Supporting Application Growth and Diversity with Simplified and Optimized IT Infrastructure

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Introduction

This ESG Validation report documents our evaluation of the Cisco UCS X-Series Modular System, with a goal of verifying how Cisco’s latest release can consolidate and manage a growing number and diversity of workloads and applications. We reviewed how the Cisco UCS X-Series can help organizations to simplify hardware upgrades, increase operational efficiency, and minimize overall IT infrastructure within the data center.

Background

ESG research recently uncovered that 79% of respondents believe that their IT environments are equally, if not more, complex than they were two years ago (see Figure 1). 33% of respondents attributed this persistent complexity to the increase in the number and type of applications employees are using. This is no surprise, as 51% of respondents support between 250 and 999 applications.¹

Figure 1. State of Complexity in IT Environments

In general, how complex is your organization’s IT environment relative to two years ago? (Percent of respondents)

<table>
<thead>
<tr>
<th>Description</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
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</tr>
<tr>
<td>Equally complex as two years ago</td>
<td>33%</td>
</tr>
<tr>
<td>Less complex than two years ago</td>
<td>15%</td>
</tr>
<tr>
<td>Significantly less complex</td>
<td>6%</td>
</tr>
</tbody>
</table>

Source: ESG, a division of TechTarget, Inc.

Only a few years ago, organizations had been focused on optimizing IT infrastructure to support multiple traditional enterprise workloads, specifically related to database, virtual desktop infrastructure (VDI), and email. Now, not only has the number of traditional enterprise applications grown, but organizations are also deploying modern workloads, such as artificial intelligence (AI), machine learning (ML), big data analytics, and accelerated VDI rendering.

This application diversity results in disjointed infrastructure, as organizations deploy islands of IT infrastructure optimized for individual workload types. While converged infrastructure (CI) enabled organizations to consolidate traditional enterprise applications, modern workloads requiring unique capabilities, such as GPU processing, high capacity local storage, or increased network bandwidth have been deployed in separate rack servers. As these workloads scale and require more resources, organizations need to either add more GPUs, storage, or network interfaces to existing servers (if allowed) or add more servers. In either case, organizations face added capital and operational expenses to manage these emerging IT infrastructure silos.

Complicating the deployment of new IT infrastructure to support any workload today is the continued adoption of public cloud services. As organizations host workloads in the public cloud, groups such as DevOps and line-of-business (LoB) owners are pressuring IT to be as flexible and scalable in deploying compute, networking, and storage resources on

premises as quickly as it can be done in the public cloud. In fact, 35% of ESG research respondents stated that their organizations have to move between 25% and 49% faster than they did three years ago to deploy applications, infrastructure, and services, while 31% see the need to move between 50% and 100% faster than three years ago.²

Cisco UCS X-Series

Cisco UCS X-Series powered by Intersight is a modular system managed from the cloud or an on-premises appliance. The system has been designed to support both traditional enterprise and modern workloads running in a hybrid cloud environment using a unified form factor, eliminating the need for multiple IT silos as the number and diversity of applications increase. The architecture of Cisco UCS X-Series enables organizations to scale infrastructure and leverage new technologies (such as increases in GPU processing power) without performing any standalone upgrades of compute and networking resources. The ability to support multiple CPU and GPU-based workloads helps organizations to increase operational efficiency and agility while minimizing current and future capital and operational expenses.

All server nodes, accelerators, and networking resources are offered as individual modules. To establish I/O connectivity, vertically oriented compute and accelerator nodes intersect with horizontally oriented I/O connectivity modules in the rear of the chassis.

The modular system consists of the following components (see Figure 2):

Figure 2. Cisco UCS X-Series

- **Cisco UCS X210c M6 Compute Node** – the first released compute node for the Cisco X-Series, combining the density and cabling advantages of a blade server and the expandability of a rack server. This compute node can support one or two third-generation Intel Xeon Scalable Processors with up to 40 cores per processor. With its compact form factor, up to eight X210c M6 compute nodes can reside in the seven-rack-unit (7RU) Cisco UCS X9508 Chassis. This compute node also supports up to six 2.5-inch SAS and SATA RAID-compatible SSDs or six 2.5-inch NVMe PCIe drives, increasing the amount of internal storage compared to previous generations of blade servers.

