Cisco Visual Networking Index: Usage

The Cisco® Visual Networking Index (VNI) Usage research is part of an ongoing initiative to measure the impact of visual networking (a combination of video, social networking and advanced collaboration applications). This paper provides the latest VNI Usage findings and describes the data collection methodology. For a look at the possible future growth of the applications discussed in this paper, please refer to the Cisco VNI Forecast and Methodology, 2009–2014.

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Highlights of the Cisco VNI Usage Results

The average broadband connection generates 14.9 GB of Internet traffic per month, up from 11.4 GB per month last year, an increase of 31 percent[1].

"Busy hour" traffic grew at a faster pace than average traffic, growing 41 percent since last year. Peak-hour Internet traffic is 72 percent higher than Internet traffic during an average hour. The ratio of the busy hour to the average hour increased from 1.59 to 1.72, globally.

Peer-to-peer (P2P) file sharing is now 25 percent of global broadband traffic, down from 38 percent last year, a decrease of 34 percent. While still growing in absolute terms, P2P is growing more slowly than visual networking and other advanced applications.

[1] The 31 percent annual growth per broadband Internet connection is consistent with VNI Forecast estimates for the consumer Internet growth of 31.5 percent between 2009 and 2010. Note that when subscriber growth is taken into account, the overall consumer Internet growth rate increases to 42.0 percent for 2010.

Peer-to-peer has been surpassed by online video as the largest category. The subset of video that includes streaming video, flash, and Internet TV represents 26 percent, compared to 25 percent for P2P[2].

Over one-third of the top 50 sites by volume are video sites. There is a high degree of diversity among the video sites in the top 50, including video viewed on gaming consoles, Internet TV, short-form user-generated video, commercial video downloads, and video distributed via content delivery networks (CDNs). Video sites appeared more frequently than any other type of site in the top 50.

Contrary to popular belief, none of the top 50 global web sites (by traffic volume) featured explicit adult content. This represents a shift in content compared to the composition of top global web sites two years ago.

Ten of the top 50 sites were associated with software updates and downloads (security and application enhancements).

Voice and video communications traffic is now six times higher than data communications traffic (email, instant messaging, instant messaging file transfer). Voice and video communications traffic (such as voice over IP [VoIP] and voice and video over instant messaging) has reached 2 percent of all traffic, up from less than 1 percent last year.

Online video fluctuates more than file sharing traffic. Online video's volatility (defined as the spread of traffic volume during the course of the day) is 51 percent higher than that of file sharing. The peak video hour is 91 percent higher than the average video hour, while the peak file sharing hour is 64 percent higher than the average file sharing hour.

The top 1 percent of broadband connections is responsible for more than 20 percent of total Internet traffic. The top 10 percent of connections is responsible for over 60 percent of broadband Internet traffic, worldwide.

In an average day, Internet "prime time" ranges from approximately 9 p.m. to 1 a.m. around the world. This contrasts to broadcast TV prime time, which is generally from 7 p.m. to 11 p.m. across most global markets.

Trends in Traffic Application Mix

The most striking shift in application mix trends continues to be the growth of video as a percentage of traffic compared to P2P file sharing. The VNI Usage results for 2010 confirm a central prediction of the VNI Forecast for the past three years: that video would surpass P2P file sharing as a percentage of the traffic by the end of 2010. While the categories in the VNI Forecast and VNI Usage efforts are not strictly comparable (video is spread across several categories in the VNI Usage results, while it is bundled into a single category in the VNI Forecast results), the VNI Usage results show that the online video subset has reached 26.2 percent of traffic per connection, while the traffic share of P2P file sharing has dropped to 24.9 percent of traffic. Also of note is the growth in voice and video communications, which is now six times greater than all email and instant messaging traffic (see Table 1).

[2] Video is also found in non-video specific applications such as gaming console traffic, HTTP traffic, VPN, and voice and video communications. Total video traffic across these additional categories will add an additional 10 to 15 percent to the 26 percent of traffic due to the video-specific categories, consistent with VNI Forecast projections.

