The Data Center Optimization Initiative and You

A Server Technology white paper by Marc Cram

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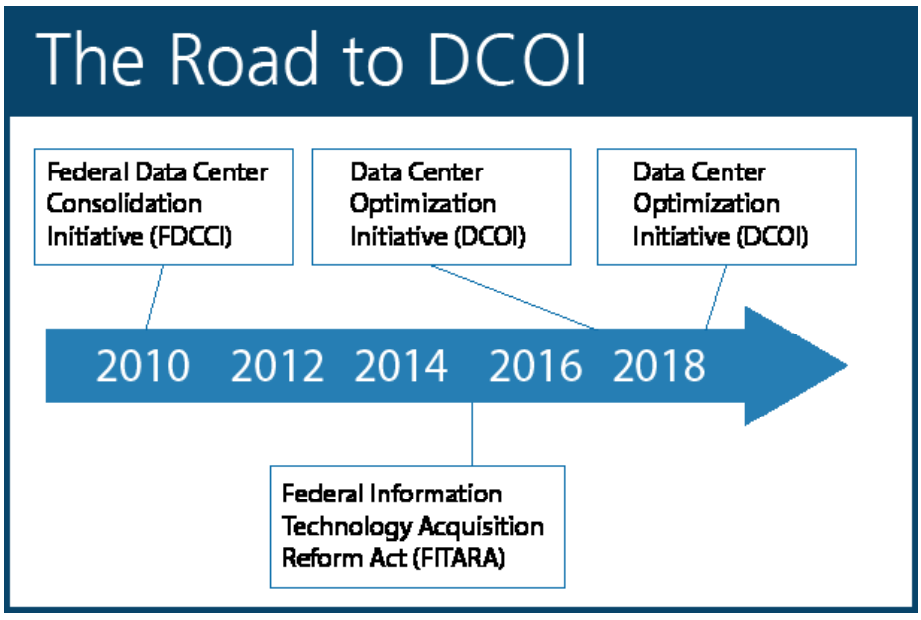
INTRODUCTION

This paper provides concrete steps that can be taken to bring a US Federal or Military data center into compliance with the latest directives from the Executive branch regarding data center optimization and consolidation. It details the evolution from FDCCI to FITARA to DCOI, with an emphasis on the roles that power measurement and management play in complying with the DCOI requirements for efficiency (through the PUE metric) and reporting through the implementation of a DCIM tool for asset tracking and power monitoring. Details are provided on how the rack and the PDU technology within the rack provide the underlying infrastructure for the base level power monitoring and control that are integral requirements of the DCOI, along with enabling the capacity planning function that leads to intelligent choices for rack and data center consolidation.



WHAT IS DCOI?

The Datacenter Optimization Initiative (DCOI) took effect in 2016 and sets goals for federal agency CIOS to:

- Reduce their number of datacenters
- Improve their operational efficiencies
- Deploy power measurement and management technologies
- Consolidate IT infrastructure where possible
- Move IT applications to the cloud

HISTORY

In 2010, President Obama signed into law the first of several pieces of legislation that were intended to drive a reduction in the total number of data centers belonging to the various agencies and military programs of the United States federal government, and at the same time reducing the total energy consumption of these facilities. This first effort was known as the Federal Data Center Consolidation Initiative (FDCCI). FDCCI[1] promoted the use of green IT by reducing the overall energy and real estate footprint of government data centers, reducing the cost of data center hardware, software, and operations; increasing the overall IT security posture of the Federal Government and shifting IT investments to more efficient computing platforms and technologies. The IT industry received the FDCCI with open arms and praise for being a first step in the right direction towards modernization and following industry best practices.ligent choices for rack and data center consolidation.

The Federal Information Technology Acquisition Reform Act (FITARA) signed into law in December 2014 enacted and built upon the requirements of FDCCI. FITARA requires that agencies submit annual reports that are to include: comprehensive data center inventories, multi-year strategies to consolidate and optimize data centers, performance metrics and a timeline for agency activities, and yearly calculations of investment and cost savings.

As of August 2016, the FDCCI was superseded by the Data Center Optimization Initiative (DCOI).[2] In a memorandum dated August 1, 2016 from Tony Scott, the Federal Chief Information Officer (CIO), the DCOI was launched as a new policy defining a framework for achieving the data center consolidation and optimization requirements of FITARA.

As part of the efforts leading up to DCOI, the U.S. Government Accountability Office reports that:

- 1,690 government data centers were closed.
- There are currently 11,700 government data centers in operation.
- Approximately 2,000 more will be consolidated.
- 19 of 24 participating agencies saved $1.1 billion in cost savings and cost avoidance from 2011-2013.
- 21 agencies had collectively reported planning an additional $2.1 billion in cost savings and avoidances by the end of fiscal year 2015[3]

[1] The FDCCI was first established by OMB "Memo for CIOs: Federal Data Center Consolidation Initiative," issued on February 26, 2010, and modified by subsequent memoranda

[2] m_16_19_1.pdf, published by www.whitehouse.gov and Federal CIO

DCOI REQUIREMENTS

Does the DCOI apply to you and your data center? The DCOI explicitly states that:

"All federal and military data center infrastructure and services, including contracts for third-party data centers and services agency-wide, shall be managed by the agency CIO in a manner consistent with FITARA and OMB Memorandum M-15-14. The CIO is responsible for implementing and measuring progress toward meeting the goals set forth in DCOI."

Rooms with at least one server providing services are considered to be datacenters, whether they are in a production, test, staging, development, or any other environment. Rooms containing only print servers, routing equipment, switches, security devices such as firewalls are not considered to be datacenters.

Thus, if you are part of any Federal agency, department, or military branch having at least one server, then your data center is subject to the requirements of the DCOI of 2016. See Appendix B for details.

The DCOI requires agencies to:

- Develop and report on their data center strategies;
- Transition to more efficient infrastructure, such as cloud services and inter-agency shared services;
- Leverage technology advancements to optimize infrastructure; and
- Improve security posture
- Provide quality services for the public good.[5]

DEADLINES FOR DCOI COMPLIANCE

Agencies are required to publish their Strategic Plans for DCOI compliance at agency.gov/digitalstrategy by October 1, 2016. Strategic plan updates are due on April 17, 2017, and April 13, 2018. A minimum of 5 milestones per fiscal year are to be included, and updated quarterly.[6]

[3] http://it-resource.schneider-electric.com/h/i/239568064-federal-data-center-optimization-initiative-dcoi-fundamentals-where-to-start/141801
[4] Appendix C
[5] https://data centers.cio.gov/
[6] m_16_19_1.pdf

DEADLINES

- Oct 1, 2016 – Strategic Plans
- April 17, 2017 – Plan update
- April 13, 2018 – Plan update

There is a minimum of 5 milestones to be updated annually.

DCOI REQUIREMENTS

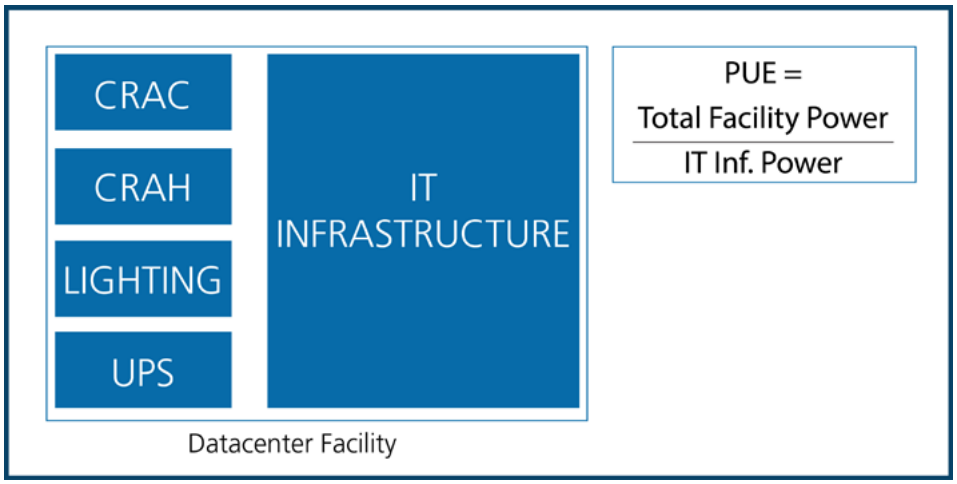
- Energy metering of all data center inventory
- Power Usage Effectiveness (PUE) of 1.5 or lower
- Virtualization > 4:1
- Server utilization >= 65%
- Facility utilization >= 80%

Data center optimization. Five optimization objectives must be met by 2018:

- **Energy metering**: 100 percent of total gross floor area in an agency's data center inventory in data centers must have power metering.
- **Power usage effectiveness**: Existing data centers must achieve a PUE rating of 1.5. New facilities must be less than 1.4.
- **Virtualization**: The ratio of operating systems to physical servers must be more than 4.
- **Server utilization**: The rates must come up to 65 percent.
- **Facility utilization**: The total gross floor area that is actively used for racks must be at least 80 percent.[7]

DCOI looks to have the various agencies reduce their datacenter footprints by consolidating applications across servers, and consolidating servers across racks and entire datacenters. Where possible, the agencies are to consider transitioning to provisioned services such as Software as a Service (SaaS), Platform as a Service (Paas) and Infrastructure as a Service (IaaS), consistent with a Cloud First Policy first discussed in "Federal Cloud Computing Strategy," February 8, 2011. Agencies are to use cloud infrastructure where possible.[8]

Agencies shall install automated energy metering tools and shall use these to collect and report their energy usage data in their data centers to OMB, and to report their PUE, with the goal of each agency datacenter PUE being below 1.5 by September 30, 2018. Along with the metering tools, agencies are required to eliminate manual data collection systems used for monitoring inventory and managing hardware and replace same with automated data center infrastructure management (DCIM) tools.



