TEI™

The language of value

A Total Economic Impact™ Framework for Deploying AMD Opteron™ Processor-Based Servers

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January 2003

Giga Information Group®

Technology advice. Business results.

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Executive Summary

Introduction

In June 2002, Giga Information Group commenced work on a research project commissioned by Advanced Micro Devices, Inc. (AMD) that focused on examining the potential savings that enterprises could realize by adopting AMD's x86-64 ISA (Instruction Set Architecture) AMD Opteron™ processor technology.

This forward-looking report highlights the possible benefits and costs of deploying AMD Opteron multiprocessor servers across the enterprise of a sample organization (see Appendix B for description of sample organization). The report examines the estimated savings for this sample organization, and represents the aggregate findings derived from interviews with AMD management as well as the independent research of Giga Information Group. AMD plans to ship AMD Opteron processors to customers in the first half of 2003, therefore pricing and performance metrics are not yet available; however, through numerous interviews with AMD management, Giga has established a general feel for the pricing and performance of the AMD Opteron processor, and we believe that AMD Opteron processor-based servers will be priced competitively with similarly configured 32-bit industry standard servers. As such, a framework for the potential benefits can be constructed in advance of the product release, with preliminary estimates for benefits validated upon first customer product shipments.

The objective of this report is to establish a framework for the reader through which the value statements of AMD can be filtered and applied to their own organization. It is important to note that the values contained within this report are based on projections around AMD's stated features and functionality of the AMD Opteron processor, and have not been independently validated. Therefore, this report should be seen as a guide for readers that are considering the future use of AMD Opteron processor technology within their organization. Estimates contained within this report must be adjusted to reflect each organization's own environment. Giga makes no assumptions that other organizations will achieve similar results as those cited in this report.

AMD selected Giga Information Group for this project because of Giga's Total Economic Impact™ (TEI) methodology, which not only measures costs and cost reduction, which are typically accounted for within IT, but also weighs the enabling value of a technology in increasing the effectiveness of overall business processes. Giga employed three fundamental elements of TEI (see Appendix A for an overview of TEI) in modeling the savings of using AMD Opteron processor technology: cost and cost reduction, benefits, and risk.

Key Findings

Giga's interviews with AMD management and our independent research gives us a high degree of confidence that AMD Opteron processor-based servers (formerly code-named "SledgeHammer") will be competitively priced relative to other industry-standard 32-bit servers. In addition, based on performance metrics established in AMD's labs (not yet independently certified), it appears that AMD Opteron processors may compare favorably to rival servers in 32-bit performance capability. This is of strategic importance because if the AMD Opteron processor-based servers can offer similar price/performance as well as the incremental capability to run x86-64 bit applications, then organizations could see significant cost avoidance savings in future hardware server costs and selected, (especially x86 assembly language) software conversion costs. Giga believes that organizations most likely to achieve these savings are large enterprise-class customers that are trying to manage growing and complex datasets while pushing the limit on existing 32-bit applications. These organizations are most likely running customized ERP, CRM, SCM and Web Services applications that use very large databases in a real-time processing environment.

This analysis focuses on two areas of potential savings:

Hardware Savings

In the future, organizations will likely see combined and mixed 32/64-bit environments with the catalyst to 32- to 64-bit application migrations tied to software vendor upgrade cycles, business-driven application upgrades, and developer availability. These catalysts often run contrary to normal end-of-life server strategies, especially when hardware upgrades require new non-x86 server technology due to the brand-new architectures and instruction sets being introduced in the chip industry.

A Possible Investment Protection Strategy

When upgrading large x86 32-bit in-house custom applications residing on multiple servers (with multiple end-of-life schedules) to 64-bit technology, organizations would normally need to replace all of the 32-bit servers associated with these applications with new 64-bit-capable servers, disrupting an organization's normal end-of-life server replenishment cycle. Most organizations are very inefficient at server reuse, either spending additional money to reconfigure the servers, or discarding them.

Therefore, hardware cost avoidance savings are derived from the ability to deploy x86-64 AMD Opteron processor-based server technology *in advance of* the desire or need to migrate to 64-bit operating systems and applications, allowing the organization to maintain its normal hardware end-of-life cycles.

