GLC Linux Development Funding Allocations

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Executive Decision Making
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Disclaimer

This project is based on an actual, current resource allocation problem.
Due to the sensitivity and confidentiality of dealing with unannounced products and budgets, the company and project names have been changed to protect intellectual property.

Executive Summary

GLC is a software development company with an Emerging Markets department that has developed it's own Linux software package that currently sells over the Internet. Now, in order to generate more revenue and increase market share, the developers of the Emerging Markets department want to deliver new enhancements, applications, and provide the latest hardware support.

Based on the five department objectives (on-going projects, customer satisfaction, customer requests, future direction and increased market share), the developers have identified fourteen potential projects for a total cost of $25 Million. Since the 2001 budget is only $17 Million, the team must decide which projects should be funded.

An analysis of the benefits of each project was completed using the Analytic Hierarchy Process (AHP)[1]. First, a Benefit/Cost ratio analysis[2] was completed, followed by an Optimization analysis[3]. Based on our analysis, we recommend the following ten projects be funded in 2001 for a total of $16.8 Million:

- Web Server
- Installation GUI
- Security Firewall
- Performance Enhancements
- Interoperability with Windows 2000
- Printer Device Drivers
- Development Tools
- 64-bit Support
- Network Device Drivers
- DVD Support

[1] Forman, Ernest, *Decision By Objectives (How to convince others that you are right).*
[2] Expert Choice, Inc., *Expert Choice,* 1984-1999
[3] Microsoft Corporation, *Microsoft Excel 97, Solver,* 1985-1996

Background

GLC is a software development company that has been writing software applications for many years. In the past, software was written using proprietary source code that only runs on specific hardware machines. That means, for example, that if a person is running applications on Microsoft Windows® 98, those same applications cannot run on a machine running Macintosh® or Unix®. It also means that if a person creates a document in Microsoft Word, an iMac® user cannot read the document.

As you would imagine, this makes for very dissatisfied customers. In the last few years, a grass-roots effort has begun to push for open-source software. Java®, an open-source programming language, became the first of it's kind to allow programmers to write an application one time using Java, and run that application on any machine that supports the Java Virtual Machine (JVM). Now, a Java-based application can run on Windows, Linux, Unix or Mac.

Like Java, Linux is the most popular open-source operating system available today. Linus Torvalds who, at the time, was a student at the University of Helsinki in Finland developed it in 1991. Version 1.0 was first released in 1994. Today, anyone can take the open-source code and develop their own distribution of Linux, as long as the approved guidelines are met.

GLC decided to develop their own distribution of Linux and currently sells it over the Internet. Revenue has been steady from the Linux product, but since it is free code, pricing must remain low. In order to increase future revenues, the Emerging Markets department of GLC has decided to offer additional enhancements and hardware support to the existing product, along with new applications.

Planning has just begun for 2001 with a budget of $17 Million.

Analytic Hierarchy Process

The Analytic Hierarchy Process (AHP) was used to assess this problem. First, we needed to determine our goal, objectives, and possible alternatives. This is referred to as decomposing the problem. Next we established our priorities. Finally, we synthesized the information. Each step will be further explained as we go along.

Decompose the Problem

Goal:

Determine the optimum use of the funds available for the Linux Development program.

Objectives:

- **On-going projects** – These are projects that are already started, but, if selected, will require continued funding in 2001. These projects may be cancelled if determined to be the best decision. Therefore, this is listed as an objective rather than a constraint.
- **Customer Satisfaction** – Projects that customers need in order to maintain their current operations at a satisfactory level are considered to be customer satisfaction issues.
- **Customer Requests** – Projects that customers need in order to meet their future needs are categorized at requests. This means that it is not an immediate customer problem, but it will be required in the near future.
- **Future Direction** – These are projects that meet our future strategic direction. Where customer requests are driven by customer wants, future direction is where GLC determines we need to go in the next two to three years for continued growth. Financial benefits from these projects are usually several years out and they carry a high level of risk.

