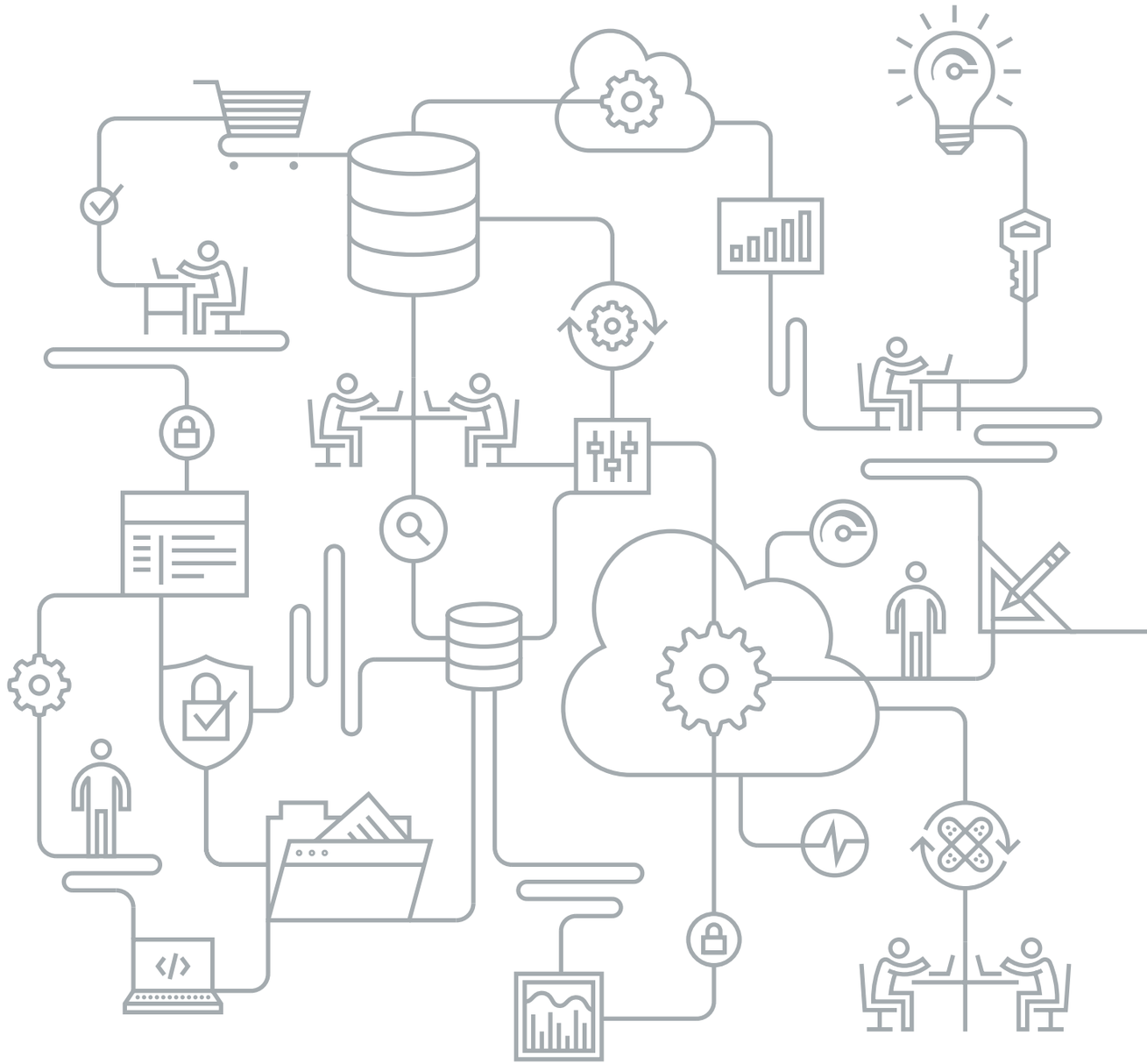
SHOULD I MIGRATE TO HOSTED PRIVATE CLOUD?

AN INSIGHTFUL TCO ANALYSIS OF ON-PREMISES VS. HOSTED PRIVATE CLOUD ENVIRONMENTS



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EXECUTIVE SUMMARY

Companies of all sizes are evaluating the strategic benefits of IaaS, and of moving on-premises IT infrastructure, systems and applications to the cloud. Because of its enhanced security features and protected environment, hosted private cloud is the logical choice for companies regulated by PCI DSS, SOX, HIPAA, FISMA and GLBA. As proof, over half of all companies recently surveyed by Tech Pro Research reported a risk decrease following an IaaS implementation in the cloud.

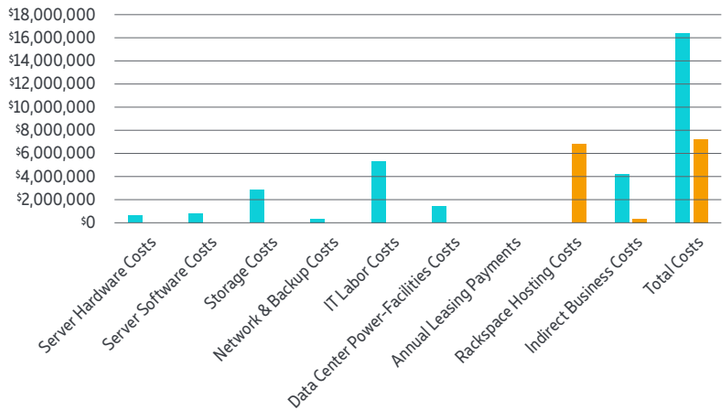
This white paper provides a comprehensive total cost of ownership (TCO) analysis of Rackspace Hosted Private Cloud for an upper midsize, U.S.-based financial services company with $500 million in annual revenue and 500 employees. The company ran its business-critical systems and web applications in its main and disaster-recovery data centers, but because of increased growth and regulatory requirements, the company required a full technology refresh to enable its 10-year strategic plan. This TCO analysis evaluated its on-premises and hosted private cloud options, and compared the results.

The TCO analysis estimated the company would achieve a 60% cost savings over five years by migrating to Rackspace Hosted Private Cloud. To compare costs, the on-premises technology refresh option totaled $16.3 million. Of this, $3.7 million was capital expenditure (CapEx), $8.4 million was operating expenditure (OpEx), and $4.2 million was indirect cost. By contrast, the Rackspace option totaled $7.2 million. Of this, CapEx was zero, $6.8 million was OpEx, and $3.7 million was indirect cost. The total five-year cost savings fell squarely between the 35-85% bell curve predicted by the financial model within two standard deviations of the mean.

The following chart compares the costs in nine technology areas, and shows the total cost of each option.

THREE-YEAR TCO SUMMARY

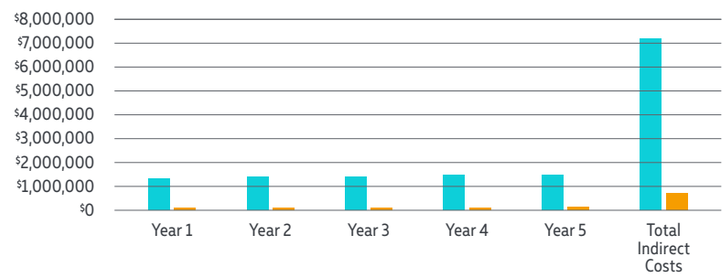
On-Premises vs. Hosted Private Cloud



Indirect costs, which are often difficult to calculate, were included in this TCO analysis using conservative numbers in the formulas. The total savings in indirect costs over five years was estimated to be $6.4 million.

FIVE-YEAR INDIRECT COST SUMMARY

On-Premises vs. Hosted Private Cloud



A detailed explanation of this TCO analysis is provided in the remainder of this white paper.

INTRODUCTION

The question, "Should I migrate to the cloud?" is one of the top inquiries made by IT professionals today in companies of all sizes, across all industries. Everyone wants to embrace the benefits of the cloud, but the choice is not a simple one. There are three basic types of cloud computing environments, plus two variations, to choose from: private, public, hybrid, community and virtual private. There are also new ways for IT to function internally and cross-organizationally, for example: as a service broker for business units, as a clearinghouse for information, or as an enterprise software development group guided by an agile relationship between application development and IT operations (DevOps). This white paper explores the benefits of hosted private cloud managed services from Rackspace, and explores why some companies may benefit more from hosted private cloud than from other cloud computing environments.

Hosted private cloud environments are implemented with dedicated hardware, software, network and storage infrastructure for the exclusive use of one corporate client; hence the name "private" cloud. The "hosted" prefix implies that the underlying infrastructure resides in off-premises data center facilities owned and operated by a managed cloud provider, like Rackspace, rather than in an on-premises data center owned and operated by the client.

Companies that choose to migrate to hosted private cloud still have an option to keep part of their IT infrastructure on-premises, because migration is not an "all or nothing" proposition. In fact, keeping part of one's IT infrastructure on-premises may be necessary when there is a requirement to maintain physical "proximity" control over the hardware and software assets. But the cost reduction benefits of hosted private cloud may be reduced if companies continue to invest in on-premises infrastructure as well as private cloud infrastructure.

