The Total Economic Impact™ Of A VDI Environment Based On HPE BladeSystem

As Deployed By A Large Multicollege District In The US
Executive Summary

The HPE BladeSystem is a modular architecture that shares power, cooling, network, and storage infrastructure via the blade enclosure. The HPE ProLiant BL460c is a two-socket server blade powered by up to two Intel Xeon® processors and designed for data center computing. HPE commissioned Forrester Consulting to conduct a Total Economic Impact™ (TEI) study and examine the potential return on investment (ROI) enterprises may realize by deploying HPE blade infrastructure as the backbone of a server-hosted virtual desktop infrastructure (VDI) environment. The purpose of this study is to provide readers with a framework to evaluate the potential financial impact of a VDI deployment based on HPE blade infrastructure on their organizations compared with deploying a traditional desktop environment.

To better understand the benefits, costs, and risks associated with this investment, Forrester interviewed a large multi-college district that had deployed a VDI environment on an HPE blade infrastructure. The initial VDI solution included 700 users. Due to the success of this project, the solution was further rolled out to about 4,300 users during the three-year term of the study, with an ultimate target of reaching 7,000 users across the different campuses by mid-2019.

Key Findings

Quantified benefits. The interviewed institution experienced the following risk-adjusted quantified benefits:

› **Direct end user device costs avoidance.** Following the introduction of the VDI environment, the institution deployed zero clients in the computer labs and thus avoided a more expensive investment in traditional desktops. The avoided hardware costs have been estimated to have a three-year risk-adjusted present value of approximately $3.3 million.

› **IT support productivity gains.** The interviewed institution estimates that it takes approximately 40% less effort to support a zero client compared with supporting a traditional desktop. The reasons for these productivity gains include simplified desktop support, fewer images to maintain, reduced downtime and increased availability, simplified application and patch management, and simplified data protection. The time saved by the IT support staff can be reallocated to other productive tasks. Over three years, these productivity gains have a risk-adjusted present value of approximately $630,000.

› **Software cost savings.** By deploying the VDI environment, the institution saved on software license costs compared with a traditional desktop environment. For the interviewed institution, these cost savings have an estimated three-year risk-adjusted present value of approximately $52,000. Note, however, that the institution benefits from special discounts that software vendors often grant to the educational sector. Organizations in other verticals might, therefore, realize higher cost savings in this area.

Unquantified benefits. The interviewed institution experienced the following benefits, which are not quantified for this study:

A VDI environment improved service delivered to students by providing anywhere, anytime, any device access

IT support productivity gains supporting VDI environment compared with traditional desktop environment: 40%

“The partnership that we have developed with HPE and another third party has been critical in our success with the virtual desktop infrastructure. They put 100% of their skin in this game to make it work.”

Senior director of IT infrastructure at a large multicollege district
Reduction in the number of dedicated computer labs. This was one of the main objectives the institution stated for introducing the VDI environment. With VDI, each physical zero client can be used with any of the images, allowing one lab to serve many different needs without reconfiguration. The freed-up rooms can be converted into classrooms, which contributes to increasing the colleges’ capacity and to the ability to accept more students in the future.

Productivity gains for students. The VDI environment also benefits the students by providing them with anywhere, anytime, any device access. Forrester’s workforce enablement research shows that people are happier and more productive when they have the flexibility to work remotely when needed.

Costs. The interviewed institution experienced the following risk-adjusted costs:

Costs related to the central VDI infrastructure. These costs include the different software and hardware components required for the institution’s central infrastructure as well as the ongoing hosting and maintenance costs. Over three years, these costs have a risk-adjusted present value of approximately $1.2 million.

End user device costs. These costs represent the hardware investment in 4,300 zero-client devices rolled out over the three years of the analysis. These costs have a three-year risk-adjusted present value of approximately $1.2 million.

Initial setup and training costs. These costs represent the internal labor costs as well as professional services and training costs for the initial setup of the VDI environment. They have a three-year risk-adjusted present value of approximately $630,000.

Forrester’s interview with this existing HPE customer and subsequent financial analysis of this VDI investment found that the interviewed institution experienced benefits of $4 million over three years versus costs of $3.1 million, adding up to a net present value (NPV) of $970,000 and an ROI of 32%.
The Total Economic Impact™ (TEI) framework and methodology from the information provided in the interview, Forrester has constructed a TEI framework for those organizations considering implementing a VDI environment based on HPE’s blade infrastructure.

