

# **A First-Ever Research Study: Estimating Google's U.S. Consumer Internet Usage & Cost -- 2007-2010**

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**Abstract:** The objective of this first-ever research study of U.S. consumer Internet bandwidth usage and costs was estimating how much bandwidth Google uses and pays for. The data confirm the study's core hypotheses, that: Google is by far the largest user of Internet bandwidth, Google's share of bandwidth usage is rising rapidly, and that Google's bandwidth use is orders of magnitude greater than its payment for its cost. The study estimated Google used 16.5% of all U.S. consumer Internet traffic in 2008, and that share is estimated to grow to 25% in 2009 and 37% in 2010. What drives this conspicuous bandwidth consumption is Google's search bots regularly copy every page on the Internet, some as frequently as every few seconds, and Google's YouTube streams almost half of all video streamed on the Internet. The study estimated Google's payment to fund just the U.S. consumer broadband Internet segment to be approximately \$344 million in 2008 or 0.8% of U.S. consumer's flat-rate monthly Internet access costs of \$44.0 billion. Thus Google's 16.5% share of all 2008 U.S. consumer bandwidth usage, is ~21 times greater than Google's 0.8% share of U.S. consumer bandwidth costs – or an implicit ~\$6.9 billion subsidy of Google by U.S. consumers. The study's methodology is straight-forward, transparent, well documented and replicable so Google or others can provide improvements or alternative estimates -- and so other countries can estimate if Google uses more of their country's Internet capacity than it pays for. This research study of Google's usage vs. cost is relevant to the current broadband policy debate, because Google is the driving force behind InternetForEveryone.org which is pushing "to adopt a national plan to bring open, high-speed Internet connections into every home, at a price all of us can afford." Internet connections could be more affordable for everyone, if Google paid its fair share of the Internet's cost. It is ironic that Google, the largest user of Internet capacity pays the least relatively to fund the Internet's cost; it is even more ironic that the company poised to profit more than any other from more broadband deployment, expects the American taxpayer to pick up its skyrocketing bandwidth tab. Since Google often compares the Internet to the public highway system, the study also examined how the U.S. highway system apportions costs among business users and consumers. The analysis of public highway funding shows that businesses/trucks, which put the most cost burden on the highways, pay substantially more than consumers/cars – the exact opposite of Google's recommended broadband model, where consumers shoulder most all of Google's costs for using and profiting off the Internet more than any other entity. The study highlights the inconsistency in Google's position supporting government ownership/regulation of the Internet like the U.S. highway system, but not adopt the economic model and fairness of the highway system -- where the heaviest users that cause the most costs -- shoulder most of the costs. The core conclusion of the study is that any sustainable national broadband policy must ensure that the heaviest Internet users pay their fair share of Internet infrastructure costs. It is neither economically rational nor equitable for the biggest users of, and beneficiaries from, shared resources to not share fairly in the recovery of costs.

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# **A First-Ever Research Study: Estimating Google's U.S. Consumer Internet Usage & Cost -- 2007-2010**

## **I. Summary of Findings**

### **Study's Hypotheses:**

- Google is the largest user of Internet bandwidth;
- Google's share of bandwidth usage is rising rapidly; and
- Google's bandwidth use is much greater than its payment for its cost.

### **Research Findings:**

This first-ever research study of the U.S. consumer Internet market estimated:

1. Segment bandwidth usage to be 1.113 exabytes per month in 2008;
  - (We estimated legal bandwidth usage for the segment to be 718 petabytes per month in 2007; legal usage excludes 90% of P2P traffic estimated to be illegal.)
2. Segment bandwidth cost to be \$44.0b in 2008;
3. Google's bandwidth usage in the segment to be 184 petabytes per month in 2008;
4. Google's bandwidth cost for the segment to be \$344m in 2008;
5. Google's percent of the U.S. consumer bandwidth usage to be 16.5% in 2008;
  - (We estimated Google's percent of legal bandwidth usage, excluding illegal P2P traffic, to be 25.6% in 2008;)
6. Google's percent of total bandwidth cost was 0.8%; and
7. Google's ratio of usage to its payment of bandwidth cost is ~21:1 implying an implicit bandwidth usage subsidy of ~\$6.9b to Google from American consumers.
  - (We estimated Google's ratio of legal usage to its bandwidth cost to be 33:1.)

### **Conclusion of the Study:**

- Any sustainable national broadband policy must ensure that the heaviest Internet users pay their fair share of the Internet infrastructure costs.

### **Summary of Study Estimates:**

This is the first-ever research study of the U.S. consumer Internet market to estimate:

1. Total bandwidth usage;
2. Total bandwidth cost;
3. Google's bandwidth usage;
4. Google's bandwidth cost;
5. Google's percent of total bandwidth usage;
6. Google's percent of total bandwidth cost;
7. Google's ratio of bandwidth usage to its payment of bandwidth cost; and
8. Google's estimated bandwidth usage growth through 2010.

### **Summary of Study Sources:**

This research study used the most respected data sources available including: Cisco, IGI Group, OECD, Comscore, Hitwise, J.D. Powers, the Pew Internet and American Life Project, the USPTO, Google Planet, and company 10-K reports from Google, Limelight and Akamai.

## **II. Methodology Summary:**

The research study's methodology and assumptions are straight-forward, open, transparent, and catalogued in detail in the appendix so other researchers can replicate the findings; test their own assumptions or data sets; and improve the estimates started with this first-ever study. We welcome suggestions and improvements to enhance the quality and accuracy of this research study's estimates in subsequent updates.

In a nutshell, we sought to make the analysis as straight-forward, open, transparent and replicable as possible, relying on publicly available data.

- The methodology for estimating the Internet traffic load was to take the best available traffic usage data by type, which is Cisco's data, and size it for the U.S. consumer market and then further apply market share data from Comscore and Hitwise, to estimate Google's share.
- The methodology for Google's bandwidth costs was necessary in the absence of cost disclosure detail from Google. Thus we estimate Google's bandwidth costs based on Google's publicly disclosed operating cost data, factored to exclude non-bandwidth costs using proxy factors from similarly situated Content Delivery Networks (CDNs), and then further factoring these bandwidth costs to exclude search index web crawling costs. Finally, we factor these results to estimate bandwidth costs attributable to US consumers.
- In subsequent updates of these estimates, we would welcome an official Google bandwidth cost provided number that was subject to confirmation by an independent third party or auditor.

### III. Study's Relevance to National Broadband Policy:

This research study of Google's usage vs. cost is **relevant to the current broadband policy debate** for a variety of reasons.

