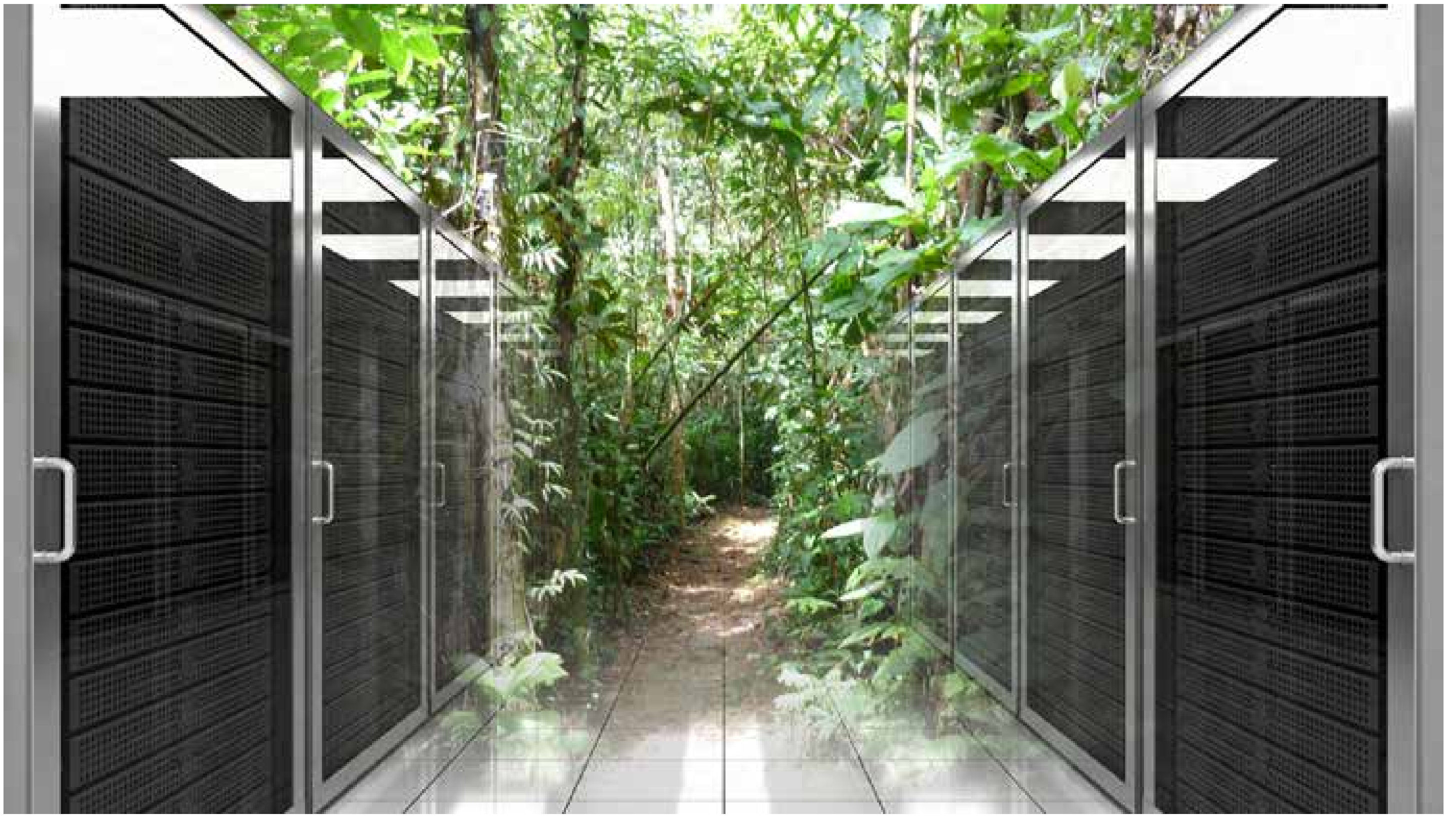
DECEMBER 2014
CS:14-09-A

NRDC's New York Data Center Upgrade:
Efficiency Case Study



DATA CENTER BUILD-OUT TEAM

ARCHITECT:
Croxton Collaborative Architects, PC

GENERAL CONTRACTOR:
ICS Builders

ENGINEER:
Goldman Copeland

TECHNOLOGY ENGINEERING AND DATA CENTER BUILDOUT:
Net Ascendance, LLC

IT INFRASTRUCTURE & DATA CENTER MANAGEMENT – LEAD PROJECT MANAGER:
Mike Martino, Net Ascendance, LLC

