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Workload Consolidation on IBM LinuxONE

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Executive Summary

IBM LinuxONE provides a powerful platform to consolidate Linux workloads, reducing cost, space, and power compared to x86 servers. Signal65 and IBM have collaborated to model and analyze the financial impact of IBM LinuxONE consolidation.

Signal65 has reviewed and validated IBM performance testing and cost modeling data, showing that IBM LinuxONE is capable of achieving:

- 44% lower TCO compared to new x86 servers
- 75% lower TCO compared to older generation x86 servers
- Up to 94% lower software costs
- Between 65% and 91% lower energy consumption
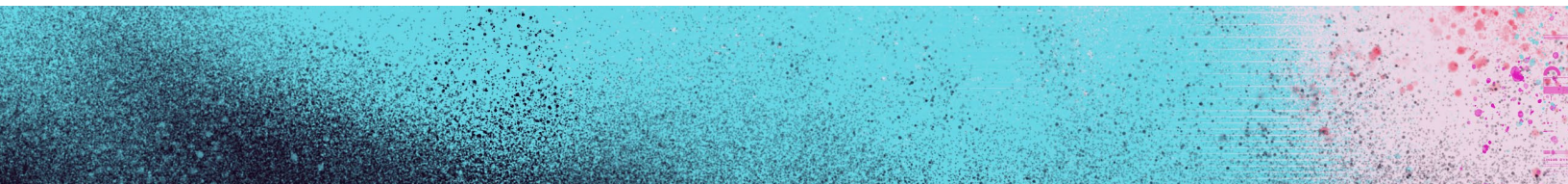
Introduction

Today's IT organizations are tasked with modernizing infrastructure while satisfying several key, yet often contrasting, goals. Improving the performance of IT infrastructure is critical, ensuring that performance meets the growing needs of new applications and increased demand. Security is another top priority, as increases in ransomware and other cyber-threats have become a growing concern. Increasingly, energy consumption must also be factored in to IT decision making due to growing sustainability concerns, corporate ESG initiatives, and data center power limitations. Meanwhile, financial considerations are often the primary driver for IT decision making due to limited budgets, requiring IT organizations to find solutions that meet all of their requirement while staying cost effective.

To balance these challenges and meet their IT infrastructure goals, IT decision makers must carefully evaluate their options in the market. While commodity x86 servers are a common choice for deploying Linux workloads, IBM LinuxONE servers present a compelling solution with notable cost, performance, security, and energy consumption characteristics.

Key to IBM LinuxONE is its workload consolidation capabilities. By leveraging this workload consolidation on IBM LinuxONE, organizations can maintain performance of their applications with fewer physical machines. This consolidation additionally aids in significant cost and energy savings. Software costs, which are often licensed per core, can be dramatically reduced with less physical hardware and a lower overall core count. Reducing hardware additionally frees up data center space, lowers energy costs, and provides management simplicity, resulting in lower operational costs.

The total cost savings of deploying IT infrastructure can be complex, involving factors well beyond the purchase price of hardware, including software costs, energy costs, and labor costs. In addition, these costs should be considered over several years to achieve a comprehensive financial evaluation and understand how costs change over the lifespan of the infrastructure. Total Cost of Ownership (TCO) analysis provides a data-driven approach to explore IT infrastructure costs over time, and such an approach can be used to explore the benefits of IBM LinuxONE servers compared to x86 servers.

TCO Study Overview and Assumptions

To evaluate the financial impact of IBM LinuxONE in enterprise IT environments, IBM and Signal65 collaborated to calculate the TCO of IBM LinuxONE servers compared to x86 servers running common enterprise applications. To achieve this, performance and economic data was collected by IBM and validated by Signal65.

Performance tests were run to simulate standard enterprise workloads on both x86 servers and IBM LinuxONE Emperor 5. These test results were used to establish core consolidation ratios, as well as measure power consumption. The performance results were then extrapolated to model full IT environments, including both production and non-production environments. These environments, as well as CPU utilization metrics, were modeled based off of IBM client data collected over 20 years. LinuxONE and x86 environments were sized relatively based on the established core consolidation ratios.