- **Increase Market Share** – These projects are usually more short-term focused than the future direction projects. These tie in closely with customer requests and future direction and are usually the current trends.

Alternatives:

Following are all of the projects that have been identified as potential candidates for funding in 2001. The cost to do all of the projects is more than our budget for 2001, so we will need to determine which projects we should fund.

- **Desktop Applications** – The following three desktop applications are the main "office" applications required by PC users. Few options are currently available on the Linux platform, so this is a common customer request.
  - **Word Processor**
  - **Spreadsheet**
  - **Graphics**
- **Hardware Support:**
  - **64-bit processor support** – Intel is scheduled to deliver a new 64-bit processor chip, code-named Merced, by mid-2000, that will extend computers to even higher levels of performance and functionality. This will position servers and clients to meet the ever increasing demands of applications. Providing support for this new technology is a key future direction project.
  - **Network device drivers** – New networking technologies are constantly becoming available, and operating systems must offer device drivers to support the new network cards.
  - **Printer device drivers** – As with network cards, new and better printers are always available and we must provide the device drivers to allow customers to exploit the new printers.
- **Performance Enhancements** – Performance is always a critical need for customers. Everyone wants faster processing, faster connections, faster file serving and faster printing. GLC continually strives to improve over existing performance benchmarks.

- **Install Graphical User Interface (GUI)** – Linux is known for having a terrible installation program. Most things are accomplished from a command line. This is fine for programmers and "techies", but the typical end-user is used to the Microsoft GUI that lets you make choices by clicking on buttons and pull-down menus. An install GUI would provide significant improvements in customer satisfaction.
- **Interoperability with Windows 2000** – Most customers today have a mixed environment for their hardware and software. They will have Unix servers and Windows NT® servers, Unix clients, Windows 98 clients and Mac clients. In order to compete in this type of environment, Linux must be able to operate, compatibly with various clients and servers. Development work is required to ensure Linux compatibility with Windows 2000.
- **Fun/Entertainment:**
  - **True Type Fonts** – TrueType is a digital font technology designed by Apple Computer. It allows you to create fonts in all point sizes, at all resolutions.
  - **DVD Support** – Digital Versatile Disc (DVD) offers faster file access and increased storage capacity, along with better quality pictures.
- **Development Tools** – These are designed for the programmers that write their own proprietary applications. The tools will include things like a Java developer's kit, debug tools to assist with their applications, system monitoring tools, etc.
- **Web Server** – Customers want a stable server that will allow them to put their business out on the Internet and Linux is a popular choice. Consequently a solid web server with strong encryption is a must.
- **Security Firewall** – Encryption will help protect data being transmitted, but a security firewall is required to prevent hackers from pulling data right off of the server.

Establish Priorities

Using Expert Choice decision making software, the AHP pairwise comparison process was used. Based on the Expert Choice verbal judgments of extreme, very strong, strong, moderate, equal and in-between judgments such as moderate to strong, comparisons were made on the relative importance of each objective with respect to the goal. Figure 1 is a view of the goal and objectives from the Expert Choice software and Figure 2 shows an example of how the judgments were made for each objective with respect to the goal. In the same manner, judgments were made for each level of intensity, with respect to the objective. From these judgments, weights are derived that are used to establish priorities.