Hosted private cloud security, control, flexibility, scalability and performance levels are generally higher than all other types of cloud computing, and companies that have strict governance or regulatory

requirements from PCI DSS, SOX, HIPAA, FISMA and GLBA usually require the increased protection to pass a compliance audit.

To further protect client IT environments against advanced persistent threats (APTs) and other cyberattacks, Rackspace offers Rackspace Managed Security. This custom offering provides deep security knowledge, leading technology and advanced threat intelligence, tailored to client business needs. It provides a 24x7x365 defense capability that actively hunts for threats in client cloud environments and responds to them immediately. This frees client IT staff to focus on top initiatives that drive the business, and offers significant cost savings when compared to internally developed security solutions.

Hosted private cloud is well-suited to application hosting, data center migration, data replication, data analytics, data backup, disaster recovery, high availability and test-development-operations integration (DevOps). Companies with those requirements should consider the potential benefits of migration.

Hosted private cloud benefits vary from company to company due to differences in owned, versus leased or licensed, hardware and software assets. But the fundamental questions that drive the decision to move to hosted private cloud never change: Does moving to the cloud make business sense? What are the investments, expenses and payoffs? How long will the migration/transition take? What are the business risks? How will existing cost structures be affected? These are all important business questions that must be answered before acting, and many companies find that analyzing the total impact on costs is one of the most challenging problems they face.

Based on a proven total cost of ownership (TCO) modeling methodology built from extensive experience working with companies of all sizes, this white paper shows how companies can make a detailed, informed assessment of the financial drivers behind their decision to move part or all of their IT environment to hosted private cloud.

OVERVIEW OF INFRASTRUCTURE ECONOMICS

Not all dollars are considered equal in business finance. When calculating the costs of purchasing, building and maintaining IT infrastructure, a business will view a dollar spent on a capital expenditure (CapEx) quite differently than a dollar spent on operating that infrastructure (OpEx). CapEx and OpEx are subject to different accounting rules, and they reflect different values to the business. CapEx spent on buildings, equipment and software is an asset, carried on a company's balance sheet, whereas OpEx spent on services impacts the income statement and affects earnings.

What does this have to do with a business decision to migrate to hosted private cloud?

Actually, quite a lot. Both CapEx and OpEx figure prominently in determining the total cost of owning and managing IT infrastructure, and in any IT manager's efforts to budget for IT costs. And these decisions flow through to the bottom line of the business.

TCO, ROI and other types of financial analyses that report on growth and profitability must be backed by hard numbers and a proven analysis process to be believable. Signoff doesn't come easy these days, and a decision to move to the cloud affects the entire company. Approving such a strategic expenditure usually involves a consensus decision by executive management, marketing operations and business units.

TOTAL COST OF OWNERSHIP

From a TCO perspective, migrating to hosted private cloud can be a preferable alternative to building, buying and managing IT infrastructure in-house, on-premises. In the past, when cloud computing was in its infancy, there was a general concern that security and compliance risk were greater in cloud environments — but today, top-tier managed cloud providers like Rackspace offer ready-made and custom-hosted private cloud solutions that provide highly secure and regulation-compliant cloud computing environments to fully protect a company's IP and assets. How is this possible? The maturity of cloud computing technology and collective implementation experience of top-tier managed cloud providers like Rackspace have evolved and become more sophisticated over the years. They can be fully leveraged by client businesses to offset technology and staffing costs that would otherwise be borne by the businesses themselves.

So how does one start the process of understanding the financial impact of migrating to a hosted private cloud? It is first necessary to identify what one's current IT infrastructure truly costs to build, buy or lease, and run (i.e., TCO). This is not an easy task because there may be hidden or indirect costs to consider in addition to ongoing and ad-hoc expenses that are not well understood.

TCO is a critical, but somewhat subjective number. To make an informed decision about migrating infrastructure to the cloud, it's essential to understand the complete costs of maintaining infrastructure in-house. However, approaches to estimating TCO vary from one organization to another in terms of accuracy.

In general, though, the more thorough the analysis and comprehensive the estimate, the more valuable the TCO figure will be. Rackspace has adopted the Alinean TCO methodology. The Alinean methodology is effective because it takes into account the broadest range of potential costs, and models them based on realistic assumptions. It separates TCO into three basic categories:

- **Capital Costs (CapEx)** – defined as new purchases of hardware and software
- **Operating Expenses (OpEx)** – includes hardware and software support costs, personnel, and related services
- **Indirect Business Costs** – includes the impact of downtime on productivity, the increase of business agility, and so forth

MODELING ABC COMPANY'S INFRASTRUCTURE TCO

This white paper applies the Alinean TCO methodology to ABC Company, a midsize-to-large enterprise in the financial services industry, with on-premises infrastructure operating in its own main and disaster recovery data centers. The company has reached a critical point in its growth cycle, and to meet demanding business requirements over the next five years, ABC must either refresh its existing on-premises infrastructure or migrate to hosted private cloud.

ABC Company should look familiar if you are involved in managing IT infrastructure at a comparable company. The company runs several critical, web-based business applications on the Microsoft® Windows Server® platform. The applications use Microsoft SQL Server® for their database component. ABC uses VMware® vSphere® software to virtualize dedicated servers, and the business applications require the infrastructure to the right:

DATA CENTER	MAIN	DISASTER RECOVERY	TOTAL
SERVERS			
HP DL380 G9, Dual 18-Core, 512GB RAM, 2x300GB 12G SAS servers – running Red Hat Linux and Oracle Enterprise database	4	12	16
HP DL380 G9, Dual 12-Core, 256GB RAM, 2x300GB 12G SAS servers – running Windows Server Datacenter Edition	30	2	32
HP DL380 G9, Dual Octal Core, 128GB RAM servers - running Windows Server and SQL Server Enterprise	6	2	8
HP DL380 G9, Dual 12-Core, 256GB RAM, 2x300GB 12G SAS servers – running Red Hat Linux	15		15
HP DL560, Quad 18-Core, 1536GB RAM, 10Gb NEC, RAID Controller		3	3
TOTAL SERVERS	**55**	**19**	**74**
NETWORK EQUIPMENT			
ASA 5525-X	2	1	3
F5 BIG-IP 5200 with LTM + AFM	2	1	3
Alert Logic Intrusion Detection (IDS) + SSL Decryption	1		1
Alert Logic Log Manager	1		1
Cisco 9372-TX/PX	8	4	12
Brocade DS-6520B 48-port Network Switches	2	2	4
TOTAL NETWORK EQUIPMENT	**16**	**8**	**24**
STORAGE			
Dell EMC Unity 400 Hybrid Flash (SAN/NAS)	1 388 TB	1 120 TB	2
TOTAL STORAGE	**1**	**1**	**2**

TCO SUMMARY

The table to the right shows the final output of the Alinean TCO analysis on ABC Company's infrastructure. In this three-year view, the TCO will be $16,351,829 to refresh the infrastructure and business applications in-house. Of this, $3.7 million is CapEx while $8.4 million is OpEx, and $4.2 million is indirect cost. We will now explore these numbers in more detail.

SELF-MANAGED ANNUAL COST DETAILS	YEAR 1	YEAR 2	YEAR 3	TOTAL
CAPITAL COSTS (CAPEX)				
Current server hardware costs	$436,180	$56,362	$58,059	$550,600
Server software license costs	$492,592	$24,630	$25,861	$543,083
Network infrastructure costs	$61,045	$3,052	$3,205	$67,302
Storage costs	$1,711,706	$327,364	$340,868	$2,379,937
Backup infrastructure costs	$121,200	$28,410	$29,831	$179,441
TOTAL ANNUAL CAPITAL COSTS	**$2,822,723**	**$439,818**	**$457,823**	**$3,720,363**
OPERATING EXPENSES (OPEX)				
Current server hardware support costs	$44,426	$46,894	$49,362	$140,681
Software support costs	$123,148	$129,305	$135,771	$388,224
Network infrastructure support costs	$4,884	$5,128	$5,384	$15,396
Storage warranty costs	$163,728	$195,041	$227,646	$586,416
Data center power and facilities cost	$504,205	$529,415	$555,886	$1,589,505
Current system admin labor costs	$1,557,141	$1,658,355	$1,766,148	$4,981,645
IT training costs	$103,980	$106,579	$109,244	$319,803
IT staff turnover costs	$46,840	$48,011	$49,211	$144,062
Network bandwidth costs	$76,500	$81,000	$81,000	$238,500
TOTAL ANNUAL OPERATING EXPENSES	**$2,624,851**	**$2,799,729**	**$2,979,652**	**$8,404,232**
INDIRECT BUSINESS COSTS				
Indirect Cost Realization Factor	20%			
Unplanned downtime - productivity impact	$10,204	$10,460	$10,721	**$31,385**
Planning downtime - productivity impact	$27,936	$28,634	$29,350	**$85,921**
Business agility - productivity impact	$443,837	$454,933	$466,306	**$1,365,076**
Unplanned downtime - business costs	$120,454	$123,465	$126,552	**$370,471**
Planning downtime - business costs	$263,808	$270,403	$277,163	**$811,374**
Business agility - revenue impact	$508,191	$520,896	$533,919	**$1,563,006**
TOTAL ANNUAL BUSINESS COSTS	**$1,374,431**	**$1,408,792**	**$1,444,011**	**$4,227,233**
TOTAL	**$6,822,005**	**$4,648,338**	**$4,881,486**	**$16,351,829**

CAPEX VS. OPEX BY TCO CATEGORY

Some of the Alinean TCO categories are purely operational, affecting only OpEx. For example, IT staff salaries are an expense. There is no direct capital investment required to hire people, if you exclude office facilities and the like. Other categories will break out into both a CapEx and an OpEx figure. Server hardware, server software, network infrastructure, storage, backup, and power and facilities all contain CapEx and OpEx expenditures. This breakout occurs because in each of these categories the purchase of the hardware or software asset invariably triggers a related, recurring maintenance charge. Typically, the numbers are in proportion. The higher the asset price, the higher the support fee. Software maintenance is usually around 25 to 28% of the license cost each year.

