ETM
ENGINEERING & TECHNOLOGY MANAGEMENT

Title: Teledesic.

Course: EMGT 535/6354
Term: Spring
Year: 1997
Author(s): G. Fischer, R. Gagnier, L. Nguyen and G. Rousseau

Report No: P97023

ETM OFFICE USE ONLY	
Report No.:	See Above
Type:	Student Project
Note:	This project is in the filing cabinet in the ETM department office.

Abstract: Teledesic is a nine billion dollar project lead by two well-know investors, Bill Gates and Craig McCaw. The intention is to put 288 satellites at low earth orbit to create an Internet in space-providing direct satellite links to personal computers to all part of the globe. This report examines Teledesic from an engineering economics perspective.

Teledesic

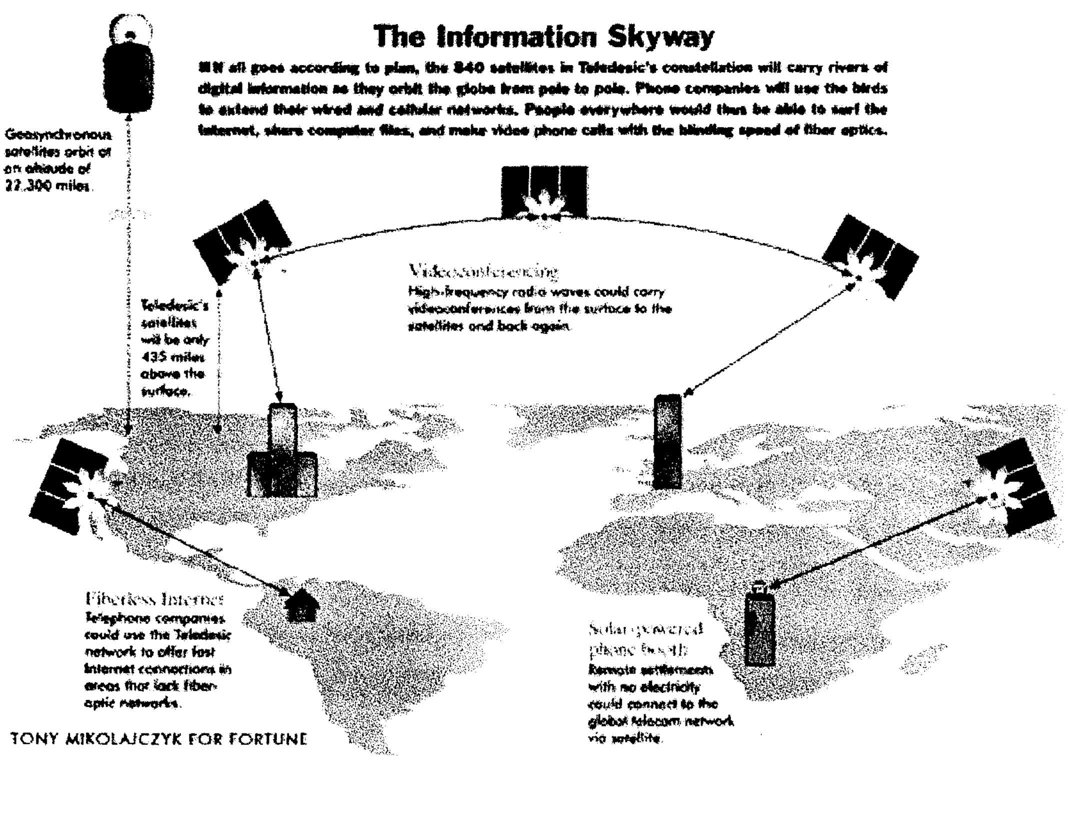
G Fischer, R Gagnier, L Nguyen, G Rousseau

EMP-9723

TELEDESIC

EMGT 535
Dr. Anderson
Spring 1997

Team Members:
Greg Fischer
Rob Gagnier
Long Nguyen
Gerard Rousseau



TONY MIKOLAJCZYK FOR FORTUNE

Abstract

Teledesic is a nine billion dollar project lead by two well-known investors Bill Gate and Craig McCaw. The intention is to put 288 satellites at low earth orbit to create an Internet in space—providing direct satellite links to personal computers to all parts of the globe. In this report we examined Teledesic from an engineering economics perspective. We examined the nine billion dollar capital structure that Teledesic needed to start the project, developed a risk analysis, created a cash flow and examined the global market available for Teledesic. From the cash flow model that includes all individual models such as capital options, tax base rate, depreciation method, operation cost, risk factors, and sales volume we derived a probability for success of the Teledesic project and the net cash flow over a period of 13 years.

Table of Contents

Executive Summary

Teledesic is a large, risky project with the potential to revolutionize the world by launching 288 satellites into low earth orbit to provide the ability to link to any computer at any location. The project receives a great deal of media attention, since it is being financially supported by Bill Gates and Craig McCaw, two of the most well known entrepreneurs of the 20th century. Many companies such as Boeing and AT&T, see the large return on investment potential and are eager to invest millions of dollars into this satellite venture.

Estimated expenditures for the project will require an excess of $9 billion; however, there is a high probability that the net present worth will be $3.034 billion or more based on the model created for this project. On the other hand, a sensitivity analysis on launch costs, revenue, and growth rate shows a 25% probability that Teledesic will obtain a negative NPW based on a 20% MARR. The variable with the biggest impact on NPW was the revenue per minute. A break-even revenue per minute was calculated and found to be 29.5 cents per minute.