- **Cisco UCS X9508 Chassis** – a midplane-free design with eight flexible slots to install a combination of compute nodes and resources such as GPU accelerator nodes, FPGAs, and storage. Vertically oriented compute and accelerator nodes


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intersect with horizontally oriented I/O connectivity modules in the rear of the chassis. The absence of cabling between compute nodes and I/O connectivity modules simplifies hardware installation and compute node upgrades. The compact form factor helps to reduce the overall footprint, helping to reduce power and cooling costs.

- **Cisco UCS 6536 Fabric Interconnect (FI)** – module that provides both Ethernet and FC switch functionality to consolidate both LAN and SAN traffic onto a single fabric, thus reducing both capital and operational expenses related to maintenance and operation of separate networks. Designed to enable 100Gbps connectivity within the UCS X-Series chassis.

- **Cisco UCS X9108 Intelligent Fabric Modules (IFMs)** – enabling multiple end-to-end 100Gbps Ethernet and 32Gbps Fiber Channel connectivity per compute node.

- **Cisco UCS X9416 X-Fabric Module (XFMs)** – used for connecting compute nodes to PCIe nodes via industry-standard PCIe Gen 4 connectivity when adding GPU processing power to the Cisco UCS X210c M6 compute node.

- **Cisco UCS X440p PCIe Node** – module for upgrading Cisco UCS X210c Compute Node with one to four GPUs via Cisco UCS X9416 X-Fabric Module. (One NVIDIA GPU family—A100 Tensor Core GPU, A16 GPU, A40 GPU, or T4 Tensor Core GPU—per X440p PCIe node.) Cisco UCS X-Series can support multiple and different X440 PCIe node configurations within a single UCS X9508 chassis.

- **Cisco UCS Virtual Interface Card (VIC) 14425** – module that enables up to 50 Gbps of unified fabric connectivity to each Intelligent Fabric Module (IFM) in the chassis for 100Gbps connectivity per server. The VIC 14425 occupies the server’s modular LAN on motherboard (mLOM) slot and concurrently supports Ethernet and Fiber Channel (FC) traffic. Along with UCS VIC 14425, an X210c compute node can have a VIC 14825 on the PCIe mezzanine slot to enable 200G throughput.

- **Cisco UCS Virtual Interface Card (VIC) 15231** – Ethernet/FC-capable modular LAN on motherboard (mLOM) designed exclusively for the Cisco UCS X210 Compute Node that supports full 100Gbps network flows to each IFM for 200Gbps connectivity. End-to-end 100Gbps network throughput can be achieved without aggregating multiple lower-speed ports. Its PCIe standards-compliant interfaces can be dynamically configured via policies (deployed via Intersight) as NIC (Ethernet) or HBA (FC) ports.

Cisco has designed the UCS X-Series to help organizations’ sustainability via the overall reduction of power consumption, a decrease in the need to purchase components (e.g., cables, adapters, and switches) over time, and the reusability of such components in light of CPU and GPU refreshes.

Organizations manage Cisco UCS X-Series via Cisco Intersight, a SaaS-based management system that provides correlated visibility and management at both application and infrastructure layers, covering bare-metal servers, hypervisors, containers, and serverless and application components. Organizations also use Cisco Intersight to configure Cisco UCS and Hyperflex servers by applying policies and templates. The VIC receives the configuration from Cisco Intersight and forwards it to the server. Users can manage all their Cisco Unified Computing System (Cisco UCS) infrastructure through a single cloud-based or on-premises GUI.

**ESG Technical Validation**

ESG evaluated Cisco UCS X-Series via remote product demonstrations conducted at Cisco headquarters in San Jose, CA. Testing was designed to review how the Cisco UCS X-Series can help organizations to simplify hardware configurations and
upgrades when business requirements change, increase operational efficiency, and simplify IT infrastructure in light of increasing application growth and diversity.

**Simplify Hardware Upgrades**

Emergence of modern workloads such as AI/ML and big data analytics typically require GPU-enabled server resources. Organizations have relied on rack servers to support these workloads, as they can upgrade compute nodes with additional GPU processing power, storage, and memory. However, rack servers are IT silos, adding to the existing IT footprint and incurring additional costs. Also, upgrading these servers slows down how quickly organizations can meet changing business requirements calling for additional IT resources.