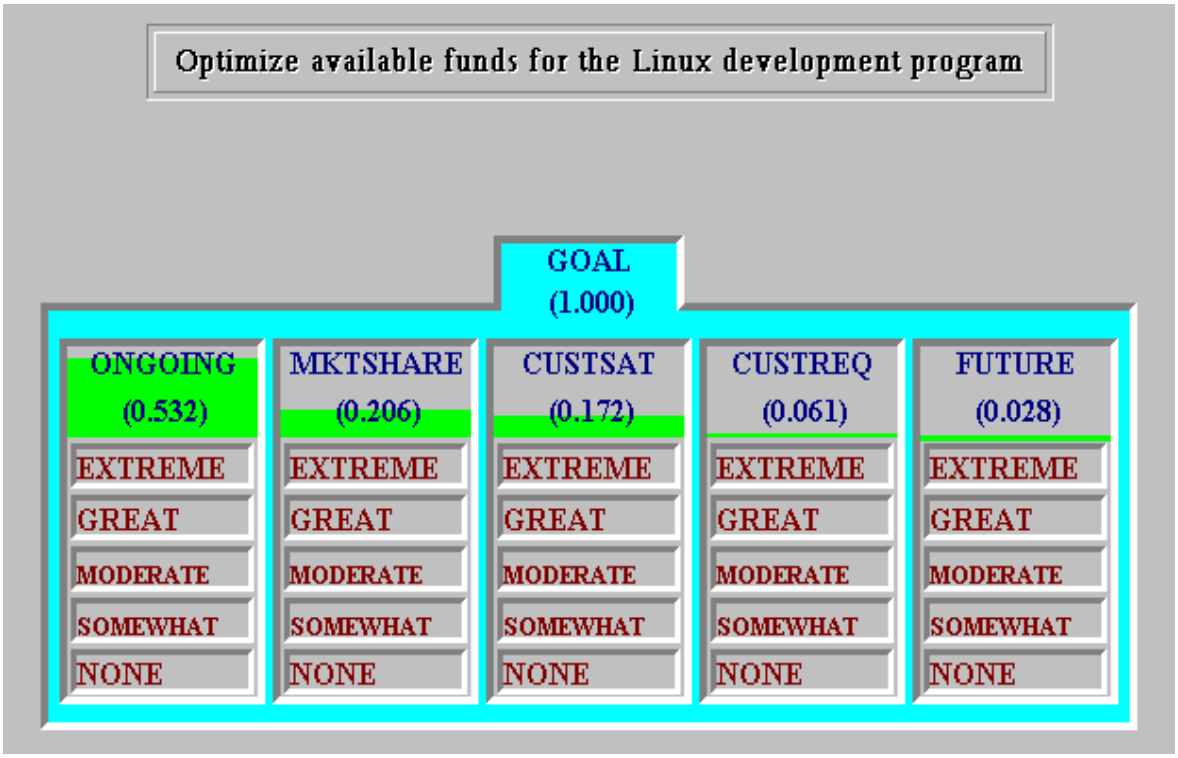

Figure 1. Basic Model from Expert Choice Software

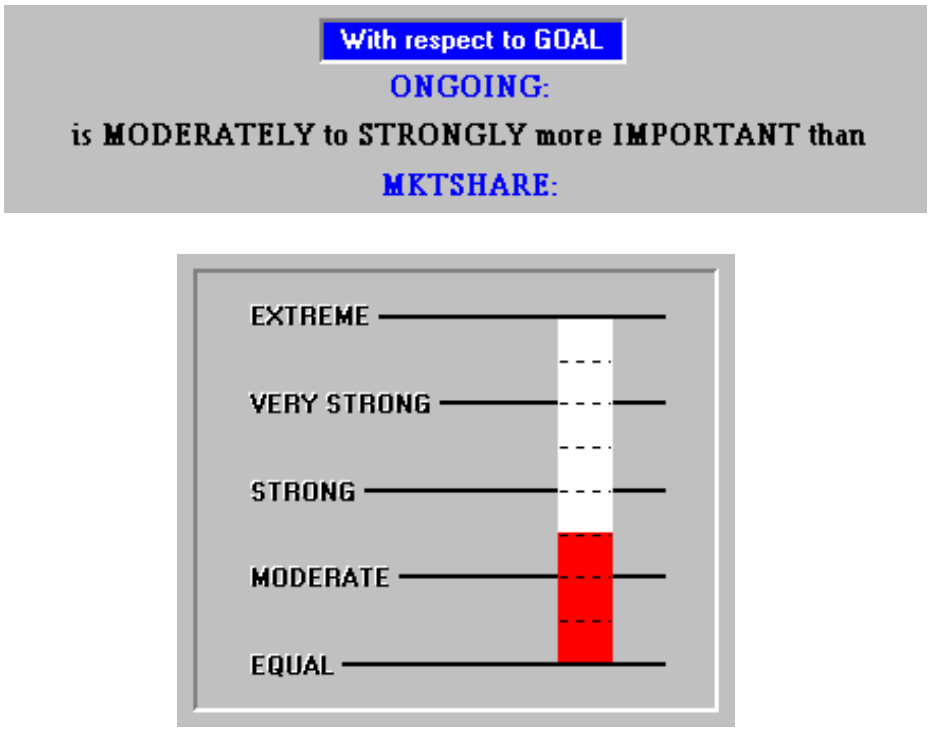

Figure 2. Pairwise Comparisons of Objectives

Intensity Levels – Five levels of intensities were used to make judgments.

- **Extreme**
- **Great**
- **Moderate**
- **Somewhat**
- **None (no impact at all)**

Using the intensities, each alternative project was assessed in order to determine how much it contributes to each of the five main business objectives. "None" was used to signify a project that has no impact at all on a specific objective. Once all the judgments are made, we can begin to synthesize the information.

Synthesis

Figure 3 shows the levels of intensity for each project with respect to the objectives, along with the cost of each project (COSTS) and the derived benefit (% OF MAX). Figure 4 shows the Benefit to Cost ratio.

	Alternatives	% OF MAX	COSTS	ONGOING 5323	MKTSHARE 2063	CUSTSAT 1723	CUSTREQ 0614	FUTURE 0277