PROJECT MANAGERS:
Milly Suarez, NRDC Facilities
Rodrigo Jaramillo, NRDC IT

TABLE OF CONTENTS

About NRDC

The Natural Resources Defense Council (NRDC) is an international nonprofit environmental organization with more than 1.4 million members and online activists. Since 1970, our lawyers, scientists, and other environmental specialists have worked to protect the world's natural resources, public health, and the environment. NRDC has offices in New York City, Washington, D.C., Los Angeles, San Francisco, Chicago, Bozeman, MT, and Beijing. Visit us at www.nrdc.org and follow us on Twitter @NRDC.

NRDC Director of Communications: Lisa Benenson
NRDC Deputy Director of Communications: Lisa Goffredi
NRDC Policy Publications Director: Alex Kennaugh
Design and Production: www.suerossi.com

ORGANIZATION AND DATA CENTER BACKGROUND

The Natural Resources Defense Council (NRDC) is the nation's most effective environmental action group, combining the grassroots power of 1.4 million members and online activists with the courtroom clout and expertise of more than 350 lawyers, scientists, and other professionals.

In 2010, NRDC updated and expanded its antiquated data center. When planning the redesign, we took a holistic view of the space and the servers with the aim of creating the most functional and sustainable data center possible. This project required a cross-functional effort that drew on advanced technical, organizational, and business techniques to create a highly efficient data center. The resulting redesign lowered environmental impact and operational costs, and increased information technology (IT) agility and space for future growth.

With the November 2011 launch of our new, state-of-the-art data center at our New York City headquarters, NRDC further cemented our reputation as a sustainability leader among environmental groups. This data center allows NRDC to capture many benefits of a private cloud installation, such as resource sharing (e.g., email servers) across offices. It also creates a high level of security for sensitive information. Additionally, NRDC used virtualization and energy efficiency to improve IT efficiency. With this data center, NRDC hopes to set an example for other similarly sized and like-minded organizations as they plan for their own IT expansions.

PROJECT DRIVERS

Over the years, NRDC's success has increased staff size and our data center has had to keep pace. To match surges in staff growth over the years, the data center grew in a piecemeal, ad-hoc fashion.

NRDC's IT and Facilities teams brainstormed ways to upgrade technology and design an updated system that would meet NRDC's current and future demands. The team evaluated the data center's capacity and functionality; compared that with NRDC's expected needs; and concluded that the existing model for growth was unsustainable environmentally, financially, and logistically. Eventually the data center would reach its limit of available space and fail to support infrastructure.

While the initial driver for this initiative was to maximize IT efficiency to best meet increasing demand for capacity, technology improvements allowed us to address several environmental, office space, and future data center considerations. This initiative can serve as a model for other organizations coping with the need for increasingly powerful data centers while trying to minimize environmental and fiscal impacts.

IDENTIFY AND IMPLEMENT OPPORTUNITIES TO IMPROVE DATA CENTER EFFICIENCY AND RELIABILITY

IMPLEMENT COST AND SPACE SAVING OPPORTUNITIES

MEET SUSTAINABILITY GOALS TO IMPROVE ENERGY EFFICIENCY AND REDUCE GHG EMISSIONS OF NRDC

THE NEW DATA CENTER

A cross-departmental committee of NRDC Facilities and IT staff, external consultants, and equipment vendors determined that two elements were necessary to create a successful outcome for the data center project: the virtualization and consolidation of servers and storage and the development of a hot-aisle containment solution equipped with in-row cooling units.

Advances in computing power and efficiency have allowed for virtualization, which creates virtual servers without the physical hardware. Current central processing units (CPUs) are underutilized, leading to inefficiencies. Thus, virtual servers create higher server utilization and IT efficiency. NRDC's new data center is currently operating at 30KW n+1 (i.e., one level of redundancy). The center is flexible enough to be reconfigured from 10KW (n+1 or 2) to a maximum of 50KW n+0, by adding or removing simple slide-in power-supplies, as needed. This allows us to remove supplies (and conserve energy) as we more efficiently consolidate through virtualization, or add supplies to support sudden spurts of organizational growth between periods of reconsolidation—all without needing to reengineer our solution to accommodate these typical organizational lifecycle variations.

