IT@Intel White Paper

Intel IT
DCIM
Data Centers
March 2014

Exploring DCIM for Intel's Data Centers

We have identified several best-known methods (BKMs) that set the stage for further DCIM investigation and solution deployment.

Ted Burdine
Disaster Recovery/Business Continuity and Data Center Security Project Manager, Intel IT

Ofer Lior
Data Center Operations Manager, Intel IT

Paul Vaccaro
Data Center Architect, Intel IT

Executive Overview

In the fall of 2012 Intel IT began exploring the potential benefits of data center infrastructure management (DCIM) solutions in Intel data centers. DCIM may potentially help us achieve cost savings through remote management of critical data center infrastructure and increased operational efficiency.

We conducted a DCIM proof of concept (PoC) that explored existing capabilities and the feasibility of deploying a DCIM solution. The PoC revealed that the effort required for deployment and the level of benefit associated with the solution made the returns less than what we had planned for. Consequently, we did not deploy the DCIM solution globally.

In parallel with the DCIM PoC, we conducted a PoC that evaluated Intel® Data Center Manager (Intel® DCM)—a power- and thermal-management solution. During this PoC, we worked with the Intel DCM product-development team to better align the product with our data center management needs. In 2014, we will conduct additional Intel DCM PoCs, and we are working to fund global deployment in the future.

Deploying a DCIM solution in an enterprise environment such as Intel's can be a significant challenge. The two PoCs helped us identify several best-known methods (BKMs) that set the stage for further DCIM investigation and solution deployment. These BKMs include the following:

- Conduct PoCs based on use cases. Establishing a formal requirements-engineering process and using elements of software-development methodology can help define the use cases. It is also important to focus on user experience as part of the methodology.
- Keep up to date with the rapidly evolving DCIM industry.
- Identify expected ROI, enterprise requirements, and stakeholders' needs. This includes understanding what is necessary for integrating the solution at the device level and with existing components of the data center environment.
- Use building management systems and RFID solutions to collect data to help measure energy consumption and demand at the most granular level.
- Develop plans and processes to effectively manage suppliers and develop partnerships.
- Develop training and support documentation during the PoCs.

As the industry matures, we will continue to stay informed about DCIM product capabilities, especially data modeling and analysis capabilities. We will also continue to test DCIM tools that provide core capabilities with the best business value. In the interim, Intel DCM provides foundational capabilities concerning power and cooling demand and consumption with a relatively low investment of time and effort.

Contents

IT@INTEL

The IT@Intel program connects IT professionals around the world with their peers inside our organization—sharing lessons learned, methods, and strategies. Our goal is simple: share Intel IT best practices that create business value and make IT a competitive advantage. Visit us today at www.intel.com/IT or contact your local Intel representative if you'd like to learn more.

BUSINESS CHALLENGE

Managing the operations of dozens of diverse data centers that support the global business goals of a large corporation such as Intel presents business challenges associated with operational efficiency. For example, it is not always easy to determine the optimal cooling level or to track which equipment is operating most efficiently. Data center infrastructure management (DCIM) can potentially help improve efficiency—but only if we surmount certain hurdles.

Integrating IT and Facilities Data

One of the main challenges of effective data center management at Intel is the successful merging of two distinct knowledge domains—IT and facilities.

- The IT knowledge domain concerns all aspects of service delivery and service support for IT equipment, such as servers, storage, and network equipment. IT is also responsible for planning tasks related to space, power, and cooling.
- The facilities knowledge domain concerns the management of power and cooling capacity and reliability. Understanding how additions, moves, and modifications to IT equipment impacts facilities infrastructure equipment is key to enabling operational efficiencies.

At Intel, separate organizations manage these two knowledge domains. Each organization has its own analysis tools and system of record (SOR) to manage their data. Currently, the information exchange between the two organizations is not efficient because each organization monitors their respective domains differently. Additionally, the separation of duties for control and response varies for each organization. We can improve the efficiency of Intel's data centers by closely managing the amount of power consumed and heat generated by IT equipment—which would require integrating server and network equipment data with facilities data related to power distribution and cooling systems.

A DCIM solution can create a holistic model of the data center by establishing new relationships and dependencies between data elements from disparate SORs in different knowledge domains. These relationships and dependencies can illustrate how IT-controlled assets are related to facilities-controlled assets.

However, Intel is not poised to reach this potential today because Intel's facilities environment is characterized by multiple supplier solutions, multiple generations of technology, and a lack of industry standardization. Also, our IT environment poses obstacles to data integration, including lack of standardization across configuration items (CIs)[1]; numerous monitoring points, protocols, and proprietary software packages; time-consuming manual collection of data to input into a DCIM solution; and CI data quality issues. In our experience, a significant amount of time and effort is required to collect the data necessary to create an accurate Intel data center model.