SERVER HARDWARE

Server hardware costs depend on processor speeds, memory, on-board storage and other factors. The Server Hardware Appendix shows the pricing and feature detail for servers acquired by ABC Company to fully refresh the current server environment to meet business requirements. The five-year server hardware cost projection shown in Table 2 reflects the assumption that ABC Company will add servers at a growth rate of 5% a year. In year 1, the company must buy (refresh) 72 servers, for a CapEx expenditure of $403,870. In years 2 through 5 they buy four more servers per year. By year 5, ABC Company has 88 servers. Assuming a 36-month replacement cycle for server hardware, the company must purchase 72 replacement machines in year 4, and four more in year 5.

Spare parts are estimated at 8% of purchase cost, an expenditure that starts at $32,310 in year 1 and grows in proportion to the installed base of servers. Total CapEx for server hardware is $436,180 in year 1. CapEx drops in years 2 and 3, but rises again to $463,710 in year 4 as adding servers for growth and replacing aging servers require a substantial capital outlay.

OpEx for server hardware is based on server maintenance costs. Service contracts, priced at 11% of purchase price, generate an annual OpEx expenditure that starts at $44,426 in year 1 and grows to $54,298 in year 5. Total costs for server hardware, including CapEx and OpEx, are $691,282 for the first three years and $1,345,266 for the five-year projection.

TABLE 2: ANNUAL SERVER HARDWARE COSTS

ANNUAL SERVER HARDWARE COSTS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Number of servers (beginning of year)	0	72	76	80	84
Servers added for growth	72	4	4	4	4
Servers purchased for replacement	0	0	0	72	4
Average purchase price per new server (initially)	$5,609				
Average purchase price per growth or replacement server	$0	$5,609	$5,609	$5,609	$5,609
Annual server purchase costs	$403,870	$22,437	$22,437	$426,307	$44,874
Annual costs for server spare and replacement parts	$32,310	$33,925	$35,621	$37,402	$39,273
Annual Server Hardware Costs (Capex)	$436,180	$56,362	$58,059	$463,710	$84,147
Annual Server Hardware Maintenance (Opex)	$44,426	$46,894	$49,362	$51,830	$54,298
TOTAL SERVER HARDWARE COSTS	**$480,605**	**$103,256**	**$107,420**	**$515,540**	**$138,445**

SERVER SOFTWARE

To run its business-critical web applications, ABC Company must purchase server software, including multiple editions of Microsoft Windows Server, Red Hat® Linux, SQL Server and Oracle® database software, and VMware vSphere software. The details of the license count and fees are contained in the Server Software Appendix. Software is an asset.

Though you can't touch it or see it, software must be booked on the corporate balance sheet as a capital expense and depreciated over time just like a server, storage or network equipment. Acquiring the software for this technology refresh requires a CapEx of $492,592 in year 1. As shown in Table 3, with a 5% annual growth rate in the server install base, software CapEx continues to accrue in each subsequent year, starting with $24,630 in year 2 and growing to a total of $598,749 by year 5.

OpEx for server software is based on ongoing support, which is standard for most enterprise software products. Calculated in this case at 25% of license fees, server support costs total $123,148 in year 1. With the growth in the server install base, the server software OpEx grows to a total of $680,470 by year 5. The three-year total cost for server software, including CapEx and OpEx expenditures, is $931,307. The five-year total is $1,279,219.

TABLE 3: ANNUAL SERVER SOFTWARE COSTS

ANNUAL SERVER SOFTWARE COSTS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Annual server software purchase costs (CapEx)	$492,592	$24,630	$25,861	$27,154	$28,512
Annual server software support costs (OpEx)	$123,148	$129,305	$135,771	$142,559	$149,687
TOTAL SERVER SOFTWARE COSTS	**$615,740**	**$153,935**	**$161,632**	**$169,713**	**$178,199**

NETWORK INFRASTRUCTURE

Network infrastructure required to connect ABC Company web applications to all users, internal and external, must be included in TCO. ABC's web applications technology refresh will involve the purchase of new network equipment to replace outdated technology. This makes it relatively easy to estimate CapEx and OpEx for the network infrastructure elements of the TCO calculation.

Some companies, however, will already have suitable network infrastructure in place. A new application will share that infrastructure with other systems already running. Should the costs associated with that network be applied to the TCO for the new application? Yes, they should. This may contradict what is generally known as the "sunk cost" theory of TCO. In this approach, if the assets in question have already been paid for, then the cost is "sunk" and they should not be considered relevant to future investments. While there may be financial and accounting merit to this argument, the best practice is to include the cost of any IT asset that is deployed in a proposed use case. Alinean TCO methodology requires the cost of shared infrastructure assets to be applied proportionally to the TCO of a proposed use case.

ABC Company's refreshed web applications need firewalls, load balancers, network switches and an intrusion detection system. Specific equipment models and costs are detailed in the Network Infrastructure Appendix. The initial CapEx outlay for network infrastructure equipment is $61,045, as shown in Table 4. As the server install base grows, CapEx continues to accrue in each subsequent year, starting at $3,052 in year 2 and growing to $74,201 by year 5. OpEx is based on ongoing maintenance costs and service contracts estimated at 8% of hardware purchase cost. OpEx for network infrastructure grows from $4,884 in year 1 to $26,985 by year 5. The three-year TCO for network infrastructure is $82,698. By the fifth year, the total cost of network infrastructure will be $101,186.

TABLE 4: ANNUAL NETWORK INFRASTRUCTURE COSTS

ANNUAL NETWORK INFRASTRUCTURE COSTS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Annual network equipment purchase costs (CapEx)	$61,045	$3,052	$3,205	$3,365	$3,533
Annual network equipment maintenance costs (OpEx)	$4,884	$5,128	$5,384	$5,653	$5,936
TOTAL NETWORK INFRASTRUCTURE COSTS	**$65,929**	**$8,180**	**$8,589**	**$9,019**	**$9,469**

STORAGE

ABC Company's web applications need refreshed storage infrastructure as well. Based on requirements, ABC believes it can benefit from the cost-performance characteristics of Dell EMC Unity 400 Hybrid Flash storage, configurable as SAN or NAS. ABC needs roughly 388TB for its main data center, and 120TB for its disaster recovery site. The Storage Appendix contains the cost details. The interesting thing about storage TCO is that while company storage needs invariably rise over time, the cost per TB typically falls year by year.

ABC projects it will need 508TB in year 1, 114TB more in year 2, 140 more TB in year 3, and so forth. Storage costs are projected to decrease from about $3 per GB in year 1 to just less than $2 in year 5 — a 33% drop! With storage networking costs calculated at 15% of storage hardware purchase price, storage CapEx is $1,711,706 in year 1. Year 2 will require supplemental storage purchases of $284,664, with similar purchases required for years 3 and 4. By year 5, total storage CapEx will be $3,104,435. Storage OpEx, estimated as an 11% support fee for the storage hardware, grows from $163,728 in year 1 to a total of $1,144,958 by year 5. The three-year TCO for storage is $2,966,353. The five-year TCO is $4,249,393.

TABLE 5: ANNUAL STORAGE COSTS

ANNUAL STORAGE COSTS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Storage capacity	0	508,000	622,300	762,318	933,839
Storage capacity added for growth (GBs)	508,000	114,300	140,018	171,521	210,114
Average price per GB	$3	$2	$2	$2	<$2
Annual storage purchase costs	$1,488,440	$284,664	$296,407	$308,633	$321,364
Storage networking costs	$223,266	$42,700	$44,461	$46,295	$48,205
Annual storage equipment costs (CapEx)	$1,711,706	$327,364	$340,868	$354,928	$369,569
Annual storage support costs (OpEx)	$163,728	$195,041	$227,646	$261,596	$296,946
TOTAL ANNUAL STORAGE COSTS	**$1,875,434**	**$522,405**	**$568,514**	**$616,524**	**$666,515**

BACKUP INFRASTRUCTURE

Backup is another TCO element that often gets lumped into "sunk costs." But it should be included in TCO, even if the actual dollar amounts are relatively low. This is true for two reasons beyond the basic costs involved. One reason is that backup is a critical, repetitive process that requires full-time employees (FTEs) who are included in the IT staff section of the TCO analysis. Another reason is that however routine backup might be, if not done correctly, it can be the source of extremely costly incidents that may be visible outside the company, and impact reputation, brand and profitability.