With UCS X-Series modularity, organizations can install and upgrade Cisco UCS X210c M6 compute nodes with additional processing, memory, and storage capacity in a matter of minutes. No longer do organizations need to build out or upgrade dedicated rack servers with additional processing power or storage to support modern workloads. Components can be upgraded on independent lifecycles, reducing unnecessary replacements and improving sustainability.

**ESG Testing**

ESG reviewed how organizations can add GPU processing power to a compute node via X-Fabric. We first navigated to the Cisco Intersight interface and saw the front view of Cisco UCS X9508 chassis, equipped with Cisco UCS X9416 X-Fabric Module, set up in a lab located at Cisco headquarters (see Figure 3). “Slot1,” circled in blue, contained a Cisco UCS X210c M6 compute node, named “FI-5G-1-1,” containing two Intel Xeon processors. “Slot2” contained a blank.

**Figure 3. Front View of Cisco UCS X9508 Chassis with Slot1 Populated**

We watched, in real time, a Cisco engineer remove the blank from “Slot2” and insert a PCIe node named “PCIe-Node2-GPU1,” populated with a single NVIDIA A40 GPU into Slot 2. Once inserted, green indicator lights at the bottom of “Slot2” showed that the node was powered up.

ESG then navigated back to Cisco Intersight and verified that the compute node contained two Intel Xeon processors and a fabric mezzanine adapter, “PCI-MEZZ-X-FABRIC,” that would enable connectivity between the compute and PCIe nodes through the X9416 fabric module (see Figure 4). We then prompted Intersight to “rediscover” the server “FI-5G-1-1.” In other words, Intersight would review the existing hardware inventory and check if any changes occurred.
Figure 4. Cisco Intersight Verifying Compute Node Configuration

In less than 10 minutes, Cisco Intersight rediscovered the “FI-5G-1-1” compute node. The PCIe node containing the NVIDIA A40 GPU was listed under the server hardware inventory (see Figure 5). Intersight also indicated that “PCIe-Node2-GPU1” populated “Slot2.” We also saw graphically that the PCIe node was inserted (circled in blue).

Figure 5. Inventory of Rediscovered “FI-5G-1-1” Compute Node

Adding GPUs to a rack server will never be done in a matter of minutes. Many steps need to be completed when adding GPUs to an existing server, such as verifying that the existing server has the available PCIe slots on the system motherboard to insert GPU cards, ensuring that the server can support the GPU’s power requirements, ordering the right number of GPU cards, manually inserting the cards after taking the server apart, and installing OS drivers so that the server recognizes the GPUs. Completing these steps can easily take weeks. Now imagine having to repeat these steps for multiple applications requiring GPU processing. Following this process does not support business agility when workload requirements change. With Cisco UCS X-Series modularity, we noted that organizations can install and upgrade compute resources quickly, decreasing response time to changing business needs.

3 The observed time for upgrading the Cisco UCS X210c M6 compute node with a single NVIDIA A40 may not reflect actual times observed in production networks. Yet, ESG is confident that Cisco’s hardware upgrade process will require much less time than upgrading a CPU-based rack server manually.
ESG also noted that Cisco’s implementation of upgrading hardware simplifies lifecycle management. As long as Cisco offers support, organizations could upgrade different UCS X-Series servers with different GPUs. With Cisco’s UCS X-Series modularity, the lifecycle of both CPUs and GPUs can be managed separately.

### Why This Matters

As organizations deploy compute-intensive workloads, they have typically been supported by GPU-enabled rack servers. However, when these modern workloads scale, increasing GPU processing power is labor intensive. Either GPU processing power is added to existing servers or more servers are purchased. In short, organizations cannot respond to changing business needs quickly.

ESG validated that the Cisco UCS X-Series Modular System helps organizations to upgrade compute resources simply and efficiently as more workloads demand additional GPU processing power. We verified the ease of adding GPUs to a server in a matter of minutes via the Cisco UCS X-Series fabric. Organizations can now manage the lifecycle of CPUs and GPUs separately, as they can swap out GPUs instead of having to manually rebuild traditional rack servers.