Maximizing ROI

Another challenge for Intel IT—as for any IT organization—is the need to do more with fewer resources. This reality creates pressure to manage critical infrastructure facilities remotely and to get the most ROI in the shortest amount of time.

Intel IT is looking for ways to focus investments on improving data center efficiencies. For example, we must accurately estimate the amount of required resources, and determine where those resources must be located, to efficiently manage a data center and its operations. However,

[1] Configuration items include IT equipment such as servers, power connections, circuit panels, and power sources.

constrained budgets force us to allocate funds to resources that trade off efficiency for quicker ROI. While DCIM has the potential to successfully integrate IT and facilities domains by providing a unified view of the data center, if the solution is difficult and time-consuming to deploy, the amount of effort associated with deployment could offset the benefits and reduce ROI.

Therefore, for DCIM to become a priority investment at Intel, it must be relatively easy to deploy and provide significant returns. Also, a chosen DCIM solution must provide the anticipated value.

Selecting the appropriate DCIM solution is a challenge in itself. The DCIM industry offers may options, and the overall capabilities of any given product may not provide a real benefit. For example, a supplier's product may calculate power usage based only on the manufacturer's nameplate power values or on worst-case power consumption numbers, which may not equal real-time power usage.

For DCIM to provide maximum ROI to Intel, we need to carefully analyze suppliers' offerings and determine the ways they will integrate with our data center environment and whether they will scale over time.

WHAT INTEL IT HAS LEARNED ABOUT DCIM AND INTEL® DATA CENTER MANAGER

Since the fall of 2012, Intel IT has been exploring the best way to merge the IT and facility knowledge domains. Concurrently, we explored DCIM and tested Intel® Data Center Manager (Intel® DCM)[2]. During this time, we have learned not only about the benefits and shortfalls of DCIM and Intel DCM, but we also learned about our own processes and solution requirements.

As described in the "Business Challenge" section, a DCIM solution is needed at Intel. However, the DCIM industry, although rapidly evolving, is currently immature and there are many diverse solution providers to choose from. We have identified six best-known methods (BKMs) during our investigation, which included a thorough industry survey and proofs of concept (PoCs) based on use cases.

Best-Known Methods

The following BKMs are a direct result of our PoCs based on use cases. Before we conducted the PoCs (described in detail later), we did not have a complete understanding of the DCIM industry and the way it would affect our business processes. Also, we did not fully comprehend all the benefits Intel DCM could offer.

BKM #1: CONDUCT PROOFS OF CONCEPT BASED ON USE CASES

When we performed a survey of the DCIM industry with the goal of choosing a DCIM solution, we crafted a request for proposal (RFP) and distributed it to several suppliers. We based the RFP on product claims and descriptions from the suppliers themselves. We discovered that we needed to do more; the PoCs revealed limitations of the DCIM solution that we were unaware of as well as enterprise requirements that we had not considered. What we learned during the PoCs will enable us to ask more informed questions about DCIM solutions in the future.

During the RFP process and PoCs, we discovered two important issues we need to understand more about before deciding on a long-term solution.

Intel® Data Center Manager

Intel® Data Center Manager (Intel® DCM) is a standalone power management solution for the data center. Intel DCM provides accurate, real-time power and thermal monitoring and management for individual servers, groups of servers, racks, and IT equipment such as power distribution units. Intel DCM provides benefits for both IT and facility administrators, enabling these groups to collaborate to reduce the data center energy footprint.

For more information about Intel DCM, visit http://software.intel.com/sites/datacentermanager

[2] This software is subject to the U.S. Export Administration Regulations and other U.S. law and may not be exported or re-exported to certain countries (Burma, Cuba, Iran, North Korea, Sudan, and Syria) or to persons or entities prohibited from receiving U.S. exports (including Denied Parties, Specially Designated Nationals, and entities on the Bureau of Export Administration Entity List or involved with missile technology or nuclear, chemical, or biological weapons).

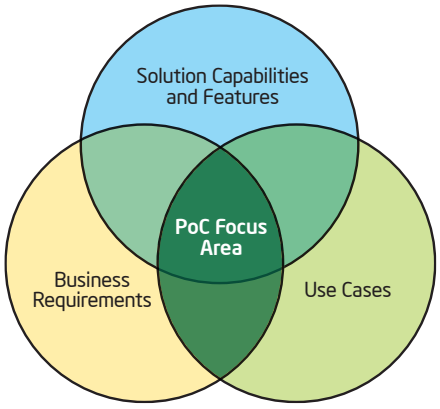

Figure 1. Our proofs of concept focused on the intersection of business requirements, use cases, and solution capabilities and features.