[7] https://gcn.com/articles/2016/08/19/dcoi-dcim.aspx
[8] m_16_19_1.pdf

MEETING THE DCOI REQUIREMENTS

Meeting the requirements of DCOI does not have to be a painful exercise. Instead, following the leadership of many who have worked in hyperscale compute environments such as Google and Amazon can prove to be a prudent and expedient path to achieving both the goals and the intent of DCOI. The following steps are a proven methodology for improving upon all the metrics that are required in DCOI.

1. Migrating data center operations to cloud infrastructure that has already met the PUE goals and has achieved FedRAMP certification
2. Consolidating IT workloads through virtualization (a la VMWare and Microsoft Hyper-V, Xen) and containerization (like Docker), followed by consolidation of datacenters between agencies, thus reducing the number of physical servers and data center "closets" dispersed across the Federal real estate portfolio
3. Implementing a Data Center Infrastructure Management (DCIM) tool to provide asset tracking, asset placement optimization, physical and energy capacity management and reporting, asset grouping by function or agency, network connection management, and so forth
4. Deploying physical infrastructure that incorporates support for remote power measurement and management such as smart power supplies in servers and intelligent power strips for the IT and networking equipment racks
5. Utilizing newer, high power density IT infrastructure to lessen the square footage of real estate required to provide the same or greater amounts of functionality, then consolidating IT from multiple facilities/agencies into common facilities
6. Raising the operating temperatures of the typical datacenter, going from a 25°C ambient to 35°C ambient cold aisle temperature can yield significant cost savings on cooling expenses as well as improving the PUE

KEYS TO DCOI

Migrate to the cloud where possible

Consolidate workloads within remaining datacenters

Implement DCIM to collect power information

Deploy intelligent power measurement (like PDUS)

Utilize high compute density IT

Raising the operating temperature of the data center

GOING TO THE CLOUD

There are a wide number of facilities and services that are already certified through the FedRAMP process that are logical candidates for any agency to consider as a first step towards DCOI compliance. A comprehensive listing can be found at https://www.fedramp.gov/.

Products and services from reputable vendors such as Amazon Web Services (AWS), Dell, Google, HPE, IBM, Microsoft, and Oracle are all FedRAMP certified to facilitate the agencies' needs to meet the security and efficiency requirements of DCOI.

VIRTUALIZATION AND CONTAINERS

The path to virtualization and containerization of workloads within the datacenter are well understood by most IT professionals today. Deploying hypervisors from VMWare (now Dell Technologies), Microsoft, or Canonical on servers enables multiple virtual servers to exist on a single piece of physical hardware. Alternatively, deploying containers running on top of a server operating system (OS) provides more computational performance and density than virtual machines (VM), because only one instance of the OS exists on the hardware level, whereas using VMs requires a separate OS instance for each VM. Containerization software is readily available from Docker, Canonical and others that is suitable for deployment within the Federal data center space.

By putting multiple VMs or numerous containers onto a single server, the server can be loaded to the ideal range of 70-80% of its compute capacity, making it much more power efficient than having the server idle most of the time while still drawing as much as 50% of its peak power requirement.

DCIM TOOLS

"Because DCIM solutions were built for data center optimization, they offer one of the best tools to help meet recent mandates. However, not all solutions are created equal, and selecting the best DCIM provider is vital. At last count, there were over 50 vendors who offered a variety DCIM solutions -- from data center fans to complete robust software solutions across all DCIM disciplines (e.g. power monitoring, asset management, workflow management, etc.). When choosing a DCIM vendor, look for one that:

- Supports all five DCOI optimization metrics such as calculating PUE
- Has a comprehensive DCIM suite that covers the entire data center lifecycle
- Focuses on software solutions
- Has a sophisticated workflow to support all data center processes
- Integrates with critical IT service management ecosystems
- Exceeds security thresholds
- Provides after-sale support and professional services

These basic guidelines will prepare data center managers to meet the goals of DCOI as well as their agency's next set of objectives."

Quality DCIM tools have the software interfaces necessary to read power information directly from the power distribution infrastructure present within a datacenter, aggregate that information, process it, and

[9] Mark Gaydos, nlyte – "How DCIM can help with data center optimization goals"

act upon it in the form of issuing alarms, sending out trending reports, or interfacing to building management systems (BMS) to activate cooling systems and the like.

The operating environment of most data centers is extremely dynamic. A well designed and implemented DCIM tool facilitates change within the data center rather than hindering it, by making it easy to assess where power is available, what slots within the rack can be used, and what assets can be safely taken off line.

A list of top DCIM providers as measured by Gartner can be seen in Appendix G of this document.

REMOTE POWER MEASUREMENT AND MANAGEMENT

There is a broad ecosystem of physical hardware that is present in every datacenter. Servers, storage, networking, UPS, battery banks, cooling systems, distribution panels and the like are necessary in every data center.

Within each category of hardware, there are multiple products coming from multiple vendors, each having its own management tools and communications interfaces, some of which are proprietary in nature. The choice on server types and brands are too numerous to list here. Likewise, on the networking side, there are routers, top of row switches, fabrics, hubs, patch panels, and so on. Not every piece of gear is Ethernet enabled, so it does not make sense for all devices to be able to measure their own power consumption. And trying to find a single tool that interfaces to ILO, DRAC, and so forth while also supporting SNMP can be difficult.

Every piece of active electronics must be "plugged in" to a source of electricity. Inside the data center, the standard outlet types for compute, storage, and networking to plug into within an IT or networking rack are C13 and C19 outlets found on rack-level (cabinet) power distribution units (PDUS).

Server Technology, Inc. (STI) of Reno, NV is the leading innovator in the PDU market, having the highest number of PDU and power management patents along with the largest engineering team devoted specifically to PDU development. STI is also TAA compliant, and offers the broadest portfolio of PDU products in the IT industry, along with supporting the broadest range of DCIM tools. The easiest way to ensure that the agency can measure the power usage of its' IT infrastructure is to use intelligent PDUS having remote management capabilities. These power strips enable DCOI compliance by providing:

- Data collection of power consumption at the outlet, device, and cabinet
- Support for reporting, alarming, and smart load shedding capabilities
- Facilitating capacity planning and rack consolidation, leading to data center consolidation
- Switching off unused or underutilized assets (zombie servers, storage, load balancers, etc.) resulting in lower IT power consumption and higher efficiencies

The PDUS from Server Technology are supported in more DCIM tools than any other PDU brand can offer. See Appendix H for details.

HIGH DENSITY COMPUTE SOLUTIONS

Datacenters were first conceived as part of the infrastructure needed to implement mainframe based data processing dating back to the 1950's and 1960's. In the late 1980's through 1990's, the first client- server distributed processing systems were adopted, as token ring and other networking technologies yielded to the Ethernet and Internet Protocol. Mainframes occupying an entire room were replaced by "tower" sized departmental servers, then by 1U and 2U sized boxed mounted horizontally into racks. Today, blade servers and multi-CPU servers vie for the role of "king of the hill" when it comes to compute and power density when stuffed into an IT rack enclosure. Systems from Dell, HPE, IBM, Cray, and others routinely put hundreds of CPUs and thousands of cores into a single rack consuming anywhere from 10kW to 80kW or more. These racks are all heavier, denser, and hotter than their predecessors and are frequently found in datacenters that have moved away from raised floor facilities to bare concrete slab, with all power, cooling, and networking coming in from overhead. Frequently these deployments rely on either cold or hot aisle containment as a means of ensuring positive airflow pressure from the cold aisle to the hot aisle while maximizing the heat transfer efficiency of the air flow and the electrical efficiency of the cooling systems.