The model takes into consideration depreciation using a 10-year MACRS schedule, income taxes at a 40% corporate rate, and capital financing to target a 50% debt ratio. The model's cash flow statement is backed by separate spreadsheets which include revenue, depreciation, tax-investment, satellite cost, and operational cost.

Introduction to Teledesic

What is Teledesic?

Teledesic is "a whole new way to deliver the Internet, using hundreds of satellites." [1] The basic idea is to launch enough satellites to be able to reach the entire surface area of the Earth. This network of satellites would satisfy the world's craving for communication and remove the penalty from location.

"Ironically, McCaw first conceived Teledesic with much more modest aims: as a rural cellular telephony project that would extend the reach of wireless phone networks." [1] Originally, the idea came from Ed Tuck, then called Calling Communications. However, McCaw envisioned a broader, band like fiber-optic network so it could handle videoconferencing and distance learning. This idea soon became known as Teledesics.

The original plan was to have 840 satellites at a low earth orbit (LEO) altitude of 435 miles. Simple geometry called "for 21 rings of 40 satellites apiece, or 840 in all, to keep at least two satellites accessible to everyone in the world at all times." [1]

Boeing engineers figured out how to reduce the number of satellites to 288 and still meet the system's requirements. [2] The smaller number of satellites simplifies launch logistics; however, it does not significantly reduce the project's cost. Each satellite must be larger and more complex than the previous design. For analysis of this project, the total cost and weights involved with the original design were kept as known constants; the individual cost and weight per satellite were calculated to use in the reduced model.

Who are the Investors and Team Members?

William H. Gates III and Craig O. McCaw, two of the greatest entrepreneurs of the 20th century, along with Boeing are the big name supporters of the Teledesic project. "Boeing will take a $100 million stake in the company, joining Bill Gates and Craig McCaw as Teledesic's major investors." [3] Boeing's large investment in Teledesic gives the project credibility and the support it needs to succeed.

AT&T has also invested heavily into Teledesics; however, as Craig McCaw points out "AT&T can't own too much of it. We need global partners, because it's a global project." [1]

"Of the 60 people who work at Teledesic, about half are corporate strategists and administrators, and half engineers and programmers doing R&D on satellite design." [1] McCaw has cherry-picked veterans who span the breadth of the infotech industry to join the Teledesic venture. These high power veterans include the following:

Name	Previous Career	Teledesic Role
David Twyver	President of Northern Telecom Ltd.	Chief Executive Officer, CEO
Russell Daggatt	International telecom lawyer who has represented IBM and American Express.	President who is navigating Teledesic through the international regulatory bodies.
David Patterson	Helped design Sprint's fiber-optic network.	Vice President of Engineering
Hans-Werner Braun	One of the designers of the Internet.	Chief network architect
Blaise Judja-Sato	Headed sales and marketing for AT&T's $2.7 billion project to link 44 countries in Africa, the Middle East and Europe with undersea fiber-optic cables.	Director of business development

David Montanaro	Headed production of Iridium satellites for Motorola	Vice President of strategic partnerships

Technical Background

For decades many communication companies have raced to launch satellites networks to provide global telephone services. Projects such as Globalstar, ICO, Iridium, and Odyssey do not provide the bandwidth required for computer data and video services. Internet networks require individual, two way and high speed broadband connections. The Teledesic project plans to bring cyberspace to outer space by providing direct satellite links to personal computers and free the constraints that current telephone networks have. [4]

Most communication satellites today are geosynchronous satellites that orbit at a fixed position 22,300 miles above the Earth. At this altitude, signals take fractions of a second to travel between satellites and Earth. Teledesic's satellites need to be low altitude orbits, close enough so there is not any significant delay. [5] Teledesic settled on an altitude of 435 miles. Teledesic's plan was to carry all the digital data to convey wide radio channels, but with high-frequency signals they do not penetrate or curl around obstructions; rather high-frequency signals are stopped dead by objects such as rain and trees. [4] To get any good signal from the satellites the users almost have to be directly overhead at a steep angle to keep signal clear from objects and this means more satellites. With simple geometry Teledesic called for 21 rings of orbits and 40 satellites per orbits or 840 satellites. [1] The ideal was to provide two satellites accessible to everyone in the world at all times.

Once the satellites are launched and in orbit, users depend on a small outdoor antenna to pull the signals. Teledesic plans to design an electronic antenna called a phased array that can track satellites' signals without moving physically and shift the focus of it center point instantaneously. The antenna will lock on the moving satellites and pick up the next one as it comes into position. [1] The satellites are positioned in a concentric orbit and at slightly varying elevations. Each satellite will be equipped with thrusters that will shoot out tiny particles of Teflon to make delicate adjustments in direction. There will be 12,000 batteries fed by thin film solar collectors stretching out behind the satellite in a 130 square kilometer wing. These cells together generate 10 megawatts of power.