- Google is the driving force behind [www.InternetForEveryone.org](http://www.InternetForEveryone.org) which is pushing “*to adopt a national plan to bring open, high-speed Internet connections into every home, at a price all of us can afford.*” Internet connections could be more affordable for everyone, if Google simply paid its fair share of the Internet's cost.
- Google is a leading proponent of no limits on Internet usage.
  - It is ironic that Google, the largest user of Internet capacity pays the least relatively to fund the Internet's cost.
  - It is even more ironic that the company poised to profit more than any other from more broadband deployment, expects the American taxpayer to pick up its skyrocketing bandwidth tab.
  - Simply, Google abuses a shared resource yet denies the responsibility of shared costs.
- The goal for universal broadband access is modeled in part on the successful Universal Service system for telecommunications. Universal Service has long been funded based on usage, the exact opposite of the current situation where Google, and other large Silicon Valley high-users of bandwidth, believe there should be a one-tier Internet where consumers, not providers, should pay for the delivery of applications and content on the Internet.
- It is remarkable that in most all of the discussion of a national broadband policy, and the potential need for subsidies for under-served areas, there has been little to no discussion of usage-based cost recovery for the broadband Internet.
- It seems incongruous that any proposed universal broadband cost recovery system would not have a usage-based cost recovery component to it, especially given that:
  - Universal Service for telecommunications has long had a usage-based cost recovery component; and
  - There is such a wide disparity in broadband usage (i.e. a few percent of users use most of the bandwidth).
- In the absence of at least a partially usage-based cost recovery mechanism for Universal Broadband, the system would be exceptionally regressive, where the lowest volume users who could least afford it, would be heavily subsidizing the Internet's heaviest users like Google, who can most afford it.

#### **IV. Relevance of Broadband Funding to Highway Funding:**

Since Google often compares the Internet to the public highway system, the study also examined how the U.S. highway system apportions costs among business users and consumers.

- Any analysis of public highway funding will show that businesses/trucks, which put the most cost burden on the highways, pay substantially more than consumers/cars – the exact opposite of Google’s recommended broadband model, where consumers shoulder most all of Google’s distribution costs.
- Google is inconsistent in supporting government ownership/regulation of the Internet like the U.S. highway system, but not adopt the economic model and fairness of the highway system -- where the heaviest users that cause a bulk of the costs – shoulder a fair portion of those costs.

#### **How are U.S. Highways funded?**

The Federal Interstate highway system is funded through taxes on gasoline/diesel fuels, and extra taxes on trucks/heavy-use-vehicles. According to the United States Federal Budget, funding for U.S. highways is ~\$37 billion in 2008, slightly less than this study’s estimate of \$38.0b for the cost of U.S. consumer broadband.

- In total, trucks/businesses pay for ~40% of the cost of highways and cars/consumers pay ~60%.
- Trucks/businesses are taxed ~33% more per gallon of fuel than cars/consumers, as diesel is taxed at ~24 cents per gallon and cars at ~18 cents per gallon.
- Since cars get dramatically better miles per gallon than trucks on average, ~20 MPG for cars and ~5 MPG for diesel trucks, cars/consumers pay less than one-cent-per-mile of Federal fuel tax where trucks/businesses pay more than 4-cents-per-mile of Federal fuel tax.
  - In short, trucks/businesses pay over four times more for their usage of the U.S. Interstate Highway system than cars/consumers do.

Funding fairness for the U.S. highway system is based on usage and stress on the system, i.e. the heaviest users shoulder a disproportionate share of its cost to maintain. This is in stark contrast to the proposed stance of Google and others which maintain that consumers should shoulder most all of the cost of the Internet and that heavy users and the biggest causers of Internet traffic, like Google, should not have to pay commensurate with their usage or stress on the system.

Sources for the data in this section on highway transportation are: the United States Federal Budget and the U.S. Bureau of Transportation’s “Transportation Energy Data Book Edition 25-2006.

## **V. The Research Study's Conclusions:**

- Any sustainable national broadband policy must ensure that the heaviest Internet users pay their fair share of Internet infrastructure costs.
  - It is neither economically rational nor equitable for the biggest users of, and beneficiaries from, shared resources to not share fairly in the recovery of costs.
- The absence of a usage-based cost-recovery component ensures a regressive broadband system.
- The absence of usage-based cost obligations on exceptionally high users unsustainably incents waste and abuse of the Internet infrastructure.

## VI. Detailed Research Study Methodology & Results

### Overview

The objective of this research is to identify US Consumer traffic loads on the Internet attributable to content from Google or its affiliates, consumer bandwidth costs of downloading Google's content, and the bandwidth costs Google incurs in providing that same content to consumers.

We sought to make the analysis as simple, open, transparent and easily replicable as possible, relying solely on data that is publicly available on the Internet. Unfortunately, Google does not report data on its traffic volumes, nor its bandwidth costs. As a result, these must be estimated using what data they do provide, and applying proxy factors where available from reliable third-party sources.

### Traffic Loads

#### Step 1: Identify US Consumer Internet traffic

The primary source of Internet traffic loads used in the analysis was "Cisco Visual Networking Index – Forecast and Methodology, 2007 - 2012."<sup>1</sup> This was a companion piece to Cisco's "Approaching the Zettabyte Era."<sup>2</sup> The Cisco study disaggregates Internet and non-Internet IP traffic by customer class (consumer, business and mobile), and by region (North America, Western Europe, etc.). It further disaggregates Internet consumer traffic by application. From this data we compile the North American consumer usage (reported in Petabytes per month)<sup>3</sup> by application for 2007-2010, and derive *US Consumer: Total Internet Traffic* in Table I by applying the US share (89%) of combined US and Canadian broadband lines as reported by OECD.<sup>4</sup>

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<sup>1</sup> See <http://newsroom.cisco.com/visualnetworkingindex/>

<sup>2</sup> See [http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white\\_paper\\_c11-481374.pdf](http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/white_paper_c11-481374.pdf)

<sup>3</sup> A Petabyte is 2<sup>50</sup> bytes. See "Measuring Internet Traffic" in Appendix for further explanation.

<sup>4</sup> See <http://www.oecd.org/dataoecd/22/15/39574806.xls>



**Table I**  
**US Consumer: Total Internet Traffic**

<b>US Consumer (PB per month)</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>
Web, email, transfer	186	249	325	425
P2P	370	439	507	562
Gaming	15	19	23	28
Video Communications	4	4	5	7
VoIP	5	7	9	11
Internet Video to PC	139	240	346	449
Internet Video to TV	48	155	301	492
<b>Total</b>	<b>767</b>	<b>1113</b>	<b>1517</b>	<b>1976</b>

For analysis purposes as discussed later, in Table II we estimate the *US Consumer: Legal Internet Traffic*, where “Legal” Internet traffic is defined as all traffic *except* the 90% of P2P traffic estimated to be illegal file-sharing of copyrighted materials.<sup>5</sup>

**Table II**  
**US Consumer: Legal Internet Traffic**

<b>US Consumer (PB per month)</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>
Web, email, transfer	186	249	325	425
P2P (legal)	37	44	51	56
Gaming	15	19	23	28
Video Communications	4	4	5	7
VoIP	5	7	9	11
Internet Video to PC	139	240	346	449
Internet Video to TV	48	155	301	492
	<b>434</b>	<b>718</b>	<b>1060</b>	<b>1470</b>