The objective of the framework is to identify the cost, benefit, flexibility, and risk factors that affect the investment decision. Forrester took a multistep approach to evaluate the impact that a VDI environment based on HPE’s BladeSystem infrastructure can have on an organization:

- **DUE DILIGENCE**
  Interviewed HPE stakeholders and Forrester analysts to gather data relative to VDI and blade server infrastructure.

- **CUSTOMER INTERVIEW**
  Interviewed one organization using HPE’s BladeSystem infrastructure for its VDI environment to obtain data with respect to costs, benefits, and risks.

- **FINANCIAL MODEL FRAMEWORK**
  Constructed a financial model representative of the interview using the TEI methodology and risk-adjusted the financial model based on issues and concerns of the interviewed organization.

- **CASE STUDY**
  Employed four fundamental elements of TEI in modeling VDI’s impact for the interviewed organization: benefits, costs, flexibility, and risks. Given the increasing sophistication that enterprises have regarding ROI analyses related to IT investments, Forrester’s TEI methodology serves to provide a complete picture of the total economic impact of purchase decisions. Please see Appendix A for additional information on the TEI methodology.

**DISCLOSURES**

Readers should be aware of the following:

This study is commissioned by HPE and delivered by Forrester Consulting. It is not meant to be used as a competitive analysis.

Forrester makes no assumptions as to the potential ROI that other organizations will receive. Forrester strongly advises that readers use their own estimates within the framework provided in the report to determine the appropriateness of an investment in a VDI environment based on HPE’s blade infrastructure.

HPE reviewed and provided feedback to Forrester, but Forrester maintains editorial control over the study and its findings and does not accept changes to the study that contradict Forrester’s findings or obscure the meaning of the study.

HPE provided the customer name for the interview but did not participate in the interview.
The VDI Customer Journey

BEFORE AND AFTER THE VDI INVESTMENT

Interviewed Organization

For this study, Forrester interviewed a senior director of IT infrastructure at a large multicollege district in the US.

Key Objectives

The district’s colleges offer associate degrees, vocational certificates, and transfer education, as well as developmental instruction and a broad array of specialized training. Together, these colleges enroll more than 60,000 students each year in more than 300 degree and certificate programs.

With the introduction of the VDI environment, the institution primarily wanted to:

› **Reduce the number of dedicated computer labs.** When one of the district colleges was preparing to move to a newly constructed building, the institution saw the opportunity to consolidate the number of dedicated computer labs. Through infrastructure and application virtualization, specific software was no longer tied to a computer but to a student profile. By reducing the number of computer labs, more rooms could be converted to classrooms.

› **Provide students with better services.** For each major investment at the colleges, the institution is first asking itself how this project will benefit the students or the faculty. By providing a virtual desktop infrastructure, students can access their environments and applications from anywhere, anytime, and through any device.

› **Harmonize the server infrastructure.** In parallel to the introduction of the VDI environments, the institution also started virtualizing the server infrastructure of one of the colleges as a first step to the future consolidation of three separate college data centers into one district data center. The goal is to consolidate and simplify the infrastructure to reduce operational costs.

Solution Requirements

The interviewed institution searched for a VDI and underlying infrastructure solution that would:

› **Meet its unique performance requirements.** Because of the educational institution’s specific use case (i.e., a large number of students logging into the system simultaneously at the beginning of each class), the system needed to be able to cope with high peaks of traffic and still guarantee a good user experience.

› **Ensure ease of scalability.** While the initial phase of the VDI project included 700 users and the solution was further rolled out to about 4,300 users during the term of the study, the ultimate goal is to roll it out to 7,000 users across the different campuses within a few years.

The institution chose to invest in a commercial desktop-virtualization product and decided to use HPE’s BladeSystem infrastructure as the backbone. The underlying HPE infrastructure includes 12 HPE ProLiant

"Reducing the number of dedicated computer labs was the No. 1 reason for doing the VDI environments at our colleges. By freeing up classrooms, we increase our capacity and can receive more students."

Senior director of IT infrastructure at a large multicollege district

"The virtual desktop infrastructure is all about performance. If you do not have the right infrastructure in place, it will fail."

Senior director of IT infrastructure at a large multicollege district
BL460c server blades, four HPE ProLiant DL380 servers, 3PAR storage, and HPE OneView. The zero clients were provided by another vendor.

Key Results
The interview revealed that key results from the VDI investment include:

› **Reduction in number of dedicated computer labs.** Thanks to the VDI technology, the institution managed to consolidate the number of dedicated computer labs and free up rooms that could be converted into classrooms.