Table 6 summarizes ABC Company's backup TCO. As detailed in the Backup Appendix, a single tape drive can accommodate five servers. With 72 servers installed, ABC will need 15 tape drives, each costing $2,500. Each backup server requires its own software, with its own support fees. Tape media alone, which requires two sets of tapes for each server, totals $70,013 by year 5. Backup has a three-year TCO of $179,441. The five-year TCO is $243,651.

TABLE 6: ANNUAL BACKUP COSTS

ANNUAL BACKUP COSTS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Backup equipment costs (tape drives)	0	508,000	622,300	762,318	933,839
Backup software licenses	508,000	114,300	140,018	171,521	210,114
Annual backup software support costs	$3	$2	$2	$2	<$2
Annual tape media costs	$1,488,440	$284,664	$296,407	$308,633	$321,364
Annual off-site tape storage costs	$223,266	$42,700	$44,461	$46,295	$48,205
TOTAL ANNUAL STORAGE COSTS	**$1,875,434**	**$522,405**	**$568,514**	**$616,524**	**$666,515**

POWER AND FACILITIES

ABC Company's business applications have, in the past, been hosted in the company's own physical data center facilities. The main site in Chicago and the disaster recovery site in Dallas both require electrical power to run and cool the hardware and power the lights, air conditioning, fire protection equipment, etc. ABC built the two data centers years ago, and many of the assets have been fully depreciated — but they should not be treated as sunk cost in TCO estimates. Instead, the CapEx that went into building the data centers should be factored into TCO as a per-square-foot-of-floor-space cost based on the depreciation of data center assets. Accordingly, this TCO analysis treats the two data centers as OpEx, even though their construction was treated as CapEx.

If a new data center were required today to support future growth, then its cost would of course be treated as CapEx. Some companies today are building new data centers to handle increases in computing load, but it's a costly proposition. A 15,000 square foot data center, which can hold about 460 equipment racks, will cost between $5.2 and $20 million for basic construction and infrastructure. This is one reason companies like ABC are looking to leverage hosted private cloud infrastructure to handle growth and scalability, and to minimize massive CapEx projects that weigh down profitability.

The Power & Facilities Appendix details how data center operating costs were determined. There are two basic cost factors: floor space and power. Floor space costs were derived from a combination of operating overhead and depreciation of facility construction costs. For instance, if a 15,000 square foot data center costs $10 million to build, and was depreciated over 15 years, which is an industry norm, the depreciation charge for data center floor space would be $44 per square foot per year. The Alinean TCO model calculates data center floor space at $62 per square foot per year, which adds overhead such as insurance, maintenance, fire protection and so forth to the base depreciation figure.

How much floor space should be assigned to ABC Company's refreshed web applications, systems and infrastructure? Based on the size of the hardware required, the analysis shows that the environment will use roughly 602 Us of rack space over five years. A U is 1 .75" high, and most servers are one, two or four Us in height. There are 42 Us in a standard 19"-wide data center rack.

For practical purposes, this analysis assumes that there are 40 usable Us in a rack. Each rack requires 20 square feet of floor space. The web applications, with 610 Us, require 15 racks, for a total of 300 square feet of floor space.

As Table 7 shows, this results in an annual floor space charge of $11,547 in year 1, growing to $63,807 by year 5.

TABLE 7: ANNUAL DATA CENTER FACILITIES COSTS

ANNUAL DATA CENTER FACILITIES COSTS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Annual costs for data center floor space	$11,547	$12,125	$12,731	$13,368	$14,036
Annual data center energy costs	$217,637	$228,518	$239,944	$251,942	$264,539
Data center additional cost factor	2.2	2.2	2.2	2.2	2.2
ANNUAL DATA CENTER FACILITIES COSTS	**$504,205**	**$529,415**	**$555,886**	**$583,680**	**$612,864**

Energy costs in the data center are estimated using two criteria. First, there is the power consumption required to run the equipment included in the TCO analysis — and each piece of hardware uses power differently. For example, HP ProLiant DL380 G9 (2ch x 18 core, 512GB) servers use about 822 watts of power, on average, whereas the HP ProLiant DL380 G9 (4ch x 18 core, 1536GB) servers use about 1,330 watts of power. Over the course of five years, the servers, storage and network equipment used by ABC business web applications will need 5,969,848 kilowatt hours of electricity.

Then there's the energy used to power the rest of the data center, including lighting, cooling and supplemental systems. The two figures are connected by a factor known as "Power Usage Effectiveness" or PUE, which is the ratio of system-specific energy use to general-purpose power use in a data center. The lower the PUE, the more energy-efficient the data center. In the most advanced data centers in the world, the PUE hovers around 1.2. This means that for every watt used to power an actual server, another 1.2 watts is required to cool the place down and keep the lights on. In this analysis, we assume a PUE of 2.5, which is standard in the industry. Applying this PUE to the 45,750 kilowatt hours (KwH) needed for the system hardware, the overall power use for the system will be just over 1 million KwH per year. At a cost of nine cents per KwH, that comes to an annual energy cost for ABC Company of $240,516,235. The total data center facilities and power cost, after multiplying by Alinean's add-on factor of 2.2 to account for corporate overhead and many other related expenses, averages $557,210 per year of OpEx. The three-year total is $1,589,505. The five-year TCO is $2,786,049.

IT LABOR COSTS

People costs are the largest OpEx category. This makes sense because IT is an inherently human activity. It's important to capture the full measure of staffing costs in TCO. Salaries and benefits are not the only cost items that need to be tracked. The Alinean TCO model also factors in training and turnover costs. Unlike equipment or code, people are not static. People change jobs. They must learn new skills. They leave. The costs of these circumstances must be modeled and analyzed for their impact on TCO. We'll return to this later, but one of the top benefits of migrating to hosted private cloud is the ability to lower labor costs and increase specialized skills by leveraging the cloud provider's staff resources as part of a bundled service.

SYSTEM ADMINISTRATION STAFF

Each technology component of ABC Company's business-critical web applications needs to be administered, at least part of the time. A person with many duties might devote part of his or her time to the web applications. For other parts of the system, one or more full-time people will be required to keep those components running smoothly. The TCO analysis for system administration staff is detailed in the System Admin Labor Appendix. It calculates how many full-time employees (FTEs) are needed to oversee the servers, network, databases, storage, security and so forth. A person who only spends part of his or her time on a component is estimated as a fraction of an FTE. For instance, if an IT staffer spends one quarter of his or her time on the web application, the TCO analysis counts that as .25 FTEs.

Different administrator types earn different salaries. In this analysis, we estimate a server administrator earns an average salary of $76,860 a year while a database administrator earns $85,644. These figures are based on standard industry salaries from the Alinean TCO methodology. With taxes and benefits, the "fully burdened" salary across all types of administrators averages $96,750 per year. As shown in Table 8, with 16.39 FTEs required for the web application across both data centers, the system admin labor costs total $1,557,141 in year 1 alone. Over five years, it amounts to $8,865,803.

TABLE 8: IT LABOR COSTS

IT LABOR COSTS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Average fully burdened salary	$73,948	$92,434	$115,543	$144,429	$180,536.52
System admin labor costs	$1,557,141	$1,658,355	$1,766,148	$1,880,948	$2,003,210
System admin staff (FTEs)	16.39	16.80	17.22	17.65	18.09
SYSTEM ADMINISTRATION EFFORTS (HOURS)	**29,497**	**30,234**	**30,999**	**31,765**	**32,559**

TRAINING AND TURNOVER

The Alinean TCO model assumes IT staff members will receive either 40 or 80 hours of training per year, as detailed in the IT Training Costs Appendix. At a rate of $3,500 per 40-hour training unit, the IT staff required to run ABC Company's web applications will accrue training costs that average $109,310 per year. Table 9 summarizes the costs and hours involved.

Staff turnover is estimated at 15% per year, which means that ABC Company will be replacing 2.46 FTEs per year. Recruitment costs per new position are estimated at 20% of the fully burdened salary, or $14,790 per year. Adding onboarding costs equivalent to three weeks' salary, the total cost of IT staff turnover averages $49,421 per year. A detailed look at these costs is found in the Staff Turnover Costs Appendix.

NETWORK BANDWIDTH

The business-critical web applications will use a portion of ABC Company's network bandwidth, and a pro-rata share of the bandwidth cost will be applied to OpEx. The Network Bandwidth Costs Appendix outlines how each server requires roughly 350 Mbps of bandwidth. At that rate, ABC Company must provision the equivalent of 17 T-1 Lines in year 1, each with 1.54 Mbps of bandwidth. At roughly $375 per month, these lines will add OpEx of $76,500 per year, and this number will grow proportionally over the next five years to $90,000.