To create a comprehensive understanding of how IBM LinuxONE compares to x86 servers in various enterprise scenarios, two distinct TCO studies were created. The first TCO analysis models IBM LinuxONE Emperor 5 as a replacement for existing x86 servers from previous generations. This analysis assumes that x86 servers have already been purchased and includes no new upfront hardware costs. Modelling was achieved utilizing 6 previous-generation servers.

The second TCO analysis models a comparison between IBM LinuxONE Emperor 5 and purchasing new x86 servers. This analysis includes the upfront hardware acquisition cost of the x86 servers, which are modeled after a commercially available enterprise server with two 5th-generation Intel® Xeon® Platinum 8592+ processors with 64 cores per CPU.

To create a comprehensive TCO calculation, the following costs were included in both TCO studies:

- Hardware
- Software
- Energy
- Network
- Datacenter space
- Labor

All hardware and software cost estimates were based on publicly available U.S. General Services Administration[1] pricing data. Energy costs were calculated using the energy metrics gathered during performance testing in combination with an electricity cost of $0.15/kWH. While exact pricing of electricity varies by region, this value was chosen as a realistic approximation of US electricity pricing. CO_2e was additionally calculated using this energy data and standard carbon conversion calculations. Labor costs were calculated using a flat salary of $150,000 per full-time employee. To account for the reduced hardware, reduced downtime due to 8-9's of reliability, and greater operational efficiency, IBM LinuxONE environments were assumed to require 50% overall labor.

In both TCO studies, the IBM LinuxONE and x86 servers were running identical software stacks. Each environment was configured to run a WebSphere Liberty application and EDB Postgres on Red Hat OpenShift Container Platform, deployed on Red Hat Enterprise Linux 9.5 with KVM. In addition, both solutions had access to the same storage.

[1] https://www.gsa.gov/

Production and Non-Production Environments

Key to modelling a comparison between x86 and LinuxONE environments is understanding the differences in how the two solutions support production and non-production environments. When using standard x86 servers, physically separate hardware is used to separate these environments. Based on data gathered from IBM customers, non-production environments are typically comprised of 3x to 4x as many servers as in production environments. On average, it was found that these servers have 7-15% CPU utilization. In production environments, servers were found to have between 15-80% CPU utilization, and on average, less than 50% utilization. While the specifics of each environment will vary between organizations, this data is well aligned with what Signal65 has observed across various IT organizations.
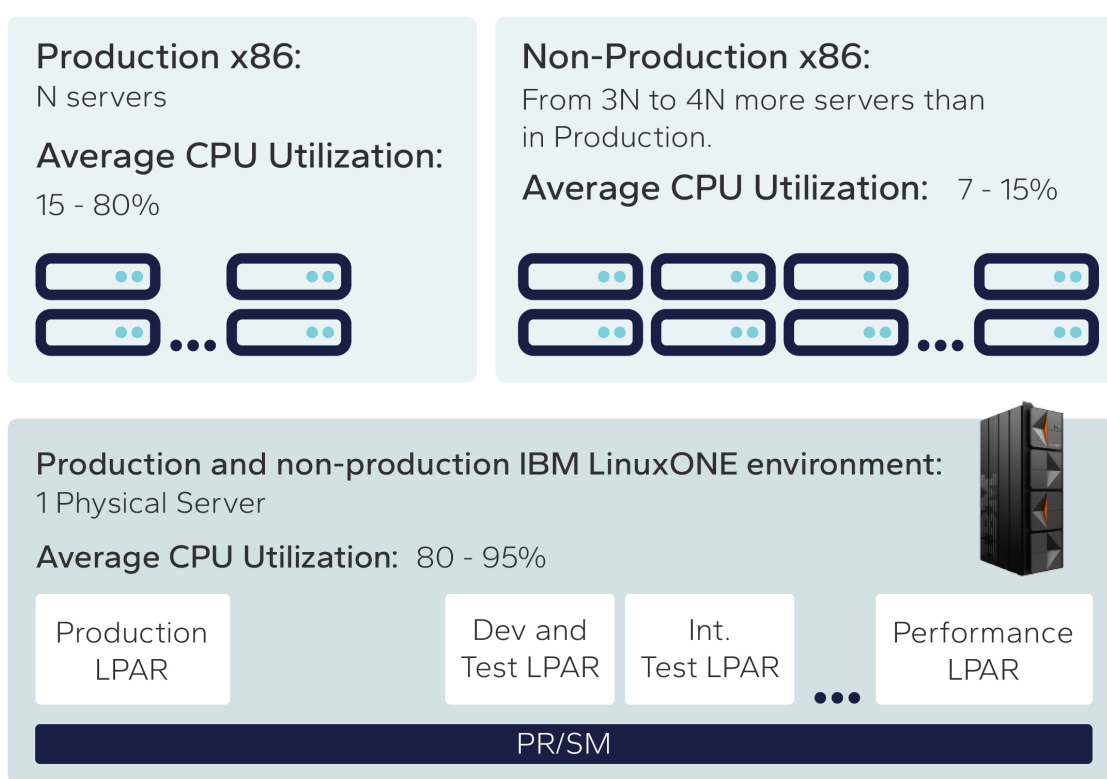
Figure 1: Production and Non-production Environments