The computational density (number of instructions per second processed by a given volume of IT equipment) of a single rack of modern IT gear is millions to billions of times faster and more efficient than it was in the 1970's. This trend continues to dominate the design methodology for new datacenters, and speaks to the feasibility of the goals set forth in the IT consolidation requirement of DCOI.

ASHRAE AND THE DATA CENTER ENVIRONMENT

ASHRAE issued its first thermal guidelines for datacenters in 2004. The original air temperature specification for data centers was 20-25°C. This was a very conservative specification based on where a data center could be reliably operated at the time. Maintaining IT equipment at this temperature also required massive amounts of cooling equipment and large amounts of energy to power the cooling systems. This caused the datacenter operator to spend as much on cooling as they did on computing.

More recently, ASHRAE has published classes of data center that operate over a range of 5°C to 45°C as the ambient air temperature in the cold aisle. Class A3 goes to 40°C while class A4 goes to 45°C. Commensurate with these recommendations, economization (the use of outdoor air to cool the data center), has become a mainstay of highly efficient data centers. Rather than relying on complex chiller systems and liquid cooling loops, economization relies on intelligently controlled fans to move just enough filtered outside air through the data center to provide the cooling necessary to keep the data center hardware from going over the targeted 45°C operating temperature. Today, the exhaust air temperature of a datacenter can reach 45-50°C, and in some extreme cases is reaching 60-65°C. Increasing the operating temperature and reducing the cooling requirements helps lower the numerator (total facility power) of the PUE equation.

Any federal agency that adopts a "greener" data center design that supports a higher operating temperature environment and uses economization will likely find the PUE target for DCOI easier to achieve. Converting the data center lighting from incandescent or fluorescent bulbs over to LED technology helps lower the facility power requirements as well, again positively impacting the total facility power portion of the PUE equation.

CONCLUSION

DCOI is an evolution in governmental thinking from the initial FDCCI. It raises the bar with respect to the efforts to be taken by the respective agencies to control the proliferation of datacenters and computational infrastructure required to provide the services that the other branches of government, industry, and the public expect of them. Complying with DCOI does not have to be a stress point for the CIO of the agency, but instead can be part of the discipline of running an environmentally responsible, well-managed organization and its IT assets.

Taking positive steps towards systems consolidation, power measurement and management, and outsourcing various platforms and services all give the agency CIO plenty of options and tools for meeting the needs for environmental sustainability required by DCOI while also giving the CIO a chance for improving employee productivity, achieving higher efficiency, and delivering improved services.

Using remotely managed intelligent power strips (PDUS) for powering the agency's IT infrastructure can help the CIO achieve the goals necessary to comply with the Data Center Optimization Initiative.

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https://www.gpo.gov/fdsys/pkg/FR-2015-03-25/pdf/2015-07016.pdf - Executive Order 13693 Planning for Federal Sustainability in the next decade

https://www.fema.gov/continuity-operations - Continuity of Operations (COOP)

https://www.fedramp.gov/

https://marketplace.fedramp.gov/-/products?status=FedRAMP%20Ready&sort=productName-FedRAMP Ready compliant products, such as SaaS and IaaS

APPENDICES

- Appendix A - Terminology
- Appendix B - Copy of DCOI Memorandum
- Appendix C - Agencies (as of August 2016)
- Appendix D – Agency Strategic Plans
- Appendix E – NASA, an Agency Strategic Plan Example
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- Appendix G - Top DCIM tools according to Gartner
- Appendix H - List of DCIM tools that work with STI hardware and SPM

APPENDIX A - TERMINOLOGY

PUE AND DCIE

Power Usage Effectiveness (PUE) and Data Center Infrastructure Efficiency (DCiE)

PUE is defined as the ratio of the total power to run the data center facility to the total power drawn by all IT equipment:

$$PUE = \frac{Total\ Facility\ Power}{IT\ Equipment\ Power}$$

Standard	Good	Better
2.0	1.4	1.1

An average data center has a PUE of 2.0; however, several recent super-efficient data centers have been known to achieve a PUE as low as 1.1.

DCiE is defined as the ratio of the total power drawn by all IT equipment to the total power to run the data center facility, or the inverse of the PUE:

$$DCIE = \frac{1}{PUE} = \frac{IT\ Equipment\ Power}{Total\ Facility\ Power}$$

Standard	Good	Better
0.5	0.7	0.9

The Green Grid developed benchmarking protocol for these two metrics for which references and URLs are provided at the end of this guide.

It is important to note that these two terms—PUE and DCiE—do not define the overall efficiency of an entire data center, but only the efficiency of the supporting equipment within a data center. These metrics could be alternatively defined using units of average annual power or annual energy (kWh) rather than an instantaneous power draw (kW). Using the annual measurements provides the advantage of accounting for variable free-cooling energy savings as well as the trend for dynamic IT loads due to practices such as IT power management.

Figure 1- USDOE Best Practices Guide for Energy-Efficient Data Center Design http://energy.gov/sites/prod/files/2013/10/f3/eedatacenterbestpractices.pdf

From the 42u.com website

PUE Example:
Having a facility that uses 100,000 kW of total power of which 80,000 kW is used to power your IT equipment, would generate a PUE of 1.25. The 100,000 kW of total facility power divided by the 80,000 kW of IT power.

DCIM – Data Center Infrastructure Management. DCIM is most frequently thought of as a combination of data center management practices centered around the use of a suite of software applications focused on asset tracking, asset management, power consumption measurement and reporting, physical layout, environmental data collection and management

Cloud – the National Institute of Standards and Technology (NIST) characteristics for cloud computing are: on demand self-service, broad network access, resource pooling, rapid elasticity

[10] http://www.42u.com/measurement/pue-dcie.htm

or expansion, and measured service. NIST also lists three "service models (software, platform, and infrastructure) and four "deployment models" (private, community, public, and hybrid) that together categorize ways to deliver cloud services.

Consolidation – the act of combining IT workloads from dedicated infrastructure onto shared infrastructure. Consolidating IT applications can result in physical hardware redundancies that can be eliminated such as un-needed servers, storage, and so on up through the rack, row, and data center levels.

Efficiency – in the context of data centers, efficiency is the amount of compute or storage that can be done per watt, relative to the amount of power overhead required for cooling, lighting, and other support infrastructure necessary for the operation of a data center

DCSSM - The Data Center Shared Services Marketplace (https://data centers.cio.gov/data center-shared-services/)- is designed as the central location where agencies can choose from an inventory of data center services and automated management tools and products to achieve efficiency and cost savings. Agencies can participate in the Marketplace as either an ISSP, a customer, or a tenant. An ISSP is a high performing agency which effectively manages its data centers.

[11] https://www.nist.gov/news-events/news/2011/10/final-version-nist-cloud-computing-definition-published

APPENDIX B - MEMORANDUM M-16-19_1

August 1, 2016

M-16-19

MEMORANDUM FOR HEADS OF EXECUTIVE DEPARTMENTS AND AGENCIES

FROM: Tony Scott
Federal Chief Information Officer

SUBJECT: Data Center Optimization Initiative (DCOI)

Background

In 2010, the Office of Management and Budget (OMB) launched the Federal Data Center Consolidation Initiative (FDCCI) to promote the use of green IT by reducing the overall energy and real estate footprint of government data centers; reduce the cost of data center hardware, software, and operations; increase the overall IT security posture of the Federal Government; and shift IT investments to more efficient computing platforms and technologies.1

In December 2014, the President signed into law the Federal Information Technology Acquisition Reform Act (FITARA),2 which enacts and builds upon the requirements of the FDCCI. FITARA requires that agencies submit annual reports that are to include: comprehensive data center inventories, multi-year strategies to consolidate and optimize data centers, performance metrics and a timeline for agency activities, and yearly calculations of investment and cost savings.

In addition, FITARA requires the Administrator of the Office of E-Government and Information Technology (henceforth referred to as the Office of the Federal Chief Information Officer (OFCIO)3) to establish and publish cost savings and optimization improvements, provide public updates on cumulative cost savings and optimization improvements, and review agencies' data center inventories and the implementation of data center management strategies.

[1] The FDCCI was first established by OMB "Memo for CIOs: Federal Data Center Consolidation Initiative," issued on February 26, 2010, and modified by subsequent memoranda.
[2] Title VIII, Subtitle D of the National Defense Authorization Act (NDAA) for Fiscal Year 2015, Pub. L. No. 113-291.
[3] This office was established in accordance with Section 101 of the E-government Act of 2002, codified at [4]4 U.S.C. § 3602, and is headed by the Federal Government Chief Information Officer. This office will also be referred to as OMB's Office of the Federal Chief Information Officer (OFCIO).