The spectrum that Teledesic planned to use is one Gigahertz in Ka band between 19 and 30 gigahertz. Their modulation scheme will be TDMA (time division multiple access) with a bit error rate that can accommodate the new fiber standards such as SONET-ATM (synchronous optical network/asynchronous transfer mode). Teledesic satellites will have the ability to handle asynchronous transfer mode and TCP/IP packet traffic, 64-byte packets within each data stream. The streams of data "concentrate between ground-base gigalink terminals in ATM/Sonet-like multiples, from the 155-Mbits/s OC-3 to the 1.244-GBITS/s OC-24 rate." [6]

Market Analysis

"Ventures like Iridium and Teledesic dramatically show how satellites will play a key role in serving telecommunication and information service markets...but with sticker prices of $3.4 billion for Iridium and $9 billion for Teledesic, and per-minute rates of $3 or more, one has to wonder whether adequate demand will arise to support these ventures." [7]

Analysis of the market has shown that as of about 1994, communications was a $460 billion per year industry worldwide, and rapidly growing (projections are for $2 trillion in 2003)." [8] This represents an approximate 18% per year growth over the nine year time span.

Within the general communications market is the satellite branch. "From roughly $9 billion today (1997), Bear, Stearns & Co. analyst Thomas W. Watts expects annual revenue from satellite services to more than triple, to $29 billion, by 2000." [9] This represents a 48% increase per year over the three year time frame.

Teledesic is focusing on the computer data and videoconferencing market within the satellite services segment. "New York consultants Access Media International USA Inc. estimate this market to be $10 billion by 2005." [9]

On a user based level, it is estimated that 30 - 60 million US households will have online access by the end of the decade. The number of US households with access to Internet services such as the World Wide Web is estimated to grow to somewhere between 20 million and 45 million by the end of this decade. Currently, 16 million US online users. Internet use is growing at a rate of (double every 6 months). [10]

"Estimating the demand for telecom services in the developing world is enormously difficult." [1] To be conservative, the model developed used forecasts based primarily on US customer use. In comparison, DirecTV is a satellite venture focusing on a different market segment. "By 2002, they expect to hit 16 million subscribers in the U.S. alone, with revenues of $6 billion. Global growth could double that." [9] Teledesic wants to be the DirecTV of satellite Internet services.

In summary, "Teledesic has targeted the fastest-growing market of the future: communications for the world's 125 million PCs, now growing at some 20% a year." [11] "The only thing we know for sure is that the market is either huge or very huge. It will be $25 billion a year from now until 2005, excluding military and Teledesic." [1]

How Teledesic Plans to Distribute

Teledesic does not intend to market services directly to users. It will provide an open network for delivery of such services by others. The Teledesic Network will enable local telephone exchanges and telecommunications authorities in host countries to cost-effectively modernize existing communications systems and bring affordable access to rural and remote locations. "Whatever the application, end users won't pay Teledesic directly; it will contract with local telephone companies that will market the services." [1]

Other Players and Competitors

"McCaw hopes that Teledesic's delirious grandness will discourage competitors. With the amount of spectrum required, the global significance, the cooperation necessary-only a few fools will ever try that." [1] However, there appear to many "fools" across the globe as "dozens of corporations, large and small, are pouring roughly $50 billion into an exploding race to build, launch, and connect seamless satellite networks which is becoming the space-age equivalent of the California Gold Rush." [9]

Fiber-optics pose a potential threat to the Teledesic project. Satellite project skeptics point out that companies in Europe, Japan, and North America are laying on more and more fiber and wireless capacity every year which would eliminate the need for Teledesic and other similar ventures. However, Teledesic supporters point out that the satellites would be able to fill in the blanks everywhere else; Teledesic alone will not have the capacity to carry all the world's high-speed communication's traffic. Even in the most developed countries, high cost will prevent the deployment of a significant supply of fiber for local access. Teledesic's "Internet-in-the-sky" will be able to bridge this gap and provide affordable access to telecommunications capability anywhere in the world. [12]

Competition:

Motorola's Iridium project calls for a total of 66 satellites at a price tag of approximately $3.4 billion. However, Iridium is focusing on the cellular communications market. Similarly, "a 28-satellite system called Orbcomm will do the same [as Iriduim] for places without paging. [1]

Other satellite projects include the following:

Project	Description
Teledesic	288 satellites; uses: computer data and video conferencing; 40 cents per minute. (service is supposed to be cheap enough that a developing-nation village could afford it).
Spaceway	17 satellites; uses: computer data and video conferencing; 20 cents per minute.
Globalstar	48 satellites; uses: mobile voice, fax and E-mail; 30 cents per minute; $2.2 billion.
Iridium	66 satellites; uses: mobile voice, fax and paging; $3 per minute; $3.4 billion.
Odyssey	12 satellites; $3.2 billion.
Orbcomm	Paging systems: - 36 satellites; $320 million (smaller satellites).

Others include: Immarstat, M-Star, Sativod, Astrolink, Echostar, GE Star, Millennium, Morningstar, Netsat 28, Orion, PAS-9, VisionStar, Voicespan

Each of these satellite projects cost millions or billions of dollars and require a lot of support and coordination. Major corporate supporters of various satellite projects include the following: [7]

- Motorola
- Sprint
- Loral Corporation
- Qualcomm
- AirTouch
- TESAM (joint venture between France and Italy)
- Deutsche Aerospace
- TRW, Inc.
- Hughes Communications
- McCaw Cellular Radio, Inc.
- Mobile Telecommunications Technologies, Inc.
- Singapore Telecom
- (Not mentioned: Boeing, Arianespace, Westinghouse, Mitsubishi)

Project Economic Evaluation Model

Assumptions and Preliminary Calculations

To perform the economic evaluation of the Teledesic project, we created a MS Excel Spreadsheet using the following color rule:

- Input variables in blue,
- Computed responses in green.

Some of the following assumptions found in this economic evaluation have been gathered through a literature search, others using our team's judgment.