In contrast, IBM LinuxONE provides a distinct approach to separating production and non-production environments. LinuxONE's PR/SM technology separates workloads for different types of IT environments by LPARs. This approach allows deployment of multiple IT environments on the same physical hardware, offering greater flexibility and security. With this architecture, up to 85 logically isolated servers, each running a distinct hypervisor instance, can co-exist on a single LinuxONE system sharing compute, memory, and I/O resources. This allows for highly efficient resource utilization, while maintaining strict air-gap isolation. IBM customer data shows that this approach enables LinuxONE servers to achieve 80-95% CPU utilization. More information about the unique architectural features of IBM LinuxONE that enable enterprise-level efficiency and scalability, such as LPARs and PR/SM, can be found in The Futurum Group's report - Efficiency & Innovation: IBM LinuxONE for Modern Workloads.

TCO Study #1: IBM LinuxONE Emperor 5 vs Older x86 Servers

The first TCO analysis models replacing existing x86 servers of previous generations with new LinuxONE servers. To create the TCO comparison, performance testing was completed across both LinuxONE and x86 servers. The LinuxONE test environment was comprised of an IBM LinuxONE Emperor 5 Max 136 system consisting of three CPC drawers containing 136 configurable processor units and six I/O drawers. To evaluate older generation x86 servers, several servers were tested with Intel Xeon Gen 2 or older processors.

Both environments were tested with the same workload and sized such that they achieved approximately 10,000 requests per second. For the x86 environment, this resulted in six x86 servers, totaling 256 cores, while the LinuxONE environment included one LinuxONE Emperor 5 with 1 LPAR and 16 IFLs. In both environments, tests were run for a total of five minutes, with the following pattern:

- 1 minute to ramp up to 1,000 users
- 3 minutes of testing
- 1 minute to ramp down

The test results, including performance and power consumption data from the compared LinuxONE and x86 servers at various levels of processor utilization, were then extrapolated to model a complete IT solution in a typical customer environment. Using the core consolidation ratios found in this testing and IBM customer environment data, the two compared solutions were sized according to the number of cores required for production and non-production environments, as can be seen in Figure 2:

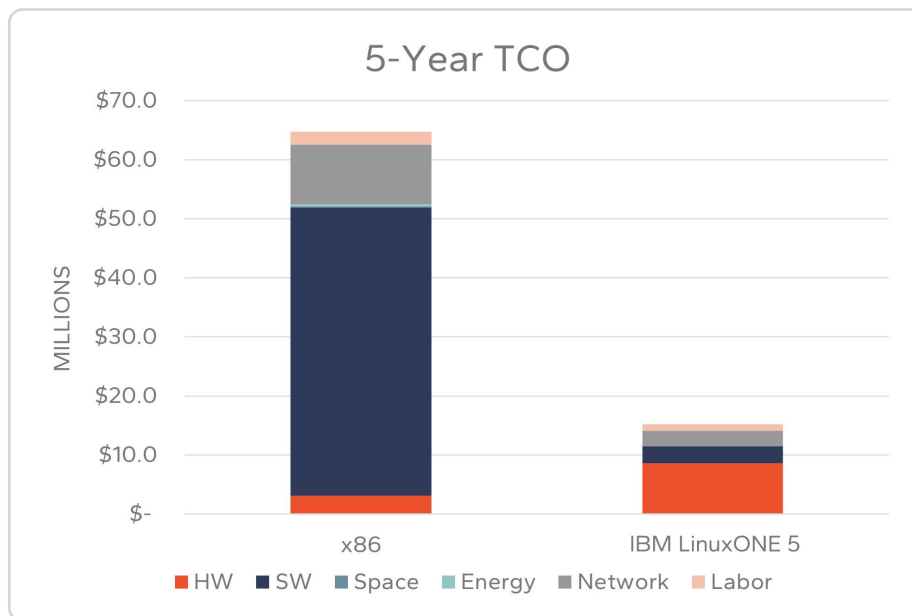|	IBM LinuxONE	x86
Production cores	39	512
Non-production cores	97	4,864
Total cores	136	5,376
Total servers	1	126