Based on Giga's research, an organization should consider a server replenishment strategy that includes deploying AMD Opteron processors prior to the need to migrate to 64-bit applications. With this strategy AMD Opteron processor-based servers will be able to run existing 32-bit applications while being available to adopt 64-bit applications at the organization's own pace, as hardware, ISV software support and developers' time become available. This migration strategy and binary feature would likely reduce future server costs for an organization adopting the AMD's x86-64 technology, as these AMD Opteron processor-based servers would not have to be discarded and replaced with a 64-bit upgrade.

Giga built a cost savings model based on a sample organization that compares hardware costs using the AMD Opteron processor-based strategy described above vs. using hardware that does not support x86 64-bit technology, where servers will need to be replaced coincident with 64-bit migration. Based on the assumptions in this model including the cost avoidance of not purchasing duplicate servers and/or retiring servers early, the AMD Opteron processor-based strategy saves the sample organization $2,773,848 (risk adjusted) over five years. (See Appendix C for hardware cost and benefits assumptions.)

Software Savings

Giga found considerable cost avoidance savings associated with the ability to write/port/support x86 custom software to leverage the full 64-bit capabilities of x86-64 technology using the AMD Opteron processor, as compared to the significant conversion costs associated with migrating assembly language coded x86 software to *non*-x86-64-bit competitive servers that have been introduced in the past year.

The cost avoidance savings outlined in this analysis are based on AMD's claims that its AMD Opteron processor, with its ability to extend the x86 architecture for 64-bit computing, is a more cost-effective alternative to competitors' strategies of establishing brand-new non-86 64-bit architectures. The sample organization saves $1,902,100 (risk adjusted) over five years. (See Appendix C for software conversion cost assumptions.)

Summary of Cost Avoidance Savings Over 5 Years:

	Risk-Adjusted	Un-Adjusted
Hardware Cost Avoidance Savings	$2,773,848	$2,971,980
Software Conversion Savings	$1,902,100	$2,481,000

Note: Cost avoidance savings over five years — not discounted for present value.

32-Bit to 64-Bit Migration — Brief Industry Overview

The original IBM PC used an Intel 8088 microprocessor that was a 16-bit version of x86; an instruction set that has evolved over the years into the current 32-bit version used in modern Windows-based PCs today. Today, x86 is by far the most widely adopted CPU language, with the amount of x86 programming far exceeding what is available for competing instruction sets. With the Microsoft Windows code base, the number of applications that run on x86 is ubiquitous.

Today, 64-bit computing technology is being driven by applications that handle large amounts of data and address large amounts of memory. Higher-end 64-bit processors can handle twice as many bits of information per clock cycle as their 32-bit counterparts, making them well suited for data-intensive applications such as database management or computer-aided design.

The challenge for processor designers and manufacturers will be to make the conversion from 32-bit to 64-bit processing as seamless as possible for their customers. Ideally, users should be able to make the 64-bit transition at their own pace and with minimal software redevelopment and deployment costs. 32-bit technology will be available for the next several years for the majority of users, although nearly all organizations will need to develop a migration strategy in order to adopt the inevitable 64-bit technology (similar to the evolution from 16-bit to 32 bit years ago). As part of their migration plans, organizations should consider any processor implementing the x86-64 technology, since it will be a natural extension of the x86-32 instruction set that is in widespread use today. An x86-64 strategy allows the latest in processor innovation to be brought to the existing installed base of 32-bit applications and operating systems.

There are some industry-wide issues that will have to be resolved during the next several years:

1. Independent software vendors (ISVs) will need to determine whether to incur the costs of developing both 32-bit and 64-bit applications simultaneously, or abandon the 32-bit efforts and concentrate on developing programs for 64-bit environments.
2. Processor designers and manufacturers must decide how to offer 64-bit functionality while preserving x86 compatibility for their 32-bit customers.
3. IT managers must plan for the inevitable transition to replace existing 32-bit applications, and understand the risks of not transitioning and being left with their 32-bit applications at the current performance and functionality levels.
4. Platform suppliers must consider the impact of providing technical support for two (32-bit and 64-bit) technologies.