Use a Software-Development Methodology

We established a formal requirements-engineering process to guide our PoCs. As part of this process, we followed a software-development methodology centered on use case development. This was key to the success of our PoCs. The software-development methodology helped us define use cases for the new software. This approach presented several benefits:

- It clarified how a DCIM solution would be used in the Intel data center environment
- It enabled us to better understand DCIM solution features
- It helped us codify business processes and requirements as they relate to DCIM

As shown in Figure 1, a better understanding of the business requirements, use cases in Intel's data center environment, and the DCIM solution's capabilities and features will enable us to choose a DCIM solution in the future that balances all three perspectives, and helps us prioritize product capabilities. This will help us identify and focus on what is most important to the enterprise and what problems we are trying to solve.

Focus on the User Experience

Understanding how a product is used is essential for planning and designing activities, and user experience is an important part of product differentiation and innovation. Therefore, our PoCs attempted to capture supporting data, overview information, and usage details to better describe product usage and identify products that meet the end users' real needs and desires.

BKM #2: KEEP UP TO DATE WITH THE RAPIDLY EVOLVING DCIM INDUSTRY

The DCIM industry is changing rapidly. We have found it challenging to evaluate all the supplier offerings and determine which one is the best solution for Intel's data center environment. The product evaluation process is further complicated by the fact that different suppliers' products have specific capabilities that may be better than products from other suppliers; however, that same product may not be superior overall. We need to understand the entire broad scope of DCIM capabilities as well as the more detailed aspects of that scope on which each supplier focuses. Staying aware of industry developments helps identify recent advances and remaining challenges.

We also must understand and establish our own goals and priorities as they relate to DCIM and concentrate on those first, incrementally adding capabilities when they provide value from a business perspective. We are prepared to use multiple suppliers to meet our DCIM requirements or possibly form a strategic alliance with a supplier to help develop the capabilities we need.

BKM #3: IDENTIFY EXPECTED ROI AND INTEGRATION EFFORT

When we started the DCIM PoC, we established an expected ROI and balanced decisions against this starting-point analysis. We then developed an understanding of how a DCIM solution would integrate into our data center. This was a significant challenge because the environment is so complex. Environment components include existing in-house tools, workflows, RFID solutions, SORs, a configuration management database (CMDB), an information service management platform (ISMP), an asset database, and processes. Any integration efforts also needed to incorporate data quality efforts.

BKM #4: MEASURE ENERGY CONSUMPTION AND DEMAND AT THE MOST GRANULAR LEVEL

IT equipment creates power and cooling demand in a data center. Knowing the power consumption of the entire facility is not as useful as knowing exactly how much power each server draws and being able to scale the measurement at any level required (such as by rack or by room). The most efficient way to manage the data center and to distribute the power and cooling most efficiently is to measure consumption and demand at

the most granular level possible. Smart infrastructures, such as building management systems and RFID solutions, can provide some of this data. Intel IT is taking advantage of investments previously made in such systems.

However, smart infrastructure does not provide device-level data, such as that provided by servers equipped with power- and thermal-aware scheduling (PTAS) functionality. PTAS functionality provides power, thermal, and usage information out-of-band (OOB). This data can be used in many use cases, ranging from data center planning to facilities actions such as monitoring, alerting, and control. We believe that deploying servers with PTAS functionality can provide long-term cost savings. The data provided by servers with PTAS is more timely and involves much less effort compared to manually modeling data center operations using computational fluid dynamics (CFD). Another advantage is this data can be collected and then entered into a CFD modeling tool for an improved, more timely, and more efficient method of modeling.

Based on our ROI analysis of PTAS functionality, we plan to deploy equipment manageability updates on multiprocessor platforms starting in 2014 and use the data in the following data center activities:

- Advanced real-time monitoring and reporting for planning
- Intelligent facilities actions for airflow and cooling optimization
- PTAS functionality for increased data center optimization
- Stranded capacity recovery and asset deployment optimization

BKM #5: DEVELOP PROCESSES TO EFFECTIVELY MANAGE SUPPLIERS

We have found it useful, both for generating business value and for guiding the DCIM industry toward maturity, to actively engage with suppliers. During and after our DCIM PoC (see later section), we provided feedback about the product and our experiences.

Spending time with the supplier to explain our software-development methodology and enterprise requirements that were based on use cases helped them to more quickly deliver capabilities that match those requirements.