TABLE 9: ANNUAL IT TRAINING COSTS

ANNUAL IT TRAINING COSTS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
IT training costs	$103,980	$106,579	$109,244	$111,975	$114,774
IT training hours	1,188	1,218	1,248	1,280	1,312

TABLE 10: ANNUAL IT STAFF TURNOVER COSTS

ANNUAL IT STAFF TURNOVER COSTS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
IT staff turnover costs	$46,840	$48,011	$49,211	$50,442	$51,703

TABLE 11: ANNUAL NETWORK BANDWIDTH COSTS

ANNUAL NETWORK BANDWIDTH COSTS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Number of T-1 lines required	17	18	18	19	20
TOTAL ANNUAL NETWORK BANDWIDTH COSTS	**$76,500**	**$81,000**	**$81,000**	**$85,500**	**$90,000**

INDIRECT COSTS

Accurate TCO must include an estimate of the indirect costs required to host ABC's business-critical applications and systems in-house, compared to a managed hosting environment. Indirect costs include unplanned downtime, planned downtime and business agility. Each of these indirect costs has a real impact on ABC's financial picture, even if they can be somewhat challenging to measure.

Indirect cost estimation tends to be more subjective and assumption-based than the clear-cut dollars and cents of the hardware, software and network TCO elements. However, the Alinean TCO model, which is based on years of experience in cost analysis, shows that managed hosting delivers significantly better indirect cost performance than on-premises hosting, as detailed in the Indirect Cost Appendix and summarized in Table 12. On average, managed hosting indirect costs are only 10% of on-premises hosting indirect costs. That's an average benefit of $1,293,286 per year, and a total of $6,466,429 over a five-year period.

For example, the financial impact of planned and unplanned downtime is estimated by calculating the number of worker hours that are lost to system outages. Managed hosting solutions typically have a higher rate of uptime and less planned downtime; as a result, they reduce the impact of downtime on productivity. Managed hosting solutions also speed up planned downtime cycles, which reduces the revenue opportunity cost associated with having systems offline.

Business agility is another example. This analysis measures business agility by the rate at which the company can develop and deploy upgraded and/or new applications to drive competitiveness and differentiation. The faster the applications are put into production and contribute to revenue growth, the more financial benefit the company will gain. A revenue-enhancing application whose deployment is delayed results in an opportunity cost of lost revenue. In this case, as shown in the Indirect Cost Appendix, the ability to provision applications in two days instead of 45 reduces the average lost productivity improvement value per system from $61,644 to $2,740, and the annual value of productivity losses from $2,219,184 to $98,640. We'll talk more about agility, using time to market as an example, in the final section.

TABLE 12: INDIRECT BUSINESS COSTS

INDIRECT BUSINESS COSTS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
CURRENT SELF-MANAGED COSTS					
Unplanned downtime - productivity impact	$51,022	$52,298	$53,605	$54,945	$56,319
Planned downtime - productivity impact	$139,680	$143,172	$146,751	$150,420	$154,181
Business agility - productivity impact	$2,219,184	$2,274,664	$2,331,531	$2,389,819	$2,449,564
Unplanned downtime - business costs (Revenue opportunity cost)	$602,270	$617,327	$632,760	$648,579	$664,793
Planned downtime - business costs (Revenue opportunity cost)	$1,319,040	$1,352,016	$1,385,816	$1,420,461	$1,455,973
Business agility - revenue impact (Lost revenue opportunity)	$2,540,957	$2,604,481	$2,669,593	$2,736,333	$2,804,741
Total self-managed costs	$6,872,153	$7,043,958	$7,220,056	$7,400,557	$7,585,571
Indirect benefit realization factor	20%	20%	20%	20%	20%
TOTAL REALIZED COSTS	**$1,374,431**	**$1,408,792**	**$1,444,011**	**$1,480,111**	**$1,517,114**

INDIRECT BUSINESS COSTS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
COSTS WITH HOSTED SOLUTION					
Unplanned downtime - productivity impact	$17,004	$17,429	$17,865	$18,312	$18,770
Planned downtime - productivity impact	$27,936	$28,634	$29,350	$30,084	$30,836
Business agility - productivity impact	$98,640	$101,106	$103,634	$106,225	$108,881
Unplanned downtime - business costs (Revenue opportunity cost)	$200,741	$205,760	$210,904	$216,177	$221,581
Planned downtime - business costs (Revenue opportunity cost)	$263,808	$270,403	$277,163	$284,092	$291,194
Business agility – revenue impact (Revenue opportunity cost)	$112,935	$115,758	$118,652	$121,618	$124,658
Total hosted costs	$721,064	$739,090	$757,568	$776,508	$795,920
Indirect benefit realization factor	20%	20%	20%	20%	20%
Total realized costs	**$144,213**	**$147,818**	**$151,514**	**$155,302**	**$159,184**
TOTAL IMPROVED SERVICE LEVEL BENEFITS	**$1,374,431**	**$1,408,792**	**$1,444,011**	**$1,480,111**	**$1,517,114**

ESTIMATING THE TCO DIFFERENTIAL FROM MIGRATING

The actual cost of migrating to hosted private cloud will vary depending on one's business requirements and the cloud services one wishes to leverage to drive flexibility, scalability and growth. The Alinean TCO model, guided by experience with clients of all sizes and from all industries, shows a potential CapEx plus OpEx savings of 35% to 85%. ABC Company achieved a 60% savings. Table 13 summarizes the five-year outlook for on-premises, in-house infrastructure versus hosted infrastructure, and shows where ABC Company was within the expected range.

For ABC Company, as shown in Table 14, migrating to hosted private cloud might save $1 million over the three-year time horizon and $1.6 million over five years. For the sake of simplicity, we have set aside indirect business costs, but they too, favor hosting due to efficiencies of administration at the hosting provider. The annual OpEx outlay will be higher with hosting, but ABC Company will save $3.8 million in CapEx in year 1.

TABLE 13: TOTAL CAPEX/OPEX OF IN-HOUSE VS. HOSTED INFRASTRUCTURE OVER FIVE YEARS

TOTAL CAPEX/OPEX OF IN-HOUSE VS. HOSTED INFRASTRUCTURE OVER FIVE YEARS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6
In-house	$5,447,574	$3,239,547	$3,437,475	$4,259,897	$3,898,067	$20,282,559
Hosted (Low Estimate)	$1,906,651	$1,133,841	$1,203,116	$1,490,964	$1,364,323	$7,098,896
Hosted (Actual)	$2,160,000	$2,268,000	$2,381,400	$2,500,470	$2,625,494	$11,935,364
Hosted (High Estimate)	$4,630,438	$2,753,615	$2,921,853	$3,620,912	$3,313,357	$17,240,175

TABLE 14: IN-HOUSE VS. HOSTED FINANCIAL COMPARISON

IN-HOUSE VS. HOSTED FINANCIAL COMPARISON	THREE-YEAR IN-HOUSE	HOSTED	FIVE-YEAR IN-HOUSE	HOSTED
CapEx	$3,720,363		$5,119,492	
OpEx	$8,404,232	$6,809,400	$15,163,067	$11,935,364
Total	$12,124,595	$6,809,400	$20,22,559	$11,935,364
Savings from hosting	$5,315,195		$8,347,196	
Year 1 CapEx savings	**$2,822,723**			

MIGRATE TO HOSTED PRIVATE CLOUD, OR NOT?

Cloud hosting TCO is always lower than that needed for in-house hosting; for some companies, the costs are significantly lower over three to five years. That is a strong argument in favor of cloud hosting. The decision to migrate to hosted private cloud must account for many distinct factors that affect how one's business operates today, and how it must operate tomorrow. In practical terms, most workloads migrate and perform very well in the cloud, but some workloads can be challenging if they are custom-written applications based on non-standard interfaces and platforms. It's a good idea to start small with one hosting candidate and then migrate more workloads as the IT staff becomes familiar with the process. At the end of this white paper are links to several references that provide guidance on choosing workloads to migrate.

Financially, the total savings on CapEx and OpEx are a compelling argument in favor of hosted cloud migration. ABC Company's $3.28 million savings in year one alone is significant, and will be meaningful to the people responsible for managing ABC's assets on behalf of its shareholders. That is $3.28 million that could be used for other business investment purposes. There's also a risk-reduction benefit to offloading CapEx to a third party. Not only is there a high opportunity cost of putting down large capital outlays on infrastructure, but the risks associated with managing those purchases are high as well. If the infrastructure does not deliver the desired business benefits, the capital will have been wasted or put to suboptimal use. These kinds of problems show up indirectly in financial results and share prices.

Another way to look at the benefit of CapEx savings is to estimate the cost of that capital. Capital comes at a cost to the business. Most financial executives evaluate capital expenses based on a "cost of equity capital" criterion to determine if an investment is worth making. Cost of capital varies by industry, but the average, according to accounting firm KPMG, is 9.1%. That means that most companies assume that any CapEx is costing 9.1% a year, as if they were paying interest on a loan. For ABC, the five-year, $5.1 million CapEx savings will accrue a capital cost charge of $345,664 per year, on top of the other costs. The charge further widens the gap between in-house and hosted infrastructure. If ABC Company must borrow money to invest in infrastructure, it would probably use the average cost of debt of 4.5%, which is the current average of high-grade corporate bonds. At that rate, the web applications will need to tack about $170,000 a year onto their TCO for interest expense.