AMD Opteron Processor's Features

AMD expects AMD Opteron processors to ship to end-user customers in the first half of 2003.

Based on interviews with senior AMD executives, Giga believes that the upcoming AMD Opteron processor will have the following features:

- AMD's eighth generation architecture is based on x86 instruction set
    - Full 32-bit compatibility and performance
    - Eighth generation processors are designed to run any 32-bit legacy operating system and applications
    - Compatible with prior 32-bit generations
    - 32-bit and 64-bit applications can co-exist on the same system

- Under control of the 64-bit operating system, existing 32-bit applications can run as they do today
- No application recompile required, no emulation layer

- 64-bit mode
  - Desired applications can be written/ported to leverage the full 64-bit capabilities of x86-64 technology
  - Migrate only where needed, and on the users timetable
  - Low percentage of applications need to be in this mode

AMD announced in April 2002 that Microsoft agreed to develop 64-bit Windows products that will work with the company's new technology. This support is key to the chip's successful launch in 2003. AMD publicly displayed a dual AMD Opteron processor-based server running a developmental 64-bit version of Windows at their annual shareholders' meeting, also in April 2002. In June 2002, AMD demonstrated the first 4-way AMD Opteron processor-based server at the Computex trade show. At the November 2002 COMDEX show, AMD demonstrated a prototype version of the 64-bit Microsoft Windows operating system using 64-bit Microsoft Internet Information Server (IIS), 64-bit Terminal Services and 64-bit Microsoft Internet Explorer running on AMD Opteron processor-based systems. Also in November 2002, AMD announced that Covalent and Red Hat have committed to develop Apache-based Web server software for the AMD Opteron processor. AMD has also demonstrated the chip running on Linux systems.

Risks Associated With Cost Savings Avoidance

Risk-adjusted and non-risk adjusted savings are both discussed in this study. The assessment of risks provides a range of possible outcomes, based on the risks associated with IT projects in general and specific risks relative to the AMD Opteron processor.

Risk factors are used in TEI to widen the possible outcomes of the costs and benefits (and the resulting savings) associated with an investment. Since the future cannot be accurately predicted, there is risk inherent in any project, especially in trying to determine costs and savings. Risk and uncertainty are even greater for yet-to-be delivered products such as the AMD Opteron processor. TEI attempts to quantify risk in the form of risks-to-benefits and risks-to-costs.

These are the *general* risks that were considered in this report, which assumes an organization adopts a 64-bit migration strategy that includes deploying AMD Opteron processors prior to the need or desire to migrate to 64-bit applications:

- Lack of organizational discipline in creating processes and procedures to best take advantage of the benefits of migrating to 64-bit operating systems and applications
- Lack of appropriate training for IT personnel who will be responsible for optimizing the benefits from AMD Opteron processor-based servers
- Internal inertia, conflicting priorities and turnover, reducing the organization's ability to achieve the benefits

The following specific risks associated with the AMD Opteron processor were considered in this report:

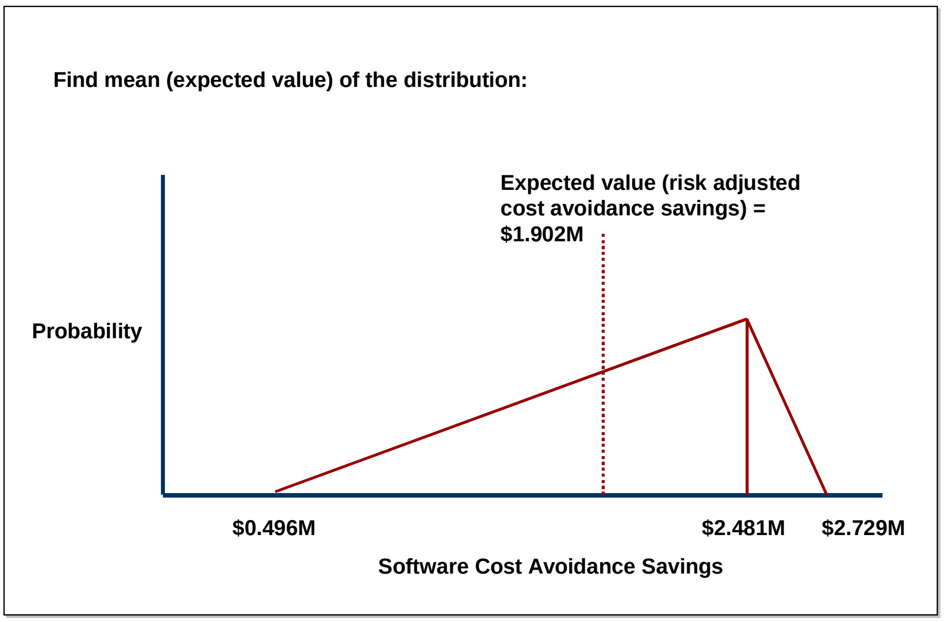
- If ISVs do not port their subsequent software versions to x86-64 instruction sets, the AMD Opteron processor's long-term investment value to end users will diminish.
- If enterprise server vendors do not adopt and thereafter continue to support AMD Opteron processor technology, then market penetration will erode causing other industry participants (e.g., ISVs) to reduce their efforts to support the AMD Opteron processor.

- Microsoft has agreed to develop 64-bit Windows products that will work with the new AMD Opteron processor technology. This support is key to the chip's successful launch in 2003 and, therefore, it is essential that Microsoft continue its commitment to AMD's x86-64 technology.
- The risk that AMD does not keep up with the latest chip processor technologies that AMD Opteron processor competitors have subscribed to, leaving AMD's customer with a less than optimum solution in the longer-term future.

If a risk-adjusted savings still demonstrates a compelling business case, it raises confidence that the investment is likely to succeed, since the risks that threaten the project have been taken into consideration and quantified. The risk-adjusted numbers should be taken as "realistic" expectations, since they represent the expected value considering risk. Assuming normal success at mitigating all risk, the risk-adjusted numbers should more closely reflect the expected outcome of the investment.

Risks-to-benefits considers all possible risks to each benefit. Likewise, risks-to-costs considers all possible risks to each cost. Using probability density functions, we create a triangular distribution range of three values, including a low estimate, a most likely estimate and a high estimate. Figure 1 below shows the risk adjustments for the software conversion and testing savings. Figure 2 shows the risk adjustments for the hardware savings.