› **Improved services delivered to students.** The VDI environment provides students with anywhere, anytime, and any device access. The initial phase with 700 users was successful, so the institution decided to rapidly extend the scope and roll out the solution to the other colleges.

› **Reduction in end user device support.** The interviewed institution estimates that supporting zero clients takes 40% less effort compared with supporting a traditional desktop environment.

› **Realization of direct cost savings.** In deploying zero clients rather than traditional desktops the institution saved on end user device costs but also avoided some related software license fees.

› **First steps in gradually harmonizing the server infrastructure.** Not only the VDI environment, but also the ongoing and future data center consolidation projects across the different campuses, rely on HPE BladeSystem. The interviewed institution appreciates the reliability, scalability, density, and performance of the HPE BladeSystem.

“We save around 40% in support time with our VDI environment as compared to our previous desktop environment. The support team can reallocate this time to other productive tasks.”

*Senior director of IT infrastructure at a large multicollege district*

“The HPE blade infrastructure is really hard to break. It doesn’t fail. It’s built as a virtualized infrastructure. Reliability, scalability, and elasticity were all built into it.”

*Senior director of IT infrastructure at a large multicollege district*
Financial Analysis

QUANTIFIED BENEFIT AND COST DATA

Total Benefits

<table>
<thead>
<tr>
<th>REF</th>
<th>BENEFIT</th>
<th>Initial</th>
<th>YEAR 1</th>
<th>YEAR 2</th>
<th>YEAR 3</th>
<th>TOTAL</th>
<th>Present Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atr</td>
<td>Direct end user device costs avoided</td>
<td>$665,000</td>
<td>$0</td>
<td>$1,520,000</td>
<td>$1,900,000</td>
<td>$4,085,000</td>
<td>$3,348,696</td>
</tr>
<tr>
<td>Btr</td>
<td>IT support productivity gains</td>
<td>$0</td>
<td>$76,760</td>
<td>$252,130</td>
<td>$471,390</td>
<td>$800,280</td>
<td>$632,316</td>
</tr>
<tr>
<td>Ctr</td>
<td>Software cost savings</td>
<td>$0</td>
<td>$6,300</td>
<td>$20,700</td>
<td>$38,700</td>
<td>$65,700</td>
<td>$51,911</td>
</tr>
</tbody>
</table>

Total benefits (risk-adjusted) $665,000 $83,060 $1,792,830 $2,410,090 $4,950,980 $4,032,923

Direct End User Device Cost Avoidance

While realizing cost savings was not one of the principle objectives of the VDI project for the institution, the institution avoided direct hardware costs, representing a significant portion of the benefits quantified in this business case. On the one hand, the institution had to invest in the central VDI infrastructure and the zero clients, but on the other hand, it avoided purchasing traditional desktops as end user devices.

For the interviewed institution, the average price of its zero-client devices is $350, while the average price of its traditional desktop PCs is $1,000. As the costs for the zero clients are included in the cost section of this analysis, this benefit accounts for the costs avoided by not having to invest in traditional desktops.

The initial phase of the VDI deployment included 700 zero clients, and the institution then started rolling it out to more and more users. We assume here that the rollout coincides with the refresh cycle of the existing desktop infrastructure and that 1,600 zero clients have been added in Year 2 and 2,000 in Year 3 of the analysis, totaling a deployment of 4,300 zero clients within the first three years. This corresponds to approximately 60% of the stated goal, which is a rollout of the VDI solution to about 7,000 users across the different colleges.

Forrester risk-adjusted the avoided costs down by 5% to account for uncertainty of the estimations, resulting in a risk-adjusted total present value for this benefit of $3.3 million over three years.

Impact risk is the risk that the business or technology needs of the organization may not be met by the investment, resulting in lower overall total benefits. The greater the uncertainty, the wider the potential range of outcomes for benefit estimates.
The introduction of the VDI solution also resulted in productivity gains for the IT support teams. The interviewed institution estimates that supporting the VDI environment takes approximately 40% less effort than supporting a traditional desktop environment.

In case of the interviewed institution, the main time savings were realized in the following areas:

› Simplified desktop support.
› Reduced number of images to maintain.
› Reduced downtime and increased availability.
› Simplified application and patch management.
› Simplified data protection.

The time saved on those activities can be reallocated to other productive tasks. Together with the interviewed institution, we conservatively estimated average time savings of 4 hours per zero client for the IT support staff.

Forrester further assumes that only a portion of the time gained from improved productivity will actually be realized by the institution. In this analysis, we assume that 75% of the time saved by IT staff will be converted into other productive output.