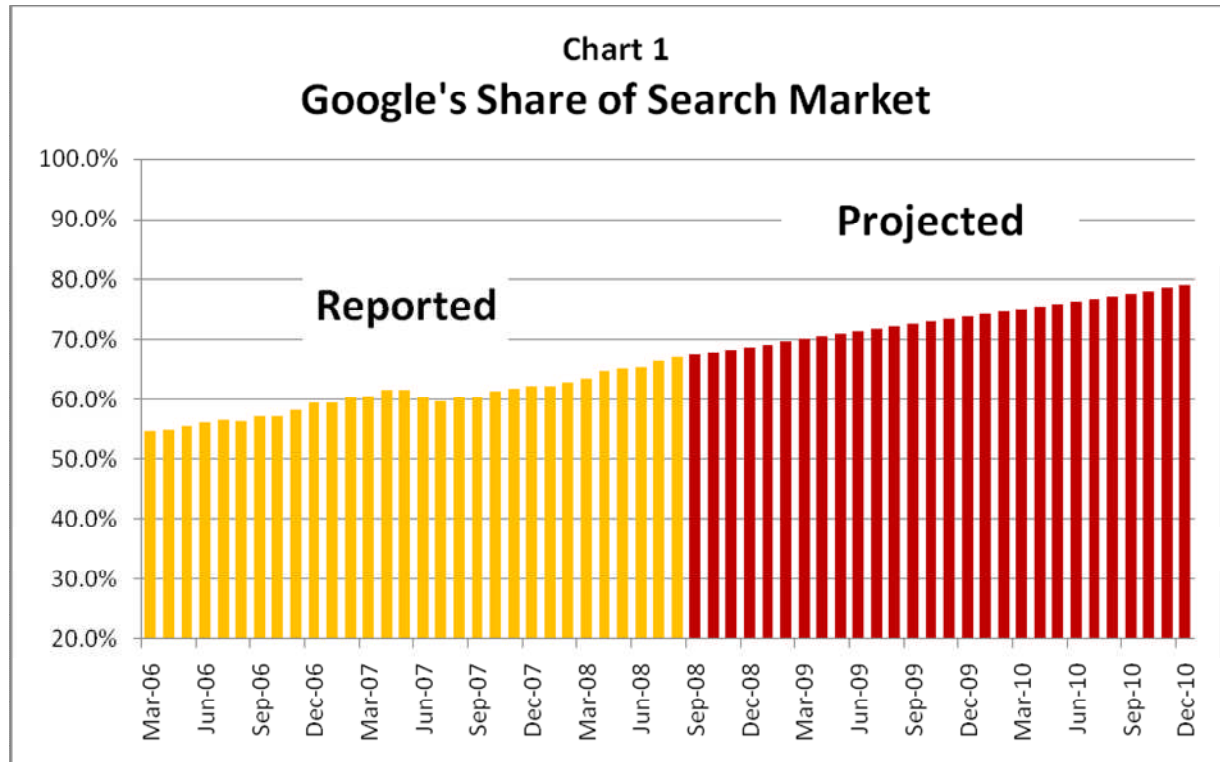
Additional data from the Cisco report can be found in the Appendix.

<sup>5</sup> See “Filesharing Programs And Technological Features to Induce Users to Share: A Report to the United States Patent and Trademark Office from the Office of International Relations,” November 2006, at 5.

[http://www.uspto.gov/web/offices/dcom/olia/copyright/oir\\_report\\_on\\_inadvertent\\_sharing\\_v1012.pdf](http://www.uspto.gov/web/offices/dcom/olia/copyright/oir_report_on_inadvertent_sharing_v1012.pdf)

## Step 2: Identify share of US Consumer Internet traffic attributable to Google content

The share of US consumer Internet traffic attributable to Google content was calculated by applying year-end Google application (e.g., search, video, etc.) market shares to the disaggregated traffic data reported by Cisco. Google search share data is typically reported monthly by comScore<sup>6</sup> and Hitwise.<sup>7</sup> We average their reported results, and project a simple linear trend of the data through 2010.



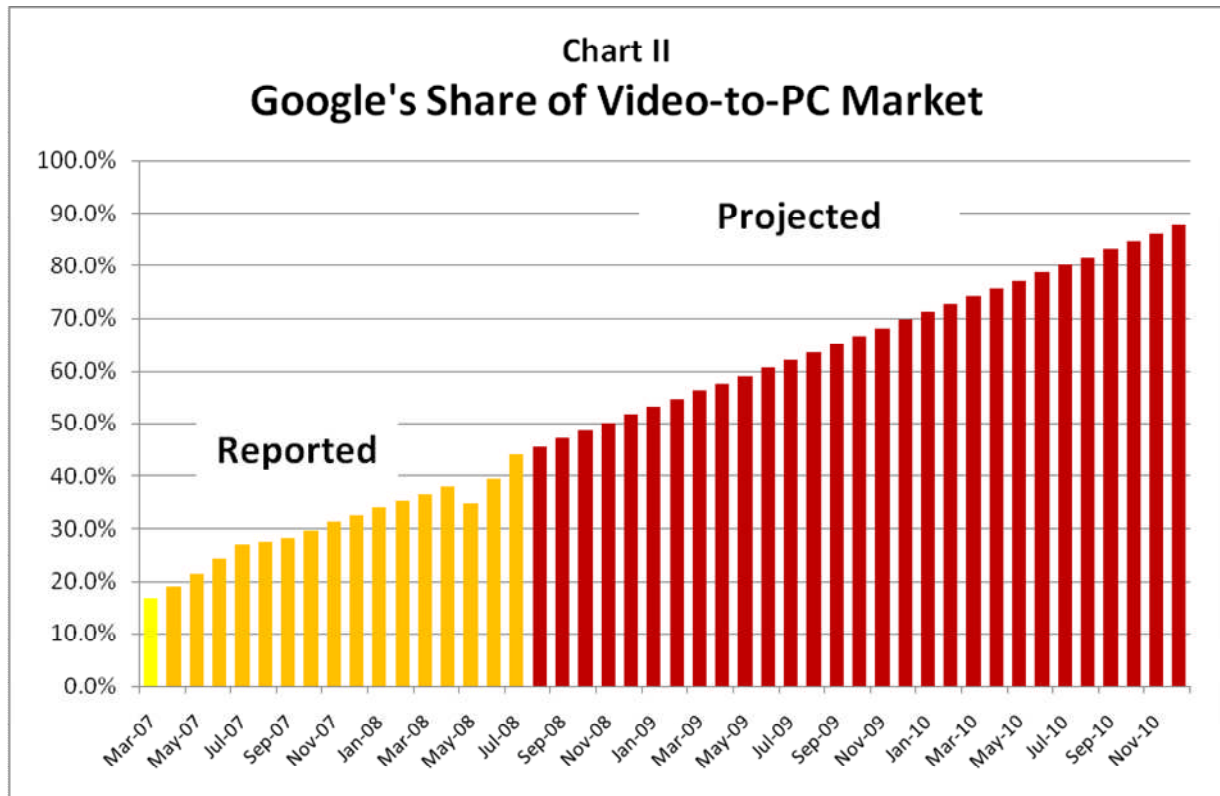
**Table III**  
**Google's Share of Search Market**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2006			54.7%	55.0%	55.6%	56.1%	56.6%	56.3%	57.3%	57.3%	58.2%	59.5%
2007	59.4%	60.2%	60.5%	61.6%	61.5%	60.2%	59.8%	60.2%	60.3%	61.4%	61.9%	62.2%
2008	62.2%	62.8%	63.5%	64.8%	65.0%	65.3%	66.3%	67.0%	67.4%	67.9%	68.3%	68.7%
2009	69.1%	69.6%	70.0%	70.4%	70.8%	71.3%	71.7%	72.1%	72.5%	73.0%	73.4%	73.8%
2010	74.2%	74.7%	75.1%	75.5%	75.9%	76.4%	76.8%	77.2%	77.7%	78.1%	78.5%	78.9%

<sup>6</sup> See <http://www.comscore.com/press/pr.asp>

<sup>7</sup> See <http://www.hitwise.com/other/press-center.php>

Google's share of video-to-PC is also available from comScore. We project a simple linear trend of the data through 2010.



