IBM LinuxONE
A Truly Engineered System for Oracle

Summary

In today's landscape where disruption is the new norm, your business expects more from IT. Technology, business models, and client expectations continue to evolve and grow. The established model of today was yesterday's stretch goal. While no-SQL databases such as MongoDB, and PostgreSQL give organizations infinite flexibility and promise scale, Oracle and other traditional SQL databases still represent the majority of IT spend on databases. Organizations have tangible concerns around database deployments that support digital transformation projects. Those concerns can be categorized into five critical focus areas; Performance, Availability, Security, Scale and finally the Cost to deploy, manage and license a large database deployment.

Performance – In order to scale the performance of the most crucial part of an IT landscape, the database infrastructure, organizations spend a disproportionate amount of time tuning database parameters and searching for performance utilities that can optimize the last 10% out of a server - just to keep up with this week's database growth. This struggle to scale puts undue pressure on your IT support functions at a time when innovation should be the focus.

Availability – While containers are preferred for most projects, when a database moves because, yet another box fails, it holds everything up. Transactions are halted or may even be lost. For most IT requirements, the cloud is the planned location for mission-critical database architectures, as the cloud provides needed resilience and availability. However, IBM studies have shown organizations are on a journey to the cloud with as little as 20% of workloads having moved to the public cloud. According to recent Rimini Street research study[7], 47% of CIOs are not moving to Oracle SaaS and 33% have not decided either way.

Security – Databases are the crown jewels of any IT landscape. They store the most vital information including credit card data, Personal Identifying Information (PII) or other vital information upon which your business operates. You need this layer to be secure, encrypted, tamperproof, and protected from both external hackers and disgruntled employees who attempt nefarious acts once they access the data.

Scale – While horizontal scaling is a solid approach for non-stateful workloads, and sharding databases is becoming the norm, sharding can become an issue at scale. For those 'crown jewel' environments, you need to have faith that your underlying infrastructure will accommodate whatever growth is experienced without operational issues or further complication.

Cost – Traditional legacy database deployments are laden with infrastructure and licensing costs. Per Core licensing models, coupled with aggressive tactics to ensure compliance through audits, mean that organizations are increasingly looking for options to minimize and consolidate database footprints.

Against the backdrop of these 5 requirements for the most crucial element of an IT landscape, the database layer, organizations are looking for a server that is designed to handle performance with ease, be always available, secure, and can scale to whatever your business demands, all within the envelope of manageable predictable investment.

This infrastructure option exists — it's called LinuxONE. LinuxONE is built for speed and scale, built to be secure and trusted, built to be open and flexible, and built with unparalleled resiliency and availability. LinuxONE is open by design for the next Digital Transformation project and the crowdsourced tomorrow. Always on, always performing, always handling the scale for whatever the business has planned. With LinuxONE, you can optimize your environment, leaving more time and resources available for business innovation and growth.

LinuxONE - Today's Truly *Engineered* System for Oracle

LinuxONE is a single system for running your Linux-based workloads with enterprise-grade quality of service for security, availability and performance. These workloads include Oracle DB and Oracle WebLogic Server as well as Open Source and other Linux-based commercial software.

LinuxONE is the *ideal* platform for your Oracle-based workloads

TechomBank Case Study:

Don't let the volume outrun your capabilities.

Operating in one of the fastest-growing economies in Southeast Asia, Techcombank wants to be future ready in a market primed for massive growth. Techcombank chose IBM LinuxONE to power a bold new approach to banking, delivering rapid, reliable performance for new customer-centric services and scaling seamlessly to fast-growing demands. IBM LinuxONE ensured Protecting customers' data security with performance and flexibility to handle very large and variable workloads, combined with strong security and cost-efficiency. Techcombank moved away from a fragmented approach to IT to a highly centralized and scalable model – unlocking impressive efficiency gains and cost savings in the process. The switch from a distributed platform and horizontal scaling to a consolidated, scalable server platform, has enabled simplification of operations. Moving Temenos core banking and other Tier-1 systems to IBM LinuxONE helped reduce total cost of ownership by 44%. This was driven by lower software licensing and maintenance costs, improved hardware utilization and reduced floorspace, power and cooling requirements.