This memorandum defines a framework for achieving the data center consolidation and optimization requirements of FITARA, the criteria for successful agency data center strategies, and the metrics OMB OFCIO will use to evaluate the success of those strategies.

Policy

As of August 1, 2016, the FDCCI is superseded by the Data Center Optimization Initiative (DCOI) established in this memorandum.

The DCOI, as described in this memorandum, requires agencies to develop and report on data center strategies to consolidate inefficient infrastructure, optimize existing facilities, improve security posture, achieve cost savings, and transition to more efficient infrastructure, such as cloud services and inter-agency shared services.4

The requirements in this memorandum apply to all CFO Act agencies,5 including the Department of Defense.6

Leadership and Responsibilities

All data center infrastructure and services, including contracts for third-party data centers and services agency-wide, shall be managed by the agency CIO in a manner consistent with FITARA7 and OMB Memorandum M-15-14, "Management and Oversight of Information Technology."8 The agency CIO shall be responsible for implementing and measuring progress toward meeting the goals set forth in this memorandum.

Transition to Cloud and Data Center Shared Services

Development Freeze for New and Current Data Centers

Beginning 180 days after issuance of this memorandum, agencies may not budget any funds or resources toward initiating a new data center or significantly expanding9 an existing data center

4 Federal Information Technology Shared Services Strategy, May 2, 2012, https://www.whitehouse.gov/sites/default/files/omb/assets/egov_docs/shared_services_strategy.pdf.
5 See Chief Financial Officers Act of 1990, Pub. L. No. 101–576.
6 Per Sec. 834(b)(1)(C) of the FY2015 NDAA, the Department of Defense may submit to OMB, in lieu of the Strategic Plan described in this memorandum, the defense-wide plan and cost savings report required under sections 2867(b)(2) and 2867(d), respectively, of the FY2012 NDAA. If submitting such plans and reports in lieu of the Strategic Plan, DOD shall ensure all information required by the Strategic Plan is included in the submitted plans and reports.
7 Title VIII, Subtitle D of the National Defense Authorization Act (NDAA) for Fiscal Year 2015, Pub. L. No. 113-291.
8 OMB Memorandum M-15-14, "Management and Oversight of Federal Information Technology," June 10, 2015, https://www.whitehouse.gov/sites/default/files/omb/memoranda/2015/m-15-14.pdf.
9 The General Services Administration (GSA) Office of Government-wide Policy (OGP) will coordinate with OMB to define thresholds for what constitutes "significant" expansion within 60 days of publication of this memorandum.

3
without approval from OMB OFCIO. 10 To request such approval, agencies must submit a written justification that includes an analysis of alternatives (including opportunities for cloud services, inter-agency shared services, and third party co-location) and an explanation of the net reduction in the agency's data center inventory that will be facilitated by the new or expanded data center (such as through consolidation of multiple existing data centers into a single new data center).

Consolidation and Closure of Existing Data Centers

As previously required by the FDCCI, agencies shall continue to principally reduce application, system, and database inventories to essential enterprise levels by increasing the use of virtualization to enable pooling of storage, network and computer resources, and dynamic allocation on-demand. Thereafter, agencies shall evaluate options for the consolidation and closure of existing data centers,11by (in order of priority):

1. Transitioning to provisioned services, including configurable and flexible technology such as Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS) to the furthest extent practicable, consistent with the Cloud First policy.[12]
2. Migrating to inter-agency shared services or co-location data centers.
3. Migratingto more optimized data centers within the agency's data center inventory.

Cloud Investment

Cloud environments are scalable and allow agencies to provision resources as required, on-demand.[13]Consistent with the Cloud First policy, agencies shall use cloud infrastructure where possible when planning new mission or support applications or consolidating existing applications. Agencies should take into consideration cost, security requirements, and application needs when evaluating cloud environments. As required by FITARA, agencies utilizing cloud services shall do so in a manner that is consistent with requirements of the Federal Risk and Authorization Management Program (FedRAMP) and National Institute of Standards and Technology (NIST) guidance.[14]

Shared Services Managing Partner

To support the shared services efforts described by this memorandum, the General Services Administration (GSA) Office of Government-wide Policy (OGP) shall serve as the managing

[10]Data centers certified by GSA OGP as Inter-Agency Shared Service Provider data centers are excluded from this development freeze.[11]This requirement does not apply to GSA OGP designated inter-agency shared services data centers.[12]Federal Cloud Computing Strategy, February 8, 2011,https://www.whitehouse.gov/sites/default/files/omb/assets/egov_docs/federal-cloud-computing-strategy.pdf.13Ibid.[14]See FY2015 NDAA Sec. 834(3)(c).4 and data center shared services. OGP, in consultation with the Unified Shared Services Management office, shall establish and maintain a data center shared services marketplace and coordinate shared services for inter-agency consumption by:

partner of the Federal Government's data center line of business[15]and data center shared services. OGP, in consultation with the Unified Shared Services Management office, shall establish and maintain a data center shared services marketplace and coordinate shared services for inter-agency consumption by:

- Coordinating with OMB to define qualifying operating standards for inter-agency shared services providers, creating guidance materials for becoming such a provider, and identifying and approving candidate providers.
- Maintaining and monitoring inter-agency shared services provider operating standards.

- Maintaining an online inventory of qualified inter-agency shared services providers.
- Establishing an online decision support tool to facilitate agency review, selection, and analysis of inter-agency shared services providers.
- Coordinating with the GSA Federal Acquisition Service(FAS)to create and maintain an inventory of acquisition tools and products specific to the technology and services surrounding data center optimization, including procurement vehicles for the acquisition of automated infrastructure management and monitoring tools.
- Developing, implementing, and maintaining financial and service models, as well as contracts, pertaining to data center procurement with customer/partner agencies and shared service providers.
- Providing a forum for participating and interested agencies to discuss the inter-agency shared services marketplace.

In this role, OGP will serve as a trusted agent and subject matter expert to assist data center providers and consumers of data center services by providing guidance on technology advancements, innovation, cybersecurity, and best practices.

All agencies will have the option of submitting data centers of their choosing for review by OGP. Data centers that OGP determines satisfactory in all of their operating standards will be designated as inter-agency shared services providers.

Optimization of Physical Data Centers

Classification of Physical Data Centers

For the purposes of this memorandum, rooms with at least one server, providing services (whether in a production, test, staging, development, or any other environment) are considered data centers. However, rooms containing only print servers, routing equipment, switches, security devices (such as firewalls), or other telecommunications components shall not be [15]Formed in 2004, lines of business (LOB) are cross-agency initiatives to define, design, implement and monitor a set of common solutions for government-wide businessfunctions, processes, or desires capabilities. EachLOB isgoverned by a Managing Partner-which is designated as the lead organization responsible for managing the business requirements of their community.

5 considered data centers. Agencies shall perform a comprehensive review of their data center inventories and continue to maintain complete and updated datacenter inventories. This comprehensive review shall be completed byAugust31, 2016, to align with the Integrated Data Collection (IDC) process.[16]

Data centers shall be categorized into two groups: tiered17data centers and non-tiered data centers. Tiered data centers are defined as those that utilize each of the following: 1) a separate physical space for IT infrastructure; 2) an uninterruptible power supply; 3) a dedicated cooling system or zone; and4) a back-up power generator for prolonged power outages. All other datacenters shall be considered non-tiered data centers.18Private sector-provided cloud services are not considered data centers for the purposes of this memorandum, but must continue to be included in agencies' quarterly inventory data submissions to OMB.

Agencies shall self-classify data centers as either tiered or non-tiered data centers based on the above criteria; however, any data center previously reported to OMB as a Tier1-4 data center shall be automatically categorized as a tiered data center.

Under this memorandum, OMB sets closure and optimization targets that are applicable to each type of data center. Additionally, the terms "core" and "non-core" will no longer be used as the categorical benchmarks for OMB oversight.

Energy Metering and Power Efficiency

Agencies shall install automated energy metering tools and shall use these to collect and report energy usage data in their data centers to OMB. The March 19, 2015, Executive Order 13693, "Planning for Federal Sustainability in the Next Decade," requires agencies to install and monitor advanced energy meters in data centers by September 30, 2018.19

Consistent with the Implementing Instructions for Executive Order 13693(E.O. Implementing Instructions), energy metering tools shall enable the active tracking of PUE for the data center and shall be installed in all tiered Federal data centers by September 30, 2018.20The E.O.