The model is made of seven preliminary modules leading to the results; these modules are:

1. Satellite costs,
2. Revenue,
3. Depreciation Period,
4. Tax and Investment,
5. Analysis Period,
6. Operation and Maintenance Costs,
7. Capital.

The results will include:

- Income and Cash Flow statements, Net Present Value and Internal Rate of Return.
- Chart showing the annual cash flows and the payback period.

Satellite Costs (see Appendix A)

The Teledesic project will require 288 satellites (+ 30 spares, 10% risk failure included); it will take 20 launches per year with each launch including 8 satellites per launch.

One of the main assumptions that we made is that the 288 satellites required for the project will be launched over a period of 2 years with 144 satellites launched each year. The first 144 satellites will be launched in 2000 and the second half in 2001.

The objective of this module is to determine the investment amounts and launch schedules that will trigger depreciation and revenue schedules for the year 2000 and beyond.

The total cost per launched satellite includes the cost of the satellite itself ($16 million and 4960 pounds each) plus the cost of launching it, assuming that there will be 8 satellites per launch at a cost of $1400 per pound.

The total cost of this depreciable assets ends up being $7,296,192,000 or $3,648,096,000 per group of 20 satellites.

Revenue (see Appendix B)

The revenue will start the year following the placement of the satellites on orbit. Therefore, we will also have two flows of revenue: one starting in 2001, the other one in 2002.

The variables used to calculate the revenue consider the expected market captured in the first year (8 million users), the average air time per user (60 minutes per month), and the amount charged per minute ($0.40). We then assign an estimated rate of growth for the revenue (15%) to the revenue for the first year and obtain the revenue flow for the years beyond 2001.

Depreciation (see Appendix C)

We selected a 10-year MACRS depreciation schedule for this project based on a cost basis of $3,648,096,000 for the 40 satellites. As we already mentioned in the Revenue section, half of the satellites will start being depreciated in the year 2000, the other one in the year 2001.

Analysis Period

For the Teledesic project, we chose an analysis period of 13 years (1999-2011) so that the depreciable assets are fully depreciated by the last year of this period.

Tax and Investment (see Appendix D)

This section covers our assumptions relative to the total capital that will be required to finance this project for which we have to include some R&D costs of $0.5 million. We also describe here our rates for inflation, interest and income tax; these will be used in our Income and Cash Flow statements when we evaluate the project in constant as well as actual dollars.

Operation and Maintenance Costs (see Appendix E)

To determine the cost of operating and maintaining these satellites, we estimated their probability of failure (0.02) and applied an additional coefficient (0.1) to account for the fact that the older these satellites get, the more likely they are to fail. Finally, we express the O&M cost by applying these two coefficients to the cost of a launched satellite. The result is a cost of about $72 million in 2001 to $414 million in 2012. At this point of the definition of the project, it is not clear what will be the strategy used to service the failing satellites; send new ones or repair the faulty ones?

Capital (see Appendix F)

This section deals with the capital structure that Teledesic will choose to have. We decide that the company will use:

- debt financing by borrowing $3 million at 15% over 10 years,
- equity financing by issuing common stocks for $3 billion.

This will give Teledesic a 50% debt financing ratio.

Results

Cash Flow (see Appendix G)

This section summarizes the previous one by generating:

- income statement,
- cash flow statement (in constant and actual dollars)
- calculation of the internal rate of return for a given MARR.

In constant dollars, our analysis shows that the Teledesic project will have 33% rate of return at a 20% MARR. The net present worth for the project is then about $3 billion.

Payback Period (see Appendix H)

This chart is intended to be a representation of the annual and cumulative cash flows for the duration of the analysis period. It allows us to find what the payback period is: 4.5 years.

Sensitivity and Risk Analysis

After completing the model describing Teledesic's project, we wanted to quantify the impacts associated with the probabilistic ranges for the variables used. Some of the literature pointed us to realistic ranges for each of the values tested, but as in any high-risk project, very few coefficients of the equation are known with 100% confidence. For this reason, we chose to perform a sensitivity analysis on three of the variables we used.

Both a sensitivity graph (Appendix I - Figure 1) and a joint probability expected NPW (Appendix I - Figure 2) were performed to test the following variables and the changes associated with variance of each. For each one of the 3 variables, the joint probabilities were developed for a total of 12 combinations. The probabilistic NPW was calculated for each combination and the total was calculated to compare the base case NPW to the probabilistic expected NPW. While the sensitivity graph variations are not exactly all +/- 50%, they are extremely close to +/- 50% and the gap between the most sensitive variable and the next most sensitive variable is conclusive.

Launch Cost

The first parameter varied was the launch cost. Current satellite launch prices are approximately $1,400 per pound. On the drawing boards of several major aerospace companies, including Boeing, Lockheed, McDonnell Douglas, are plans to develop re-usable vehicles to launch satellites for less money. Not only would they benefit Teledesic, but are crucial to the commercialization of space. Once these new vehicles are proliferated, the costs should be reduced to approximately $400-600 per pound. [13] For our sensitivity, we used $600 per pound.

The issue with these new vehicles is timing. Most plans don't count on full vehicle production until the time when we hope to be complete with deploying the satellites. If the estimates of 2002 hold true for competing products, it will mean that we may be able to use them for the last of our launches and for re-launches as satellites fail over time, but not for a large percentage of the satellite population. The schedules were still soft in 1994, and no updated information was available during our literature search.