1	Word Processor	15.577	2,500,000	NONE	GREAT	MODERATE	MODERATE	SOMEWHAT
2	Spreadsheet	21.428	2,687,500	SOMEWHAT	GREAT	GREAT	MODERATE	SOMEWHAT
3	Graphics	13.427	2,500,000	NONE	GREAT	SOMEWHAT	SOMEWHAT	SOMEWHAT
4	64-bit support	19.662	2,187,500	NONE	GREAT	MODERATE	GREAT	EXTREME
5	Network drivers	14.934	687,500	SOMEWHAT	SOMEWHAT	GREAT	MODERATE	MODERATE
6	Printer drivers	29.070	1,150,000	SOMEWHAT	MODERATE	EXTREME	GREAT	MODERATE
7	Performance enhancements	39.469	1,250,000	MODERATE	GREAT	EXTREME	GREAT	GREAT
8	Install GUI	87.469	2,187,500	EXTREME	EXTREME	GREAT	GREAT	GREAT
9	Interoperability w/ Win2000	36.640	575,000	NONE	EXTREME	GREAT	GREAT	EXTREME
10	True Type fonts	6.933	587,500	NONE	SOMEWHAT	SOMEWHAT	SOMEWHAT	MODERATE
11	DVD support	11.631	400,000	NONE	MODERATE	MODERATE	MODERATE	GREAT
12	Development tools	28.022	675,000	MODERATE	GREAT	GREAT	GREAT	MODERATE
13	Web Server	100.000	3,350,000	EXTREME	EXTREME	EXTREME	GREAT	EXTREME
14	Security firewall	70.497	4,300,000	GREAT	EXTREME	EXTREME	EXTREME	EXTREME