The new data center has 252U, "units", of rack space, which is easily expandable to 336U, (a flexible growth capacity of 33 percent that is easily installed via simple "bolt-on" and does not require any additional engineering or construction). In addition, battery run time is 26 minutes (expandable up to 75 minutes), and in-row cooling is variable from 3 to 9 tons in a system-wide n+1 configuration. All of this capacity was engineered down to a total area of 300 square feet. In comparison, our legacy data center, (a common design for many organizations) had only 176U of rack space, with no further growth possible, a battery run time of 5–10 minutes, and a total of 4 tons of cooling—a capacity we had exceeded

Fig 1. Legacy Data Center

Fig 2. Legacy Data Center

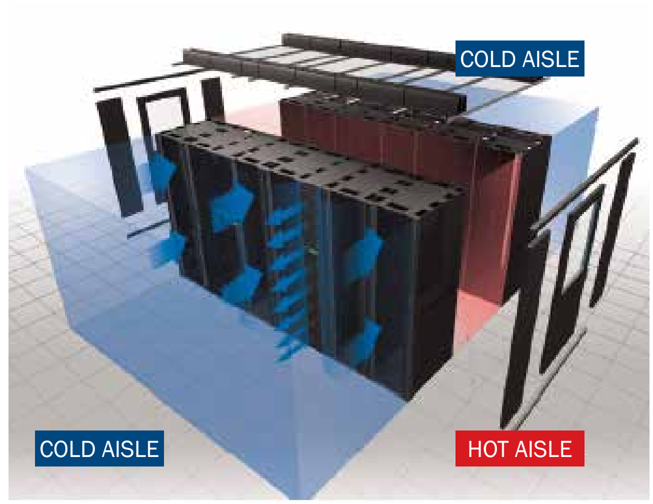


Fig 3. Hot Aisle Containment Design

and had to supplement with roll-in units during equipment outages and maintenance. This less efficient legacy data center also consumed 27 percent more office space at 415 square feet.

The virtualization of the legacy servers is currently ongoing and will be completed according to a three-year timeline established by NRDC.

Because the original data center never followed a planned design, new components were added as needed. This led to three major issues that addressed with the new data center:

- **Airflow:** mixing hot and cool air resulted in inefficient cooling, especially during hotter days.
- **Power:** the inadequate power supply could not support data center expansion.
- **Space:** office space was already at a premium and could not accommodate a sprawling data center.

DATA CENTER AT-A-GLANCE

300 Square Footage

Hot aisle design

30KW n+1 (1 layer of redundancy)

Expandable to 40KW n+1

252U's of rack space allowing for future expansion

26 minutes of battery back-up in the event of a power outage

The power and airflow issues increased the risk of downtime for the legacy data server, which threatened productivity and daily operations. Inadequate and improper cooling caused persistent HVAC system failures, causing the data center to overheat or shut down. The new data center is designed around the concept of "hot-aisle containment"and "in-row" cooling. This hot-aisle containment system separates hot and cold air; physically containing hot exhaust from the servers in a relatively small area, (and preventing the remixing of this hot air with the cooler, ambient, data center air). This contained hot air is then processed by a pair of cooling units (air-conditioners), which pull this warm air from the full-enclosed "hot aisle", remove the heat energy from the air, and recycle this, now cooled, air back into the data center—directly adjacent to the cooling intakes on the servers and storage systems. These in-row cooling units are configured to operate on an alternating basis for redundancy. In the event of a failure, the unit on stand-by automatically begins processing air in the hot-aisle, allowing for equipment repairs and general maintenance. The improved server room design enabled this greater efficiency in less space. In addition, the latest server technologies allow the new data center to operate at higher temperatures. The new design's efficiency is supported and improved through the best practice of selecting equipment equipped with thermally controlled variable speed fans.

Fig 4. NRDC's New Data Center

HOW MUCH MORE EFFICIENT IS THE NEW DATA CENTER?

Legacy Data Center: 2.09 PUE

New Data Center: 1.36 PUE

Power Usage Effectiveness (PUE) is a measure of how effectively energy is used by the data center to power and cool IT equipment.

OTHER KEY FEATURES

The new data center provides the following benefits and additional features:

- Virtualization freed up office space for other uses at NRDC's headquarters. The new data center has been equipped with four physical "host" servers, which support more than 45 "virtual machines" or servers—compared to the legacy center's 39 physical servers. Our virtualization plan projects that the final count will be well below 20 servers when the bulk of the consolidation is complete.
- Dense rack deployments, based on a consolidated set of server designs, balanced speed, power, cooling, cabling, and weight configurations for maximum speed, workload agility, and efficiency.
- Individual server models optimized for lower power consumption and the ability to vary the CPU clock frequency to closely profile power consumption with workload requirements.
- The data center was built to accommodate rapid deployment and rapid change at both rack and container levels. Thus, equipment can be replaced or upgraded in a matter of minutes with the potential to increase power and cooling without additional major construction.
- Modular and scalable design is also capable of handling 10 years of future technology upgrades, thus increasing agility and the facility's overall lifespan. The technology will be reviewed every five years.