Figure 2: Environment Sizing (TCO Study #1)

Notably, the LinuxONE environment achieved a cost advantage during each year over the five-year period modeled. At year zero, the cost of the LinuxONE environment is 68.5% lower than the x86 environment. By year four, the LinuxONE environment tallied a 76.5% lower cumulative cost than the x86 environment, with a total cost savings of $49.56 Million.
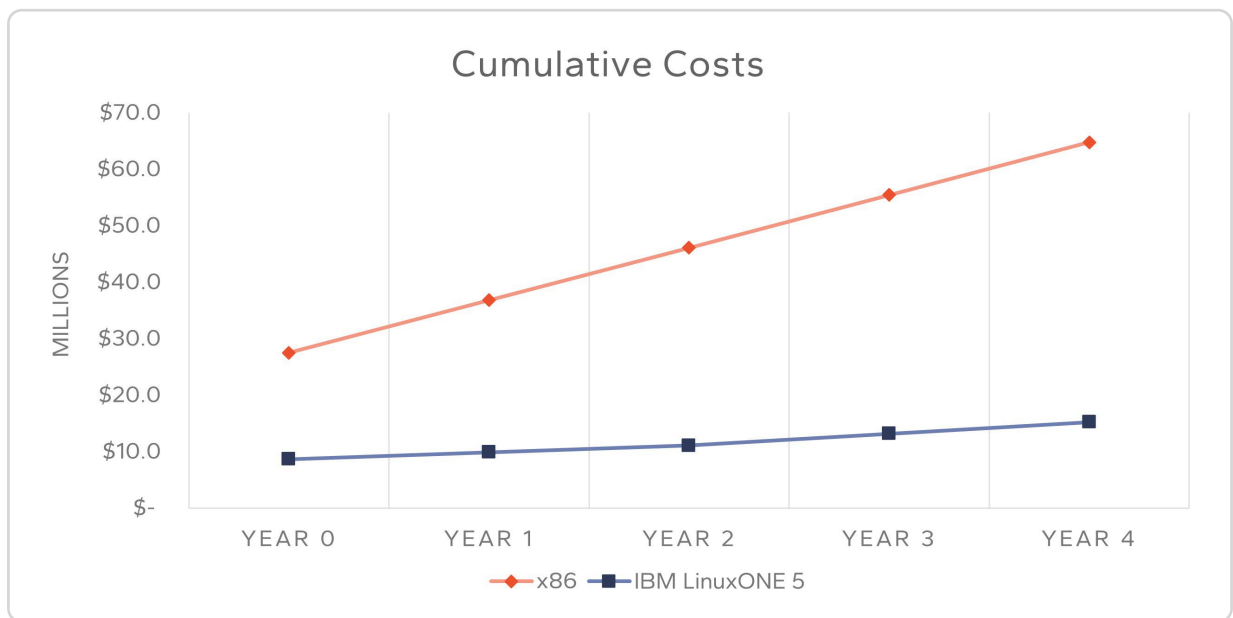
Figure 3: *5 Year Cumulative Costs (TCO Study #1)*

The cost savings achieved by IBM LinuxONE can be further understood by evaluating the individual cost components included in the analysis. Since this study evaluates an x86 environment with existing servers, its hardware costs only include the ongoing support and subscription costs, without any large upfront hardware purchases. This gives the x86 environment a notable advantage in hardware costs, as a replacement with IBM LinuxONE requires a new hardware purchase.