Figure 1: Risk Adjusting Software Conversion and Testing — Cost Avoidance



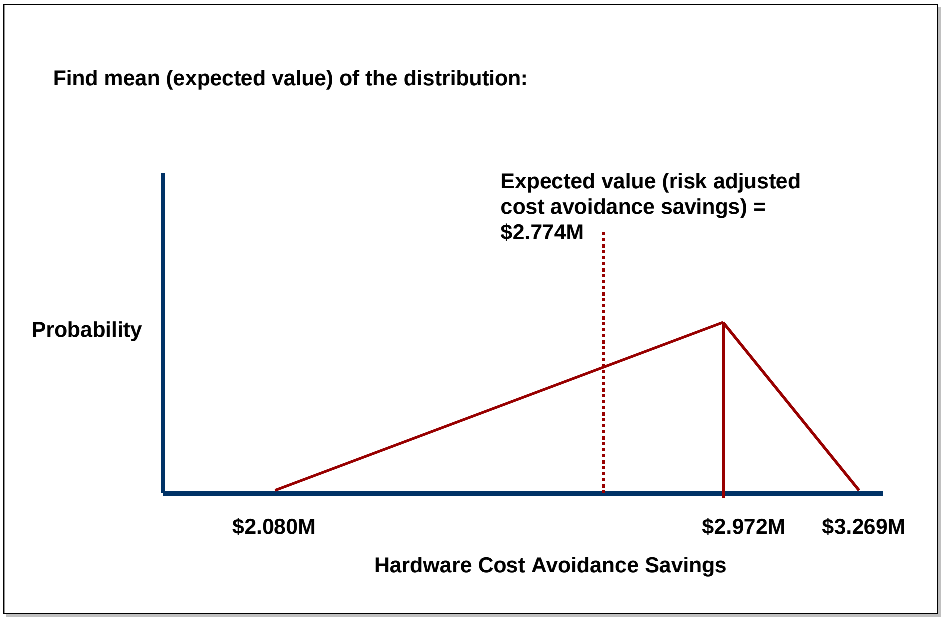
Source: Giga Information Group

In our sample organization, we risk adjusted the total software conversion savings of $2,481,000 (non-risk adjusted). For this cost avoidance category, the risks-to-savings for the low estimate was 20 percent of the $2,481,000, or $496,200, suggesting that there's a high degree of certainty that vendors will develop and/or enhance tools that automate the process of retrofitting existing 32-bit assembly language coded applications. These tools would significantly reduce the software conversion and testing costs used in this analysis, and therefore reduce the projected savings realized by companies adopting the AMD Opteron processor-based server's strategy (vs. non-AMD Opteron processor-based servers).

The high (risk) estimate is 110 percent of $2,481,000 or $2,729,100, indicating a possible slight overachievement of the cost avoidance if it's determined that non-x86-64 migrations involve more effort to convert and test the software. Using triangular distribution, we sum the three possibilities of low, most likely and high and divide by three to get the mean (or risk-adjusted cost savings) of $1,902,100 ($496,200 + $2,481,000 + 2,729,100 = $5,706,300 / 3 =

$1,902,100). Figure 1 illustrates the concept of triangular distribution, and the vertical dashed line in the center represents the expected value of $1,902,100. In our sample organization, all costs and benefits were adjusted for risk.

Figure 2: Risk Adjusting Hardware Savings Cost Avoidance



Source: Giga Information Group

In our sample organization, we risk adjusted the total hardware savings of $2,971,980 (non-risk adjusted). For this category, the risks-to-savings for the low estimate was 70 percent of the $2,971,980 or $2,080,386, suggesting that there's a reasonable degree of certainty that end users will realize the cost avoidance savings of not purchasing duplicate servers and/or retiring servers early.

The high (risk) estimate is 110 percent of $2,971,980 or $3,269,178, indicating a possible slight overachievement of the cost avoidance if organizations deploying the non-AMD Opteron processor-based strategy fail to mitigate costs associated with the early retirement of servers. Using triangular distribution, we sum the three possibilities of low, most likely and high and divide by three to get the mean (or risk-adjusted cost savings) of $2,773,848 ($2,080,386 + $2,971,980 + 3,269,178 = $8,321,544 / 3 = $2,773,848). Figure 2 illustrates the concept of triangular distribution, and the vertical dashed line in the center represents the expected value of $2,773,848. In our sample organization, all costs and benefits were adjusted for risk.

Summary

As the data in this framework study indicates, AMD's Opteron processor-based server technology has the potential to provide a savings in both hardware cost avoidance and software conversion and testing cost avoidance.

Giga's interviews with AMD executives and our independent research give us a high degree of confidence that AMD Opteron processor-based servers will be competitively priced relative to other industry-standard 32-bit servers. In addition, based on performance metrics established in AMD's labs (not yet independently certified), it appears that the AMD Opteron processor may compare favorably to rival servers in 32-bit performance capability. Strategically, if the AMD Opteron processor can offer similar price/performance as well as the incremental capability to run x86-64 bit applications, then organizations that deploy AMD Opteron technology in their normal server replenishment cycles could see significant cost avoidance savings in future hardware server costs and x86 assembly language software conversions costs.

For our sample organization, the risk-adjusted hardware savings of $2,773,848 added to the risk adjusted software conversion savings of $1,902,100 raises confidence that the investment is likely to succeed, since the risks that may threaten the investment have been taken into consideration and quantified.

As stated from the outset, the purpose of this document is to provide a guide to examine the potential value propositions around the AMD Opteron processor as it applies to one's own internal organization. Since AMD has stated its AMD Opteron processor will be available in the first half of 2003, it is important to keep in mind that this document should be used as a tool to validate one's own estimates, and not used as a document to justify a purchase of AMD Opteron technology. Giga makes no assumptions that other organizations will achieve results similar to those cited in this report.