Forrester risk-adjusted this benefit down by 5% to account for uncertainty of the estimations, resulting in a risk-adjusted total present value for this benefit of approximately $632,000 over three years.

### IT Productivity Gains

<table>
<thead>
<tr>
<th>REF.</th>
<th>METRIC</th>
<th>CALC.</th>
<th>INITIAL</th>
<th>YEAR 1</th>
<th>YEAR 2</th>
<th>YEAR 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>Number of PCs avoided purchasing</td>
<td></td>
<td>700</td>
<td>0</td>
<td>1,600</td>
<td>2,000</td>
</tr>
<tr>
<td>A2</td>
<td>Average cost of a PC</td>
<td></td>
<td>$1,000</td>
<td>$0</td>
<td>$1,600</td>
<td>$2,000</td>
</tr>
<tr>
<td>At</td>
<td>Direct end user device costs avoided</td>
<td>A1*A2</td>
<td>$700,000</td>
<td>$0</td>
<td>$1,600</td>
<td>$2,000</td>
</tr>
<tr>
<td></td>
<td>Risk adjustment (risk-adjusted)</td>
<td></td>
<td>$665,000</td>
<td>$0</td>
<td>$1,520</td>
<td>$1,900</td>
</tr>
</tbody>
</table>

**Direct Cost Avoidance**

- **A1**: Number of PCs avoided purchasing
  - **CALC.**: $700
  - **Initial**: 0
  - **Year 1**: 1,600
  - **Year 2**: 2,000

- **A2**: Average cost of a PC
  - **CALC.**: $1,000

- **At**: Direct end user device costs avoided
  - **CALC.**: A1*A2

- **Risk adjustment**: ↓5%

- **Atr**: Direct end user device costs avoided (risk-adjusted)
  - **CALC.**: $665,000
  - **Year 1**: $0
  - **Year 2**: $1,520,000
  - **Year 3**: $1,900,000

**IT productivity gains: 16% of total benefits**

**VDI: 40% IT support productivity gains compared with supporting traditional desktop environment**
The Total Economic Impact™ Of A VDI Environment Based On HPE Blade Infrastructure

Software Cost Savings

Generally, a VDI environment, compared with a traditional desktop environment, also has the advantage that it might reduce the number of software licenses required. However, as an educational institution, the institution benefits from special discounts for commercial software from the different vendors.

We therefore included in this analysis only a conservative estimation of average cost savings per zero client of $10.

Forrester risk-adjusted this benefit down by 10% to account for uncertainty of the estimations, resulting in a risk-adjusted total present value for this benefit of approximately $52,000 over three years.

Software Cost Savings

<table>
<thead>
<tr>
<th>REF.</th>
<th>METRIC</th>
<th>CALC.</th>
<th>YEAR 1</th>
<th>YEAR 2</th>
<th>YEAR 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>Cumulated number of zero clients deployed instead of PCs</td>
<td>B2</td>
<td>700</td>
<td>2,300</td>
<td>4,300</td>
</tr>
<tr>
<td>C2</td>
<td>Assumed software cost savings per zero client per year</td>
<td></td>
<td>$10</td>
<td>$10</td>
<td>$10</td>
</tr>
<tr>
<td>Ct</td>
<td>Software cost savings</td>
<td>C1*C2</td>
<td>$7,000</td>
<td>$23,000</td>
<td>$43,000</td>
</tr>
<tr>
<td>Ctr</td>
<td>Software cost savings (risk-adjusted)</td>
<td></td>
<td>$6,300</td>
<td>$20,700</td>
<td>$38,700</td>
</tr>
</tbody>
</table>

Software cost savings: 1% of total benefits

IT Productivity Gains

<table>
<thead>
<tr>
<th>REF.</th>
<th>METRIC</th>
<th>CALC.</th>
<th>YEAR 1</th>
<th>YEAR 2</th>
<th>YEAR 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>Assumed support hours saved per zero client per year (versus a PC)</td>
<td></td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>B2</td>
<td>Cumulated number of zero clients deployed instead of PCs</td>
<td>Sum(A1) to date</td>
<td>700</td>
<td>2,300</td>
<td>4,300</td>
</tr>
<tr>
<td>B3</td>
<td>Productivity captured</td>
<td></td>
<td>75%</td>
<td>75%</td>
<td>75%</td>
</tr>
<tr>
<td>B4</td>
<td>Number of hours repurposed productively</td>
<td>B1<em>B2</em>B3</td>
<td>2,100</td>
<td>6,900</td>
<td>12,900</td>
</tr>
<tr>
<td>B5</td>
<td>Average fully loaded annual salary rate (IT)</td>
<td></td>
<td>$80,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bt</td>
<td>IT support productivity gains</td>
<td>B4*B5/2080 (rounded)</td>
<td>$80,800</td>
<td>$265,400</td>
<td>$496,200</td>
</tr>
<tr>
<td>Btr</td>
<td>IT support productivity gains (risk-adjusted)</td>
<td></td>
<td>$76,760</td>
<td>$252,130</td>
<td>$471,390</td>
</tr>
</tbody>
</table>