**Table IV**  
**Google's Share of Video-to-PC Market**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2007			16.7%	19.1%	21.5%	24.3%	27.0%	27.7%	28.3%	29.8%	31.3%	32.6%
2008	34.3%	35.4%	36.7%	37.9%	34.8%	39.5%	44.1%	45.6%	47.1%	48.6%	50.1%	51.6%
2009	53.1%	54.6%	56.1%	57.6%	59.1%	60.6%	62.1%	63.6%	65.1%	66.6%	68.1%	69.6%
2010	71.1%	72.6%	74.1%	75.6%	77.1%	78.6%	80.1%	81.6%	83.1%	84.6%	86.1%	87.6%

A point estimate of Google's share of email (6%) traffic was available from Hitwise, and we assume this share holds throughout the forecast period.<sup>8</sup> We assume Google's share of P2P, Gaming, Video Communications and VoIP to be 0%; and Google's share of music and miscellaneous/other to be 5%.

The Cisco data aggregates several types of Internet traffic (search, email, etc.), into its "Web, Email and Transfer" category. Because Google's market share estimates vary by application, we must find a means of calculating a weighted average of Google's share of this category. For this purpose, we use DSL/Cable usage traffic data from the IGI Group, as reported by Network World.<sup>9</sup> The IGI data is segmented by video, music, search, email, miscellaneous and other. We exclude the video traffic from our analysis since Cisco reports this separately. We also adjust the IGI data to exclude 75% of the Music traffic.<sup>10</sup> We then calculate the reweighted "factors" that will serve as our allocations for the Google shares of Email, Misc/Other, Music and Search. Our Email, Misc/Other and Music factors do not vary over time, and when aggregated, provide us with a 3.7% Google share of Cisco's Web, Email and Transfer category. To this, we add the changing share of Google's weighted "Search" factors ranging from 18.4% in 2007 to 23.4% in 2010.<sup>11</sup> This resulted in Google share's of Web, Email and Transfer ranging from 22.1% in 2007 to 27.1% in 2010. See Table V.

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<sup>8</sup> [http://weblogs.hitwise.com/bill-tancer/2008/02/microsoft\\_and\\_yahoo\\_putting\\_th.html](http://weblogs.hitwise.com/bill-tancer/2008/02/microsoft_and_yahoo_putting_th.html)

<sup>9</sup> IGI Group. <http://www.networkworld.com/news/2007/021507-dont-expect-video.html>. See Appendix for IGI share chart.

<sup>10</sup> The IGI results do not separate P2P traffic from other Internet traffic. We assume 75% of music downloads are through P2P programs such as Bittorrent and Limewire, and therefore are not part of Cisco's Web/Email/Transfer traffic, and should not be included here.

<sup>11</sup> There also appears to be a synergistic effect between Google's search engine and downloading of other Google content. See <http://precursorblog.com/content/new-evidence-google-search-bias-its-relevant-doj-investigation-google-yahoo-ad-deal>

**Table V**  
**IGI Internet Traffic Data Analysis**

<b>Application</b>	<b>% Internet</b>	<b>Factor</b>	<b>Google %</b>	<b>Google % AppGroup</b>	
Email	9.0%	19.0%	6.0%	1.1%	
Misc/Other	19.0%	40.2%	5.0%	2.0%	
Music (25%)	5.3%	11.1%	5.0%	0.6%	
Search	14.0%	29.6%	(see below)		
Total	47.3%	100.0%		3.7%	

<b>Year</b>	<b>Search</b>	<b>Google Search</b>	<b>Google % AppGroup</b>	<b>Add 3.7%</b>	<b>Google % Cisco W/E/T</b>
2007	29.6%	62.2%	18.4%	3.7%	22.1%
2008	29.6%	68.7%	20.4%	3.7%	24.1%
2009	29.6%	73.8%	21.9%	3.7%	25.6%
2010	29.6%	78.9%	23.4%	3.7%	27.1%

Finally, we develop an estimate of Google's share of the rapidly growing Video-to-TV market. We assume that Google has no meaningful share of this market through 2008, but quickly stakes out a position in 2009 and 2010, reaching a share equal to 25% of its Video-to-PC share in 2009, and 50% in 2010.

Based in the previous analysis, we can now calculate Google's share of the US Consumer Internet market by Cisco's application categories, which is summarized in Table VI below.

**Table VI**  
**Google's Share of US Consumer Internet Market**

<b>Google Share %</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>
Web, email, transfer	22.1%	24.1%	25.6%	27.1%
P2P	0.0%	0.0%	0.0%	0.0%
Gaming	0.0%	0.0%	0.0%	0.0%
Video Communications	0.0%	0.0%	0.0%	0.0%
VoIP	0.0%	0.0%	0.0%	0.0%
Internet Video to PC	32.6%	51.6%	69.6%	87.6%
Internet Video to TV	0.0%	0.0%	17.4%	43.8%

Applying these share estimates to the total US Consumer Internet market in Table I, we find Google's aggregate market share to be increasing from 86 PB per month in 2007, to a projected 725 PB per month in 2010.