Appendix A: Total Economic Impact™ (TEI) Primer

Total Economic Impact is primarily a common language tool, designed to capture and properly communicate the value of IT initiatives in a common business language. In so doing, TEI considers four elements of any initiative:

1. Benefits
2. Costs (sometimes referred to as total cost of ownership (TCO))
3. Flexibility (due to the forward-looking nature of this AMD Opteron processor analysis and the uncertainty in the inability to independently validate AMD's performance claims, Flexibility was not modeled in this study)
4. Risk

Benefits

Benefits represent the *value* delivered to the business by the proposed project. Oftentimes, IT project justification exercises focus on cost (e.g., TCO) and cost reductions. Among industry leaders, IT is deployed as an offensive weapon, with greater value expectations than simple cost reduction, especially when those cost reductions tend to focus within IT. TEI captures the value proposition of the proposed project by measuring the benefits against the incurred costs.

The TEI process begins with a discovery of potential benefit areas. A representative, who has the ability to capture the benefit in question, from the organization under examination, must validate each benefit captured during discovery. In other words, values cannot arbitrarily be assigned to a benefit if that person is not in a position to deliver that benefit should the project be approved. Additionally, projects that are expected to deliver business value require some effort on the part of the business to realize that value. That effort may be in the form of training, organizational change or a modification of extant business processes.

Costs

Costs represent the investment necessary to capture the value, or benefits, of the proposed project. IT or the business units may incur costs. These may be in the form of fully burdened labor, subcontractors or materials. Additionally, costs consider all the investment and expenses necessary to deliver the value proposed.

Flexibility

Flexibility, as defined by TEI, represents investing in additional capacity that can, for some future additional investment, be turned into business benefit — for instance, an investment in an enterprise-wide upgrade of the desktop word processor application where the primary driver may be standardization (to increase efficiency) and licensing (to decrease IT costs). However, a collaborative workgroup feature may translate into greater worker productivity when the organization is ready to absorb the discipline necessary to capture that benefit. The collaboration feature does not promise benefit during this phase of the project and must be captured later, incorporating additional investment, most likely in the form of training. However, the existence of the option has a present value that can be estimated. The flexibility component of TEI captures that value.

Risk

Risks are used to widen the possible outcomes of the project. Since the future cannot be accurately predicted, there is risk inherent in any project. TEI captures risk in the form of risks-to-benefits and risks-to-costs.

Risks-to-benefits considers all possible risks to each possible benefit. Likewise, risks-to-costs considers all possible risks to each possible cost. Then, a range is chosen by applying best judgment for each cost and benefit, based on the set of risks assigned to each cost and benefit. The range is entered in the form of a low estimate, a most likely value and a high estimate. For example, the risks to a cost may result in a range from the expected value as the low estimate, to two times the expected value as the high for a particular cost (representing a potential two times cost overrun).

TEI applies a probability density function known as "triangular distribution" to the values entered. The expected value — the mean of the distribution — is used as the risk-adjusted cost or benefit number. The risk-adjusted costs and benefits are then summed to yield a complete risk-adjusted summary.

Appendix B — Description of Sample Organization

In this analysis, we have created a sample organization to illustrate the cost savings of a typical midsize enterprise or division of a larger firm.

- A Fortune 1000-size financial services organization with a distributed computing environment using 2,000 existing 32-bit servers running 32-bit x86 custom applications: ERP, CRM, SFA with significant database and memory requirements.

Appendix C — Hardware and Software Cost Assumptions

Hardware Cost Assumptions

An organization recognizes the long-term advantages of replacing normal end-of-life servers with AMD Opteron processor-based servers, which will not have to be displaced during a future migration to x86-64 bit applications.