Figure 4: *Cost Comparison (TCO Study #1)*

Despite higher hardware costs, the LinuxONE environment results in notably lower costs for all other categories. The most significant cost savings can be seen when evaluating software, where IBM LinuxONE achieves 94% lower costs. The LinuxONE environment additionally achieves 91% lower energy costs and 82% less data center space.

TCO Study #2: IBM LinuxONE Emperor 5 vs New x86 Servers

The second TCO study closely follows the approach of the first, with the key differentiation of evaluating IBM LinuxONE in comparison to the purchase of new x86 servers, rather than to existing infrastructure. For the LinuxONE environment, this study utilizes performance and power consumption collected from an IBM LinuxONE Emperor 5 Max 136 system, just as in the prior study. For the x86 environment, performance and power consumption data were again gathered from x86 servers, but in this case, all servers were purchased in December 2024 and were based on two 5th generation Intel Xeon Platinum 8592+ processors with 64 cores per CPU.

The performance data was extrapolated to model the following production and non-production environments:

	IBM LinuxONE	x86
Production cores	20	256
Non-production cores	116	2,688
Total cores	136	2,944
Total servers	1	23

Figure 5: *Environment Sizing (TCO Study #2)*

In year 0, the IBM LinuxONE environment achieves a slight cost advantage over the x86 environment with 6% lower costs. The cost savings achieved by LinuxONE over the remaining four years, however, are much more significant, leading to a 44% lower cumulative cost by year four. In total, the LinuxONE environment was found to save $10.68 Million over five years.
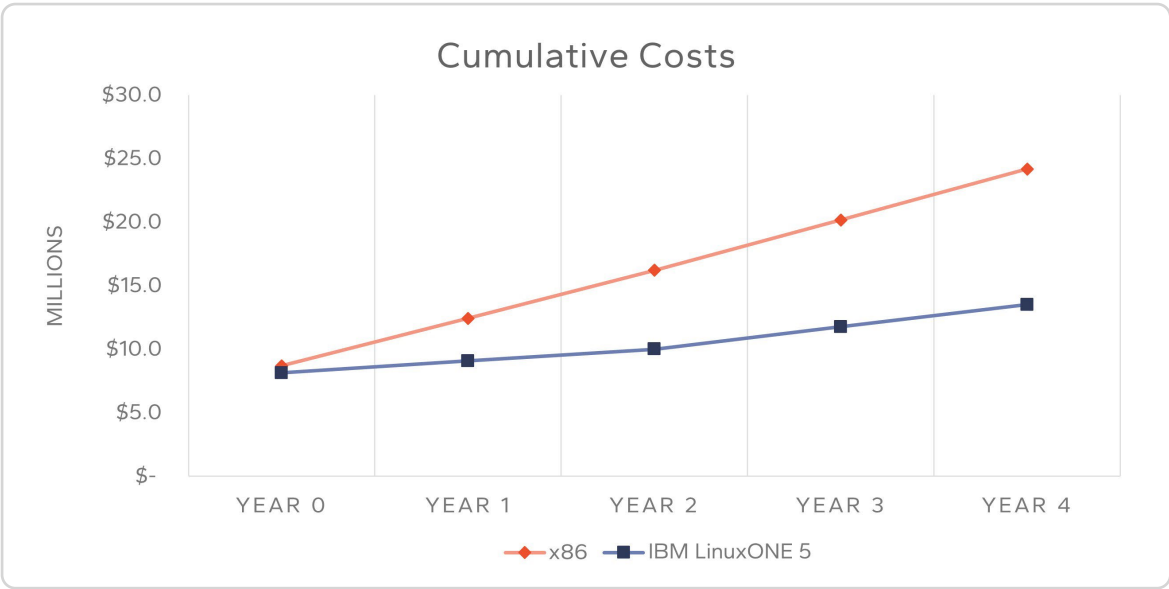