Here are some of the enterprise requirements that we shared with the supplier during our DCIM PoC:

- Simplified asset data collection and modeling
- Power, cooling, space reporting, and trending data—in particular, the presentation of data at the rack, row, and facility levels; user-defined regional levels; or user-defined line-of-business segment levels
- Electrical distribution data collection, load calculation and reporting, tiered levels of detail, presentation layer, and modeling
- Product training and support documentation including release notes, automated install scripts, software release tracking and planning, how-to documentation, and a roadmap for new releases and capabilities
- A mature release management process
- New feature tracking and reporting

We also provided the supplier with information they can use for estimating the level of effort required to integrate the solution with CIs, using actual metrics such as hours per CI, as opposed to industry-recommended hours per square foot. These more tangible metrics closely reflect the varying densities of Intel's data centers; for example, newer facilities tend to be more densely populated than legacy facilities. We believe that actual metrics are the best way to scope level of effort for deploying a DCIM solution or a specific DCIM capability.

Concurrently, our collaboration with the Intel product group also helped to improve the Intel DCM (see "Partnering with the Business" on the next page).

A DCIM Solution Is Only Useful If It Is Used

If data center infrastructure management (DCIM) systems do not deliver the business value promised, there is little chance that they will be used. Organizations must also be prepared to evolve their management functions to accommodate the new real-time monitoring capabilities.

- Even if the DCIM solution maps the data center environment perfectly, if it lacks the capability to perform real-time monitoring on the environment, it will probably not be used on a daily basis. Without real-time sensors (such as those provided by a building management system), RFID solutions, and intelligent IT servers, real-time data is difficult to obtain.
- If an organization implements a DCIM solution but fails to modify management functions, such as asset management and planning based on real-time monitoring, they may neglect to use the DCIM solution because the data it produces is essentially irrelevant.
- During deployment of the DCIM, if an organization discovers flaws in its systems, databases, or workflows, it is important to address these issues, including appropriate communication with IT and facility management and stakeholders. Otherwise, the DCIM solution could be rendered less valuable, or may be perceived as more effort than it is worth.

Intel IT is focusing on the following items to realize the benefits of a DCIM solution:

- Working with DCIM solution providers to properly embed the solution in the data center management processes.
- Deploying the DCIM solution in a modular fashion to impose less risk on the organization—starting with solving specific pain points and prioritizing them.
- Understanding that the value of DCIM does not come only from capacity management, but also from real-time data that can be used for incident management, asset management, problem management, and more.

Partnering with the Business

Intel IT has been working to collaborate more effectively with Intel's business units. As part of this effort, when we initiated a proof of concept (PoC) to evaluate Intel® Data Center Manager (Intel® DCM), we established a unique and beneficial relationship with the product-development team.

> "We looked at this as a partnership from the beginning," said Ofer Lior, Data Center Operations Manager. "It wasn't me finding the downside of the product; it was us working together to get the best product we can with the best impact on the data center."

During the PoC, Intel IT provided the product-development team with actual insight into how data centers are managed and into the operational processes of other potential customers. For example, we emphasized the importance of full monitoring coverage of devices in the data center, the importance of a visual representation of the data center's physical layout, and the usefulness of a scriptable command-line interface. The product team quickly developed solutions to some of the capability gaps we identified during the PoC.

> "The fact that Ofer was using the tool on a daily basis to manage production data centers, and continuously provided feedback on the tool, helped me understand the product strengths and gaps, and prioritize the product roadmap," said Dror Shenkar, Intel DCM Chief Architect, "because Ofer's needs are representative of industry-wide data center managers."

Ofer and Dror agree that communicating the benefits and expected outcome of the partnership to both groups' management teams has contributed to the success of their relationship.

> "We focused on how this will help both organizations," said Ofer. "We made a business justification for the partnership."
>
> "We presented the partnership to management as win-win," added Dror. "It's an opportunity to learn from Ofer, and for Ofer to learn from us."

Dror presented the Intel DCM product to Ofer. Then Ofer gave Dror a tour of the data center. Once the product was installed, the two groups held weekly meetings to discussed bugs, opportunities, new requirements, and future steps. Once a month, they held a longer, four- to five-hour meeting dedicated to reviewing and scrubbing data, such as data that wasn't synchronizing well. The meetings, said Ofer, were kept as small as possible—usually just him, Dror, the system engineer, and subject matter experts when necessary (such as a network specialist).

Another aspect of the partnership involved Intel IT subject matter experts participating in Intel DCM sales meetings. These experts had significant experience in implementing and using the product and could intelligently and cogently discuss actual use cases for the product with potential customers. This discussion, combined with a physical tour of a data center where Intel DCM was implemented, had a positive impact on customers' perspective of the product and emphasized the fact that Intel uses its own products to support and monitor internal infrastructure.

> "Ofer is part of our team now," said Dror. "This is a project that we are jointly approaching, and everyone benefits from it."