Table 1. Broadband Traffic by Application Category, 3QCY10

	Traffic Share
Data*	28.05%
Online Video*	26.15%
Data Communications (Email and Instant Messaging)	0.28%
Voice and Video Communications*	1.71%
P2P File Sharing	24.85%
Other File Sharing	18.69%
Gaming Consoles*	0.16%
PC Gaming	0.65%

** The marked categories contain video.*

Source: VNI Usage, 2010

Table 2 shows more granular results by application. Two important trends revealed by the detailed application traffic data are:

- Video is already diverse. Of the 26 percent traffic share belonging to the Online Video category in the Usage results, only 7 percent is flash video.
- At 19 percent, web-based file sharing, as well as other means of file sharing, forms a significant portion of overall traffic.

Table 2. Broadband Traffic by Application Subcategory, 3QCY10

	Application	Share of Traffic
Data*	HTTP	26.39%
	HTTPS	0.64%
	VPN and Tunneling	0.57%
	Admin	0.21%
	Default Service	0.14%
	Maps	0.02%
	Other	0.00%
Data Communications	Email	0.23%
	Instant Messaging	0.12%
	Instant Messaging File Transfer	0.03%
File Sharing	P2P	24.85%
	Web-Based and Other File Sharing	18.69%
Gaming	PC Gaming	0.65%
Gaming Consoles*	Xbox	0.12%
	PlayStation	0.04%
	Nintendo Wii	0.00%
Online Video*	Streaming Video	10.52%
	Flash Video	6.99%
	Streaming Video via P2P	4.80%
	Audio and Video over HTTP	3.56%
	Video Downloads	0.28%

	Application	Share of Traffic
Voice and Video Communications*	Other VoIP	0.64%
	Skype	0.57%
	Media Gateway Control Protocol (MGCP)	0.40%
	Session Initiation Protocol (SIP)	0.05%
	Voice and Video over Instant Messaging	0.04%
	Phone VoIP	0.01%
	H.323	0.00%

** These categories contain video.*

Source: VNI Usage, 2010

Trends in Traffic Volume and Dynamics

The application mix shifts illustrated by the VNI Usage results have far-reaching implications. As the traffic share of video rises, so does the volatility of the traffic. The busy hour is busier on a network that carries more video than P2P. P2P has the lowest volatility of any application category, and since it has been the dominant application on the Internet for the past decade, the peak-to- average ratio has been close to that of P2P. As Table 3 shows, online video's volatility (defined as the spread of traffic volume during the course of the day[3]) is 51 percent higher than that of file sharing. The volatility of communications and collaborative applications is even higher than that of video, and as those applications gain traffic share, the peak-to-average ratio is likely to continue to increase.

Table 3. Peak Versus Average by Application Category, 3QCY10

	Volatility	Peak-Hour-to-Average Ratio
Gaming Consoles	63%	2.19
Voice and Video Communications	56%	1.87
Data Communications	54%	2.14
Online Video	53%	1.91
Data	49%	1.71
Other File Sharing	42%	1.77
P2P	33%	1.61

Source: VNI Usage, 2010

Viewing each application as a percentage of traffic provides a slightly different perspective. Online video exceeds P2P as a percentage of traffic most of the day, whereas P2P exceeds online video from midnight until 9 a.m. At its peak, P2P file sharing is 40 percent of traffic, and at its nadir, it is 16 percent of traffic, as the data in Table 4 shows. Video is 29 percent at its peak and 16 percent at its low point. While this may make the volatility of P2P file sharing seem comparatively high, the overall volume also needs to be taken into account. The traffic volume is lowest from midnight to 9 a.m., so the volume of P2P is in fact relatively constant throughout the day.

[3] Volatility is calculated here as the standard deviation of hourly volumes, divided by the hourly average. Peak to average is the ratio of the volume of the maximum hour to the volume of the average hour for that application.