Figure 3. Ratings Table from Expert Choice

Alternatives	Benefit	Cost	B/C	Cum C.	Cum B.
Interoperability w/ Win2000	36.640	575000	63.722	575000	36.640
Development tools	28.022	675000	41.514	1250000	64.662
Install GUI	87.469	2187500	39.986	3437500	152.131
Performance enhancements	39.469	1250000	31.575	4687500	191.600
Web Server	100.000	3350000	29.851	8037500	291.600
DVD support	11.631	400000	29.077	8437500	303.231
Printer drivers	29.070	1150000	25.278	9587500	332.301
Network drivers	14.934	687500	21.722	10275000	347.235
Security firewall	70.497	4300000	16.395	14575000	417.732
True Type fonts	6.933	587500	11.801	15162500	424.665
64-bit support	19.662	2187500	8.988	17350000	444.327
Spreadsheet	21.428	2687500	7.973	20037500	465.755
Word Processor	15.577	2500000	6.231	22537500	481.332
Graphics	13.427	2500000	5.371	25037500	494.759

Figure 4. Benefit/Cost Ratio Results

Optimization

Based solely on a benefit to cost ratio analysis, all but the last four projects shown in Figure 4 should be funded in 2001. The total cost of these ten projects is $15,152,500. The next step is to optimize the benefits for the available funds. To do this, we used Microsoft's Excel spreadsheet Solver function.

Our goal here is to maximize our benefit, while keeping within the following constraints:

1. The total cost must be less than or equal to our budget of $17 Million.
2. Each project cannot be funded more than once.

Figure 5 shows the results of optimizing the benefits. There is only a slight difference between a benefit/cost analysis and optimization. Both recommend the same projects, except for one. The benefit/cost analysis recommends funding the True Type Fonts project, while the optimization analysis recommends the 64-bit support project.

Alternatives	BENEFITS	COSTS (in thousands)	DV	Funded Benefits	Funded Costs	Cum Costs
Web Server	100.000	$3,350.0	1	100	$3,350.0	$3,350.0
Install GUI	87.469	$2,187.5	1	87.469	$2,187.5	$5,537.5
Security firewall	70.497	$4,300.0	1	70.497	$4,300.0	$9,837.5
Performance Enhancements	39.469	$1,250.0	1	39.469	$1,250.0	$11,087.5
Interoperability w/ Win2000	36.640	$575.0	1	36.64	$575.0	$11,662.5
Printer drivers	29.070	$1,150.0	1	29.07	$1,150.0	$12,812.5
Development Tools	28.022	$675.0	1	28.022	$675.0	$13,487.5
64-bit support	19.662	$2,187.5	1	19.662	$2,187.5	$15,675.0
Network drivers	14.934	$687.5	1	14.934	$687.5	$16,362.5
DVD support	11.631	$400.0	1	11.631	$400.0	$16,762.5
Spreadsheet	21.428	$2,687.5	0	0	$0.0	$16,762.5
Word Processor	15.577	$2,500.0	0	0	$0.0	$16,762.5
Graphics	13.427	$2,500.0	0	0	$0.0	$16,762.5
True Type fonts	6.933	$587.5	0	0	$0.0	$16,762.5
	494.759	**$25,037.5**		**437.394**	**$16,762.5**	

Figure 5. Optimization Results

Figure 6 shows a graphical comparison of the results of the benefit/cost ratio analysis and the optimization analysis. Each point on the graph shows the level of benefit for a specific level of funding. At the $17 Million funding level, both methods produce the same level of benefit.