Figure 6: *5 Year Cumulative Costs (TCO Study #2)*

Although this model includes the purchase of new x86 hardware, the use of commodity x86 servers achieves lower overall hardware costs than the LinuxONE environment. Alternatively, the upfront hardware purchase makes up the largest individual cost in the LinuxONE environment. This results in relatively competitive costs between the two environments in year 0, however, the large cost savings achieved by LinuxONE quickly overcome the hardware costs over the course of five years.
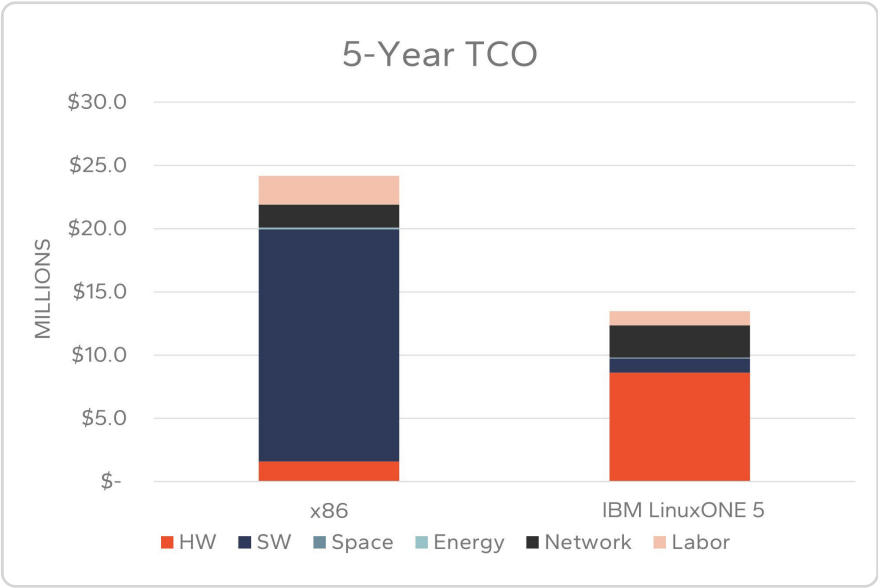

Figure 7: *Cost Comparison (TCO Study #2)*

As in the previous analysis, the software costs result in the largest impact to the overall cost savings. In this study, IBM LinuxONE achieved 94% lower software costs over 5 years. The energy savings in this study are also notable, with LinuxONE achieving 65% lower energy costs.

Analysis: IBM LinuxONE Consolidation Benefits

TCO analysis demonstrates that IBM LinuxONE is capable of achieving significant cost savings compared to x86 systems, both as a replacement for existing servers and as an alternative to new x86 acquisitions. In addition to the raw cost savings, the consolidation achieved by IBM LinuxONE achieves several key benefits for IT organizations.

Operational Efficiency

The high consolidation ratios achieved by IBM LinuxONE result in fewer physical servers, which in turn results in greater operational efficiency. By replacing tens to hundreds of x86 servers with a single LinuxONE system, organizations can greatly reduce operational tasks such as firmware updates and management of network ports. In addition, IBM LinuxONE simplifies management via logical partitions (LPARs), removing the requirement for physically separate production and non-production environments. By offering greater operational efficiency, IBM LinuxONE can reduce total labor costs, as has been seen in IBM customer environments, and is reflected in both TCO scenarios.

Reduced Software Cost

As seen across both TCO studies, the consolidation achieved by LinuxONE is capable of dramatically reducing software costs and improving energy efficiency. This is primarily achieved by the significant core reduction. In the first TCO scenario, a single IBM LinuxONE Emperor 5 Max 136 system is achieving the same job as 126 x86 servers with 5,376 cores. In the second TCO study, the LinuxONE Emperor 5 Max 136 system is achieving the same job as 23 new x86 servers with 2,944 cores. With many key enterprise software applications priced per-core, software can comprise the largest overall cost in environments with a high core count, as can be seen in the two TCO studies. By leveraging the core consolidation provided by IBM LinuxONE, organizations can significantly reduce their software costs.

Energy Efficiency

By consolidating several servers and thousands of cores to a single IBM LinuxONE system, IT organizations can recognize significant energy savings. The TCO studies demonstrated an energy reduction of 91% when replacing older x86 systems and 65% compared to newer x86 servers. This type of energy reduction not only reduces operational costs, but improves organizations' carbon footprint and helps achieve strategic ESG initiatives.