Since there is some risk associated with counting on these lower costs as we get closer to the Teledesic launch date, we chose a probability of 0.2 that Teledesic would be able to take advantage of any such vehicles. The resultant probability of 0.8 was attributed to the current costs of $1400 per pound. Of note on the sensitivity graph (Appendix I - Figure 1), we did not allow the launch cost to rise by 50%, it was assumed that the cost would not get any higher but could decrease to $600 per pound. Now that Boeing is involved in Teledesic, they may be able to pull in there development schedule in order to sell vehicles to one of their investments.

Revenue Per Minute

The next variation we chose for the model was the revenue we expected to make per minute of usage. This variable goes into the equation with the estimated users and average user minutes. The literature provided gross ranges, some of which were in terms of end user rates and some supplier revenues, from about \$0.10 to \$3.00 per minute. Most listed the rates as 'competitive' to current rates, so we used \$0.40/min in our base case and went as high as \$0.60 and as low as \$0.20 per minute. We utilized a fairly flat distribution of revenue per minute, giving probabilities of 0.3, 0.4, 0.3 to the values of 20, 40, and 60 cents per minute, respectively.

Growth Rate

The base case started with 8 million users using Teledesic services 60 minutes per month and the revenues growing at 15% per year. Since the differing personal computer and communication service revenues are (and are expected to continue) growing from 10% to 48%, we also performed a sensitivity analysis on this variable. Some combinations in this overall growth rate include the possibilities of decreasing revenue per minute as the customer base grows faster than 15% and the user-base not growing at 15% but using the service more than 60 minutes per month. The model was also run for 10% and 20% since this industry has seen tremendous growth in the past 5 years.

Results of Sensitivity Analysis

From the sensitivity graph, we see that varying revenue per minute has the biggest impact on NPW. The graph looks suspicious due to the single direction variance of the launch cost, but

Appendix C

Depreciation

Asset Depreciation:

Cost Basis: $3,648,096,000

end of year:	1	2	3	4	5	6	7	8	9	10	11	
MACRS:	10 years											
MACRS Schedule:	10.00%	18.00%	14.40%	####	####	####	####	####	6.56%	6.55%	3.28%	100.00%
Depreciation:	$364,809,600	$656,657,280	$525,325,824	####	####	####	####	####	$239,315,098	$238,950,288	$119,657,549	$3,648,096,000
Cumul.	$364,809,600	$1,021,466,880	$1,546,792,704	####	####	####	####	####	$3,289,488,163	$3,528,438,451	$3,648,096,000	
Book Value:	$3,283,286,400	$2,626,629,120	$2,101,303,296	####	####	####	####	####	$358,607,837	$119,657,549	$0	

Appendix D

Tax and Investment

Investment:	1999	2000	
	year		
Depreciable Asset:	$3,648,096,000	$3,648,096,000	(See Satellite Costs Sheet)
R&D (year 2000):	$300,000,000	$200,000,000	
Total:	$3,948,096,000	$3,848,096,000	

General Inflation Rate:	5%
Inflation-free Interest rate:	12%
Market Interest Rate:	18%
Income Tax Rate:	40%
Gains Tax Rate:	40%

Appendix E

Operation and Maintenance Costs

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
year		0	1	2	3	4	5	6	7	8	9	10	11	12
satellites up		144	288	288	288	288	288	288	288	288	288	288	288	288
satellites to maintain			144	288	288	288	288	288	288	288	288	288	288	288
% replacement cost														
base (probability of failure)	**0.02**	0.02	0.022	0.0242	0.02662	0.029282	0.03	0.04	0.04	0.04	0.05	0.051874849	0.057062334	0.062768568
%increase/year	**0.1**	50	45	41	38	34	31	28	26	23	21	19	18	16
Maintenance cost/year/satellite		$ 458,880	$ 504,768	$ 555,245	$ 610,769	$ 671,846	###	###	###	###	###	$ 1,190,217	$ 1,309,238	$ 1,440,162
probability*satellite cost(incl.cost +launch)														
			$ 72,686,592	$ 159,910,502	$ 175,901,553	$ 193,491,708	###	###	###	###	###	$ 342,782,364	$ 377,060,600	$ 414,766,660

Conclusions

Teledesic is an information revolution ...

> "Teledesic could be on the magnitude of the first transcontinental railroad or Charles Lindbergh's flight across the Atlantic. If successful, it could be one of those events that shrinks the world and changes it forever." [5]

The magnitude of the investments suggested by Teledesic and already made by other competing projects around the world shows that this type of communication has been selected to be utilized in the next decades.

... that has a 75% probability of success ...

The economic and risk analysis that we performed in this report demonstrates that there is of course a chance that the project will fail but an even bigger change to see it succeed. As always when evaluating a new technology, it is difficult to comprehend the actual market that will be drawn once it is made available; it is very likely that the market will experience a growth exceeding the forecast used in our analysis.

... and benefits from the quality of its proponents.

It is our belief that if the Teledesic is able to "take off", i.e. if the necessary capital is raised, then, it will be a very successful project generating sufficient revenue to reward those who invested in it. This being said, the current key factor is the trust that investors have in such visionary people as Bill Gates and Craig McCaw who have a very successful track record in this high-tech communication field.

Therefore, our conclusion is that Teledesic will most probably happen and be an economically successful project.

References

[1] A. Kupfer, "Craig McCaw sees an Internet," *Fortune*, pp. 62-67, May 27, 1996.