We discussed cooling the data center by taking advantage of lower, three-season, outdoor air temperatures, but have postponed implementation of this "free-cooling" option due to some current in-ceiling constraints and the lack of ductwork. The data center design is capable of using free cooling and the issue will be revisited during the next retrofit of the larger office space.

OPERATING THE NEW DATA CENTER

The Facilities group has continually monitored energy use since the launch of the data center, using power usage effectiveness (PUE) as the primary metric. PUE contrasts how much power the computing equipment uses with the energy required for cooling and other overhead costs (such as lighting).

$$PUE = \frac{\textit{total facility power}}{\textit{IT equipment power}} = \frac{\textit{IT equipment energy} + \textit{facility overhead energy}}{\textit{IT equipment energy}}$$

PUE must be measured continuously over an extended period in order to be a useful metric of energy efficiency. Computing PUE at specific times revealed improved PUE in the new data center. In January and May 2012, the data center yielded 1.43 PUE and 1.36 PUE, respectively, compared to an average of 2.08 PUE for the legacy data server.

PUE shows the efficiency of the IT power usage in comparison to total power usage, but it does not provide hard data on actual power reduction. Data from November 2009 to December 2011 showed that the cooling units for the legacy data server used about 60,000 kWh/year. The new data center cooling units use 36,000 kWh/year—a reduction of approximately 40 percent.

Analysis revealed the primary energy efficiency measure, the hot/cold aisle containment system, increased the overall project cost by nearly $13,000, which NRDC covered through a ConEdison Efficiency Incentive Offer. Based on the average price of electricity in New York City, the reduction in kWh yields a yearly savings of approximately $4,500. Since the scope of this study was limited to energy efficiency gains, additional benefits of the project such as reduced footprint of the data center were not quantified in our cost savings analysis.

It is important to note that in our case the new data center came about before virtualization of the legacy systems. There were a number of factors for this, one of which was the complete lack of space to deploy any additional production equipment in support of our planned transition to a consolidated and heavily virtualized environment. Ideally, virtualization, and planning growth within a virtualized environment, should occur so that a new data center facility is scaled according to these technologies and not heavily overbuilt as is the typical rule with most data center designs. Planning for the impending virtualization we heavily contained our footprint, but we also did fully leverage and design the new enclosure and in-row cooling solutions to provide for future expansion capability should it truly be required. Finally, we are still continually improving the new data center. Weather stripping the hot aisle door and ceiling panels will further improve the separation of hot and cold air. Also, we could increase temperature for the hot aisle to lessen cooling needs. While energy efficiency has improved, it is not yet optimal. Going forward, we will take every opportunity to ensure continual improvements in energy efficiency.

CONCLUSION

To meet the present and future needs of NRDC, we created a highly efficient, scalable data center that improved environmental performance and freed space for other office needs. It serves as a model for other similar-sized organizations dealing with the same issues.

The new data center combines new technology with green IT best practices to greatly improve energy efficiency. The lowered PUE is a significant achievement. Monitoring the new data center's energy usage will allow us to continue to maximize energy efficiency. Additional energy efficiency gains and absolute energy use reduction can be achieved through design refinements, hot aisle temperature calibration, and decommissioning legacy servers. These next steps are expected to further reduce energy usage.

The new NRDC data center illustrates the many opportunities available to small- to mid-sized organizations as they seek to minimize their environmental impact and operational costs while maintaining a high performance level. Through careful planning and astute use of energy efficiency incentives, NRDC accomplished this with no additional costs.

Natural Resources Defense Council
40 West 20th Street
New York, NY 10011
212 727-2700
Fax 212 727-1773

Beijing

Chicago

Los Angeles

Bozeman

San Francisco

Washington, D.C.

www.nrdc.org

www.nrdc.org/energy
www.twitter.com/nrdcEnergy
www.twitter.com/nrdc
www.facebook.com/nrdc.org

Report Author and Data Center Energy Efficiency Analyst:
Closed Loop Advisors
www.closedloopadvisors.com

Printed on recycled paper