mandates when the end of fiscal year 2018 rolls around. Figure 4-3 shows a typical DCIM dashboard.

Figure 4-3: The Nlyte main operational dashboard.

Reducing some costs and avoiding others

To save on costs, you must understand where your money is going right now. Only when you have that knowledge can you take effective steps to reduce the outflow of cash. When you have a full DCIM suite in place, that tracks and manages both a data center's IT and facility assets, you have a view of which assets are and are not being productively employed. From there, it's easy to decide what steps to take to reduce costs without compromising productivity or weakening security.

Closing data centers

One must assume that if a data center exists and is operational, that it must be doing at least some useful work. As a prelude to closing a data center, that useful work must be transferred somewhere else. The Office of Management and Budget (OMB) is encouraging agencies to rise above any silo mentality that may exist and find a place with excess computational resources that can accept work from a data center that is closing down, even if that place is located in a different agency.

Mandated closings will be substantial. Sixty percent of non-tiered data centers are set to be shuttered, and 25 percent of tiered data centers are destined to go the same way. This will call for major evaluations of the value of the work being done at each data center. If that work is worth continuing, a new

place for it must be found. If the data center facing closure has DCIM software, it will show exactly what resources are needed by running applications, and that requirement can be matched with the excess capacity of a destination data center that also is running DCIM software.

How a DCIM Package Can Satisfy the Requirements of DCOI

Many data center infrastructure management products are on the market. Some address only one or a small number of tasks that are needed to monitor and control a data center, others offer a more complete suite of functions, and others cover the full gamut of functionality. You can cobble together a system from multiple products supplied by multiple vendors, but that isn't the best way to have a well-integrated, smoothly running system with a consistent look and feel across the board.

When shopping for a DCIM package to monitor the operational parameters of your data center, look for a vendor with a track record and with a product that covers all the bases. Doing so will give you the best chance of meeting the goals of the DCOI. It will also be critical to keeping your data centers running smoothly.

Chapter 5

Ten (Or So) Questions to Ask a DCIM Vendor

A data center infrastructure management (DCIM) package is a key piece of infrastructure. It forms a bridge between IT and the facilities aspects of a data center, and it facilitates the smooth execution of workflows. Even if the Data Center Optimization Initiative (DCOI) didn't mandate that every federal data center in the DCOI program have DCIM, it would make a lot of sense to have it anyway. Products containing modules specifically designed to address the mandates of the DCOI are the cream of the crop.

Here are questions to ask when you're considering the offerings of a DCIM vendor:

- **Does your product address all five DCOI optimization metrics?** For tiered data centers, the target values of all five DCOI optimization metrics must be achieved by the end of fiscal year 2018. There are two possible ways to do this:
  - Procure a full-featured product that addresses all the metrics.
  - Piece together a solution from the offerings of vendors who have more limited capabilities, and hope that they work together, without leaving any gaps and without interfering with each other.

  It makes sense to go for the first option, which has a consistent user interface across all functions.
- **Do you have a comprehensive DCIM suite that covers the entire data center life cycle?** Covering the five DCOI metrics is one thing, but a DCIM suite must do much more than that. You want your DCIM suite to be helping

you throughout the entire life cycle of your data center, from the first day you power it up to the last day you shut it down.

There are different things to be concerned about at different stages of the life cycle. You want your DCIM suite to give you the information you need and to provide the management functionality you need throughout all those stages.

- **Do you have a long-established roster of federal clients who can vouch for deployment success?** Nothing instills confidence in a vendor like a track record of success in providing similar services to similar customers. Doing business with the government is very different from doing business with commercial enterprise customers. A vendor that understands the ins and outs of doing business with the federal government will be a lot easier to work with than one whose existing customer base is largely or entirely made up of enterprises.
- **Is DCIM key to your business, or is it peripheral?** The comprehensiveness of a DCIM solution is likely to depend on its overall importance to the vendor's business. A vendor founded to provide a DCIM product and totally committed to making that product a success is more likely to develop a product with more depth and comprehensiveness than a vendor whose main emphasis is elsewhere and for whom DCIM is a minor part of its overall business. Companies that "bet the business" on a single product line have more at stake and are more likely to make sure customer needs are met and continue to be met over the long term.
- **Are you hardware agnostic, or do you want to sell hardware along with your software solution?** When a vendor shows up to perform a service at your facility, is it also on the lookout for additional things it can sell you? At the very least, that can be annoying. At the worst, it could mean that the vendor's number-one priority is something other than meeting the need that you called them for. Look for vendors that are exclusively dedicated to providing you with a DCIM solution that meets your needs.