This partnership is ongoing; IT and the Intel DCM product-development team plan to continue to work together to deliver a better product to the market with features that support actual data center operational needs and provide IT with a highly capable data center management tool.

> "It's the right thing to do for Intel," said Ofer. "We both realized that. It's not just the right thing for me or for Dror—it's the right thing for the business."

BKM #6: DEVELOP TRAINING AND SUPPORT DOCUMENTATION DURING PROOFS OF CONCEPT

During our PoCs, we worked with the supplier to make sure training documentation was available, then developed internal components that were specific to Intel. Developing this sort of documentation required us to understand how the new tool would affect business processes and to standardize and document business processes and workflows. If we had decided to deploy the DCIM solution immediately after the PoCs, we could have used this documentation to speed integration and adoption. Because we eventually plan on deploying one or more DCIM solutions, we expect to take advantage of the documentation and process workflow efforts we have already done.

We believe the effort associated with documenting a DCIM solution should not be underestimated. Therefore, it is important for the supplier to provide quality documentation and training materials that complement a DCIM solution.

Proofs of Concept

Starting in 2012 and finishing up in 2013, Intel IT conducted two PoCs relating to DCIM. One PoC focused on the use cases surrounding a full-featured DCIM solution. The other PoC focused on exploring the use cases and benefits of Intel DCM. Both PoCs involved multiple Intel data centers and each lasted several months. The following sections provide details about each PoC's methodology, key learnings, and results.

The two PoCs provided substantial practical experience with industry DCIM offerings. We have shared our experiences and been successful in gaining additional resources and support from our engineering team to help us further define our requirements and analyze our data center management tools. We continue to use several off-the-shelf products and in-house tools for managing facility, data center, and IT equipment operations. But our long-term objective is to explore optimal ways to integrate these solutions into a common dashboard for a holistic view of data center health and equipment workloads. This type of integration can potentially reduce costs as well as add significant data center management capabilities and can foster closer working relationships between business groups at Intel.

DCIM PROOF OF CONCEPT

After sending an RFP to seven DCIM solution providers, we reviewed and graded their responses based on our understanding of Intel's DCIM requirements at the time. Based on the results of this evaluation, we selected a DCIM solution to explore.

Methodology

We conducted a six-site PoC to test the product's capabilities and to understand what was involved in building a software model of Intel's data center. The data centers represented a total of 23,000 CIs. Each CI represented a data element that had to be collected, imported, and modeled. Some of this data could be collected using automated tools; however, a substantial amount of the data had to be collected manually.

As shown in Table 1, five subteams helped evaluate the DCIM solution. The goal for each of these subteams was to evaluate the product and report on the level of product readiness against a set of defined grading

Table 1. DCIM Proof of Concept Subteams

Subteam	Scope of Investigation
Capacity Planning	Evaluate how well the DCIM solution aligns with our existing processes and tools for capacity planning. ▪ Does the tool offer improved data quality for consumption? ▪ Does the tool offer potential efficiency improvements to deliver long-range planning (LRP) reporting in less time or more frequently over what exists today?
Operations	Evaluate product readiness and the value added to our equipment landing decision support process. ▪ Does the tool have the ability to provide a reservation system for allocated space? ▪ Can the tool support facility audits?
Data Collection	Evaluate how well the data definitions, data collection, software modeling, data-collection workflows, and processes used during the PoC worked. ▪ What long-term improvements are required for a global deployment? ▪ Does the product enable users to capture data and model solutions?
Facilities Management	Evaluate the product for floor loading, space, power, cooling reporting, and management at the rack, row, and facility level. ▪ Does the product include capabilities for modeling and managing facility-to-device electrical distribution and capacity? ▪ What standard communications protocols and supplier devices are supported, and what tools or utilities are provided for modeling a proprietary device? ▪ Does the product enable users to model single points of failures, and/or to perform what-if analysis for analyzing downtime?
Product Management	Evaluate the product, services, and user experience against defined criteria and strategic objectives. ▪ What training materials are available from the supplier? ▪ Does the supplier have a mature release management process that covers bug fixes, extra support for show stoppers, feature requests, requirements management, and product roadmap? ▪ Does the product meet minimum standards for user acceptance and performance?

criteria created by the subteams. If a subteam identified gaps between product capabilities and enterprise requirements, they made recommendations for improvements and an estimate of how much effort would be required to achieve the desired results. We used the subteams' responses to reach a deployment decision.

At the beginning of the PoC, we calculated estimated ROI figures associated with DCIM, so that after the PoC was complete, we could determine if the product's ROI was sufficient to warrant global deployment. We estimated that DCIM could reduce our operational budget by USD 2.24 million over the five years after deployment. These savings include staff productivity gains and cost avoidance. We anticipated that we would also gain significant business value from process improvements, standardization, and automation.