[16]Data centers containing only print servers that were previously reported as "closed" shall remain classified as closed data centers in agencies' data center reporting.[17]The term "tiered" and the definitions that follow are derived from the Uptime Institute's Tier Classification System; however, this shall not be construed as requiring any certification in order for a data center to be considered tiered by OMB.[18]Data centers previously classified as tiered in past inventories will automatically be classified as tiered under the DCOI.[19]Executive Order, "Planning for Federal Sustainability in the Next Decade" https://www.whitehouse.gov/the-press-office/2015/03/19/executive-order-planning-federal-sustainability-next-decade.
[20]While Executive Order 13693 requires advanced energy metering in all data centers, OMB will monitor PUE for tiered data centers only. 6

Implementing Instructions also advise that "[a]ll existing and new data centers shall have at least one certified Data Center Energy Practitioner(DCEP) assigned to manage its performance."[21]

Consistent with the E.O. Implementing Instructions, agency CIOs are also required under this memorandum to ensure that existing tiered data centers achieve and maintain a PUE of less than 1.5 by September 30, 2018. Agency CIOs shall evaluate options for consolidation or closure of existing data centers in which a PUE target of less than 1.5 is not cost-effective, such as through transition to cloud services or migration to inter-agency shared services data centers.

Accordingly, OMB will monitor the energy efficiency of data center power and cooling infrastructure through the Power Usage Effectiveness (PUE) metric. Consistent with the E.O. Implementing Instructions, effective immediately, all new data centers must implement energy metering capable of measuring PUE and must be designed and operated to maintain a PUE no greater than 1.4, and are encouraged to be designed and operated to achieve a PUE no greater than 1.2.

To the extent permissible under the Federal Acquisition Regulation (FAR), agencies must include PUE

requirements for all new data center contracts or procurement vehicles. Further, any new data center contractor procurement vehicle must require the contractor to report the quarterly average PUE of the contracted facility22to the contracting agency, except where that data center's PUE is already being reported directly to OMB or GSA through participation in a multi-agency service program. Agencies are encouraged to require the same for extension of existing vehicles. PUE reporting is not required for cloud services.

Automated Infrastructure Management

Agencies shall replace manual collections and reporting of systems, software, and hardware inventory housed within data centers with automated monitoring, inventory, and management tools (e.g., data center infrastructure management) by the end of fiscalyear2018.These tools shall provide the capability to, at a minimum, measure progress toward the server utilization and virtualization metrics defined in the Metric Target Values section of this memorandum.[23]

Any data center initiation, significant expansion, or migration project that receives Development, Modernization, and Enhancement (DM&E) funds in fiscal year 2017 and beyond must immediately implement automated monitoring and management tools. However, agencies are strongly encouraged to implement automated monitoring and management tools throughout their data centers immediately.

[21]See "Implementing Instructions for Executive Order 13693, 'Planning for Federal Sustainability in the Next Decade'" https://www.whitehouse.gov/sites/default/files/docs/eo_13693_implementing_instructions_june_10_2015.pdf. 22This can be PUE for the facility in cases where the agency only contracts for a portion of a larger facility; however, if PUE metrics are available specific to the agency's use, that is preferred.[23] For non-tiered data centers, only automated monitoring of server utilization is required.7

To the extent permissible under the FAR, agencies must include automated infrastructure management requirements for all new data center service contracts or procurement vehicles. Further, any new data center contractor procurement vehicle must require the contractor to report to the contracting agency whether the contracted facility utilizes automated infrastructure management, except where such data is already being reported directly to OMB or GSA through participation in a multi-agency service program. Agencies are encouraged to require the same for extension of existing vehicles.

GSA shall make available an acquisition vehicle for automated monitoring and management tools to support agency needs. Once established, agencies shall not issue new solicitations for these requirements unless they have developed a business case, approved by the agency's CIO and shared with OMB, to establish that the separate procurement of these needs results in better value, considering price and other appropriate factors.

Metric Target Values

OMB will measure agency progress for this initiative using the following optimization, cost savings, and closure metrics and goals on a quarterly basis, by way of agencies' quarterly data center inventory submissions. These optimization, cost-savings, and closure metrics and goals apply to all data centers at agency facilities.

Goal 1: Optimization

The following optimization metrics are listed in order of priority. Agencies shall achieve and maintain all listed target values by the end of fiscal year 2018: **Table 1. Government-wide Optimization Targets for Tiered Data Centers**[24]

Metric
Definition
Calculation
FYE 2018 Target Value

Energy Metering

(%) Percent of total gross floor area (GFA)25 in an agency's tiered data center inventory located in tiered data centers that have power metering.

Total GFA of Energy Metered
Data Centers
Total GFA of All Tiered Data Centers

APPENDIX C – AGENCIES, AND AGENCY STRATEGIC PLAN LOCATIONS

- Department of Agriculture
- Department of Commerce
- Department of Defense
- Department of Education
- Department of Energy
- Department of Health and Human Services
- Department of Homeland Security
- Department of Housing and Urban Development
- Department of Justice
- Department of Labor
- Department of State
- Department of the Interior
- Department of the Treasury
- Department of Transportation
- Department of Veterans Affairs
- Environmental Protection Agency
- General Services Administration
- National Archives and Records Administration
- National Aeronautics and Space Administration
- National Science Foundation
- Nuclear Regulatory Commission
- Office of Personnel Management
- Small Business Administration
- Social Security Administration
- U.S. Army Corps of Engineers
- USAID

APPENDIX D - AGENCY STRATEGIC PLAN

Agency Strategic Plans & Agency-Specific Cost Savings Targets

Agency	New DCOI Savings Target ($M)	FY18 Cumulative Target (including FDCCI Savings Achieved) ($M)
Commerce	$94.97	$356.71
DHS	$154.94	$349.62
DOD	$1800	$2056.94
DOT	$30.26	$30.9
ED	$0	$0
Energy	$0	$10.47
EPA	$0	$36.06
GSA	$8.35	$26.13
HHS	$77.84	$84.48
HUD	$0	$0
Interior	$88.19	$88.19
Justice	$65.86	$87.83
Labor	$23.94	$23.94
NARA	$0	$0
NASA	$15.1	$68.6

Agency	New DCOI Savings Target ($M)	FY18 Cumulative Target (including FDCCI Savings Achieved) ($M)
NRC	$1.21	$1.3
NSF	$0	$6.84
OPM	$21.92	$21.92
SBA	$0.86	$0.86
SSA	$164.69	$285.86
State	$17.07	$17.07
Treasury	$86.16	$86.16
USACE	$0	$0
USAID	$0	$3.73
USDA	$23.62	$109.23
VA	$66.04	$85.35
USG	$2741	$3942

APPENDIX E – NASA, AND AGENCY STRATEGIC PLAN EXAMPLE

NASA's Data Center Consolidation Strategy

- Promote at least one healthy Data Center for each NASA Center
- Focus on increasing IT efficiency:
  - » Fully utilize existing Data Centers for initial consolidation efforts
  - » Implement strategic improvements to strengthen health and availability of objective Data Centers
  - » Employ best practices
  - » Eliminate underutilized facilities, systems and applications
- Aggressively work to eliminate rouge "server rooms"