### Increasing Operational Efficiency

Any organization managing IT infrastructure all deal with the same types of tasks, such as configuring and updating hardware to accommodate new workloads, troubleshooting network issues, and managing overall equipment lifecycle. Yet, these tasks can easily cause downtime that organizations cannot afford to spend.

The combination of Cisco Intersight with the flexibility of the Cisco UCS X-Series architecture can help organizations to spend less time on these tasks. Since operational efficiency increases, organizations can respond more quickly to business needs.

### ESG Testing

ESG reviewed how the combination of Cisco Intersight and Cisco UCS X-Series can help IT to decrease their effort spent on ongoing operations. In this section, we review how to deploy additional network interfaces using the Cisco UCS VIC 15231. Because the VIC was designed so that each port could support both Ethernet and FC protocols, as well as various speeds, the VIC can function as a network interface card (NIC), a host bus adapter (HBA), or a combination of both, within the same server.

To verify how to accomplish the task, we navigated to the Cisco Intersight interface to modify a LAN Connectivity policy named “cc7-esx-rg.” We noted that the policy was associated with multiple server profiles (see Figure 6). Modifying this policy would change all related profiles. ESG clicked on the button, “Add vNIC.”

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4 A Cisco UCS server profile is a software definition of a server and its LAN and SAN network connectivity. A policy defines how specific components within the server are configured. One policy can be applied to multiple server profiles.
Figure 6. Navigating to the LAN Connectivity Policy

ESG was then presented with a blank vNIC policy (see left of Figure 7). To configure the vNIC, we simply populated each line item with preset policies. The configured vNIC was then displayed, as show in the right-hand side of Figure 7.

Figure 7. Modifying vNIC Policy

As we observed this process, ESG noted how the UCS X-Series platform flexibility can increase operational flexibility and efficiency. Because the vNIC did not have a hard-coded identity, organizations could reconfigure the hardware depending on the workload to be supported. No longer would organizations incur capital expense in purchasing separate NICs and/or HBAs and their respective cables as technology evolves. Less downtime and operational efforts are spent on time to replace cards, reconnecting new cards to upstream switches, and assessing the new hardware before spinning up the new workloads.

With 100Gbps connectivity support on both the IFMs and the VICs, ESG observed that end-to-end 100Gbps network connectivity can be supported without aggregating traffic from multiple hardware components supporting lower port speeds. Using fewer hardware components, supporting higher throughput, also helps in achieving higher overall performance as organizations consolidate more workloads onto Cisco UCS X-Series.

ESG proceeded to upgrade the affected servers with the new vNIC policy. As mentioned previously, the vNIC policy was associated with three server profiles Intersight noted did not have the changes in that vNIC policy deployed (see Figure 8). We found that we could deploy changes to a single profile or multiple profiles as long we as checked off their boxes. As
long as a VIC was installed into the affected server blades, those vNICs would be configured as defined by the modified LAN connectivity policy, “cc7-esx-sg.”

Figure 8. Deploying vNIC Policy

Because Intersight simplified how organizations can update server configurations via a few mouse clicks, we clearly saw how operational efficiency can increase, especially if multiple servers need to be updated to support a specific workload. While ESG already considered how much downtime organizations would incur when reconfiguring a single server to support a workload different from one currently supported, imagine that downtime extended when multiple servers are involved. The combination of Cisco UCS X-Series and Intersight could reduce that downtime significantly.

To assess how Cisco Intersight facilitates troubleshooting, ESG navigated back to the page listing the Cisco UCS X-Series inventory deployed in this test environment (see Figure 9.) We viewed all UCS X-Series related components and focused on the servers. (We should note that this view enabled visibility into other UCS servers.) We could apply customer filters to view any subset, such as those servers with Critical issues to resolve. Because Intersight continuously monitors the IT environment, ESG could see how organizations can identify infrastructure issues quickly and deal with them proactively. Operational efficiency could increase as potential and/or actual downtime is minimized or eliminated.

Figure 9. Identifying UCS X-Series Critical Issues
**Why This Matters**

Daily management of IT infrastructure has typically required navigating through a patchwork of management systems and manual processes. However, the result is increased downtime of single or multiple workloads at any given time. The business is unable to fulfill business needs as they arise.