Results

4x rise in transactions during peak season handled effortlessly, supporting smooth service

44% lower total cost of ownership projected by migrating to LinuxONE platform

Modern, future-proof banking services help Techcombank win new customers

According to Rimini Street's recent research study[7] published in May 2019, 53% of CIOs are actively reducing or planning to reduce their Oracle spend in 2019. Why? Because Oracle licensing remains the single largest line item in most company's IT budgets, therefore it garners the full attention of the C-Suite who demand the CIO make this their #1 priority. As your business continues to grow, how is it possible to contain these costs while at the same time scale to keep ahead of your growth, stay compliant, increase your security capabilities, increase operational efficiency and innovate to get ahead of the competition all at the same time? Achieving these goals at the same time has been infeasible – until now, with LinuxONE.

Optimized Performance

Given the amount of focus paid to ensure that LinuxONE can be trusted be no surprise that it is also engineered to perform at extremely high levels.

Some of the performance benefits of LinuxONE are as follows:

LinuxONE is particularly well suited for I/O intensive applications. I/O is offloaded from the customer's purchased chips to hundreds of dedicated built-in IBM power cores, engineered for fast servicing of I/O requests.
https://www.mainline.com/why-businesses-are-buying-ibm-linuxone/

- Run pfBench 9.6.1 read-only benchmark on PostgreSQL 1.1 to achieve up to 2.3x more throughput on 8 cores as compared with an x86 system

- Run the YSCB (and…)

- Execute up to 1 Trillion HTTPS transactions per day on a single server (as compared to…)

- Compress up to 250GB of data per second (could use a comparative statement here as well)

Six 9's of Availability

When your IT system is your business, you must be able to trust it. The architecture that runs LinuxONE is used by many of the most demanding customers on the planet. In fact, as of 2017 it was still operating 92 of the 100 largest banks in the world,[1] managing a significant percentage of the world's wealth, and processing 87 percent of the world's credit card transactions. When it comes to relying on your infrastructure, the two most important aspects are availability and resiliency. Availability is a measure of the total amount of uptime for the system, accounting for both unplanned and planned downtime.

> **LinuxONE designed for 99.9999% uptime, or about 31 seconds of downtime per year.**

Met Office

Weather waits for no one. The Met Office has a mandate to deliver timely weather information to millions of customers across the UK. How could it ensure 24x7 availability for the systems that share weather data with customers?

Met Office collects ~200 million unique observations every single day from the UK and around the globe, and they are collected, processed, stored, and then reissued by a home-grown application. The database is already 50 petabytes and growing by up to 100 terabytes per day. The scalability of their platform is always at the front of mind. If Met Office runs the application on the x86 platform, they would have needed to scale horizontally to meet demand at peak times. However, scaling out would have caused load contention, forcing to invest in new software to keep data moving smoothly.

LinuxONE:
- **Enables a single lean team to support a large number of core Linux applications**
- **Cuts operational costs through ongoing database consolidation**
- **Ensures millions of customers can access critical weather data 24x7**

Met Office replaced their x86- processor based systems to deliver timely weather warnings to its customers and meet the increasing demand for weather information. LinuxONE represented the most reliable platform, simplified manageability, enhanced cost-effectiveness of the IT infrastructure

The Met Office is now migrating key database systems—including Oracle, PostgreSQL and MongoDB databases, as well as Apache Tomcat web services and Apache ActiveMQ middleware technologies—from x86 systems to LinuxONE

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[1] https://www.ibm.com/blogs/systems/ibm-z-the-banking-platform-for-the-future/

In a recent ITIC study on server reliability, 83% of customers reported that the architecture that LinuxONE runs on delivered between five and six nines – 99.999% and 99.9999% – or greater uptime.[2]