Scalability & Security

The consolidation and architectural differences of IBM LinuxONE not only help organizations meet their cost and power efficiency goals, they also provide a strong foundation for secure, scalable IT infrastructure. By leveraging LPAR technology, LinuxONE enables secure multi-tenancy, allowing multiple isolated workloads to run on a single system. At the same time, its high-performance design supports vertical scaling, making it well-suited for consolidating dense, mission-critical workloads without compromising performance or security.

Final Thoughts

Today's IT organizations are challenged with a broad range of requirements, including upholding application performance, ensuring security, and reducing energy consumption. For most organizations, these requirements are additionally interwoven with tight financial constraints and shrinking operational budgets.

When making IT purchasing decisions, organizations should look to data-driven approaches, such as TCO analysis, as a core tool to understand the financial impact of solutions over an extended period of time. The two TCO studies outlined in this paper highlight how workload consolidation on IBM LinuxONE can save significant costs compared to both old and new x86 infrastructure. By consolidating key workloads on fewer cores, IBM LinuxONE can dramatically reduce software costs as well as reduce operational costs, and improve energy efficiency.

For IT decision makers faced with fulfilling key IT infrastructure challenges while balancing cost considerations, the architectural approach and consolidation capabilities of IBM LinuxONE present a compelling solution.

TCO Study #1 Additional Information

	HW	SW	Space	Energy	Network	Labor	Total
x86	$3,064,893	$48,854,340	$165,000	$371,949	$10,080,000	$2,250,000	$64,786,182
IBM LinuxONE 5	$8,627,879	$2,855,749	$30,000	$32,358	$2,560,000	$1,125,000	$15,230,986
Diff. %	182%	-94%	-82%	-91%	-75%	-50%	-76%

Figure 8: *Total Costs (TCO Study #1)*

	Year 0	Year 1	Year 2	Year 3	Year 4
x86	$27,516,593	$36,805,830	$46,113,348	$55,439,878	$64,786,182
IBM LinuxONE 5	$8,660,851	$9,875,925	$11,105,799	$13,160,389	$15,230,986
Diff. %	-69%	-73%	-76%	-76%	-76%

Figure 9: *Yearly Cumulative Costs (TCO Study #1)*

Previous generation x86 servers with the following processors	Total Cores per server
2x Intel Xeon Platinum 8260 24C 2.40GHz	48
2x Intel Xeon E5-2690v3 12C 2.60GHz	24
2x Xeon Gold 5220R 24C 2.20GHz	48
2x Intel Xeon Gold 6242 16C 2.80GHz	32
2x Intel Xeon Gold 6252 24C 2.10GHz	48
2x Intel Xeon Platinum 8276 28C 2.20GHz	56

Figure 10: *x86 Systems Tested (TCO Study #1)*

TCO Study #2 Additional Information

	HW	SW	Space	Energy	Network	Labor	Total
x86	$1,581,172	$18,385,012	$30,000	$87,922	$1,840,000	$2,250,000	$24,174,106
IBM LinuxONE 5	$8,627,879	$1,124,120	$30,000	$30,464	$2,560,000	$1,125,000	$13,497,463
Diff. %	446%	-94%	0%	-65%	39%	-50%	-44%

Figure 11: Total Costs (TCO Study #2)

	Year 0	Year 1	Year 2	Year 3	Year 4
x86	$8,677,434	$12,418,184	$16,202,777	$20,164,731	$24,174,106
IBM LinuxONE 5	$8,132,777	$9,060,929	$9,994,506	$11,743,050	$13,497,463
Diff. %	-6%	-27%	-38%	-42%	-44%

Figure 12: Yearly Cumulative Costs (TCO Study #2)

New x86 servers with the following processor	Total Cores per server
2 x Intel® Xeon® Platinum 8592+ processors, 64 cores per CPU	128

Figure 13: x86 Systems Tested (TCO Study #2)

IBM LinuxONE Migration Demo

A demonstration of migrating x86 servers to a IBM LinuxONE system, as discussed in this report, can be found here:
IBM LinuxONE 5: Optimized IT for energy and cost savings

Important Information About this Report

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