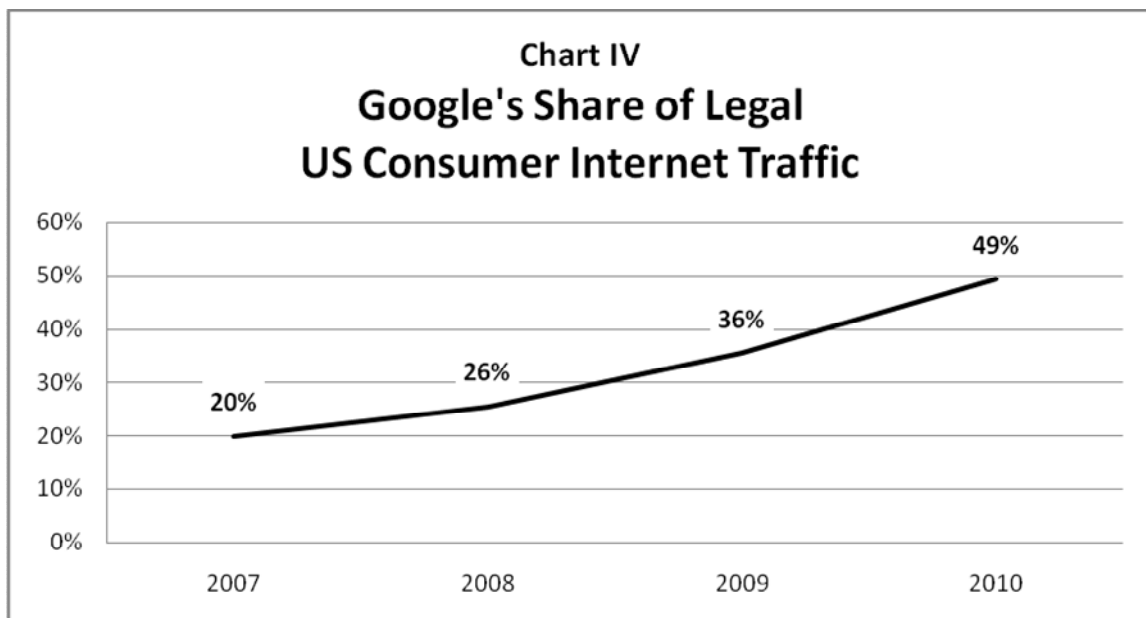
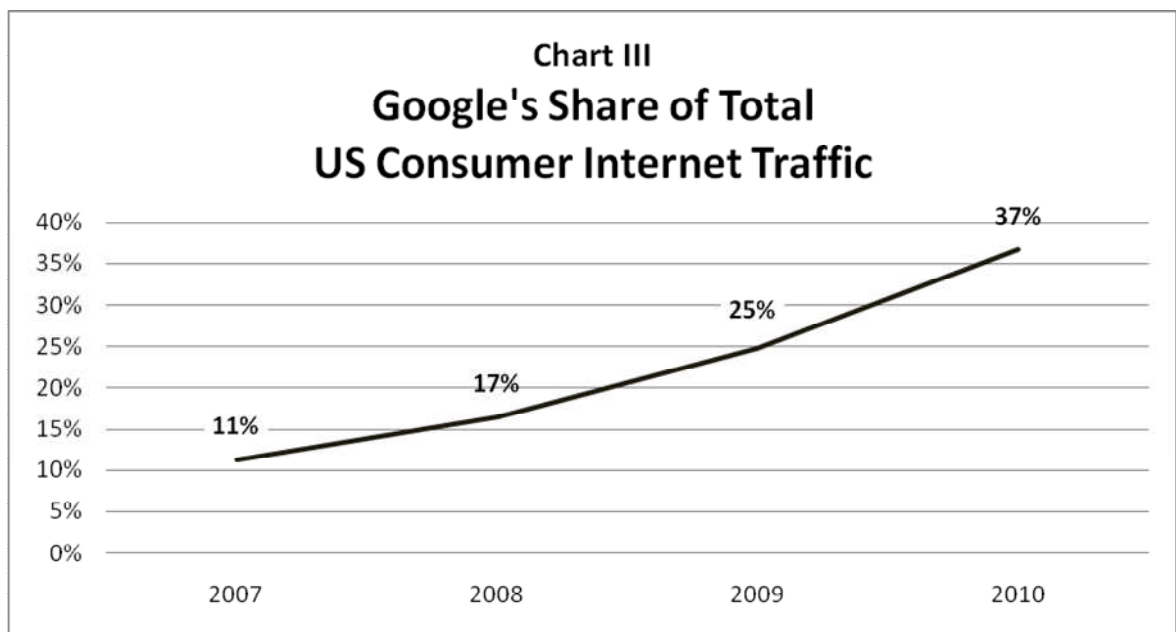
**Table VII**  
**Google's US Consumer Internet Market Traffic**

<b>Google (PB per month)</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>
Web, email, transfer	41	60	83	115
P2P	0	0	0	0
Gaming	0	0	0	0
Video Communications	0	0	0	0
VoIP	0	0	0	0
Internet Video to PC	45	124	241	394
Internet Video to TV	0	0	52	216
Google Traffic	86	184	376	725

Table VIII summarizes Google's aggregate share of both Total US Consumer Internet Traffic, as well as its aggregate share of Legal US Consumer Internet Traffic.

**Table VIII**  
**Google's US Consumer Internet Traffic**

<b>PB per month</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>
All Internet Traffic	767	1113	1517	1976
Legal Internet Traffic	434	718	1060	1470
Google Traffic	86	184	376	725
<b>Google's Share</b>				
Total Internet Traffic	11%	17%	25%	37%
Legal Internet Traffic	20%	26%	36%	49%



## Bandwidth Costs

### Step 1: Identify US Consumer Costs of Internet Access

For the purposes of this study, US Consumer Internet costs are defined as the annual costs of Internet services paid by consumers to a wireline Internet Service Provider (ISP) by Dial-Up and Broadband subscribers. OECD reports there were 69.9 million US Broadband subscribers as of December 2007, and 75.0 million in June 2008.<sup>12</sup> We assume a comparable growth rate for the last six months of 2008, resulting in 80.5 million broadband subscribers. JD Powers finds that dial-up connections constituted 35% of the US market in 2007, and 25% in 2008, and reports that the average dial-up subscriber paid \$17.81 per month, while the average broadband subscriber paid \$44.09.<sup>13</sup> The Pew Research Center reports that the average dial-up subscriber paid \$19.70 per month, while the average broadband subscriber pays \$34.50 per month.<sup>14</sup> We average the JD Powers and Pew Research results to derive an average dial-up rate of \$18.76, and an average broadband rate of \$39.30. We assume these rates hold for both 2007 and 2008. An annual estimate of US Consumer Internet costs was calculated by applying these average monthly prices for broadband and dial-up subscribers to the total number of consumer broadband and dial-up lines, and annualizing the data for twelve months. This resulted in an aggregate consumer cost of \$41.4 billion for 2007, and \$44.0 billion for 2008. See Table IX.

**Table IX**  
**US Consumer Internet Costs: 2007-2008**

	Dec 2007	Jun 2008	Dec 2008	Avg. Price	2007	2008
Broadband	69,859,707	75,009,521	80,538,961	\$39.30	\$32,946	\$37,982
Dial-Up	37,616,765		26,846,320	\$18.76	\$8,468	\$6,044
Total US	107,476,472		107,385,282		\$41,414	\$44,026

<sup>12</sup> The FCC reports there were 100.9M High-Speed Lines (over 200 kbps in at least one direction) in the US as of June 30, 2007. See [http://hraunfoss.fcc.gov/edocs\\_public/attachmatch/DOC-280906A1.pdf](http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-280906A1.pdf). This includes 35.3M mobile wireless lines, 586K fixed wireless lines, and 669K satellite lines. Excluding wireless lines brings the total to 64.3M lines as of June 30, 2007. This appears consistent with 69.9M lines reported by OECD for December 2007.

<sup>13</sup> See “High-Speed Internet Subscribers are Less Loyal to Their Providers Than are Dial-Up Subscribers, Despite Steady Growth in High-Speed Internet Market Share,” JD Powers, Sep. 19, 2007, at <http://www.jdpower.com/corporate/news/releases/pdf/2007210.pdf>. For 2008 Dial-up subscribers, see <http://www.jdpower.com/corporate/news/releases/pdf/2008236.pdf>

<sup>14</sup> “Home Broadband Adoption,” Pew Internet and American Life Project, July 2, 2008, at [http://www.pewinternet.org/PPF/r/257/report\\_display.asp](http://www.pewinternet.org/PPF/r/257/report_display.asp)



## Step 2. Identify Google's bandwidth costs of delivering US Consumer Internet traffic

Because Google does not report its bandwidth costs, we estimate these costs by examining Google's 10-Q and 10-K filings with the SEC for 2007 and 2008. Google separates its operating costs into (1) Traffic Acquisition Costs, and (2) Other Costs of Revenues. Traffic Acquisition Costs consist of amounts ultimately paid to Google Network members under AdSense arrangements and to certain other partners ("distribution partners") who distribute Google's toolbar and other products (collectively referred to as "access points") or otherwise direct search queries to Google's web site (collectively referred to as "distribution arrangements"). Other Costs of Revenue includes the expenses associated with the operation of data centers, including depreciation, labor, energy and bandwidth costs, credit card and other transaction fees related to processing customer transactions, as well as content acquisition costs. See Table X.