In the future, as the organization upgrades large x86 32-bit applications residing on AMD Opteron processor's binary 32/64-bit servers to x86-64 technology, one will be able to use the existing AMD Opteron processor-based server farm, avoiding the need to replace, reconfigure or discard midlife servers, as one would with non-x86 64 bit server technology. The costs assumptions for acquiring incremental competitive servers as well as the cost for discarding and/or reconfiguring old servers are listed below:

- Assumes the useful life of existing and future servers is three years
- Since AMD Opteron processor prices have not been determined yet, we assumed that all new 32/64-bit dual AMD Opteron processor-based servers as well as 32-bit and 64-bit competitive servers are priced similarly at an average of $20,000, using an industry standard 32-bit dual processor configuration.
- 60 medium-to-large scale x86 business applications each deployed across four servers will be upgraded to 64-bit functionality on 64-bit servers at the rate of 15 per year (in years two through five).
- For <u>each</u> of the 60 applications running on four servers:
    - One server is scheduled to be replaced in the current year and will be discarded
    - The second server is one year old and will be reconfigured at a cost of $1,500 to be re-used in the sample companies normal replenishment cycle
    - The third server is two years old and will be reconfigured at a cost of $1,500 to be re-used in the sample companies normal replenishment cycle
    - The fourth server is scheduled to be replaced next year and will be discarded
- For <u>each</u> of the 60 applications migrated to 64-bit, we assume the following costs associated with the non-AMD Opteron processor strategy:
    - <u>Net</u> server costs of $40,000 as follows: purchase four competitive 64-bit servers at $80,000 ($20,000 each), although two of the 32-bit servers replaced will be reconfigured and made available for re-use for a cost avoidance of $40,000.
    - Need to discard and write-off two servers at a cost of $3,333.
    - For the other two servers there will be reconfiguration costs of $1,500 per server ($3000 per application) including labor and materials. These two servers will be re-used in the sample company's normal replenishment cycle.
    - Other costs associated with purchasing competitive servers average $3,200 per application, as follows:
        - Administration/management/middleware tools that will have to be replaced on the new server. ($500 per server, $1,000 per application)

- Asset management — the acquisition, inventory, contract costs that would be avoided in a normal end-of-life strategy. ($1,000 per server; $2,000 per application)
- Savings in setting up the new servers: $200 per application

Total hardware and associated costs per migrated Application = $49,533

Total annual hardware and associated costs (15 applications) = $742,995

Four-year total costs (non-risk adjusted) = $2,971,980 (years two through five of analysis)
(See Appendix D for the Incremental Hardware Costs of Deploying (non-x86) 64 bit Servers vs. AMD Opteron Processor-Based Servers)

Software Cost Assumptions

The cost to convert a custom assembly language coded 32-bit application to a (non-x86) 64-bit server*

The cost savings outlined in this analysis are based on the AMD Opteron processor's ability to extend the x86 architecture for 64-bit computing; and it being a more cost-effective alternative to competitors' strategies of establishing brand-new non-86 64-bit architectures.

Giga found considerable cost avoidance savings associated with the ability to write/port/support x86 custom software to leverage the full 64-bit capabilities of x86-64 technology using AMD Opteron processors, as compared to the significant conversion costs associated with migrating assembly language coded x86 software to *non*-x86-64 servers.

Giga feels there are wide variations in the average size of an application based on organizational practice and definition of "an application." There will also be dramatic variations between technologies and languages, where COBOL will have fewer lines of code than a GUI application written in C++. Giga Information Group feels a range of 100,000 to 200,000 lines of code is appropriate and, therefore, this model uses an average of 150,000 lines.

Building on that, the model assumes around 1,500 lines of assembly language code per program within an application, and around 1,000 programs within a major application. Our sample company has 30 assembly language coded applications that would require conversion. In a "conversion" scenario we assumed that 75 percent of the programs would require about 45 to 60 minutes of work (750 * 53 min. avg. = 663 hours). We would further assume that 20 percent of the programs would have some kind of issue that requires an average of two hours to resolve (200 * 120 min = 400 hours); and 5 percent of the programs would have some kind of issue that requires an average of five hours to resolve (50 * 300 min = 250 hours). After conversion, we assumed, at minimum, to regression test the whole application, which would take five to 10 people (7.5 average used in this analysis) working 50 percent FTE for three to four weeks (3.5 weeks), with another week for problem resolution.