Key Learnings

The DCIM PoC taught us a lot about what we need to do to prepare for deploying a DCIM solution. The PoC revealed limitations in both the evaluated product and in our own processes. We learned about some strengths, as well.

Overall, the PoC demonstrated that the business value we originally estimated was not achievable with the product in its current form when combined with our current processes. The product's feature set was not as mature as we expected. Also, we discovered that integrating the product with our ISMP and CMDB requires a significant amount of effort and manual data entry. Without this integration, however, the opportunity for improved efficiency would be compromised.

These examples demonstrate the product limitations that were exposed by the PoC:

- Our current in-house tools do not easily adapt to the data-collection techniques and data elements that an off-the-shelf DCIM solution uses. The DCIM solution we evaluated was not sufficient in the areas of data analytics and the ability to aggregate and model data for capacity planning.
- The product's base capabilities provided only partial expected value in the following areas:
  - Equipment landing and decision improvements for local and remote facilities
  - Power distribution modeling, including dependencies and relationships between power distribution and IT equipment
  - Facility modeling and sustaining support
  - Data reporting engine

Some of the challenges we identified during the PoC were not product-related, but rather reflected issues at the system and workflow levels.

System level—Some of our IT equipment and facility monitoring devices, such as temperature and humidity probes, pressure sensors, and smart uninterrupted power systems, may not support standard data protocols and data display capabilities.

Workflow level—Because the IT and facilities knowledge domains use separate databases—the CMDB and the ISMP, respectively—one must serve as the SOR, and the other must synchronize with it. If a conflict arises during the synchronization process, there must be a method for resolving the conflict and choosing which version of the data is correct. Therefore, data quality and consistency between ISMP and CMDB data elements and data transactions are important areas of concentration. Integration of the DCIM data elements with our CMDB asset data was another problem area.

On the positive side, although the product did not provide enough benefit to warrant global deployment, by the end of the PoC, we had delivered a product that our data center operations managers could use:

- We worked with the supplier to develop a stable product that meets our performance and usability requirements. We informed the supplier about our enterprise requirements and eliminated a number of show-stopper bugs.
- We helped the supplier implement a robust process for release management and support that will help us maintain the product as new releases are available from the supplier.
- We learned how to gather and collect the necessary data, model the facilities, and support the platform.

These factors will become long-term benefits as we continue to look for future DCIM solutions.

Results

Based on the subteams' recommendations for the DCIM PoC, we identified two main challenges:

- The amount of time and effort associated with data collection and modeling was too labor-intensive.
- The product's features and capabilities did not provide the benefit and value we had expected.

Therefore, we decided to postpone deployment of DCIM, continue PoC testing and supplier engagement, and reevaluate our long-term strategy. We still are working with the supplier, providing them with feedback, and we may deploy DCIM solutions or capabilities from this supplier in the future.

Other significant benefits stemming from the PoC include the following items:

- We developed a standard method and repository for rack-level circuit data as well as standard naming conventions and an accurate inventory of facilities assets.
- We created a wiki repository for DCIM-related topics, such as how-to documents about data collection.
- We documented a standard global process for deploying and using a DCIM solution.

INTEL® DATA CENTER MANAGER (INTEL® DCM) PROOF OF CONCEPT

In parallel with the DCIM PoC, another set of Intel data centers conducted a PoC of Intel DCM. Although Intel DCM is not a full-featured DCIM solution, our PoC revealed that it does offer significant benefits for data center infrastructure management.

Initially, we investigated Intel DCM because it appeared to be a tool that could provide significant manageability information that could help us understand the power consumption of the facility. But as the PoC progressed, we understood there were other benefits to the product. Intel DCM provides a mapping of the data center's power consumption and thermal information, and it can aggregate this data in a single facility-management console. Figure 2 displays the summary view that is available through the Intel DCM management console. This summary view provides a snapshot of a data center's power and thermal conditions.

Methodology

The Intel DCM[3] PoC was conducted at six data centers in Israel and one in Russia (and was later extended to a data center in Ireland). We connected Intel DCM to the data center servers. By extracting power and thermal data from the servers, we created a real-time view of power consumed by the servers, aggregated to the rack, row, and room. We also obtained thermal maps of the data center using inlet temperature data collected by Intel DCM from all the servers.

We extracted the server name, location (rack), OOB IP address, and password from an existing database and uploaded the data to Intel DCM. The data mining took about two working days, and the first deployment of the whole system to monitor about 4,000 assets required three engineers to spend a total of nearly 100 hours—significantly less than the effort involved in deploying a complete DCIM solution.