One key component of availability is resiliency. The system must be able to adapt to stresses and faults so that it does not fail. The LinuxONE architecture employs several strategies to ensure that the system keeps running. First, IBM uses advanced engineering to ensure these systems are physically resilient, regardless of the environment in which they are deployed. This includes putting systems through a test to simulate an 8.0 magnitude earthquake[3]. Second, LinuxONE performs constant error checking to identify or predict issues with individual system components so they can be mitigated before they become a problem. It also utilizes error prevention strategies such as specialty engines for maintenance, periodic calibration, power, and power-on controls. And finally, the system is built with multiple points of redundancy, such as spare processing cores for transparent failover and RAIM (Redundant Array of Independent Memory) subsystem. The latter protects the server from single-channel errors such as sudden control, bus, buffer, and massive Dynamic RAM (DRAM) failures. All of this contributes to a Mean Time Between Failure of more than five decades.

LinuxONE also simplifies disaster recovery for enterprises. The vertical scale of LinuxONE and the ability to deploy massive scale on a single system means that a single system can be deployed in the backup site for quick failover. This is much more manageable than replicating and maintaining rack after rack of x86 servers in a second datacenter. This strategy also has the added benefit of providing a platform for test and development on the DR system if needed, during normal operation.

Superior Security for Today's Digital Economy

In a world where companies are threatened by cyber-attacks every day, security is no longer an afterthought. Data protection must play a vital role in your strategic IT plans. The risk of lost data can cripple an organization's financial stability, jeopardize the credibility of an institution, and affect the competitive position of an organization, or worse.

In this new reality, mitigating any risk to systems and data integrity is a top concern. Only the most robust and safe platform is suitable to serve your most valuable assets. IBM LinuxONE is designed to protect against cyberthreats and provide security to any company competing in the digital economy.

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[2] https://itic-corp.com/blog/2019/03/ibm-power-systems-lenovo-system-x-and-thinksystem-hpe-integrity-and-huawei-kunlun-top-itic-2019-server-reliability-poll/

IBM LinuxONE provides superior protection with security features built into the hardware, firmware and operating systems. The built-in features range from storage protection keys and workload isolation to granular audit capabilities, and more. The CPACF (Central Processor Assist for Cryptographic Functions), standard on every core, provides hardware acceleration for encryption operations.

Encrypting data is usually expensive and can heavily affect the performance, throughput, or CPU load of a system. As a result, organizations often need to choose between performance and security. IBM LinuxONE provides hardware encryption that can be used to reduce the effect of expensive encryption operations. By accelerating the encryption operations with the IBM LinuxONE CPACF processor the performance and throughput of your workload is less affected.

Oracle Database clients can encrypt a single instance database using an encrypted Linux environment with dm-crypt, which leverages the CPACF capabilities on LinuxONE. This option results in minimum impact on performance and leverages the power of hardware acceleration encryption. For customers using Oracle RAC (Real Application Clusters), IBM Spectrum Scale provides a high-performance encrypted cluster file system that is certified by Oracle.

Reducing Oracle Spend

Oracle costs may spin out of control for many reasons. Let's take a look at some of the most common:

- **Virtualization** - Hard vs. Soft Partitioning
- **Server Sprawl** – Resulting from the need to scale to serve more users or add additional applications
- **Improper Licensing Strategy** - Single purchases vs. Unlimited License Agreement (ULA)

Virtualization

Although virtualization is commonplace in today's IT environment and is often used to segment a large system into many smaller parts, if the virtualization technology you are using is classified by Oracle to be a *Soft Partitioning* technology[1], you **are not allowed** to use this virtualization as a means to limit Oracle software licensing. In other words, if you have a large server with 128 cores and create 4 virtual servers, each with 32 cores and install Oracle on one of those virtual servers, Oracle licensing rules maintain you must license all 128 cores (64 Oracle processor licenses once the *Oracle Core Factor*[2] is applied).