ESG validated that the combination of Cisco UCS X-Series and Cisco Intersight can increase an organization’s operational efficiency so that business needs can be met quickly. We reviewed how organizations can reconfigure all hardware within a Cisco UCS X-Series chassis by modifying profiles and their related policies via Cisco Intersight. The flexibility of Cisco UCS X-Series hardware translates into not having to purchase equipment dedicated to single functions. We also verified that Cisco Intersight can help to identify and pinpoint issues to resolve via a single interface. Time related to maintenance windows and troubleshooting issues decrease without introducing business risk.

**Simplifying IT Infrastructure**

Modern applications, such as accelerated VDI, medical imaging, oil and gas exploration map rendering, and AutoCAD, require GPU processing power. They continue to be supported with separate rack servers, isolated from other IT infrastructure. The result is increased complexity as organizations must manage more IT devices, possibly housed by separate racks.

The Cisco UCS X-Series has been designed to consolidate both traditional and modern applications in the same chassis. By leveraging the higher CPU processing power of the Cisco UCS X210c M6 compute node, organizations can scale traditional enterprise workloads, without degrading performance. When supporting modern workloads, the CPUs in the Cisco UCS X210c M6 compute node will not hinder the GPU’s processing power provided by the Cisco UCS X440p PCIe node. With the Cisco UCS X210c M6 compute node and its native support for up to six NVMe drives, applications typically relegated to rack servers can now be consolidated into a blade form factor.

**ESG Testing**

To review the hardware efficiency organizations can achieve when running applications on the Cisco UCS X210c M6 compute node, ESG evaluated performance testing results of an Oracle 19c database application. The testbed consisted of the following components: One Cisco UCS X9508 chassis was populated with one UCS X210c M6 compute node, powered with dual third-generation Intel Xeon Scalable Processors and six 3.2TB Intel SSD D7-P5600 NVMe drives. The chassis also contained one UCS X9108 IFM connected to dual UCS 6454 Fabric Interconnects, each via four 25Gbps links. The compute node ran Oracle 19c Linux x86-64 (v19.10.0.0).

To simulate database workloads, the test ran Oracle Swingbench, a free Java-based load generator (and benchmarks) designed to stress test an Oracle database (12c, 18c, 19c). To represent an OLTP-type workload, the Swingbench Order Entry (SOE) benchmark was used. The simulated workload generated an overall 60/40 read-write ratio using an 8KB block size. A 3TB database was created, representing a small set of database tables. Because of the small set, the simulated workload would be realistic as multiple transactions contended for database resources. Tests were run continuously for 24 hours.

We first audited test results measuring transactions per minute (TPM) as the number of users increased from 32 to 256. Results are shown in Figure 10 and Table 1. Simultaneously, system utilization was also measured.
Figure 10. TPM as Database Users Increase

Table 1. TPM as Database Users Increase

<table>
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<th>Number of Users</th>
<th>Transactions per Minute (TPM)</th>
<th>System Utilization</th>
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<tr>
<td>32</td>
<td>497,520</td>
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<tr>
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<tr>
<td>256</td>
<td>2,802,360</td>
<td>56.3%</td>
</tr>
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</table>

Source: ESG, a division of TechTarget, Inc.

We then audited test results measuring both read and write IOPS of this simulated workload, as shown in Figure 11 and Table 2. Read and Write IOPS as Database Users Increase.
What the Numbers Mean

- ESG validated that a Cisco UCS X210c M6 compute node can manage a single instance of an Oracle 19c 60% read/40% write database workload without consuming all system resources on the blade server.
- Observed read and write IOPS scaled approximately linearly. Performance is predictable as the number of users increase.
- Test results revealed that a single Cisco UCS X210c M6 compute node can process up to 2,802,360 TPM of 256 users simultaneously using the application. Less than 60% of the system was utilized, leaving much more room for the workload to scale if needed.
- Given the efficient performance observed on the Cisco UCS X210c M6 compute node, larger workloads can easily be accommodated. We can also infer that any workload requiring GPU processing power can be supported on the Cisco UCS X210c M6 compute node, as the CPU will not limit how quickly GPUs process transactions.