The cost to do code conversion and regression testing on 32-bit code to 64-bit code per application = $82,700

Total annual conversion and testing costs for 7.5 (*) assembly coded applications per year = $620,250

Four-year total conversion and testing costs = $2,481,000 (non-risk adjusted, years two through five of analysis)

* Giga found that there were no significant costs associated with converting existing 32-bit high-level code (C, C++, JAVA) to non-86 64-bit architectures. (See Appendix E for The Incremental Costs of Converting a Custom 32-bit Application to run on a (non-x86) 64-bit Server)

Appendix D — The Incremental Hardware Costs of Deploying (Non-x86) 64-Bit Servers vs. AMD Opteron Processor-Based Servers

Table 1: The Incremental Hardware Costs of Deploying (Non-x86) 64-Bit Servers vs. AMD Opteron Processor-Based Servers (The Sample Organization)

	Year 1*	Year 2	Year 3	Year 4	Year 5	Total
Number of custom applications to be upgraded to 64-bit functionality	0	15	15	15	15	60
Number of servers used per application	N/A	4	4	4	4	
Number of servers to be replaced with new 64-bit servers	N/A	60	60	60	60	240
Cost of new non-x86 64-bit servers ($20,000 per server)	0	$1,200,000	$1,200,000	$1,200,000	$1,200,000	$4,800,000
Disposal/write-off costs for two of the 32-bit servers ($3,333 per application)	0	$49,995	$49,995	$49,995	$49,995	$199,980
Server reconfiguration costs of $1,500 per server (two servers per application) to replace other end-of-life 32-bit servers	0	$45,000	$45,000	$45,000	$45,000	$180,000
Average administrative/ purchasing/middleware tool cost ($3,200 per application)	0	$48,000	$48,000	$48,000	$48,000	$192,000
Cost avoidance (benefit) by reusing reconfigured servers in normal 32-bit server replenishment cycle	0	-$600,000	-$600,000	-$600,000	-$600,000	-$2,400,000
Total incremental hardware cost of deploying (non-x86) 64-bit servers vs. AMD Opteron processor-based servers (non-risk-adjusted)	0	$742,995	$742,995	$742,995	$742,995	$2,971,980
Risk-Adjustment Factors (1/3 weighted each)						
Low estimate = 70% (lower likelihood of savings)	0	$173,365	$173,365	$173,365	$173,365	
Most likely = 100% (most likely scenario)	0	$247,665	$247,665	$247,665	$247,665	
High estimate = 110% (higher likelihood of savings)	0	$272,431	$272,431	$272,431	$272,431	
Risk-Adjusted total cost avoidance Benefit of using AMD Opteron Processor-based Servers vs. non-x86 64-bit servers	0	$693,462	$693,462	$693,462	$693,462	$2,773,848

Source: Giga Information Group
*Year 1 — Organization begins migration to 64-bit applications in Year 2

Appendix E — The Incremental Costs of Converting a Custom 32-Bit Application to Run on a (Non-x86) 64-Bit Server

Table 2: The Incremental Costs of Converting a Custom 32-Bit Application to Run on a (Non-x86) 64-Bit Server (The Sample Organization)

	Year 1*	Year 2	Year 3	Year 4	Year 5	Total
Number of custom applications to be upgraded to 64-bit functionality	0	7.5	7.5	7.5	7.5	30
Cost to convert and regression test 32-bit assembly language code to 64-bit code, for an average application	0	$82,700	$82,700	$82,700	$82,700	
Cost to convert 15 custom applications to non-x86-bit servers	0	$620,250	$620,250	$620,250	$620,250	$2,481,000
Risk-Adjustment Factors (1/3 weighted each)						
Low estimate = 20% (lower likelihood of savings)	0	$41,350	$41,350	$41,350	$41,350	
Most likely = 100% (most likely scenario)	0	$206,750	$206,750	$206,750	$206,750	
High estimate = 110% (higher likelihood of savings)	0	$227,425	$227,425	$227,425	$227,425	
Risk-Adjusted Cost Avoidance Benefit of Using AMD Opteron Processor-based Servers	0	$475,525	$475,525	$475,525	$475,525	$1,902,100

Source: Giga Information Group

*Year 1 — Organization begins migration to 64-bit applications in Year 2