**Table X**  
**Google's Other Costs of Revenue**

<b>2007</b>	<b>1Q07</b>	<b>2Q07</b>	<b>3Q07</b>	<b>4Q07</b>	<b>2007</b>
<b>Revenues</b>	\$3,664.0	\$3,872.0	\$4,231.4	\$4,826.7	\$16,594.0
<b>Costs of Revenues</b>	\$1,470.4	\$1,560.3	\$1,662.6	\$1,955.8	\$6,649.1
<b>Traffic Acquisition</b>					
<b>Costs</b>	\$1,125.0	\$1,147.9	\$1,221.1	\$1,439.9	\$4,933.9
<b>Other Costs of</b>					
<b>Revenues</b>	\$345.4	\$412.4	\$441.5	\$515.9	\$1,715.2
<b>2008</b>	<b>1Q08</b>	<b>2Q08</b>	<b>3Q08</b>	<b>4Q08</b>	<b>2008</b>
<b>Revenues</b>	\$5,186.0	\$5,367.2	\$5,541.4	\$6,033.3	\$22,128.0
<b>Costs of Revenues</b>	\$2,110.5	\$2,147.6	\$2,173.4	\$2,444.8	\$8,876.3
<b>Traffic Acquisition</b>					
<b>Costs</b>	\$1,486.4	\$1,474.0	\$1,495.2	\$1,684.7	\$6,140.3
<b>Other Costs of</b>					
<b>Revenues</b>	\$624.1	\$673.6	\$678.2	\$760.1	\$2,736.0
<b>% Change Y/Y</b>	<b>1Q</b>	<b>2Q</b>	<b>3Q</b>	<b>4Q</b>	<b>Year</b>
<b>Revenues</b>	41.5%	38.6%	31.0%	25.0%	33.3%
<b>Costs of Revenues</b>	43.5%	37.6%	30.7%	25.0%	33.5%
<b>Traffic Acquisition</b>					
<b>Costs</b>	32.1%	28.4%	22.4%	17.0%	24.5%
<b>Other Costs of</b>					
<b>Revenues</b>	80.7%	63.3%	53.6%	47.3%	59.5%

Source: Google's SEC filings. 4Q 2008 estimated

## **Google's Estimated Bandwidth Costs**

Google's bandwidth costs include both the operating costs of its own broadband fiber network, as well as broadband facilities leased from other carriers, and network transit costs paid to other carriers where they do not have network peering arrangements. We estimate a range for these costs from its reported "Other Costs of Revenues" by examining the ratio of reported bandwidth costs to total operating costs of Akamai Technologies and Limelight Networks, two of the largest Content Distribution Networks (CDNs), as reported in their SEC 10-K annual reports for 2007.

### **Limelight's 2007 10-K**

"Our contracts related to transit bandwidth provided by network operators generally commit us to pay either a fixed monthly fee or monthly fees plus additional fees for bandwidth usage above a contracted level. Our master contract with Global Crossing provides for the lease of private lines of varying capacity for our backbone, at fixed monthly fees with commitments ranging from 2 to 3 years. In addition to purchasing services from communications providers, we connect directly to over 800 broadband Internet service providers, or ISPs, generally without either party paying the other. This industry practice, known as settlement free peering, benefits us by allowing us to place content objects directly on user access networks, which helps us provide higher performance delivery for our customers and eliminate paying transit bandwidth fees to network operators. This practice also benefits the ISP and its customers by allowing them to receive improved content delivery through our local servers and eliminate cost of transit bandwidth associated with delivery receipt of the traffic. We do not consider these relationships to represent the culmination of an earnings process. Accordingly, we do not recognize as revenue the value to the ISPs associated with the use of our servers nor do we recognize as expense the value of the bandwidth received at discounted or no cost. These peering relationships are mutually beneficial and are not contractual commitments."

### **Akamai's 2007 10-K**

"Our expansive network infrastructure and sophisticated technology are the foundation of our services. We believe Akamai has deployed the world's largest globally distributed computing platform, with more than 30,000 servers located in more than 900 networks around the world. Applying our proprietary technology, we deliver our customers' content and computing applications across a system of widely distributed networks of servers; the content and applications are then processed at the most efficient places within the network. Servers are deployed in networks ranging from large, backbone network providers to medium and small ISPs, to cable modem and satellite providers to universities and other networks. By deploying servers within a wide variety of networks, we are better able to manage and control routing and delivery quality to geographically diverse users. We also have more than 1,000 peering relationships that provide us with direct paths to end user networks, which reduces data loss, while also potentially giving us more options for delivery at reduced cost."

**Table XI**  
**Limelight and Akamai Costs**

<u>2007</u>	<u>Limelight Networks</u>	<u>Akamai Technologies</u>	<u>Total</u>
<b>Revenue</b>	\$103.1	\$207.7	\$310.8
<b>Cost of revenue</b>			
Bandwidth and co-location	\$36.3	\$103.2	\$139.5
Depreciation - Network	\$20.7	\$41.1	\$61.8
Royalty Expenses	\$1.1	\$0.0	\$1.1
Payroll and related employee costs	\$4.3	\$8.8	\$13.1
Share-based compensation expense	\$1.5	\$3.3	\$4.8
Other costs of revenue	\$1.6	\$11.0	\$12.6
	<u>\$65.5</u>	<u>\$167.4</u>	<u>\$232.9</u>
Bandwidth as % Cost of Revenue	55.4%	61.6%	59.9%

Applying the weighted average bandwidth cost factor of 59.9% from Limelight and Akamai gives us the following estimates of global bandwidth costs for Google:

**Table XII**  
**Google's Global Bandwidth Costs**

	<u>2007</u>	<u>2008</u>
Other Costs of Revenues	\$1,715	\$2,736
Bandwidth Factor	59.9%	59.9%
Global Bandwidth Costs	\$1,027	\$1,639

We now turn to allocating the share of these costs attributable to the US Consumer. First, we estimate Google's bandwidth costs for building its search index database.<sup>15</sup> Googlebot is Google's automated process for collecting documents from the web to build a searchable index for the Google search engine. According to Wikipedia, Googlebot has two versions, Deepbot and Freshbot. Deepbot follows every link on the web and downloads as many pages as it can to the Google indexers. It completes this process about once a month. Freshbot visits websites that change frequently, according to how frequently they change. Google states this could be as frequently as every few seconds.<sup>16</sup>

<sup>15</sup> Google currently indexes over one trillion web pages. See <http://googleblog.blogspot.com/2008/07/we-knew-web-was-big.html>

<sup>16</sup> See Google's Googlebot FAQ at [http://www.google.co.uk/intl/en\\_uk/webmasters/bot.html](http://www.google.co.uk/intl/en_uk/webmasters/bot.html). Also see "Googlebot using too much bandwidth" at [http://groups.google.com/group/Google\\_Webmaster\\_Help-Indexing/browse\\_thread/thread/a4fe2fc965ec31c3?pli=1](http://groups.google.com/group/Google_Webmaster_Help-Indexing/browse_thread/thread/a4fe2fc965ec31c3?pli=1).