[3] Although Intel® Data Center Manager is an Intel product, Intel IT received no discount on the product, and we followed our normal IT testing and approval processes.

Key Learnings

The Intel DCM PoC helped us identify several additional use cases for Intel DCM at Intel data centers. Long-term business value through better data center planning and manageability can be provided by the following use cases:

- **Server power characteristics.** Having access to real-time data from a large sample of homogeneous servers and analyzing these servers' actual power consumption enabled us to understand the actual available future capacity a data center would be able to support. In our opinion, this is one of the most powerful capabilities in Intel DCM because it enables the data center manager to rely on actual data validated by the tool and not on industry estimations or nameplate numbers.

Figure 2. The summary view from the Intel® Data Center Manager (Intel® DCM) management console provides a snapshot of a data center's power and thermal conditions. The Intel DCM provides actual validated data rather than industry estimations or nameplate numbers.

- **Data center thermal map and cooling analysis.** The large number of temperature sensors made available by Intel DCM allows the creation of a thermal map, enabling the data center manager to determine whether the room is properly cooled. During the PoC, we discovered that Intel DCM's cooling analysis is extremely accurate. It indicated that one of the data centers had a cooling adjustment that aligned with the room's low power usage effectiveness (PUE) of 1.37; another data center was overcooled, appropriately aligning with its less efficient PUE of 1.68.
- **Detection of hot spots.** Intel DCM's cooling analysis function alerted the data center manager to hot spots in one of the data centers—the alerts came from several servers located in the same row but in different racks, and they seemed to indicate a cooling issue in that area. However, further investigation showed this anomaly was caused by malfunctioning temperature sensors in a specific server model. Such automated hot-spot analysis, with real-time data, is far more efficient and effective than a manual CFD analysis.
- **Discovery of ghost and underused servers.** Intel DCM automatically identifies servers that are working in very low usage or in idle mode. These devices are good candidates for migration into virtual servers and have a potential for both power saving and reuse of unused assets.
- **Real-time data and rack usage management.** Intel DCM provides real-time power usage data that enables energy optimization. Data center managers can use this data to make informed decisions on load balancing and right-sizing IT environments to lower TCO. Intel DCM also enables circuit protection through the use of user-defined alarms that warn of potential circuit overloads before critical IT failures occur. Because Intel DCM is easy to implement, integrate, administer, and operate, these features provide ROI in a short amount of time.

The Intel DCM PoC identified the following limitations and challenges. Some of these were addressed in the PoC; but others can help improve products and processes in the future:

- Current inability to consistently report data associated with storage and network devices.
- Lack of support for several proprietary types of devices and older devices that do not have built-in silicon capabilities to provide the necessary data through the Intelligent Platform Management Interface (IPMI) protocol.
- Security issues at both the network and the domain levels:
  - Difficulty communicating within and across networks and firewalls, which were resolved within the first 100 hours of deployment.
  - Lack of flexible security access levels, beyond just admin and view.
- Lack of a scriptable command-line interface, which would give us the ability to customize data collection and action based on certain conditions. Based on our feedback, the latest version of Intel DCM now includes a scriptable command-line interface.
- Less-than-ideal scalability in the areas of performance and user experience.
- Lack of a visual representation of the physical layout of the data center, which could help data center and facilities managers manage placement of IT equipment, make informed capacity management decisions, and keep accurate track of data center assets during any relocation, colocation, or consolidation project.

We also learned that we need to work closely with data center hosting customers to obtain their support and administration rights on monitored servers.

Results

At the end of the Intel DCM PoC, we were monitoring—and continue to do so—about 4,000 CIs spread across eight data centers with a total power consumption of more than 1 MW. In one of these data centers, we can monitor more than 70 percent of the data center power consumption.

As an example of the tangible benefits Intel DCM offers, we used the data gathered by Intel DCM to manage a data center facility incident. In this case, the cold water supply to the facility was compromised. Fortunately, the Intel DCM management console enabled the operations manager to act quickly and prevent damage to the IT equipment in the room.

Based on the success of the initial PoC, we are extending the project to data centers in Ireland and the United States. We also plan to deploy Intel DCM globally. While it is true that Intel DCM is not a complete DCIM solution, we believe that it can provide significant business value and the ability to manage IT overhead and power consumption without a lot of expensive extra effort. In addition, Intel DCM can serve as a foundational platform for additional DCIM tools and capabilities in the future.

PROOF-OF-CONCEPT COMPARISON

Simply comparing the time it took to deploy the DCIM solution during its PoC to the time it took to deploy Intel DCM is not the best way to compare the two solutions. It is more useful to compare the hours per CI each deployment took. In summary, the DCIM PoC represented far more CIs and a larger scope than the Intel DCM PoC.