Adding more hardware is counterproductive. You're trying to minimize hardware!

- **Do you provide a workflow to link facilities to IT?** Traditionally, IT and facilities are two different worlds, with two different staffs and two different fields of expertise. However, those two different worlds have to mesh together harmoniously. A complete DCIM solution would incorporate a workflow that links the two realms. Ask your vendor candidates about that.
- **Do you have prebuilt integrations to IT service management (ITSM) leaders such as ServiceNow, BMC, and HPE?** You want your DCIM solution to be able to exchange information easily with your existing or planned ITSM solution. Make sure the communication capability that you need will be available.
- **Do you meet stringent security thresholds, as certified by a third-party security inspector?** It seems like every day there is a new report of something being hacked and confidential information being compromised. Many times these hacks succeed because of flaws in user interface code. It takes a knowledgeable third-party security inspector to thoroughly vet the code of a data center service management solution to provide high confidence that the system will not be breached by hostile outsiders. Ask about such certification.
- **Do you provide top-quality after-sales support and professional services?** Talk to some of the vendor's existing customers to get the answer to this question, preferably customers who have organizations similar to yours. Ask the vendor for referrals, but also do some investigating on your own so that you talk to some people who are not among the vendor's "hero" customers.
- **Do you provide customizable dashboards that can be configured to track actual performance against all the DCOI mandates?** If moving toward compliance with the DCOI mandates is a priority, you want to be able to follow how you're doing right now, as well as whether you're making progress toward the target goals. A dashboard specifically configured to provide that information will make it easy to monitor progress and see which of the interventions you employ are most effective.

- **Does your product have the ability to calculate idle time in a server, and also take advantage of any data that is being collected by other tools?** Time spent in idle mode is one of the key factors in the calculation of one of the five optimization metrics. You need a product that can measure it, or at least be able to receive it from an existing tool that already collects that data.

Unmatched

Third Consecutive Year NIyte Named as A Leader in Gartner Magic Quadrant

Gartner has placed NIyte as a Leader within the Data Center Infrastructure Management (DCIM) Tools Magic Quadrant for three consecutive years – achieving highest placement for ability to execute and furthest placement for completeness of vision.

NIyte has a long-established roster of Federal clientele with successful DCIM deployments. Dozens of agencies across civilian, military and intelligence groups rely on NIyte to quickly become DCOI compliant and make their jobs easier.

> "From our side, we also need to comply with DCOI. NIyte gives us a single pane of glass view that allows us to build a process to compare all different systems we have."
>
> Jim Chu
> Data Center Manager,
> Jet Propulsion Library, NASA

> "It meets the White House mandate. NIyte checks all the boxes. All that remains is to fine tune to achieve the DCOI guide lines."
>
> Bill Wood
> Network Engineer,
> General Dynamics

> "Our big metrics are DCOI and energy metrics. We are getting information using NIyte DCIM tools to help us start making intelligent decisions on chargebacks: floor space, CPU, users..etc."
>
> Steve Naumann
> OTSO Project Manager,
> Social Security Administration

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Satisfy the DCOI mandates

The data centers of most federal agencies must comply with the requirements of the Data Center Optimization Initiative (DCOI). This book tells you what you need to do and when you need to do it.

- ***Use electric power more effectively* — *track usage to find and eliminate waste***
- ***Reduce unneeded hardware* — *implement virtualization to run multiple operating systems on a single server***
- ***Reduce operating expenses* — *move work to colocation facilities and the cloud, shrinking data centers in the process***
- ***Close excess data centers* — *consolidate work in the most productive data centers, closing the rest***

Open the book and find:

- **How the number of government data centers has grown**
- **What the DCOI requires**
- **How DCIM software helps with DCOI compliance**
- **How to optimize a data center**
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