We are not aware of any publicly available estimate of the bandwidth costs of Google's webcrawling activities. Because Google downloads to its servers a significant portion of the *entire* Internet on a monthly basis, and many websites are downloaded on a much more frequent basis, for the purposes of this analysis, we assume that 50% of Google's bandwidth costs are attributable to its web indexing efforts, leaving the other 50% attributable to user-generated content requests from Google services and applications such as Google Search, YouTube, Google Earth, Picasa, etc.

Google's YouTube is reported to have had bandwidth costs in 2007 of about \$1 million per day, or \$365 million on an annual basis.<sup>17</sup> This leaves \$149 million in non-YouTube user bandwidth costs for 2007. Assuming a stable cost/traffic ratio, and growing the 2007 YouTube costs of \$365 by 73% (the expected 2007 to 2008 increase for Video-to-PC traffic from Cisco's report) results in YouTube bandwidth costs of \$631 million in 2008, and non-YouTube costs of \$350 million in 2008.

According to Google, more than half of all viewers on YouTube are from outside the United States.<sup>18</sup> We can therefore conservatively assume that 50% of YouTube bandwidth costs are attributable to US Consumers (we assume all YouTube traffic is attributable to consumers, with no meaningful usage by business at this time). We assume the US Consumer share of Google's Global non-YouTube costs is proportional to the US Consumer share of Global traffic from the Cisco report, or approximately 15% for 2007 and 2008. This results in Google bandwidth costs to serve US Consumer requests for Google content or services of \$205 million in 2007 and \$344 million in 2008. This represents 40% of Google's total user-generated bandwidth costs for 2007, and 42% for 2008.

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<sup>17</sup> See Randall Stross (2008), *Google Planet*, New York: Free Press, p. 126

<sup>18</sup> See <http://news.bbc.co.uk/2/hi/technology/6757525.stm>

**Table XIII**  
**Google Costs Attributable to US Consumers**

	<b>\$ Millions</b>	
	<b>2007</b>	<b>2008</b>
Global Bandwidth Costs	\$1,027	\$1,639
<b>(less)</b> Search Indexing Cost (50%)	\$514	\$819
Global User Costs	\$514	\$819
<b>(less)</b> YouTube Costs	\$365	\$631
Global Non-YouTube Costs	\$149	\$188
<u>US Consumer Costs</u>		
YouTube (50%)	\$183	\$316
Non-YouTube (15%)	\$22	\$28
Total US Consumer	\$205	\$344
% Global User Costs	40%	42%

### **Summary: Google and the US Consumer**

Our objective was to identify US Consumer traffic loads on the Internet attributable to content from Google and its affiliates, to estimate the consumer bandwidth costs of downloading Google's content, and to estimate the bandwidth costs Google incurs in providing that same content to consumers. Table XIV summarizes our findings for both (1) total US Consumer Internet traffic, as well as (2) US Consumer Legal Internet traffic (i.e., excluding the 90% of P2P traffic estimated to be illegal filesharing of copyrighted material).

**Table XIV**  
**Google and the US Consumer**

	<b>PB per month</b>		<b>% Allocation</b>	
	<b>2007</b>	<b>2008</b>	<b>2007</b>	<b>2008</b>
<b><u>US Consumer Total Usage</u></b>				
Google	86	184	11.3%	16.5%
Non-Google	681	929	88.7%	83.5%
<b><u>US Consumer Legal Usage</u></b>				
Google	86	184	19.9%	25.6%
Non-Google	348	535	80.1%	74.4%
<b><u>Broadband Costs</u></b>				
	<b>\$Millions</b>			
Google	\$205	\$344	0.5%	0.8%
Consumer Broadband	\$32,946	\$37,982	79.2%	85.6%
Consumer Dial-Up	\$8,468	\$6,044	20.3%	13.6%
				<b><u>Ratio</u></b>
				<b>2008</b>
Google Total Traffic-to-Cost Ratio				21:1
Google Legal Traffic-to-Cost Ratio				33:1