LinuxONE contains an Oracle-approved *Hard Partitioning* technology[1] called Logical Partitions (LPARs). Any virtualization technology Oracle certifies as Hard Partitioning is allowed to be used to limit software licensing. So, for example, let's assume you have a LinuxONE server with 30 cores and create 6 LPARs, each with 5 cores. You then install Oracle in one of these LPARs. Only 5 Oracle processor licenses are required.

There are many benefits to using IBM's LPAR technology, including:

- An application running on one LPAR cannot access an application running on a different LPAR - these two applications have essentially the same security as applications running on two separate physical systems and are considered for all intents and purposes as two physically separate servers. Therefore, LPARs may be used wherever multiple servers are a requirement: Servers for Prod, Test & Dev; App Servers and DB Servers for different COTS applications; for an MSP, servers which can be allocated to different customers, etc.

- Because each LPAR is considered to be a stand-alone server, it can be further virtualized using IBM's z/VM technology or KVM. Let's look at the example of a Managed Service Provider (MSP) creating an LPAR on their LinuxONE server for a new customer. From the customer's perspective, the LPAR they have access to is their own server to use how they wish. This customer may decide to virtualize their LPAR with z/VM or KVM to subdivide the Server for their own purposes.

- LPARs give LinuxONE customers the unique ability to run many mixed workloads on the same physical server. Let's say you have two production mission-critical Oracle databases, Database A and Database B. In an x86 environment, Oracle best practice would have the you dedicate a server for Database A Production, Database A Testing and a third server for Database A Development. Furthermore, 3 additional servers would be needed to create Database B Production, Testing and Development. So, for these 2 database environments, you are now maintaining 6 individual servers. If you are using Oracle WebLogic for 2 applications that connect to these two databases, there are 6 more servers that need to be deployed - Application A Production, Testing and Development and Application B Production, Testing and Development. So, for these 2 applications you are now maintaining and administrating 12 servers.

With LinuxONE, you can use a single server and create 12 LPARs to support this same environment in a single server footprint. There is only one LinuxONE system to administrate and a single server footprint taken up in the server room.

Let's now say you want to deploy a new application using PostgreSQL. In a legacy x86 environment, you would need PostgreSQL servers for Production, Development and Testing. With LinuxONE, you would simply create 6 additional LPARs on the *same* LinuxONE server - the server footprint in the Data Center, energy consumption, and administrative costs have not increased at all to introduce this new capability to the organization.

Scalability
We've already looked a few of the reasons why an x86 Server environment could become unmanageable. However, there's another even larger culprit: *scalability*. For example: if you run an Oracle Database on a commodity x86 Server and run out of compute capacity, there are only two options available to solve this issue:

1. Refresh the Server with a Server that has greater capacity. This is a very disruptive option and not generally considered unless the Server is scheduled to be refreshed due to age.

Scale can be Costly – Case Study #3

A customer has standardized on an x86 commodity Server (Server #1) which has 2 processors and 26 cores/processor and is using Oracle Database Enterprise Edition (EE)[5]. Using a 0.5 Core Factor[2], and the current Oracle Price List[4]. The list price license cost for one Server would be:

Server #1 EE License Cost
*2 Processors * 26 Cores/Processor * 0.5 Core Factor * $47,500 Cost/Core[4] = $1,235,000*

In this example, this server has reached its capacity in the customer's environment, and they have decided to purchase RAC so they can add a second Server (Server #2) to expand capacity. They must license Oracle Database Enterprise Edition on the second server and purchase RAC for both servers. Their licensing cost increases proportionally:

Server #2 EE License Cost
*2 Processors * 26 Cores/Processor * 0.5 Core Factor * $47,500 Cost/Core[4] = $1,235,000*

Server #1 RAC License Cost
*2 Processors * 26 Cores/Processor * 0.5 Core Factor * $23,000 Cost/Core[4] = $598,000*

Server #2 RAC License Cost
*2 Processors * 26 Cores/Processor * 0.5 Core Factor * $23,000 Cost/Core[4] = $598,000*

Total License Cost to implement this 2-node RAC configuration: $3,666,000[4]. Assuming a 60% software discount, the total software cost to the customer would be $1,466,400[4].