[2] W. Wilson and J. Wallace, "Boeing Backs 'Internet-in-the-Sky' Project," *Seattle Post- Intelligencer*, April 30, 1997.

[3] K. Holland, "Boeing-Teledesic Aims for the Stars," *Business Week*, May 12, 1997.

[4] Author Unknown, "The Final Frontier," *The Economist*, July 27, 1996.

[5] K. Maney, "Where no billionaire has gone before," *USA TODAY*, March 19, 1997.

[6] L. Wirbel, "Space-To-Earth Links," *Communication Design*, April 7, 1997.

[7] R. Frieden, "Satellites in the Wireless Revolution: The Need for Realistic Perspectives," *Telecommunications Magazine Online*, June 1994.

[8] www.cyclic/space/comm.html

[9] E. Schine, "The Satellite Blasts Off," *Business Week*, January 27, 1997.

[10] J. Pike, "CyberStats," www.fas.org/cp/cyberstats.html, February 21, 1996.

[11] G. Gilder, "Telecosm Ethersphere," Forbes, p. 144, 1997.

[12] www.teledesic.com; Teledesic Home Page.

[13] P. Coy, "One Giant Leap for Space Enterprise," *BusinessWeek*, July 25, 1994.

Appendix A

Satellite Costs

Model's Legend:	User Input
	Computed Values

Satellite's Cost:	$16,000,000 /new satellite *($5.5 M target original model * 840/288)*	
Launch Cost:	$1,400 /lb. *(possibly $400 - $600 per pound by 2002)*	
	4,960 lbs./satellite *(1700 lbs original model * 840/288)*	$55,552,000 /launch
	8 satellites/launch	
Number of satellites:	318 *(288 + 30 spares to account for 10% risk failure)*	
Launches Schedule:	20 launches in year 2000 20 launches in year 2001 - launches in year 2002 ...	
Number of launches	40 (1/2 in year 2000 and 1/2 in year 2001)	

	Group A	Group B	
END of YEAR	2000	2001	Total
# of launches	20	20	
Launch Costs per year	$1,104,096,000	$1,104,096,000	$2,208,192,000
Satellite Costs per year	$2,544,000,000	$2,544,000,000	$5,088,000,000
Total Costs (satellite + launch)	$3,648,096,000	$3,648,096,000	$7,296,192,000

Appendix B

Revenue

END of YEAR	1	2	3	4	5	6	7	8	9	10	11	12
Revenue	$2,511,125,374	$2,887,794,181	$3,320,963,308	#####	#####	#####	#####	#####	$7,681,589,931	$8,833,828,421	$10,158,902,684	$11,682,738,087

ASSUMPTIONS: BASE YEAR 2002

Avg. # of users	8,000,000	
Avg. # min. per user per month	65	
Airtime charge per minute	$0.40	(Teledesic's airtime charge; Distributers will charge more depending on demand)
Revenue 1st year (Teledesic)	$2,511,125,374	
Market (revenue) increase per year	15%	

"Teledesic from the outset has targeted the fastest-growing market of the future: communications for the world's 125 million PCs, now growing some 20% a year." (Forbes, p. 144)

Appendix F

Capital

			0	1	2	3	4	5	6	7	8	9	10		
Debt Financing	Finance Activities														
loan C															
	borrowed fund ($Billions):	**3.0**													
	loan interest rate i :	**15%**													
	interest payment			($0.45)	($0.43)	($0.40)	($0.37)	($0.34)	($0.30)	($0.26)	($0.20)	($0.15)	($0.08)		
	principal payment			($0.15)	($0.17)	($0.20)	($0.22)	($0.26)	($0.30)	($0.34)	($0.39)	($0.45)	($0.52)		($3.00)
loan D			B												
	borrowed fund ($Billions):	**0.0**													
	loan interest rate i :	**15%**													
	interest owed			$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00		
	principal payment			$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00		$0.00

Equity Financing

Issue common stock

Net proceeds of sale:	**3.0** Billion $	
flotation cost :	**6%** of issue price	
Common stock price:	**$ 30.00** per share	
	Number of shares issued:	**0.106** Billions
	flotation cost :	**0.191** Billion $
dividend per share	**$2**	
annual % increase:	**10%**	
total shares:	0.123684 billion	

year	1	2	3	4	5	6	7	8	9	10	11	12	13
cash dividend paid ($Billions)	0.212766	0.234	0.257	0.283	0.312	0.343	0.377	0.415	0.456	0.502	0.552	0.607	0.668