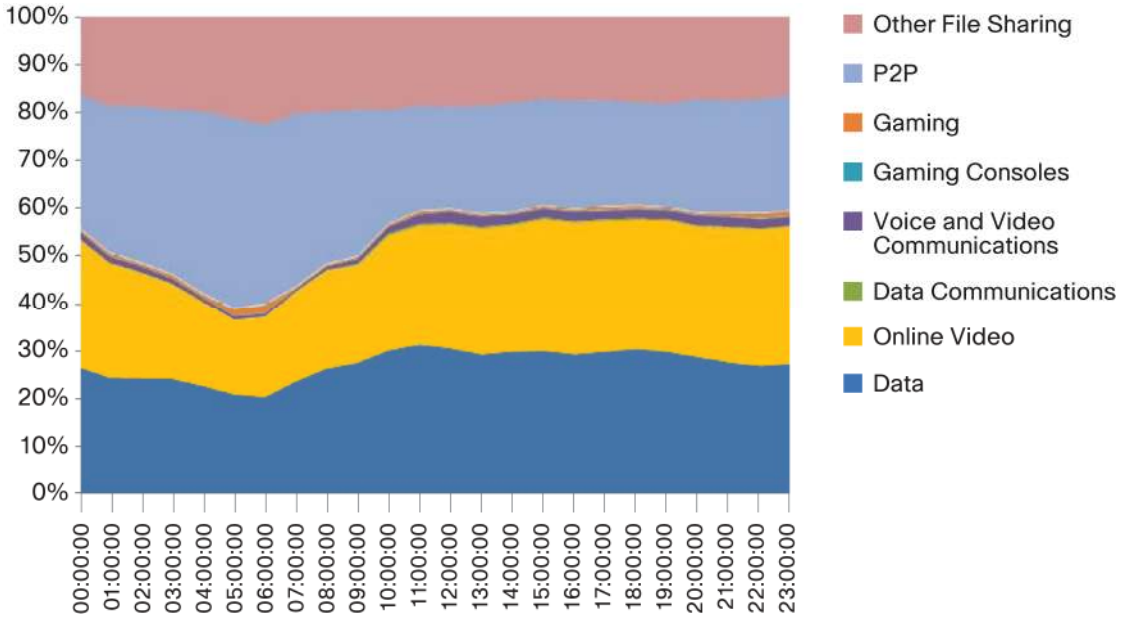
Table 4. Application Traffic Share by Hour, 3QCY10

Hour	Data and Browsing	Online Video	P2P File Sharing	Other File Sharing	Voice and Video Communi-cations	Data Communi-cations	Gaming Consoles	PC Gaming
00:00:00	26.6%	27.0%	27.6%	16.9%	1.6%	0.2%	0.2%	0.5%
01:00:00	24.4%	24.1%	30.6%	19.2%	1.3%	0.2%	0.2%	0.6%
02:00:00	24.3%	22.2%	32.6%	19.3%	1.2%	0.2%	0.2%	0.5%
03:00:00	24.2%	19.9%	34.3%	20.0%	1.1%	0.2%	0.1%	0.7%
04:00:00	22.7%	17.7%	38.1%	20.3%	0.9%	0.2%	0.1%	0.7%
05:00:00	20.9%	15.5%	39.9%	21.8%	0.8%	0.2%	0.1%	1.4%
06:00:00	20.3%	16.7%	37.5%	23.1%	0.7%	0.2%	0.1%	1.9%
07:00:00	23.6%	18.8%	36.2%	20.8%	0.5%	0.3%	0.1%	0.3%
08:00:00	26.3%	20.5%	31.8%	20.4%	0.7%	0.3%	0.1%	0.4%
09:00:00	27.5%	20.5%	30.6%	20.0%	1.0%	0.4%	0.1%	0.3%
10:00:00	30.1%	24.2%	23.7%	20.1%	1.4%	0.5%	0.1%	0.4%
11:00:00	31.3%	25.1%	21.9%	19.2%	2.0%	0.4%	0.1%	0.6%
12:00:00	30.5%	26.0%	21.3%	19.5%	2.4%	0.4%	0.1%	0.4%
13:00:00	29.3%	26.5%	22.6%	19.1%	2.2%	0.4%	0.1%	0.4%
14:00:00	29.8%	26.6%	22.8%	18.5%	2.0%	0.4%	0.2%	0.3%
15:00:00	30.0%	27.7%	22.2%	17.7%	1.9%	0.3%	0.1%	0.5%
16:00:00	29.3%	27.7%	22.6%	18.1%	1.9%	0.3%	0.2%	0.4%
17:00:00	29.8%	27.6%	22.2%	18.0%	1.8%	0.3%	0.2%	0.7%
18:00:00	30.4%	27.2%	21.5%	18.5%	1.9%	0.3%	0.2%	0.6%
19:00:00	29.8%	27.7%	21.6%	18.8%	1.9%	0.3%	0.2%	0.4%
20:00:00	28.6%	27.5%	23.8%	17.7%	2.1%	0.2%	0.2%	0.4%
21:00:00	27.6%	28.3%	23.3%	18.2%	2.1%	0.2%	0.2%	0.7%
22:00:00	26.8%	28.8%	23.8%	17.8%	2.0%	0.2%	0.2%	1.0%
23:00:00	27.3%	28.9%	24.1%	16.9%	1.9%	0.2%	0.2%	1.1%