Strategic Preference

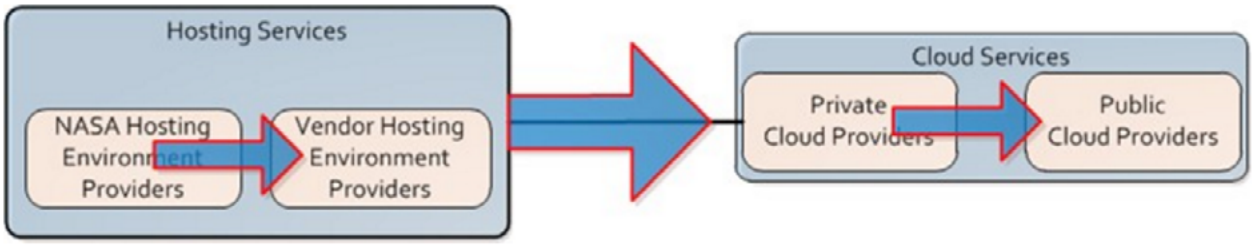
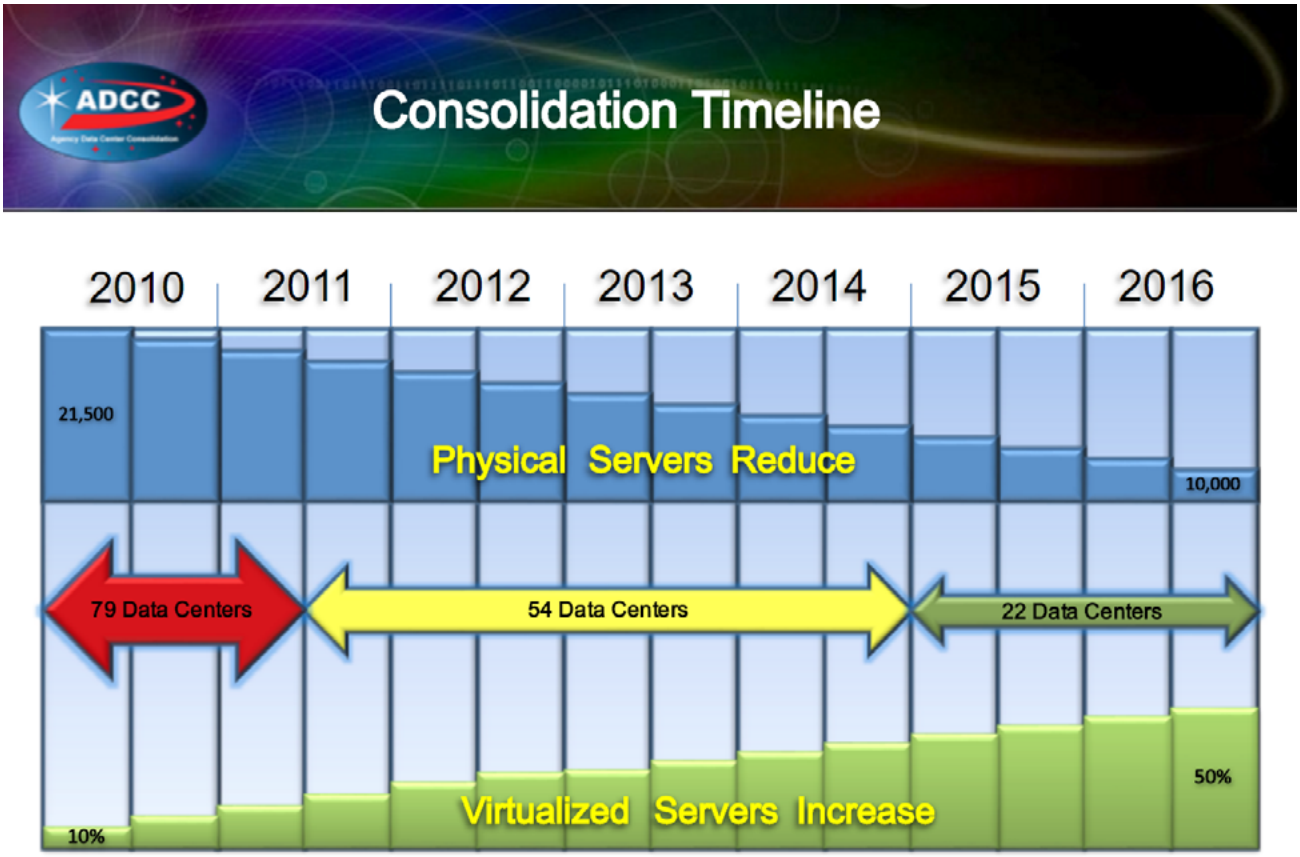
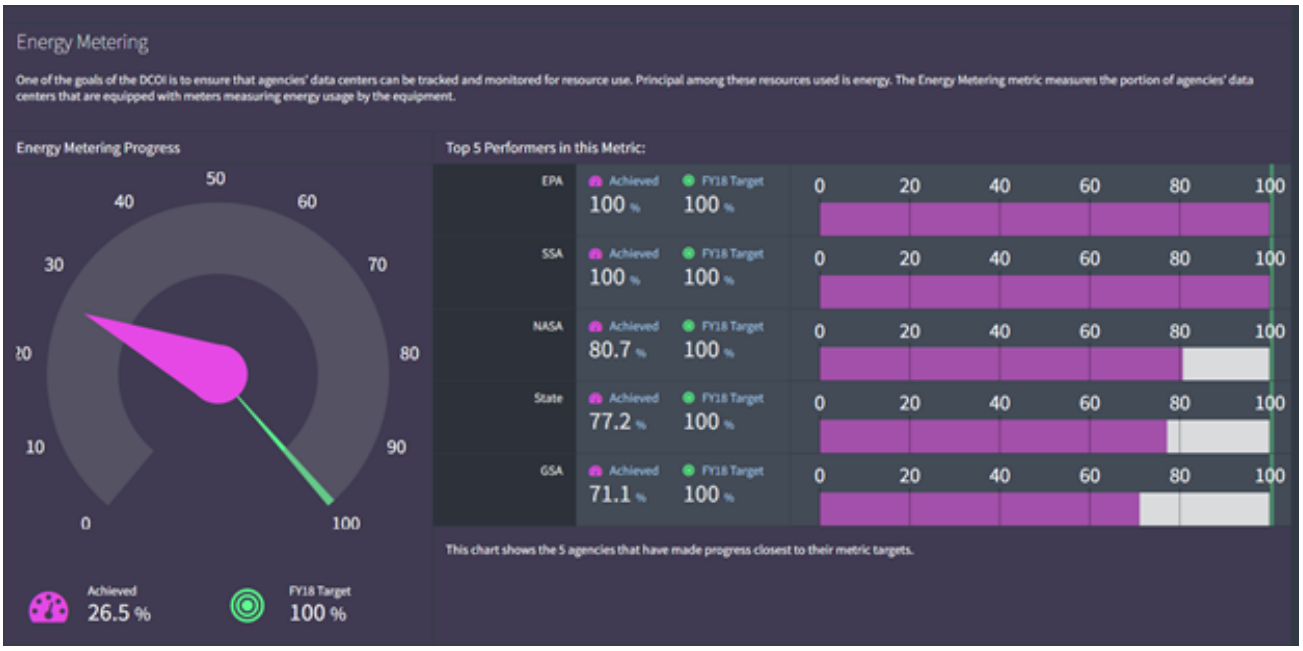


Figure 2- http://slideplayer.com/slide/1424095/

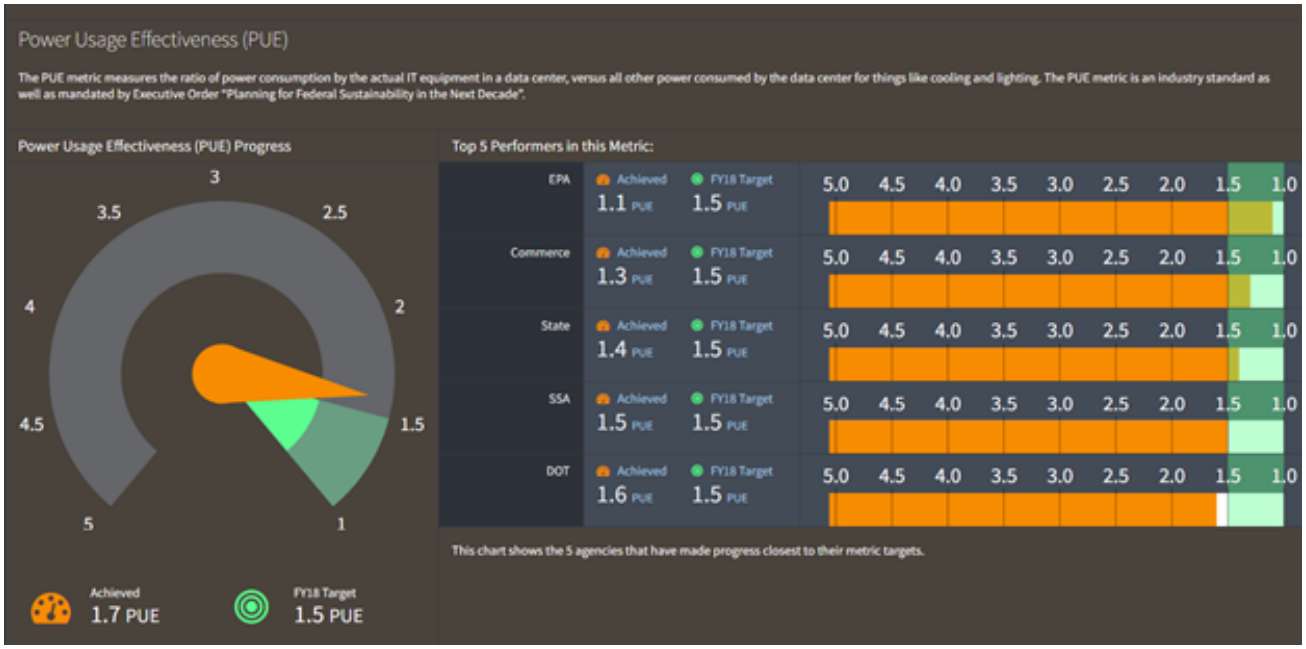

ADCC
Consolidation Timeline
2010
2011
2012
2013
2014
2015
2016
21,500
Physical Servers Reduce
10,000
79 Data Centers
54 Data Centers
22 Data Centers
50%
Virtualized Servers Increase
10%