Risk adjustment ↓5%

$51,911 three-year benefit PV

$51,911

Software cost savings: 1% of total benefits
Flexibility

The value of flexibility is clearly unique to each customer, and the measure of its value varies from organization to organization. There are multiple scenarios in which an organization might choose to implement a VDI environment or deploy HPE’s BladeSystem and later realize additional uses and business opportunities. In this particular case, the interviewed institution is expecting to realize further benefits by:

› **Scaling up the VDI environment to a total of 7,000 users.** By further rolling out the VDI solution to more users, the institution expects to realize further support productivity gains and save on end user device costs.

› **Further standardizing and harmonizing the server infrastructure.** In addition to the HPE BladeSystem for the VDI environment, the institution was also carrying out a data center virtualization project at one of the colleges at the same time. This virtualization project is a first step to the future consolidation of three separate college data centers into one district data center. The core of this new infrastructure will be four c7000 chassis fully populated with 64 HPE ProLiant BL460c servers. This standardization and harmonization of servers, storage, and backup from a single vendor will simplify the environment and help reduce operational costs.

Flexibility would also be quantified when evaluated as part of a specific project (described in more detail in Appendix A).
The Total Economic Impact™ Of A VDI Environment Based On HPE Blade Infrastructure

This section lists the incremental costs that the interviewed institution incurred in order to achieve the above benefits. The costs fell into the following three categories:

› **The costs for the central VDI infrastructure.** These costs include the commercial VDI product and related desktop virtualization and performance management tools, as well as the investment in the HPE BladeSystem elements. These include a c7000 chassis, 12 HPE ProLiant BL460c servers, four HPE ProLiant DL380 servers, approximately 50 GB of 3PAR storage, and HPE OneView. Furthermore, we estimated the ongoing hosting costs in the institution’s data center and assumed the incremental ongoing efforts for administering the VDI environment to be one full-time resource. In total, these costs have a three-year present value of approximately $1.2 million.

› **The costs of the zero client devices.** These costs reflect the expense for the end user devices installed in the computer labs. Initially, 700 zero clients were deployed, 1,600 more in Year 2, and 2,000 more in Year 3 of the analysis. The costs for the end user devices have a three-year present value of approximately $1.2 million.

› **The initial setup and training costs.** These costs include an estimation of the internal efforts required to set up the environment (the equivalent of 10 full-time resources for three months) as well as professional service costs from HPE and another third party, and some training costs. These costs have an estimated three-year present value of approximately $628,000.

The cost incurred for deploying and maintaining the VDI environment based on an HPE blade server infrastructure over three years totaled approximately $3.1 million for the interviewed institution.

The table above shows the total of all costs across the areas listed below, as well as present values (PVs) discounted at 10%. Over three years, the interviewed organization expects risk-adjusted total costs to be a PV of approximately than $3.1 million.
Financial Summary

CONSOLIDATED THREE-YEAR RISK-ADJUSTED METRICS

Cash Flow Chart (Risk-Adjusted)

The financial results calculated in the Benefits and Costs sections can be used to determine the ROI, NPV, and payback period for the interviewed organization's investment. Forrester assumes a yearly discount rate of 10% for this analysis.

These risk-adjusted ROI, NPV, and payback period values are determined by applying risk-adjustment factors to the unadjusted results in each Benefit and Cost section.