Appendix G

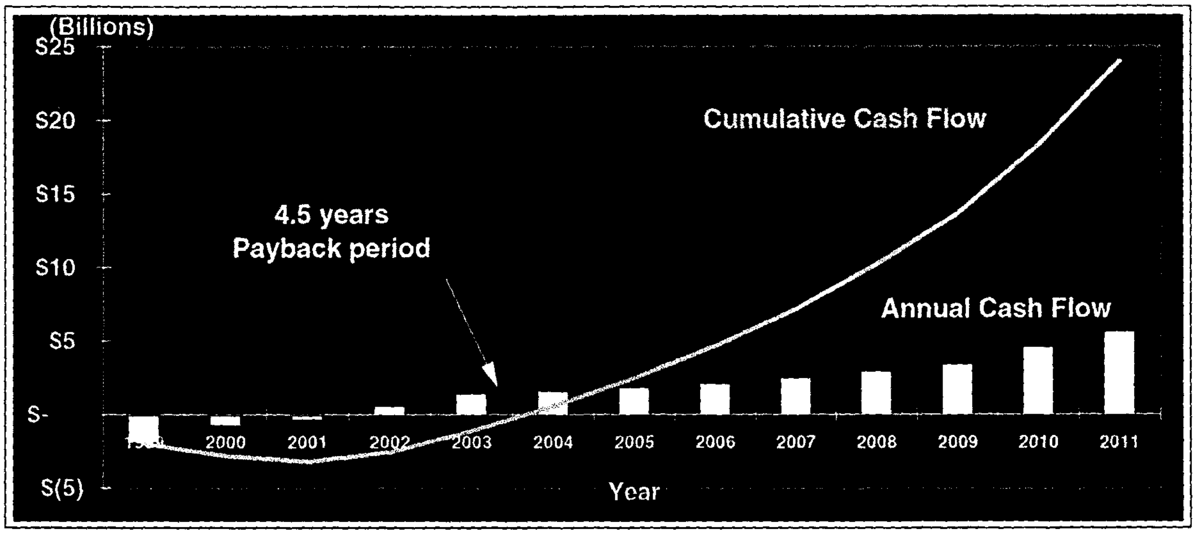
Cash Flow

Year			1999	2000	2001	2002	2003	##	##	##	##	##	2009	2010	2011
			0	1	2	3	4	5	6	7	8	9	10	11	12
Income Statement															
Revenue					$ 1,255,562,687	$ 1,443,897,090	$ 1,660,481,654	#	#	#	#	#	$ 3,840,794,966	$ 4,416,914,210	$ 5,841,369,043
						$ 1,255,562,687	$ 1,660,481,654	#	#	#	#	#	$ 3,840,794,966	$ 4,416,914,210	$ 5,079,451,342
Expenses															
O&M						$ 159,910,502	$ 175,901,553	#	#	#	#	#	$ 311,620,330	$ 342,782,364	$ 377,060,600
Depreciation	A			$ 364,809,600	$ 656,657,280	$ 525,325,824	$ 420,260,659	#	#	#	#	#	$ 238,950,288	$ 119,657,549	$ -
	B				$ 364,809,600	$ 656,657,280	$ 525,325,824	#	#	#	#	#	$ 239,315,098	$ 238,950,288	$ 119,657,549
Debt Interest		C		$ 450,000,000	$ 427,836,572	$ 402,348,630	$ 373,037,496	#	#	#	#	#	$ 77,968,198	$ -	$ -
		D			$ -	$ -	$ -	#	#	#	#	#	$ -	$ -	$ -
NOL previous					$ (814,809,600)	$ (1,008,550,365)	$ (53,332,823)	#	#	#	#	#	$ -	$ -	$ -
Taxable Income				$ (814,809,600)	$ (1,008,550,365)	$ (53,332,823)	$ 1,773,104,953	#	#	#	#	#	$ 6,813,736,017	$ 8,132,438,221	$ 10,424,102,237
Income Taxes				*$ -*	*$ -*	*$ -*	*$ 709,241,981*	*#*	*#*	*#*	*#*	*#*	*$ 2,725,494,407*	*$ 3,252,975,288*	*$ 4,169,640,895*
Net Income				$ (814,809,600)	$ (1,008,550,365)	$ (53,332,823)	$ 1,063,862,972	#	#	#	#	#	$ 4,088,241,610	$ 4,879,462,932	$ 6,254,461,342
Cash Flow Statement															
Operating Activities															
Net Income				$ (814,809,600)	$ (1,008,550,365)	$ (53,332,823)	$ 1,063,862,972	#	#	#	#	#	$ 4,088,241,610	$ 4,879,462,932	$ 6,254,461,342
Depreciation				$ 364,809,600	$ 1,021,466,880	$ 1,181,983,104	$ 945,586,483	#	#	#	#	#	$ 478,265,386	$ 358,607,837	$ 119,657,549
Investment Activities															
Investment															
Capital	A - B		$ (7,296,192,000)												
R&D			$ (500,000,000)												
Salvage															
Gains Tax															
Working Capital															
Borrowing Activities															
Borrowed funds	C		$ 3,000,000,000												
		D		$ -											
Principal Repayment	C			$ (147,756,188)	$ (169,919,616)	$ (195,407,558)	$ (224,718,692)	#	#	#	#	#	$ (519,787,989)	$ -	
		D			$ -	$ -	$ -	#	#	#	#	#	$ -	$ -	
Financing Activities															
Common Stock			$ 3,000,000,000												
Flotation Cost			$ (191,489,362)												
Cash Dividend				$ (234,042,553)	$ (257,446,809)	$ (283,191,489)	$ (311,510,638)	#	#	#	#	#	$ (551,860,098)	$ (607,046,108)	$ (667,750,718)
Net Cash Flow (constant dollars)			$ (1,987,681,362)	$ (831,798,741)	$ (414,449,909)	$ 650,051,234	$ 1,473,220,125	#	#	#	#	#	$ 3,494,858,909	$ 4,631,024,662	$ 5,706,368,172
Net Cash Flow (actual dollars)			$ (1,987,681,362)	$ (873,388,678)	$ (456,931,024)	$ 752,515,559	$ 1,790,708,270	#	#	#	#	#	$ 5,692,756,898	$ 7,920,623,747	$ 10,247,817,381

	Net Present Worth	Annual equivalent	at interest rate:	Rate of Return
Constant dollars	S 3,034,206,242	S 683,500,363	20% *inflation free rate:* 12%	33% (IRR')
Actual dollars *general inflation rate:* 5%	S 5,741,586,872	S 1,293,378,365	20%	40% (IRR)