During the Intel DCM PoC, the product was deployed across 3,600 servers plus other CIs, such as blade centers, racks, and power distribution units, for a total of approximately 4,000 CIs consuming a total of about 1 MW of electrical load. The DCIM PoC covered approximately 23,000 CIs and a total of about 5.5 MW of electrical load:

- 9,710 power-connection CIs
- 9,019 IT servers
- 738 circuit panels
- 3,171 electrical devices and circuits
- 16 power feeds

The electrical load and total number of CIs used in the DCIM PoC was 6.5x greater compared to the Intel DCM PoC. Also, the additional complexity involved with the DCIM PoC required it to take 8x longer to implement than the Intel DCM.

The DCIM PoC also required additional time to help the supplier stabilize the product and develop improved data-collection tools. These tools reduced the overall effort by eliminating challenges with data entry and formatting. These tools also improved our ability to integrate with our SOR, ISMP, and CMDB. However, none of these complexities arose with the Intel DCM PoC because Intel DCM is a standalone product, not a full-featured and integrated DCIM solution.

Ultimately, despite its merits, the DCIM solution required significantly more effort to warrant a reliable and efficient enterprise deployment. Additionally, it did not deliver the ROI we expected. As a result, we decided not to deploy it across the enterprise. By contrast, Intel DCM required less integration and customization in order to be measured as an enterprise-capable deployment with a tangible ROI.

CONCLUSION

Intel IT has been investigating the possibility of reducing data center costs across the enterprise by using a DCIM solution. We seek a solution that enables us to manage critical data center infrastructure remotely and that increases operational efficiency. In 2012-2013, we conducted two PoCs—one evaluating a complete DCIM solution and one evaluating Intel DCM. These PoCs helped us identify several BKMs that set the stage for further investigation and solution deployment.

These BKMs include the following:

- Conduct PoCs based on use cases. Establishing a formal requirements-engineering process and using elements of software-development methodology can help define the use cases. It is also important to focus on user experience as part of the methodology.
- Keep up to date with the rapidly evolving DCIM industry.
- Identify expected ROI, enterprise requirements, and stakeholders' needs. This includes understanding what is necessary for integrating the solution at the device level and with existing components of the data center environment.
- Use building management systems and RFID solutions to collect data to help measure energy consumption and demand at the most granular level.
- Develop plans and processes to effectively manage suppliers and develop partnerships.
- Develop training and support documentation during the PoCs.

During the DCIM PoC, we discovered that the product we chose to evaluate was not yet mature enough to provide the full expected business value. We also gained a better understanding of the time and effort involved in deploying a DCIM solution and learned that some of our internal processes need to be improved. Meanwhile, the Intel DCM PoC proved that this data center monitoring product is comparatively easy to implement and provides good monitoring ability with access to real-time data. We continue to work with the product-development team to better align product capabilities with Intel's data center operational needs, and we are working to fund global deployment in the future. Intel DCM will complement any further DCIM solutions we deploy.

Intel IT will continue to analyze DCIM offerings as the industry matures, as well as work with suppliers to guide them in meeting enterprise DCIM needs. In particular, we will stay informed about the data modeling and analysis capabilities of various products, as this is one area most in need of development. As appropriate, we will deploy DCIM tools that provide core capabilities with the best business value.

RELATED INFORMATION

Visit www.intel.com/IT to find content on related topics:

- "Improving Business Continuity with Data Center Capacity Planning"
- "Intel IT's Data Center Strategy for Business Transformation"
- "Facilities Design for High-density Data Centers"
- "Data Center Energy Efficiency with Intel® Power Management Technologies"
- "Using Intel® Intelligent Power Node Manager and Intel® Data Center Manager"
- "Using Lean Six Sigma* and Systemic Innovation in Mature Data Centers"

CONTRIBUTORS

Tom Greenbaum
Data Center Operations Manager
Intel IT

Dror Shenkar
Intel® Data Center Manager Chief Architect
Data Center Group

Tom Wick
Data Center Operations Manager
Intel IT

ACRONYMS

BKM	best-known method
CFD	computational fluid dynamics
CI	configuration item
CMDB	configuration management database
DCIM	data center infrastructure management
Intel® DCM	Intel® Data Center Manager
IPMI	Intelligent Platform Management Interface
ISMP	information service management platform
LRP	long-range planning
OOB	out-of-band
PoC	proof of concept
PTAS	power- and thermal-aware scheduling
PUE	power usage effectiveness
RFP	request for proposal
SOR	system of record

For more information on Intel IT best practices, visit www.intel.com/IT.

Printed in USA ♻ Please Recycle 0314/WWES/KC/PDF 329832-001US

Look Inside.™