Source: VNI Usage, 2010

Figure 1 illustrates the data in Table 4. P2P file sharing can be classified as a “passive” application because it can generate significant traffic even in the absence of the user. As the VNI Forecast has pointed out in recent years, video has an emerging passive component as well, in the form of webcams and security cams, as well as Internet personal video recorders (PVRs). Should passive and ambient video become a force on the network, the video peak-to-average ratio could be nearly as low as P2P file sharing, although this is not likely to take place in the near future.

Figure 1. Application Traffic Share by Time of Day, 3QCY10

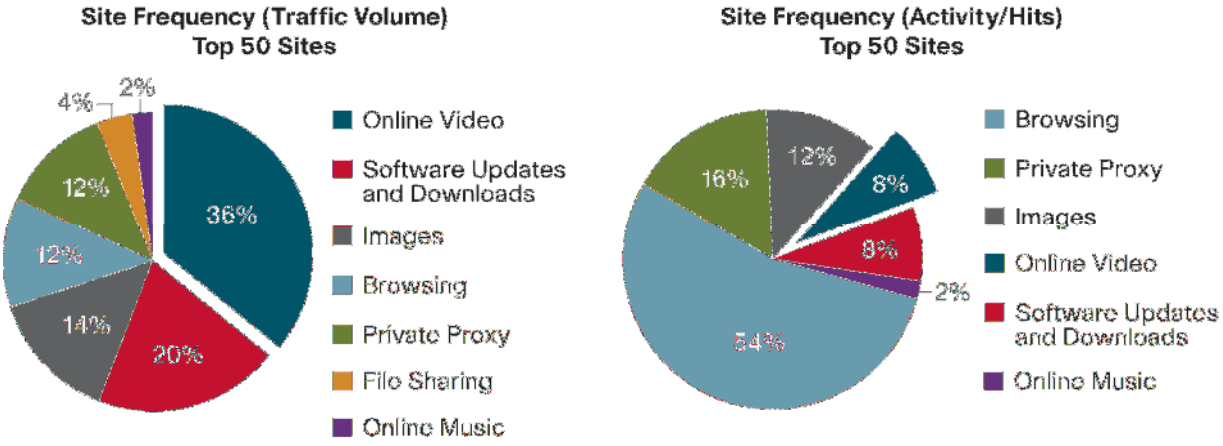


Source: VNI Usage, 2010

Top Site Movers and Shakers

As Figure 2 shows, the top 50 sites in terms of traffic volume (globally) are dominated by online video, followed by software downloads and updates.

Figure 2. Top 50 Global Sites by Traffic Volume and Activity/Hits[4]



Source: VNI Usage, 2010

Beyond the top 50 global sites, online video sites dominate the top 100 sites globally and in all regions by volume. Within the top 100 global sites, spring and fall months are more traffic intensive than summer months (seasonal trend). Video-based sites, such as MySpace video and Facebook video, and software download sites, such as Windows and Symantec, were among the top sites by traffic; while online ad sites, such as Google Analytics and Doubleclick, were among the top sites by total number of hits.

[4] Private Proxy traffic includes file sharing and private networks.

In North America, nearly 60 percent of the top 100 sites for the last year were video and gaming sites. Video streaming and downloads (including gaming), social networking, and software updates dominate the top 10 sites in North America. Approximately 29 percent of the traffic from the top 100 sites in this region comes from the top 10 sites.

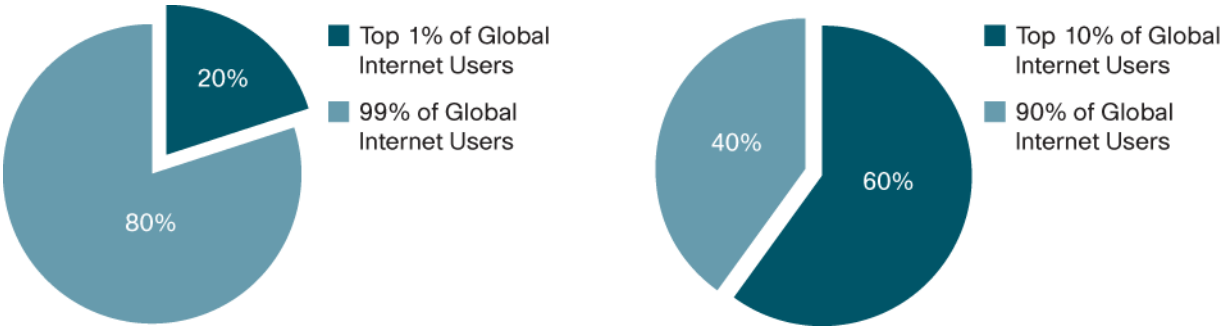
In Asia, social networking has moved up the charts in the top 100 sites over the last year. Video, social networking, P2P, music downloads, and software updates comprise the traffic mix of the top 100 sites. Approximately 42 percent of the traffic for the top 100 sites in this region comes from top 10 sites.