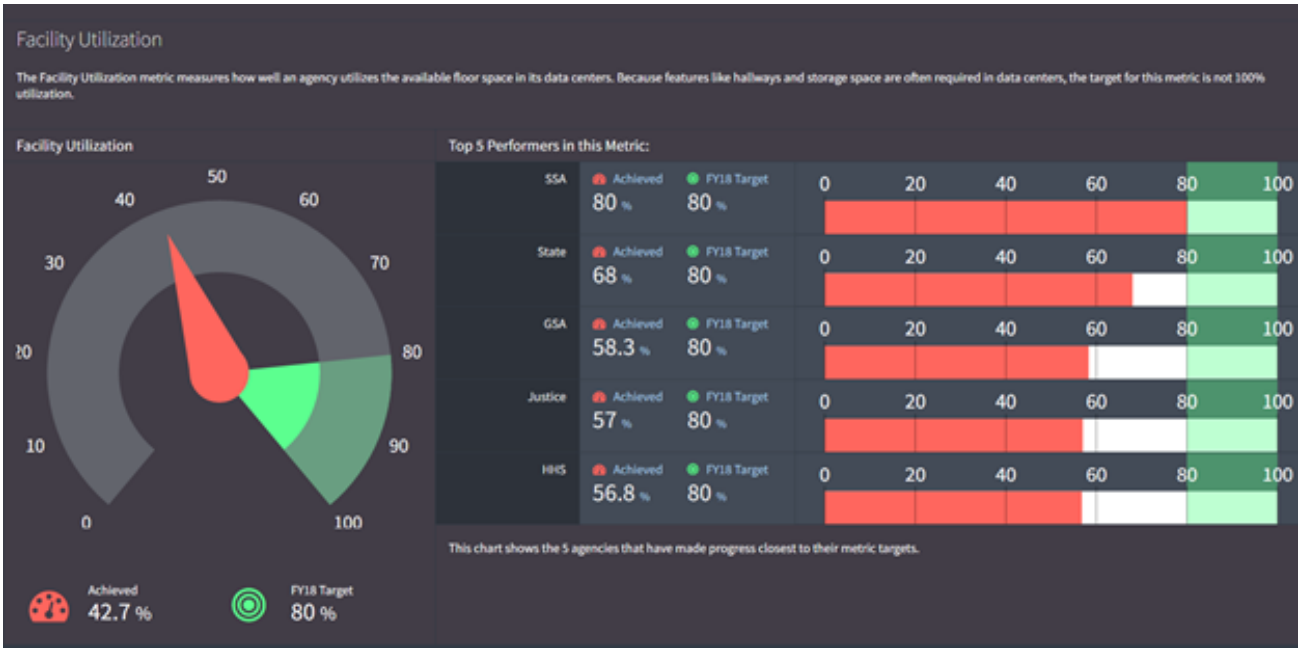
APPENDIX F – THE FEDERAL CIO DASHBOARDS

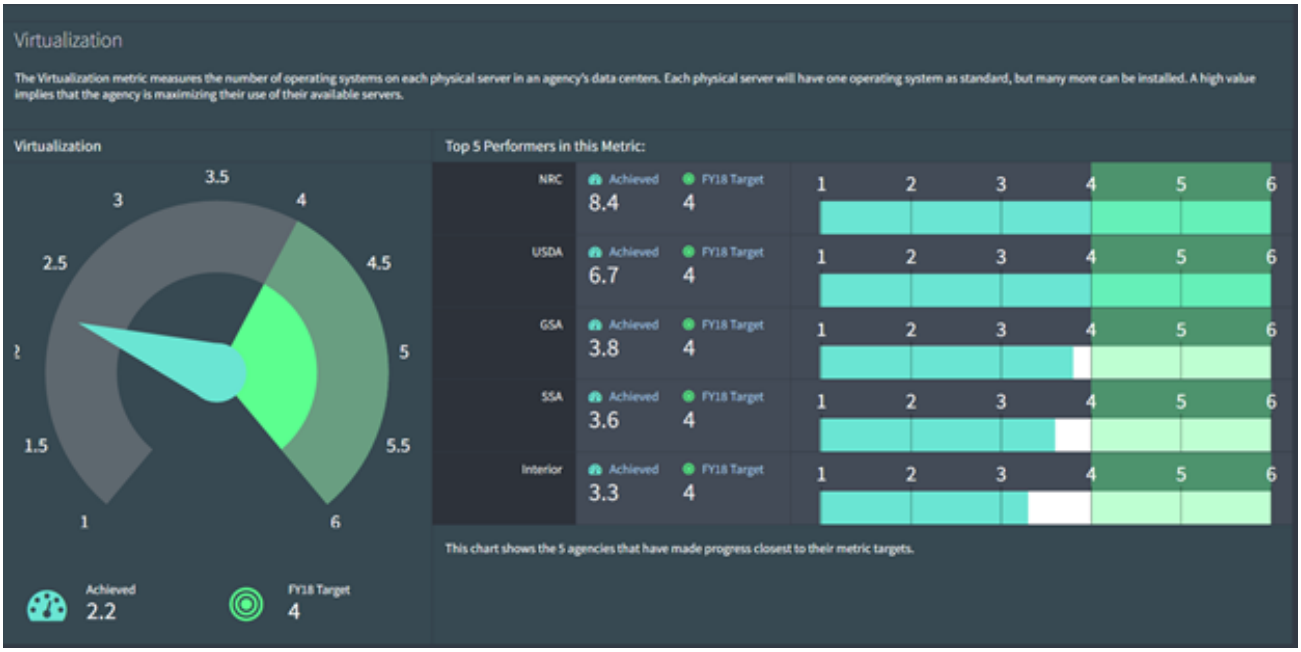
https://www.itdashboard.gov/drupal/dcoi-optimization - /a=0



As of Oct 21, 2016




Facility Utilization
The Facility Utilization metric measures how well an agency utilizes the available floor space in its data centers. Because features like hallways and storage space are often required in data centers, the target for this metric is not 100% utilization.
Facility Utilization
0
10
20
30
40
50
60
70
80
90
100
Achieved
42.7 %
FY18 Target
80 %
Top 5 Performers in this Metric:
SSA
Achieved
80 %
FY18 Target
80 %
State
Achieved
68 %
FY18 Target
80 %
GSA
Achieved
58.3 %
FY18 Target
80 %
Justice
Achieved
57 %
FY18 Target
80 %
HHS
Achieved
56.8 %
FY18 Target
80 %
0 20 40 60 80 100
This chart shows the 5 agencies that have made progress closest to their metric targets.


Virtualization
The Virtualization metric measures the number of operating systems on each physical server in an agency's data centers. Each physical server will have one operating system as standard, but many more can be installed. A high value implies that the agency is maximizing their use of their available servers.
Virtualization
1
1.5
2.5
3
3.5
4
4.5
5
5.5
6
Achieved
2.2
FY18 Target
4
Top 5 Performers in this Metric:
NRC
Achieved
8.4
FY18 Target
4
USDA
Achieved
6.7
FY18 Target
4
GSA
Achieved
3.8
FY18 Target
4
SSA
Achieved
3.6
FY18 Target
4
Interior
Achieved
3.3
FY18 Target
4
1 2 3 4 5 6
This chart shows the 5 agencies that have made progress closest to their metric targets.