Finally, it's worth pointing out the many intangible benefits that arise from migrating to hosted private cloud. These intangibles are difficult to quantify in dollar terms, but they are meaningful to the business. Time to market is an example of a subjective, intangible benefit of hosted environments. The ability to flexibly and rapidly provision IT systems that support growth initiatives can bring strong strategic and financial rewards to a business. If IT contributes to a lag in the launch of a new product or service, then that will be detrimental to the company's bottom line.

The "asset value" of IT staff is also an intangible aspect of hosted cloud environments. While staffing is OpEx, it is a useful exercise to think about IT staff as an asset of the business. This goes beyond HR talk about "people are an asset" and so forth — it's about understanding that IT salaries and skills training are an investment in the business. Like any investment, they can be analyzed for their rates of return. What is the investment in IT salaries and training yielding for the business? Is the investment being used to "keep the lights on," as is the case with many IT departments? Or is the investment yielding valuable, strategic returns for the business?

Capacity planning is another important intangible factor to assess when making the hosted private cloud decision. In today's world, where new form factors like tablets and mobile devices can cause rapid and unpredictable growth in compute demand, the ability to host capacity in the cloud takes a lot of pressure off IT capacity planners. If your data center is already reaching capacity, it can be a major challenge to figure out how much new on-premises capacity you will need over the next few years. Given the high costs of data center construction, having a private cloud hosting environment can be a big advantage.

CONCLUSION

Making the decision to migrate infrastructure to hosted private cloud can be complex and challenging. However, it can be a clear and informative process if approached analytically. With an accurate TCO analysis, based on sound financial analysis, your company will be able to make the cloud migration decision using numbers that are accurate and relevant to your specific requirements, objectives and risk profile — not to mention your regulatory environment. As this white paper has shown, the best cloud migration decisions arise from gaining a deep, thorough understanding of the actual costs of running infrastructure in-house, and comparing them to cloud infrastructure costs.

An appreciation of the differences between the CapEx and OpEx sides of TCO should also drive your discussion about the best use of capital. In the end, company management at all levels is responsible for delivering the best possible return on IT assets to shareholders, and solid numerical evidence is essential to the business decision process. The approach to TCO analysis described in this white paper was designed to give decision-making executives the tools they need to become great stewards of shareholder equity and the IT assets under their control.

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For information about Rackspace hosted private cloud solutions, including VMware, OpenStack and Microsoft, please visit https://www.rackspace.com/cloud/private.

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APPENDICES

Server Hardware

SERVER TYPE	UNITS	AVERAGE COST PER SERVER	TOTAL NEW SERVER PURCHASE COSTS	ANNUAL HARDWARE MAINTENANCE	HARDWARE MAINTENANCE AS % OF HARDWARE COSTS
HP PL DL380 G9 (2ch x 18-co) - 512GB	4	$6,739	$26,956	$2,965	11%
HP PL DL380 G9 (2ch x 12-co) - 256GB	30	$5,179	$155,370	$17,091	11%
HP PL DL380 G9 (2ch x 8-co) - 128GB	6	$3,674	$22,044	$2,425	11%
HP PL DL380 G9 (2ch x 8-co) - 128GB	15	$3,674	$55,110	$6,062	11%
HP PL DL380 G9 (2ch x 12-co) - 256GB	2	$5,179	$10,358	$1,139	11%
TOTAL NEW SERVER PURCHASE COSTS AND ANNUAL MAINTENANCE	**72**	**$5,184**	**$373,263**	**$41,059**	

Average annual costs for server spare and replacement parts:
$62,171, 8% of total purchase

Average annual growth in server requirements: **5%**

Average annual growth in server purchase costs: **3%**

Average server refresh period: **36** months

ANNUAL SERVER HARDWARE COSTS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Number of servers (beginning of year)	72	144	152	159	167
Servers added for growth	72	8	7	8	9
Servers purchased for replacement	0	0	72	72	8
Average purchase price per new server	$5,609				
Annual server purchase costs	$0	$10,794	$10,794	$10,794	$10,794
Annual costs for server spare and replacement parts	$403,870	$86,348	$852,688	$863,481	$183,490
Annual server hardware costs (CapEx)	$62,171	$65,279	$68,543	$71,970	$75,569
Annual server hardware maintenance costs (OpEx)	$466,041	$151,627	$921,231	$935,451	$259,059
TOTAL SERVER HARDWARE COSTS	**$551,525**	**$246,610**	**$1,024,525**	**$1,048,244**	**$382,536**

Server Software

SERVER SOFTWARE LICENSES	SERVERS	LICENSES	COST PER LICENSE	TOTAL LICENSE COSTS	ANNUAL SUPPORT
OPERATING SYSTEM					
> Windows Server Standard Edition	21	21	$1,209.00	$25,389.00	$6,347.25
> Windows Server Enterprise Edition	0	0	$3,919.00	$0.00	$0.00
> Windows Server Database Edition	0	0	$2,999.00	$0.00	$0.00
> Red Hat® Linux	51	51	$1,819.00	$92,769.00	$23,192.25
> CentOS	0	0	$909.00	$0.00	$0.00
VIRTUALIZATION SOFTWARE					
> VMware vSphere (ESXi)	0	0	$2,875.00	$0.00	$0.00
> VMware vCenter Server (Management)	0	0	$4,995.00	$0.00	$0.00
DATABASE					
> SQL Server Standard	0	0	$0.00	$0.00	$0.00
> SQL Server Enterprise	6	6	$30,739.00	$184,434.00	$46,108.50
> Oracle® Standard	0	0	$0.00	$0.00	$0.00
> Oracle Enterprise	4	4	$47,500.00	$190,000.00	$47,500.00
> Oracle RAC	0	0	$0.00	$0.00	$0.00
> MySQL	0	0	$0.00	$0.00	$0.00
COLLABORATION SOFTWARE					
> Microsoft Exchange (no CALs)	0	0	$120.00	$0.00	$0.00
> Microsoft SharePoint® (no CALs)	0	0	$135.00	$0.00	$0.00
TOTAL				**$492,592.00**	**$123,148.00**

ANNUAL SERVER SOFTWARE COSTS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Annual server software purchase costs (CapEx)	$492,592	$24,630	$25,861	$27,154	$28,512
Annual server software support costs (OpEx)	$123,148	$129,305	$135,771	$142,559	$149,687
TOTAL SERVER SOFTWARE COSTS	**$615,740**	**$153,935**	**$161,632**	**$169,713**	**$178,199**

Average annual growth rate in server requirements: **5%**

Network Infrastructure

NETWORK INFRASTRUCTURE EQUIPMENT	QUANTITY	AVERAGE COST PER DEVICE	TOTAL PURCHASE COSTS	ANNUAL HARDWARE MAINTENANCE
FIREWALLS				
ASA 5525-X	2	$5,179	$155,370	$17,091
ASA 5525-X	1	$3,674	$22,044	$2,425
LOAD BALANCERS				
F5 BIG-IP 5200 (HA) with LTM + AFM	2	$5,179	$10,358	$1,139
F5 BIG-IP 5200 (Single) with LTM + AFM	1	$6,414.00	$6,414.00	$513.12
ADDITIONAL INFRASTRUCTURE				
Intrusion Detection (IDS)	1	$1,000.00	$1,000.00	$80.00
Log Analyzer	1	$1,000.00	$1,000.00	$80.00
Cisco 9372-TX-HA	8	$1,000.00	$8,000.00	$640.00
Cisco 9372-TX-HA	4	$1,000.00	$4,000.00	$320.00
Network switches	8	$1,800.00	$14,400.00	$1,152.00
TOTAL	**28**		**$61,045.25**	**$4,883.62**

Average annual growth in server requirements: **5%**

ANNUAL NETWORK INFRASTRUCTURE COSTS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Annual network equipment purchase costs (CapEx)	$61,045	$3,052	$3,205	$3,365	$3,533
Annual network equipment maintenance costs (OpEx)	$4,884	$5,128	$5,384	$5,653	$5,936
TOTAL NETWORK INFRASTRUCTURE COSTS	**$65,929**	**$8,180**	**$8,589**	**$9,019**	**$9,469**

Storage

Average annual decrease in price per TB of storage: **15%**

Average annual growth in storage capacity: **22%**

NETWORK INFRASTRUCTURE EQUIPMENT	CAPACITY (GBS)	AVERAGE COST PER GB	TOTAL STORAGE PURCHASE COSTS	ANNUAL SUPPORT
Dell EMC Unity 400 Hybrid Flash (SANS)	388,000	$2.93	$1,136,840.00	$125,052.40
Dell EMC Unity 400 Hybrid Flash (NAS)	120,000	$2.93	$351,600.00	$38,676.00
TOTAL	**508,000**	**$2.93**	**$1,488,440.00**	**$163,728.40**