Appendix H

Payback Period



Appendix I

Sensitivity and Risk Analysis

Launch Cost	Revenue/ Min	Growth/Yr		NPW	Weighted NPW
00 / lb 0.8	$0.20 0.25	10% 0.3	0.06	-$5,661,923,299	-$339,715,398
		15% 0.4	0.08	-$4,012,123,496	-$320,969,880
		20% 0.3	0.06	-$2,349,962,451	-$140,997,747
	$0.40 0.5	10% 0.3	0.12	$1,148,346,371	$137,801,564
		15% 0.4	0.16	$3,034,206,242	$485,472,999
		20% 0.3	0.12	$5,426,837,725	$651,220,527
	$0.60 0.25	10% 0.3	0.06	$5,071,628,262	$304,297,696
		15% 0.4	0.08	$7,837,890,501	$627,031,240
		20% 0.3	0.06	$11,426,837,725	$685,610,264
00 / lb 0.2	$0.20 0.25	10% 0.3	0.015	-$3,187,548,629	-$47,813,229
		15% 0.4	0.02	-$1,827,434,614	-$36,548,692
		20% 0.3	0.015	-$302,141,421	-$4,532,121
	$0.40 0.5	10% 0.3	0.03	$2,498,439,223	$74,953,177
		15% 0.4	0.04	$4,342,614,049	$173,704,562
		20% 0.3	0.03	$6,735,245,532	$202,057,366
	$0.60 0.25	10% 0.3	0.015	$6,380,036,069	$95,700,541
		15% 0.4	0.02	$9,146,298,307	$182,925,966
		20% 0.3	0.015	$12,704,474,589	$190,567,119
				Conditional prob est:	**$2,920,765,952**

	-50%	Base	50%
Launch Cost	4342	3034	3034
Revenue / min	-4012	3034	7837
Growth / yr	1148	3034	5426 approx

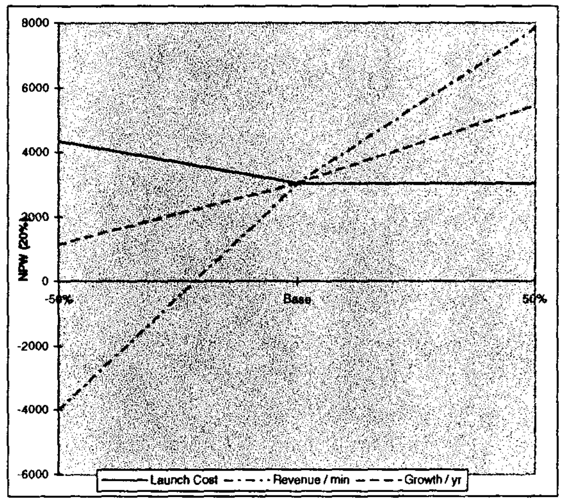


FIGURE I - 1: Sensitivity Graph

P	NPW
0.06	-$5,226,872,840
0.08	-$4,052,650,317
0.015	-$3,014,414,382
0.06	-$2,894,061,416
0.02	-$2,049,319,789
0.015	-$993,631,543
0.12	$30,416,429
0.16	$1,310,483,867
0.03	$1,371,645,387
0.04	$2,616,656,338
0.12	$2,899,432,027
0.06	$2,989,216,692
0.03	$4,205,604,497
0.015	$4,295,389,162
0.08	$4,856,733,118
0.02	$6,162,905,588
0.06	$7,240,155,357
0.015	$8,519,156,039

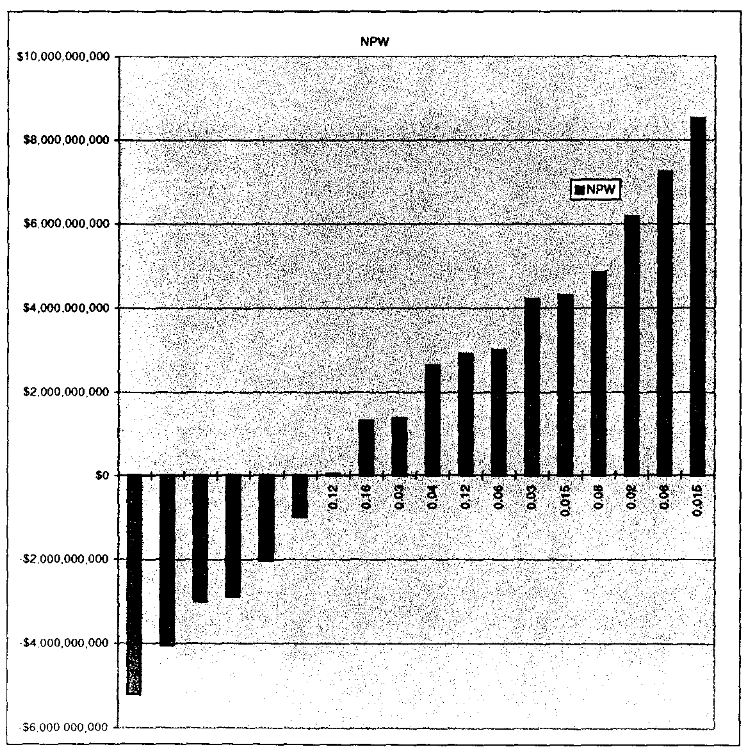


FIGURE I -2