Cash Flow Table (Risk-Adjusted)

<table>
<thead>
<tr>
<th></th>
<th>INITIAL</th>
<th>YEAR 1</th>
<th>YEAR 2</th>
<th>YEAR 3</th>
<th>TOTAL</th>
<th>PRESENT VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total costs</td>
<td>($1,574,600)</td>
<td>($168,000)</td>
<td>($812,000)</td>
<td>($882,000)</td>
<td>($3,436,600)</td>
<td>($3,061,061)</td>
</tr>
<tr>
<td>Total benefits</td>
<td>$665,000</td>
<td>$83,060</td>
<td>$1,792,830</td>
<td>$2,410,090</td>
<td>$4,950,980</td>
<td>$4,032,923</td>
</tr>
<tr>
<td>Net benefits</td>
<td>($909,600)</td>
<td>($84,940)</td>
<td>$980,830</td>
<td>$1,528,090</td>
<td>$1,514,380</td>
<td>$971,862</td>
</tr>
<tr>
<td>ROI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>32%</td>
</tr>
<tr>
<td>Payback period</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>24 months</td>
</tr>
</tbody>
</table>
HPE BladeSystem: Overview

The following information is provided by HPE. Forrester has not validated any claims and does not endorse HPE or its offerings.

HPE BladeSystem is a modular infrastructure platform that converges servers, storage, and network fabric to accelerate operations and speed delivery of applications and services running in physical, virtual, and cloud-computing environments. Because the core infrastructure is shared, capital costs can be significantly lower. Blades share power, cooling, network, and storage infrastructure at the BladeSystem enclosure level.

Designed for a wide range of configuration and deployment options, the HPE ProLiant BL460c Gen9 Server Blade provides the flexibility to enhance your core IT applications with right-sized storage for the right workload — resulting in lower total cost of ownership (TCO). This performance workhorse adapts to any demanding blades environment, including virtualization, IT and web infrastructure, collaborative systems, cloud, and high-performance computing.

The HPE ProLiant BL460c Server is a dual-socket server blade that comes with new and enhanced features, such as:

- The latest Intel Xeon processors.
- Enhanced memory capacity and performance, along with the benefit of reduced power — 16 dual inline memory module (DIMM) DDR4 slots supporting HPE SmartMemory, with the ability to operate registered DIMMs (RDIMMs).
- Dual-port flexible LAN on motherboard (FlexibleLOM), which lets you choose the technology, speed, and OEM vendor of your networking ports.
- HPE iLO Management Engine, with features that support the entire server life cycle, ranging from deployment to continued management, service alerts, and remote support.
- The BL460c Gen9 Server Blade includes an HPE Dynamic Smart Array B140i as a standard feature — plus your choice of an HPE Smart Host Bus Adapter (HBA) H244br or HPE Smart Array P244br/1 GB FBWC for performance or additional features. Both offer support for 12 GB SAS speeds for the two internal drives. The HPE ProLiant BL460c Server Blade offers a choice of two 2.5-inch small form factor (SFF) serial-attached SCSI (SAS), Serial ATA (SATA) drives, NVMe drives, and solid-state drives (SSDs).
- Two x16 PCI Express (PCIe) 3.0 I/O expansion slots, which support the highest bandwidth mezzanine option cards at present, with room for future growth.
- HPE Virtual Connect 20/40-F8 module, which consolidates external cable connections and improves manageability by allowing server blades to be added, removed, and replaced without affecting the external network, reducing both server and network management costs and streamlining operations.
Appendix A: Total Economic Impact

Total Economic Impact is a methodology developed by Forrester Research that enhances a company’s technology decision-making processes and assists vendors in communicating the value proposition of their products and services to clients. The TEI methodology helps companies demonstrate, justify, and realize the tangible value of IT initiatives to both senior management and other key business stakeholders.

Total Economic Impact Approach

**Benefits** represent the value delivered to the business by the product. The TEI methodology places equal weight on the measure of benefits and the measure of costs, allowing for a full examination of the effect of the technology on the entire organization.

**Costs** consider all expenses necessary to deliver the proposed value, or benefits, of the product. The cost category within TEI captures incremental costs over the existing environment for ongoing costs associated with the solution.

**Flexibility** represents the strategic value that can be obtained for some future additional investment building on top of the initial investment already made. Having the ability to capture that benefit has a PV that can be estimated.

**Risks** measure the uncertainty of benefit and cost estimates given: 1) the likelihood that estimates will meet original projections and 2) the likelihood that estimates will be tracked over time. TEI risk factors are based on “triangular distribution.”

The initial investment column contains costs incurred at “time 0” or at the beginning of Year 1 that are not discounted. All other cash flows are discounted using the discount rate at the end of the year. PV calculations are calculated for each total cost and benefit estimate. NPV calculations in the summary tables are the sum of the initial investment and the discounted cash flows in each year. Sums and present value calculations of the Total Benefits, Total Costs, and Cash Flow tables may not exactly add up, as some rounding may occur.