ANNUAL NETWORK INFRASTRUCTURE COSTS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Storage capacity (GBs at beginning of year)	0	508,000	622,300	762,318	933,839
Storage capacity added for growth (GBs)	508,000	114,300	140,018	171,521	210,114
Average price per GB	$3	$2	$2	$2	$2
Annual storage purchase costs	$1,488,440	$284,664	$296,407	$308,633	$321,364
Storage networking costs	$223,266	$42,700	$44,461	$46,295	$48,205
Annual storage equipment costs (CapEx)	$1,711,706	$327,364	$340,868	$354,928	$369,569
Annual storage support costs (OpEx)	$163,728	$195,041	$227,646	$261,596	$296,946
TOTAL ANNUAL STORAGE COSTS	**$1,875,434**	**$522,405**	**$568,514**	**$616,524**	**$666,515**

Backup

Total number of servers: **72**

Average number of servers per backup tape drive: **5**

Average purchase price per tape drive: **$2,500**

Purchase costs for tape drives: **$37,500**

Average backup software cost per server: **$250**

Backup software license costs: **$3,750**

Backup software support: **10% per year**

Average number of tapes per server: **10**

Average cost per tape: **$80.00**

Tape media costs: **$57,600**

Is off-site tape storage required? **Yes**

Number of tapes stored offsite: **144 (2 per server)**

Annual costs for off-site tape storage: **$21,600, $150 per tape**

Average annual growth in server requirements: **5%**

ANNUAL BACKUP COSTS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Backup equipment costs (tape drives)	0	508,000	622,300	762,318	933,839
Backup software licenses	508,000	114,300	140,018	171,521	210,114
Annual backup software support costs	$3	$2	$2	$2	$2
Annual tape media costs	$1,488,440	$284,664	$296,407	$308,633	$321,364
Annual off-site tape storage costs	$223,266	$42,700	$44,461	$46,295	$48,205
TOTAL ANNUAL BACKUP INFRASTRUCTURE COSTS	**$121,200**	**$28,410**	**$29,831**	**$31,322**	**$32,888**

Power and Facilities

DEVICE TYPE	NUMBER OF DEVICES	AVERAGE RACKSPACE (US)	TOTAL RACKSPACE (US)	AVERAGE POWER (WATTS)	TOTAL POWER (WATTS)
HP PL DL380 G9 (2ch x 18-co) - 512GB	4	2.0	8.0	822.0	3,288
HP PL DL380 G9 (2ch x 12-co) - 256GB	30	2.0	60.0	523.0	15,690
HP PL DL380 G9 (2ch x 8-co) - 128GB	6	2.0	12.0	431.0	2,586
HP PL DL380 G9 (2ch x 8-co) - 128GB	15	2.0	30.0	431.0	6,465
HP PL DL380 G9 (2ch x 12-co) - 256GB	2	2.0	4.0	523.0	1,046
HP PL DL380 G9 (2ch x 18-co) - 512GB	12	2.0	24.0	822.0	9,864
HP PL DL560 G9 (4-ch x 18-co) 1536GB	3	2.0	6.0	1,330.0	3,990
NETWORK					
ASA 5525-X	2	1.0	2.0	350.0	700
ASA 5525-X	1	1.0	1.0	350.0	350
F5 BIG-IP 5200 (HA) w LTM + AFM	2	1.0	2.0	330.0	660
F5 BIG-IP 5200 (Single) w LTM + AFM	1	1.0	1.0	165.0	165
Intrusion Detection (IDS)	1	1.0	1.0	350.0	350
Log Analyzer	1	1.0	1.0	350.0	350
Cisco 9372-TX - HA	8	1.0	8.0	350.0	2,800
Cisco 9372-PX - HA	4	1.0	4.0	350.0	1,400
Brocade DS-6520B 48 ports	4	1.0	4.0	350.0	1,400
STORAGE DEVICES					
Dell EMC Unity 400 Hybrid Flash (SANS)	127	2.0	254.0	432.0	54,864
Dell EMC Unity 400 Hybrid Flash (NAS)	40	2.0	80.0	432.0	17,280
TOTAL	**263**	**1.9**	**502.0**	**469**	**123,248**

ASSUMPTION

Average annual growth in server requirements.....**5%**

40.....Us of usable rack space per rack

20.....Sq. feet of floor space per rack

ANNUAL DATA CENTER FACILITIES COSTS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
DATA CENTER FLOOR SPACE COSTS					
Data center requirements (Us)	502.0	527.1	553.5	581.1	610.2
Square feet of data center floor space	18.5	19.4	20.4	21.4	22.5
Average annual cost per square foot of floor space	$624.31	$624.31	$624.31	$624.31	$624.31
Annual costs for data center floor space	**$11,547**	**$12,125**	**$12,731**	**$13,368**	**$14,036**
DATA CENTER POWER AND COOLING COSTS					
Average power consumption per hour	123,248	129,410	135,881	142,675	149,809
Operating hours per year	8,766	8,766	8,766	8,766	8,766
Annual power consumption (kWatts)	1,080,392	1,134,412	1,191,132	1,250,689	1,313,223
Data center PUE factor	2.0	2.0	2.0	2.0	2.0
TOTAL ANNUAL DATA CENTER POWER AND COOLING (KWATTS)	**2,202,799**	**2,312,939**	**2,428,586**	**2,550,015**	**2,677,516**
Average cost per kWatt/hour	$0.099	$0.099	$0.099	$0.099	$0.099
Annual data center energy costs	$217,637	$228,518	$239,944	$251,942	$264,539
Data center addition cost factor	2.2	2.2	2.2	2.2	2.2
Annual data center facilities costs	$504,205	$529,415	$555,886	$583,680	$612,864

System Admin Labor

SYSTEMS ADMINISTRATION STAFF	NUMBER OF STAFF (FTES)	AVERAGE ANNUAL SALARY	FULLY BURDENED COST PER FTE	TOTAL ANNUAL COSTS (YEAR 1)
Server administrators	3.81	$76,860	$98,765	$376,048
Network and security administrators	3.45	$82,350	$105,820	$364,814
Database administrators	3.06	$85,644	$110,053	$337,147
Storage administrators	3.00	$65,880	$84,656	$254,222
Backup administrators	3.07	$57,096	$73,368	$224,910
Exchange/SharePoint administrators	0.00	$104,310	$134,038	$0
TOTAL	**16.39**	**$73,948**	**$95,023**	**$1,557,141**

Average annual increase in system admin effort:.....2.5%

Fully burdened labor rate.....$61.52

Average annual increase in system admin salaries.....4.0%

Hours worked per year.....1,800

ANNUAL COSTS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Average fully burdened salary	$73,948	$92,434	$115,543	$144,429	$180,536
System admin labor costs	$1,557,141	$1,658,355	$1,766,148	$1,880,948	$2,003,210
System admin staff (FTEs)	16.39	16.80	17.22	17.65	18.09
System administration efforts (hours)	**29,497**	**30,234**	**30,990**	**31,765**	**32,559**

IT Training Costs

SYSTEMS ADMINISTRATION STAFF	NUMBER OF STAFF (FTES)	AVERAGE HOURS OF TRAINING PER YEAR	AVERAGE ANNUAL COURSE FEES AND EXPENSES	TOTAL ANNUAL COSTS (YEAR 1)
Server administrators	3.81	80.0	$7,000	$26,653
Network and security administrators	3.45	80.0	$7,000	$24,133
Database administrators	3.06	80.0	$7,000	$21,445
Storage administrators	3.00	80.0	$7,000	$21,021
Backup administrators	3.07	40.0	$3,500	$10,729
TOTAL	**16.39**	**1188**	**$103,980**	**$103,980**

Average annual increase in system administration effort 2.5%

ANNUAL COSTS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
IT training costs	$103,980	$106,579	$109,244	$111,975	$114,774
IT training hours	1,188	1,218	1,248	1,280	1,312

Staff Turnover Costs

Number of IT systems admin staff.....**16.39**

Average annual turnover rate for IT staff.....**15%**

Number of new IT staff per year.....**2.46**

Average annual fully burdened salary.....**$73,948**

Average recruitment cost per position.....**$14,790** **20%**

Average on-boarding period for IT staff.....**3.0 weeks**

On-boarding costs.....**$4,822**

Total annual IT staff turnover costs (year 1).....**$4,266**

Average annual increase in system admin effort.....**46,840%**

ANNUAL COSTS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
IT staff turnover costs	**$46,840**	**$48,011**	**$49,211**	**$50,442**	**$51,703**

Network Bandwidth Costs

PREFERRED WAN CONNECTION TYPE	T-1 (1.54 MBPS)
Available bandwidth per T-1	1 .54
Average cost per month per T-1	$375 .00
Number of servers	72
Average bandwidth requirements per server (Mbps)	350
Number of T-1 lines required (year 1)	17
Annual network bandwidth costs (year 1)	$76,500
Average annual growth rate in server requirements	10%

ANNUAL COSTS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Number of T-1 lines required	17	18	18	19	20
Total annual network bandwidth costs	**$76,500**	**$81,000**	**$81,000**	**$85,500**	**$90,000**