Therefore, $1.5M is the total Oracle license cost (after discount) to effectively double their Database compute capacity of just one Prod Database environment using these commodity x86 Servers. *So, although the customer's original intention to use these x86 "building blocks" is well intended, it has major cost ramifications to the organization for years to come, due to not only the initial license purchase but also the ongoing annual support costs for those licenses. And let's not forget - all the other Server environments (Test/Dev, etc.) need these licenses as well. Plus, when this second server has reached its compute capacity, a third server will need to be added to the cluster costing an additional $733,200[4] assuming the same 60% software discount.*

Even if this is the case, if you are looking to double capacity, then simply refreshing with a current model will not provide the capacity you require.

2. Migrate the data to a clustered hard drive technology and take advantage of Oracle's *Real Application Clusters (RAC)*[3] to add additional compute nodes to the cluster. The strategy of using commodity x86 Servers to scale in a modular "building block" fashion (which is considered horizontal scaling[6]) using RAC seems on the surface is a relatively economical way to solve this compute capacity problem, however the cost of the commodity server is dwarfed by the Oracle licensing cost for each Server added to this cluster.

LinuxONE has the ability to scale vertically[6], i.e. dynamically add resources to the existing server to increase its compute capacity. Furthermore, in working with Oracle customers over the course of many years, IBM's customers have averaged a 10:1 consolidation ratio over x86 running the same Oracle workload.

IBM's LPAR technology is used to Hard Partition one LinuxONE server into many stand-alone virtual servers, each one working completely independent of the others. If a customer decides to

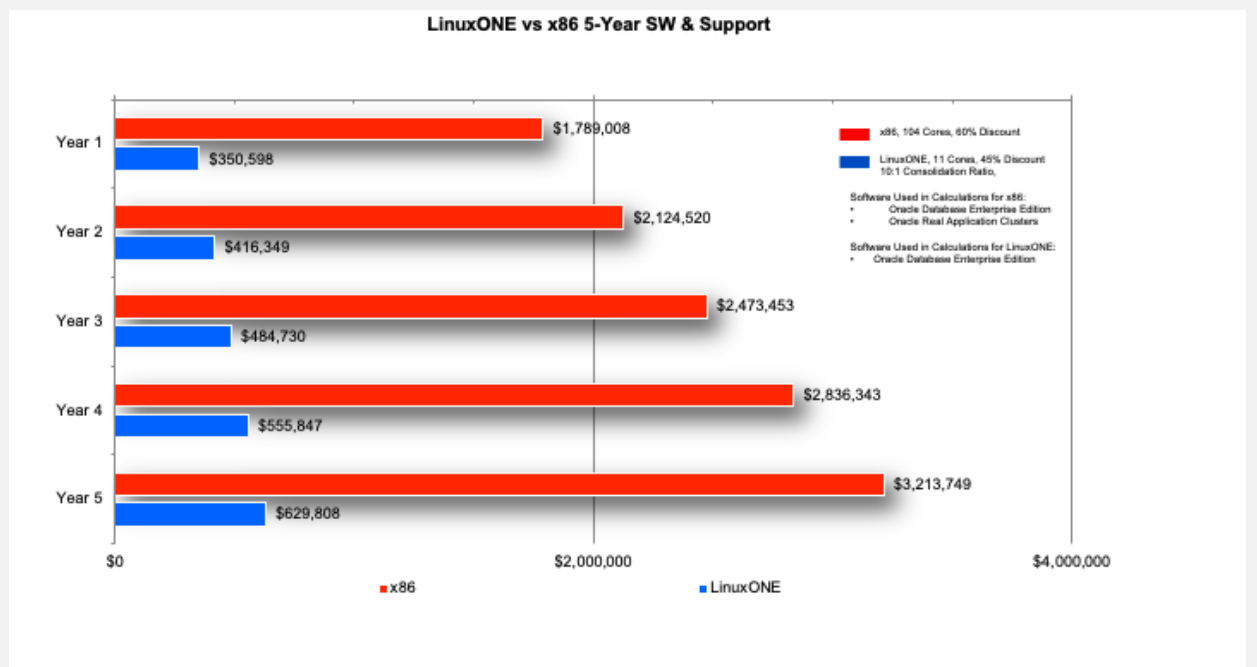***LinuxONE reduces cost with vertical scale - Case Study #4***
Using our average 10:1 consolidation ratio over x86, let's look at the Oracle licensing cost on LinuxONE to run the same workload as in #2 above.