APPENDIX G – TOP DCIM TOOLS AND MAGIC QUADRANT ACCORDING TO GARTNER

http://www.datacenterknowledge.com/archives/2016/10/19/here-are-the-top-dcim-software-vendors-according-to-gartner/

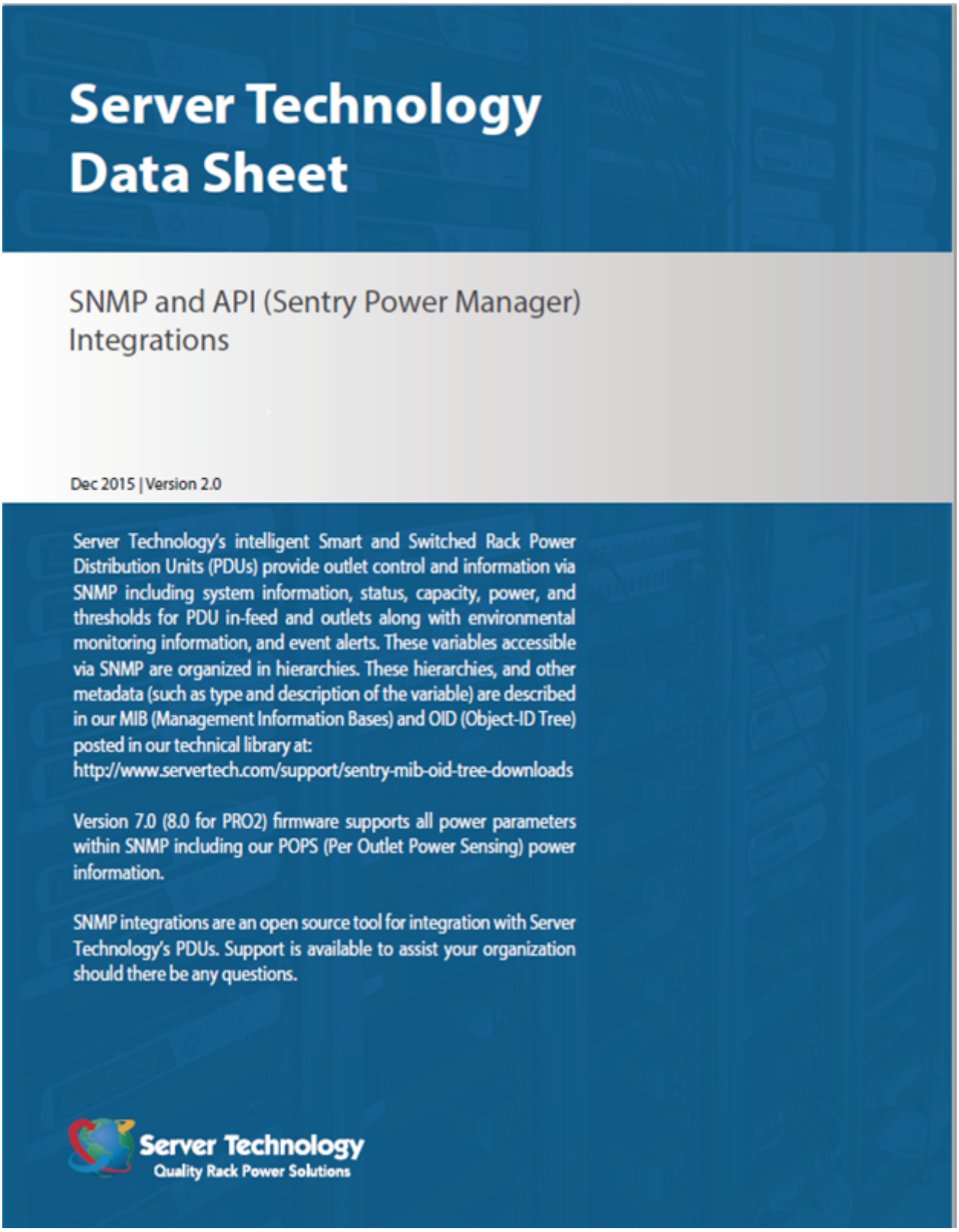
Top 3 are:

- Nlyte
- Emerson Network Power
- Schneider Electric

Analysts dropped the following vendors because they did not fully meet all the 2016 inclusion criteria:

- ABB
- Device42
- Geist
- Modius
- Optimum Path
- Rackwise
- FieldView was dropped because it has been acquired by Nlyte.

APPENDIX H – SERVER TECHNOLOGY INC AND DCIM INTEGRATIONS



Server Technology
Data Sheet

SNMP and API (Sentry Power Manager)
Integrations

Dec 2015 | Version 2.0

Server Technology's intelligent Smart and Switched Rack Power Distribution Units (PDUs) provide outlet control and information via SNMP including system information, status, capacity, power, and thresholds for PDU in-feed and outlets along with environmental monitoring information, and event alerts. These variables accessible via SNMP are organized in hierarchies. These hierarchies, and other metadata (such as type and description of the variable) are described in our MIB (Management Information Bases) and OID (Object-ID Tree) posted in our technical library at:
http://www.servertech.com/support/sentry-mib-oid-tree-downloads

Version 7.0 (8.0 for PRO2) firmware supports all power parameters within SNMP including our POPS (Per Outlet Power Sensing) power information.

SNMP integrations are an open source tool for integration with Server Technology's PDUs. Support is available to assist your organization should there be any questions.

Server Technology
Quality Rack Power Solutions

Server Technology SNMP and API Integration Partners

Partner	System	Integration Type*
ABB	Decathlon	SNMP
CA Technologies (Cassatt)	CA DCIM	SNMP
CommScope	iTRACS	SNMP
Device 42	Device 42	SNMP
Emerson/Avocent	Trellis, N-Form, DS View, Rack Power Manager	SNMP
FieldView Solutions	FieldView	SNMP
Future Facilities	6Sigma	SNMP
HP Enterprise	Insight Dynamics and Insight Control	SNMP
IBM Active Energy Manager	Active Energy Manager (AEM/Plug-in to Tivoli	SNMP
JouleX (Cisco purchased in 2013)	Energy Manager	SNMP
Microsoft	Autopilot	SNMP
Miranda Technologies	iControl	SNMP
Modius	Open Data	SNMP
No Limits Software	RaMP	SNMP
OSI Soft	PI System	SNMP
Paessler	PRTG	SNMP
Panduit	Physical Infrastructure Manager (PIM)	SNMP
Power Analytics (formerly EDSA)	Paladin Live and Smart Grid	SNMP
Rackwise	RACKWISE DCiM X	SNMP
Sentilla (Ericsson)	Sentilla Energy Manager	SNMP
SolarWinds	SolarWinds	SNMP
Tier 44	EM/8	SNMP
Viridity	EnergyCenter	SNMP
Visual Data Center	Visual Data Center	SNMP

*SPM is required for API integration

Sentry Power Manager Application Programming Interface (API) Integration with DCIM/BMS Systems:

1) Well documented and installed at multiple locations connecting to a number of different systems BMS (Building Management System), DCIM (Data Center Infrastructure Management) and Large System Suppliers.
2) Standard XML based tools such as SOAP or REST.

Why you need SPM:

1) How will your technicians support a large number of PDUs? It does not make sense to do query or update via each individual PDUs IP address.
2) Based on an IP range, SPM will go out and discover all STI Rack Power Distribution Units (PDUs) and bring them into a central system for monitoring, management & control.
3) The SPM appliance can also act as the ftp server and the user can schedule automatic PDU firmware updates – saving a huge amount of time and money.
4) SPM can put PDUs into maintenance mode where SPM will ignore all faults and alarms during fault or other testing.
5) SPM provides one central location where specific PDU configuration parameters can be set or where the user can easily jump into the PDU's interface for other setup and configuration work.
6) API is the best way to deliver the large amounts of information provided by our POPS (Per Outlet Power Sensing) units to other systems versus trying to handle literally thousands of data points via SNMP.

Server Technology SNMP and API Integration Partners

Why you need SPM (cont.):

7) Specific power and environmental reports, trends, and predictive trending.
8) Email alerts and notifications of problems.
9) SNAP configuration tool helps to ensure plug and play operation by automatically setting key configuration items like network and system settings.

Reasons why you need a DCIM solution:

1) Provides the user the "single pane of glass" view they want within their data center.
2) Many DCIM systems can communicate with all of the other devices and systems within your facility including UPSs, floor PDUs, CRAC units and others.
3) You can input power and environmental information from the PDUs but not reinvent the wheel for discovery, inventory, configuration, upgrades and support of the STI PDUs which can all be done within SPM.
4) All of the other great things that these systems do but SPM doesn't.

Partner	System	Integration Type
Cormant	Cable Solve	API
CrestPoint Solutions	FM&E (Facility Management and Engineering)	API
FieldView Solutions	FieldView	API
Integrated Building Solutions	IBIS (Intelligent Building Information Systems)	API
Modlus	Open Data	API
Nlyte	Nlyte 7	API
No Limits Software	RaMP	API
RF Code	CenterScape v1.1	API
Siemens	WinPM.net	API
Spearhead	Spearhead	API
Splunk	Splunk Enterprise	API via App
Tier 44	EM/8	API
Trackit Solutions	Trackit Enterprise	API

*SPM is required for API integration

If you are interested in doing an SNMP or API integration with Server Technology's PDUs or SPM Software please contact support@servertech.com.

Additionally, PDUs or SPM systems can be posted via an IP address for your integration verification and testing.