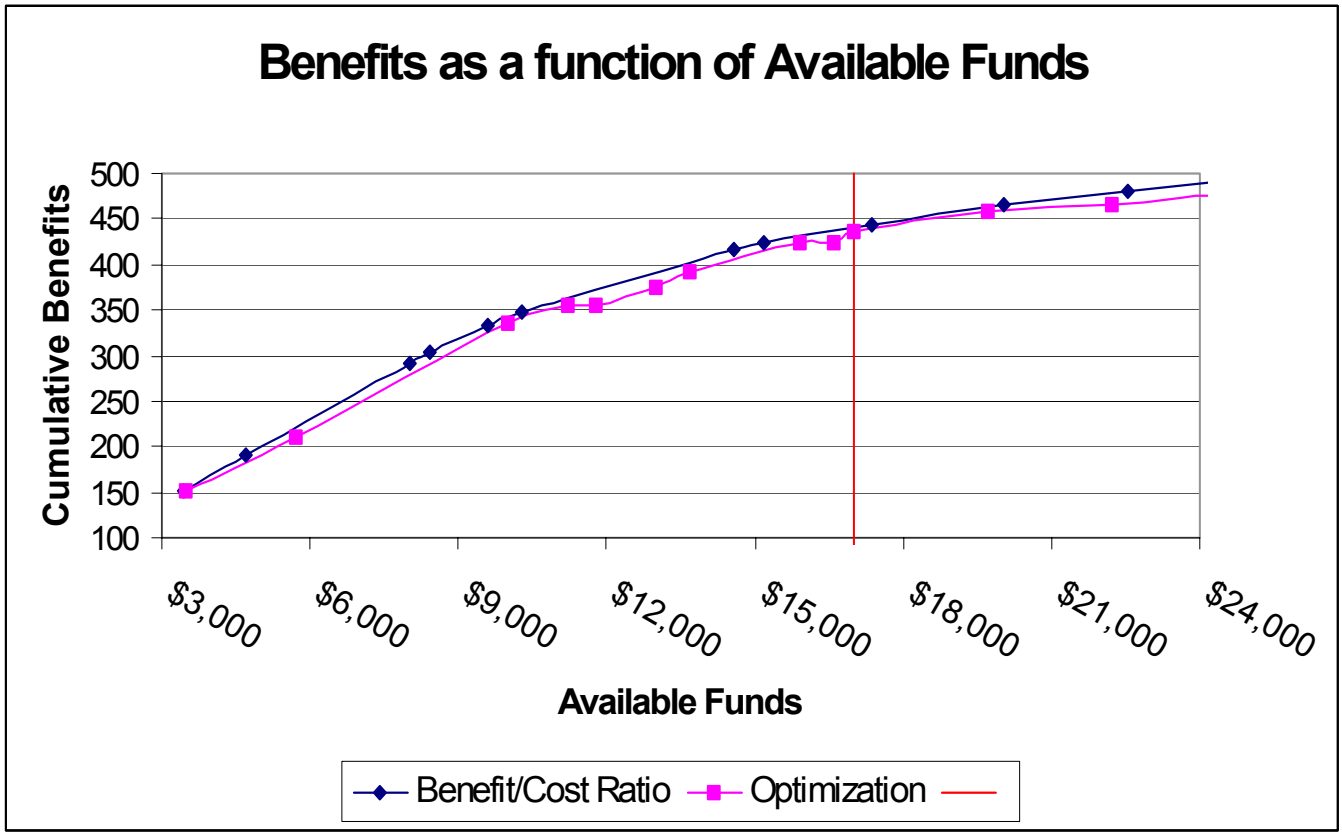

Figure 6. Comparison of Benefit Analyses

Conclusions

Our findings were reviewed with the development team. After reviewing our judgments and intensities, the team members believe that this is a good representation of what we are trying to achieve.

In comparing the results of the benefit/cost ratio analysis and the optimization analysis, it was agreed that funding the 64-bit support project is a better choice than the True Type Fonts project. True Type Fonts would, for the moment, provide a measure of customer satisfaction, but 64-bit support will tie into future strategies along with providing long-term customer satisfaction.

The following recommendations will be taken forward by the development team to the Investment Review Board in September.

Recommendation

Based on our final review of the results derived from using the AHP process, we recommend funding the following projects:

- Web Server
- Installation GUI
- Security Firewall
- Performance Enhancements
- Interoperability with Windows 2000
- Printer Device Drivers
- Development Tools
- 64-bit Support
- Network Device Drivers
- DVD Support

Trademarks

The following names are registered trademarks:

Microsoft Corporation

- Windows
- Windows NT

Apple Computer

- Macintosh
- iMac

X/Open Company

- UNIX

Sun Microsystems

- Java