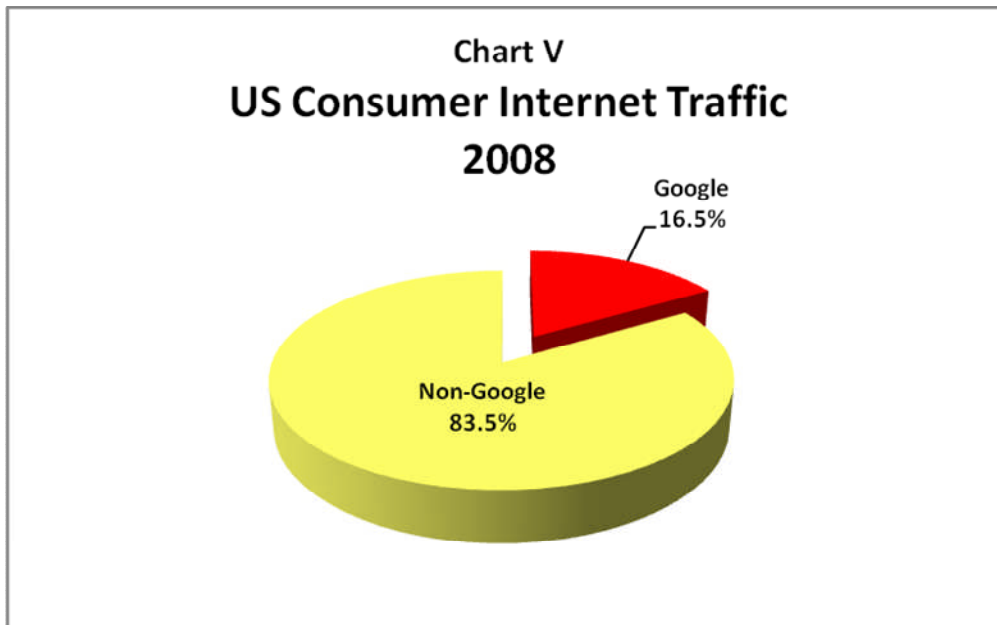


Chart VI  
**US Consumer Internet Costs  
2008**

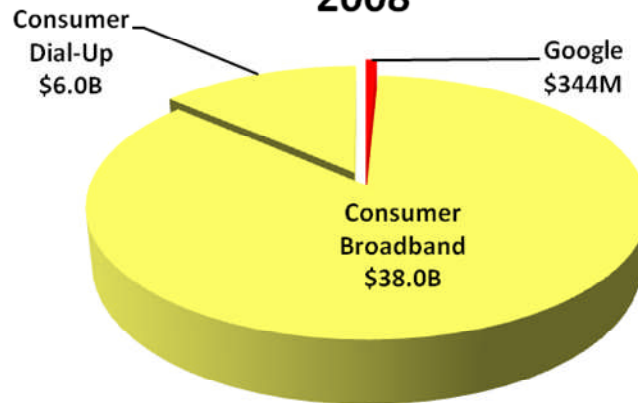
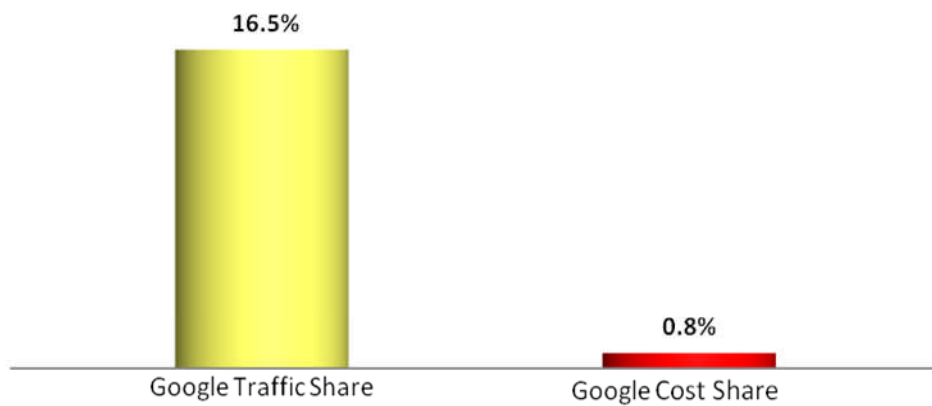


Chart VII  
**Google Traffic Share v. Cost Share  
2008**



# Appendix

## Cisco Traffic Forecasts

### Global Internet Traffic

(PB per month)	2007	2008	2009	2010
Consumer	3,397	5,315	7,735	10,884
Business	1,469	2,031	2,811	3,818
Mobile	26	65	153	345
	4,884	7,394	10,666	14,984

### Global Consumer Internet

(PB per month)	2007	2008	2009	2010
Web, email, transfer	710	999	1,336	1,785
P2P	1,747	2,361	3,075	3,981
Gaming	131	187	252	324
Video Communications	25	37	49	70
VoIP	39	56	72	87
Internet Video to PC	647	1,346	2,196	3,215
Internet Video to TV	99	330	756	1,422
	3,398	5,316	7,736	10,884

### No American Consumer Internet

(PB per month)	2007	2008	2009	2010
Web, email, transfer	209	280	365	478
P2P	416	493	570	632
Gaming	17	21	26	32
Video Communications	4	5	6	8
VoIP	6	8	10	12
Internet Video to PC	156	270	389	505
Internet Video to TV	54	174	338	553
	862	1,251	1,704	2,220



## Google “Search” share as reported by comScore and Hitwise

	comScore	Hitwise
Mar-06		58.33%
Apr-06		58.64%
May-06		59.27%
Jun-06		
Jul-06		60.23%
Aug-06		59.99%
Sep-06		60.93%
Oct-06		60.94%
Nov-06		61.84%
Dec-06		63.15%
Jan-07		63.06%
Feb-07		63.90%
Mar-07		64.13%
Apr-07		65.26%
May-07		65.13%
Jun-07		63.92%
Jul-07	55.2%	64.35%
Aug-07	56.5%	63.98%
Sep-07	57.0%	63.55%
Oct-07	58.4%	64.49%
Nov-07	58.6%	65.10%
Dec-07	58.4%	65.98%
Jan-08	58.5%	65.98%
Feb-08	59.2%	66.44%
Mar-08	59.8%	67.25%
Apr-08	61.6%	67.90%
May-08	61.8%	68.29%
Jun-08	61.5%	69.17%
Jul-08	61.9%	70.77%
Aug-08	63.0%	71.01%

comScore's core search rankings are for the top five search engines. comScore surveys two million users worldwide

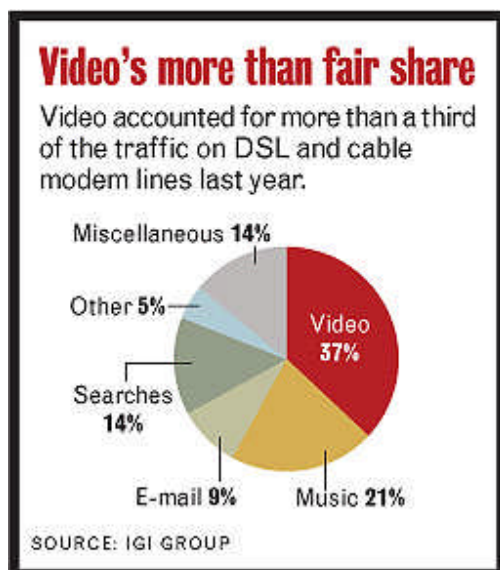
Hitwise surveys 10 million US Internet users, and measures usage of 50 search engines. The top four search engines account for approximately 98% of all searches

## Measuring Internet Traffic

Internet traffic loads are reported in bytes. A byte is eight binary bits, i.e., each bit is either a “0” or “1”). Given the enormous volume of Internet traffic, this data is often reported in factors of  $2^n$ , where n is a multiple of 10.

Kilobyte (KB)	$2^{10} =$	1,024
Megabyte (MB)	$2^{20} =$	1,048,576
Gigabyte (GB)	$2^{30} =$	1,073,741,824
Terabyte (TB)	$2^{40} =$	1,099,511,627,776
Petabyte (PB)	$2^{50} =$	1,125,899,906,842,620
Exabyte (EB)	$2^{60} =$	1,152,921,504,606,850,000
Zettabyte (ZB)	$2^{70} =$	1,180,591,620,717,410,000,000

## IGI Share Chart



## **Bio for:**

### **Scott Cleland President, Precursor® LLC**

- Scott Cleland is one of nation's foremost techcom analysts and experts *at the nexus of:* capital markets, public policy and techcom industry change. He is widely-respected in industry, government, media and capital markets as a forward thinker, free market proponent, and leading authority on the future of communications. Precursor LLC is an industry research and consulting firm, specializing in the techcom sector, whose mission is to help companies anticipate change for competitive advantage. He previously founded The Precursor Group Inc., which *Institutional Investor* magazine ranked as the #1 "Best Independent" research firm in communications for two years in a row. He is also Chairman of Netcompetition.org, a wholly-owned subsidiary of Precursor LLC and an e-forum on Net Neutrality funded by broadband telecom, cable, and wireless companies.
- Cleland has a high-profile track record of foreseeing big change before others. He coined the term "techcom" to define how information technology drives the communications future and to best name the new sector that converging communications technologies are creating. *Fortune* profiled Cleland as the first to call "WorldCom: Dead Model Walking" and to predict its bankruptcy. Then WorldCom CEO Bernie Ebbers tried to discredit Cleland's prescient and hard-hitting research on WorldCom by deriding him the "idiot Washington analyst." Cleland has testified before seven different Congressional subcommittees on a variety of forward-looking topics and was the first congressional expert witness asked to testify on what went wrong with Enron.

### **Scott Cleland's Congressional Testimony on Google:**

- Before the Senate Judiciary Subcommittee on Antitrust on the Google-DoubleClick Merger, September 27, 2007.
  - [http://googleopoly.net/cleland\\_testimony\\_092707.pdf](http://googleopoly.net/cleland_testimony_092707.pdf)
- Before the House Energy and Commerce Subcommittee on the Internet on Google Privacy issues, July 17, 2008.
  - [http://www.netcompetition.org/Written\\_Testimony\\_House\\_Privacy\\_071707.pdf](http://www.netcompetition.org/Written_Testimony_House_Privacy_071707.pdf)