Total Cost of Oracle EE on LinuxONE
<u>104</u> *x86 Cores / 10 = 11 LinuxONE Cores required (rounded up)*

*11 LinuxONE Cores * 1.0 Core Factor * $47,500 Cost/Core[4] = $522,500*

The total license cost (list price) to do the vertical scale-up on LinuxONE is $570,000[4] as opposed to the $3,666,000[4] it would cost to do a horizontal scale-out on x86, or a savings of $3,096,000[4]. *When we add annual support (22% of the purchase price and a 4% uplift/year) and look at a cost comparison over 5 years, we get the following total out-of-pocket expense comparison:*

LinuxONE vs x86 5-Year SW & Support

	x86	LinuxONE
Year 1	$1,789,008	$350,598
Year 2	$2,124,520	$416,349
Year 3	$2,473,453	$484,730
Year 4	$2,836,343	$555,847
Year 5	$3,213,749	$629,808

x86, 104 Cores, 60% Discount

LinuxONE, 11 Cores, 45% Discount
10:1 Consolidation Ratio,

Software Used in Calculations for x86:
- Oracle Database Enterprise Edition
- Oracle Real Application Clusters

Software Used in Calculations for LinuxONE:
- Oracle Database Enterprise Edition

■x86   ■LinuxONE

install Oracle EE in one of these LPARS, only the cores allocated to that LPAR require licensing.

Mixed Workloads

The digital enterprise has an insatiable need to innovate, modernize and adopt the latest technology trends to stay ahead, or at par, with the ever-growing market needs. This all results in huge amounts of data that inherently needs to be stored and protected while maintaining availability and accessibility.

Companies are choosing multiple cloud providers and cloud models, and often a combination of models—public, private, software-as-a-service—to best meet their needs. They are integrating those clouds with existing IT to derive greater value. The result is a hybrid approach to a multi-cloud environment. It's a mix of public clouds to quickly develop and deploy applications, private clouds to maintain the highest levels of security and availability for business-critical data and processes, and in many cases traditional on-premises IT.

Virtualization was an innovative solution to consolidate workloads and manage them through simpler processes, which at the same time resulted in critical challenges like performance deficiency, lower utilization of resources, and new costs such as licensing.

The LinuxONE Solution

A Linux infrastructure on LinuxONE provides an enterprise-grade Linux environment that combines the advantages of the LinuxONE hardware servers and leading IBM z/VM® virtualization with the flexibility and open standards of the Linux operating system.

LinuxONE handles it all with up to 190 cores (equivalent to up to 1,000 x86 cores), hundreds of dedicated I/O processors and the fastest commercial processor available. LinuxONE scales vertically or horizontally to meet crucial digital transformation initiatives without disrupting your business.

- Offload I/O to keep your main cores free to run multiple mixed workloads in parallel without slowing.

- Gain up to 50% faster Java performance.

- Scale instantly with great performance and support up to 2M Docker containers – even during spikes in demand.

LinuxONE provides a flexible, open, hybrid, multi-cloud and secured enterprise platform for mission-critical workloads, that allows enterprises to adopt a heterogenous path to managing their infrastructure by using the vendor of choice like Red Hat, SUSE, MongoDB, etc. LinuxONE delivers containerized applications that can scale vertically and horizontally. This flexibility allows an organization to:

- Accelerate deployment and orchestration of containers with Kubernetes;

- Help IT support rapid business growth;

- Optimize workloads to take advantage of pervasive encryption; and

- Increase container density to make systems management easier (and can reduce total cost of ownership).

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LinuxONE