ESG also reviewed how the Cisco UCS X-Series can support other applications leveraging the native support for higher storage capacities, specifically data backup, management, and recovery. The amount of storage needed to support backup and restore activities are much higher than what blade servers could traditionally support. However, organizations would face the same issues of building out, configuring, and deploying rack servers, consuming both time and resources.
With Cisco UCS X-Series, organizations can configure and add new compute nodes with sufficient capacity for its backup and restore strategy, without the need to expand its IT footprint and consume additional power and cooling resources. Cisco’s partnership with Cohesity, a data management platform, enables organizations to add nodes for backup and restore purposes with minimal manual effort. In Figure 12, ESG saw how the integration of Cohesity with Cisco UCS X-Series simplified the addition of a data protection node populated with six 15TB NVMe drives, totaling 90TB. After applying the Cohesity OS to a server profile attached to the new node via Cisco Intersight, the Cohesity GUI could then recognize the node and add it to the existing three-node Cohesity cluster.

Figure 12. Adding a New Data Protection Node in a Cisco UCS X9508 Chassis with Cohesity

ESG should mention that the proximity of the increased processing power within the UCS X210c M6 compute node to the large amount of native storage can help to recover from a catastrophic event with little delay, such as a natural disaster or ransomware.

### Why This Matters

Consolidating workloads using less hardware can help organizations to reduce overall footprint, translating into less power, cooling, and cabling requirements. However, this implies that the servers are powerful enough to support and scale workloads without consuming separate islands of IT infrastructure.

ESG validated that the Cisco UCS X-Series can help to consolidate multiple workloads into a single chassis. With the higher CPU processing power of the Cisco UCS X210c M6 compute node, we observed that a single instance of an Oracle 19c database application, generated using Oracle Swingbench, can support up to 2.8 million TPM of 256 simultaneous users, while only consuming 56% of blade server resources, without sacrificing performance. Based on these results, we can see how organizations can easily scale traditional enterprise applications on a single blade. ESG can see that the increased CPU processing power of the Cisco UCS X210c M6 compute node will support GPU-based workloads without sacrificing system efficiency and performance. ESG also observed how other applications, such as backup and recovery, can now be supported via a blade form factor, without sacrificing the high amount of storage that is usually provided via rack servers.

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The Bigger Truth

According to ESG research, respondents indicated that among their top buying criteria for purchasing data center infrastructure is scalability (32%), ease of deployment (29%), and ease of administration (25%). Fulfilling these priorities would require a solution that enables organizations to support workloads requiring either CPU or GPU processing power, without deploying separate islands of IT infrastructure, particularly rack servers. Organizations would be able to deploy this solution without spending time and resources traditionally spent on installing, configuring, and cabling IT infrastructure. Configurations and upgrades can be easily accomplished via software, while minimizing the purchase of purpose-built hardware, such as NICs and HBAs. And this infrastructure could all be managed via a single interface that provides a consistent and unified view of IT infrastructure.

Cisco designed UCS X-Series to support both traditional enterprise and modern workloads running in a hybrid cloud environment using a unified form factor. Managed via the cloud using Cisco Intersight, this modular platform enables organizations to scale and upgrade IT infrastructure in a single 7RU chassis without the need to purchase, configure, and manage multiple pieces of purpose-built hardware. Ultimately, organizations can support multiple CPU and GPU-based workloads in a single and compact form factor, thus increasing operational efficiency and agility while minimizing current and future capital and operational expenses.

Throughout our evaluation, ESG validated that organizations can:

- Install and modify Cisco UCS X210c M6 compute nodes by attaching GPU modules, to accommodate modern workloads in a matter of minutes (as opposed to physically installing GPUs into traditional rack servers).
- Increase operational efficiency of everyday IT tasks, such as updating hardware programmatically to meet evolving application requirements, troubleshooting network issues, and managing overall equipment lifecycle.
- Simplify overall IT infrastructure by consolidating both traditional and modern workloads without wasting system resources or sacrificing overall performance.

The number and diversity of applications is only increasing, but that will result in IT infrastructure sprawl within your data center, leading to increased capital expenses and operational overhead and costs. ESG suggests taking a closer look at the Cisco UCS X-Series to eliminate these pain points in your IT environments.

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