Indirect Business Costs

INDIRECT BUSINESS COSTS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
CURRENT SELF-MANAGED COSTS					
Unplanned downtime - productivity	$51,022	$52,298	$53,605	$54,945	$56,319
Impact	$139,680	$143,172	$146,751	$150,420	$154,181
Planned downtime - productivity	$2,219,184	$2,274,664	$2,331,531	$2,389,819	$2,449,564
Impact	$602,270	$617,327	$632,760	$648,579	$664,793
Business agility - productivity impact	$1,319,040	$1,352,016	$1,385,816	$1,420,461	$1,455,973
Unplanned downtime - business costs	$2,540,957	$2,604,481	$2,669,593	$2,736,333	$2,804,741
Planned downtime - business costs	$51,022	$52,298	$53,605	$54,945	$56,319
Business agility - revenue impact	$139,680	$143,172	$146,751	$150,420	$154,181
TOTAL SELF-MANAGED COSTS	**$6,872,153**	**$7,043,958**	**$7,220,056**	**$7,400,557**	**$7,585,571**
Indirect benefit realization factor	20%	20%	20%	20%	20%
TOTAL REALIZED COSTS	**$353,606**	**$353,606**	**$353,606**	**$353,606**	**$353,606**
COSTS WITH HOSTED SOLUTION					
Unplanned downtime - productivity	$17,004	$17,429	$17,865	$18,312	$18,770
Impact	$27,936	$28,634	$29,350	$30,084	$30,836
Planned downtime - productivity	$98,640	$101,106	$103,634	$106,225	$108,881
Impact	$200,741	$205,760	$210,904	$216,177	$221,581
Business agility - productivity impact	$263,808	$270,403	$277,163	$284,092	$291,194
Unplanned downtime - business costs	$112,935	$115,758	$118,652	$121,618	$124,658
Planned downtime - business costs	$17,004	$17,429	$17,865	$18,312	$18,770
Business agility - revenue Impact	$27,936	$28,634	$29,350	$30,084	$30,836
TOTAL HOSTED COSTS	**$721,064**	**$739,090**	**$757,568**	**$776,508**	**$795,920**
Indirect benefit realization factor	20%	20%	20%	20%	20%
TOTAL REALIZED COSTS	**$144,213**	**$147,818**	**$151,514**	**$155,302**	**$159,184**
TOTAL IMPROVED SERVICE LEVEL BENEFITS	**$1,230,218**	**$1,260,974**	**$1,292,498**	**$1,324,810**	**$1,357,930**

UNPLANNED DOWNTIME	SELF-MANAGED ENVIRONMENT	HOSTED SOLUTION	EXPECTED BENEFITS WITH PROPOSED SOLUTION
UNPLANNED DOWNTIME - PRODUCTIVITY IMPACT			
Average annual system availability	99 .70%	99 .90%	67%
Average hours of annual unplanned system downtime per year	26 .3	8 .8	17 .5
Average number of knowledge workers impact per outage	1,000	1,000	
Average productivity impact on knowledge workers during outage	40%	40%	
Annual productivity losses due to availability issues (hours)	10,512	3,504	7,013
Average fully burdened hour wage for knowledge workers	43 .33	$43 .33	
Annual cost of productivity losses due to availability issues	$455,485	$151,828	$303,900
PLANNED DOWNTIME - PRODUCTIVITY IMPACT			
Annual hours of planned system downtime per year	140	28	80%
Average number of knowledge workers impact per outage	250	250	
Average productivity impact on knowledge workers during outage	40%	40%	
Annual productivity losses due to availability issues (hours)	14,000	2,800	11,200
Average fully burdened hour wage for knowledge workers	43 .33	$43 .33	
Annual cost of productivity losses due to availability issues	$606,620	$121,324	$485,296

ANNUAL COSTS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Current (as is) costs	$606,620	$606,620	$606,620	$606,620	$606,620
Proposed (to be) costs	$121,324	$121,324	$121,324	$121,324	$121,324
Reduction in productivity losses from improved availability	$485,296	$485,296	$485,296	$485,296	$485,296
FTE productivity improvements	**6.2**	**6.2**	**6.2**	**6.2**	**6.2**

BUSINESS AGILITY	SELF-MANAGED ENVIRONMENT	HOSTED SOLUTION	EXPECTED BENEFITS WITH PROPOSED SOLUTION
BUSINESS AGILITY - PRODUCTIVITY IMPACT			
New application projects per year	36	36	
Average system provision time per application (days)	45	2	95.6%
Average annual value in productivity improvement per app	$500,000	$500,000	
Average lost productivity improvement value per system provisioning	$61,644	$2,740	$58,904
Annual value of productivity losses due to system provisioning	$2,219,184	$2,120,544	$2,120,544

BUSINESS AGILITY - PRODUCTIVITY IMPACT	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Current (as is) costs	$234,247	$234,247	$234,247	$234,247	$234,247
Proposed (to be) costs	$15,616	$15,616	$15,616	$15,616	$15,616
Reduction in productivity losses from improved availability	$218,630	$218,630	$218,630	$218,630	$218,630

UNPLANNED DOWNTIME	SELF-MANAGED ENVIRONMENT	HOSTED SOLUTION	EXPECTED BENEFITS WITH PROPOSED SOLUTION
UNPLANNED DOWNTIME - BUSINESS COSTS			
Average annual system availability	99 .70%	99 .90%	67%
Average hours of annual unplanned system downtime per year	26 .3	8 .8	17 .5
Estimated revenue or equivalent cost/ hour of unplanned downtime	$25,000	$25,000	$25,000
Annual business losses due to availability issues	$657,000	$219,000	$438,000
Net incremental contribution	22 .90%	22 .90%	22 .90%
ANNUAL INCREMENTAL MARGIN CONTRIBUTION	**$150,453**	**$50,151**	**$100,302**

ANNUAL COSTS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Current (as is) costs	$657,000	$657,000	$657,000	$657,000	$657,000
Incremental margin contribution	$150,453	$150,453	$150,453	$150,453	$150,453
Proposed (to be) costs	$219,000	$219,000	$219,000	$219,000	$219,000
Incremental margin contribution	$50,151	$50,151	$50,151	$50,151	$50,151
Reduction in business loss from improved availability	$438,000	$438,000	$438,000	$438,000	$438,000
INCREMENTAL MARGIN CONTRIBUTION	**$100,302**	**$100,302**	**$100,302**	**$100,302**	**$100,302**

PLANNED DOWNTIME	SELF-MANAGED ENVIRONMENT	EXPECTED PLANNED DOWNTIME FOR HOSTED SOLUTION	EXPECTED BENEFITS WITH PROPOSED SOLUTION
PLANNED DOWNTIME - BUSINESS COSTS			
Average hours of annual planned system downtime per year	140 .0	28 .0	80%
Estimated revenue or equivalent cost/ hour of planned downtime	$5,000	$5,000	$25,000
Annual business losses due to availability issues	$700,000	$140,000	$560,000
Net incremental contribution	22 .90%	22 .90%	22 .90%
ANNUAL INCREMENTAL MARGIN CONTRIBUTION	**$160,300**	**$32,060**	**$128,240**

ANNUAL COSTS	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Current (as is) costs	$700,000	$700,000	$700,000	$700,000	$700,000
Incremental margin contribution	$160,300	$160,300	$160,300	$160,300	$160,300
Proposed (to be) costs	$140,000	$140,000	$140,000	$140,000	$140,000
Incremental margin contribution	$32,060	$32,060	$32,060	$32,060	$32,060
Reduction in business loss from improved availability	$560,000	$560,000	$560,000	$560,000	$560,000
INCREMENTAL MARGIN CONTRIBUTION	**$128,240**	**$128,240**	**$128,240**	**$128,240**	**$128,240**

BUSINESS AGILITY	SELF-MANAGED ENVIRONMENT	EXPECTED PLANNED DOWNTIME FOR HOSTED SOLUTION	EXPECTED BENEFITS WITH PROPOSED SOLUTION
BUSINESS AGILITY - REVENUE IMPACT			
New application projects per year	19	19	
Average system provision time per application (days)	30 days	2 days	93 .3%
Average annual revenue value per app	$450,000	$450,000	
Average lost revenue per system provisioning	36,986	2,466	$34,521
Annual value of potential revenue losses due to system provisioning	$702,740	$46,849	$655,890
Net incremental contribution	$160,927	$10,728	$150,199
ANNUAL INCREMENTAL MARGIN CONTRIBUTION	**$160,927**	**$10,728**	**$150,199**

BUSINESS AGILITY - REVENUE IMPACT	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Current (as is) costs	$702,740	$702,740	$702,740	$702,740	$702,740
Incremental margin contribution	$160,927	$160,927	$160,927	$160,927	$160,927
Proposed (to be) costs	$46,849	$46,849	$46,849	$46,849	$46,849
Incremental margin contribution	$10,728	$10,728	$10,728	$10,728	$10,728
Reduction in business loss from system provisioning	$655,890	$655,890	$655,890	$655,890	$655,890
INCREMENTAL MARGIN CONTRIBUTION	**$150,199**	**$150,199**	**$ 150,199**	**$150,199**	**$150,199**

Further Readings:

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