In Latin America, social networking has moved up the charts in the top 100 sites over the last year. Video, social networking, P2P, music downloads, and software updates comprise the traffic mix of the top 100 sites. Approximately 36 percent of the traffic for the top 100 sites on this region comes from top 10 sites.

Top User Analysis

Internet traffic patterns vary dramatically based on subscriber usage. During 3QCY10, as in 3QCY09, the top 1 percent of the participating connections consumed over 20 percent of Internet traffic, and the top 10 percent consumed 60 percent of Internet traffic (Figure 3).

Figure 3. Top User Analysis



Source: VNI Usage, 2010

Methodology Differences Between VNI Forecast and VNI Usage Data

The methodology of the Cisco VNI Usage study is one of direct measurement, while the Cisco VNI Forecast is an estimate derived from a model of individual network behavior. The Cisco VNI Forecast approach provides a more comprehensive categorization of content types and their projected growth rates, while the Cisco VNI Usage methodology offers more precise insight into traffic patterns and application trends. Table 5 compares the two data models.

Table 5. Comparing Cisco VNI Forecast and VNI Usage Methodologies

VNI Forecast	VNI Usage
Estimate of current and future IP traffic	Direct measurement of current broadband traffic
All IP traffic including private IP, Internet, and mobile data	Internet traffic only
Aggregate traffic by month	Traffic volume by hour
Average traffic only	Average and peak traffic

Source: VNI Usage, 2010

Comparing Cisco VNI Usage Results with Cisco VNI Forecast Projections

While the VNI Forecast and VNI Usage efforts are distinct, the VNI Usage results provide confirmation of many of the projections made by the VNI Forecast model, as Table 6 shows.

Table 6. Comparing Cisco VNI Forecast and VNI Usage Results

	VNI Forecast	VNI Usage
GB of Internet Traffic per Month per Connection in 2009 (Q3)	11.8	11.4*
GB of Internet Traffic per Month per Connection in 2010 (Q3)	15.6	14.9*
Growth in Internet Traffic per Month per Connection from 2009-2010	31.5%	30.7%*
Overall Internet Traffic Growth Rate for All Users from 2009-2010	42.0%	N/A**

** The comparatively slight differences between VNI Usage results and VNI Forecast projections can be attributed to the source of the contributed VNI Usage data (a random sampling of more than 20 global service providers), while the VNI Forecast effort is designed to be a comprehensive, worldwide model.*

*** The Cisco VNI Usage Study is not designed to provide a growth rate for all global users. There is no comparative metric.*

Source: VNI Usage, 2010

The Cisco VNI Usage results also provide qualitative confirmation of many of the trends projected by the Forecast model. While many of the application categories are not strictly comparable, Table 7 describes additional results that we consider consistent between the two models.

Table 7. Consistency Between Cisco VNI Forecast Projections and VNI Usage Findings

VNI Forecast Projections	VNI Usage Evidence
By the end of 2010, online video traffic will exceed P2P traffic.	The subset of video traffic comprised of flash, streaming video, and Internet TV makes up 26 percent of broadband traffic, compared to the 25 percent of traffic that P2P represents.
Live video via Internet will reach 4 percent of consumer Internet traffic by the end of 2010.	Streaming video via P2P—the majority of which is live TV content—is 5 percent of all traffic.
Video calling will exceed 1 percent of consumer Internet traffic by the end of 2010.	Voice and video communications traffic (VoIP, voice and video over instant messaging) has reached 2 percent of all traffic.
Passive networking (consists largely of background streaming and downloading) has the potential to rival active Internet use as a traffic driver.	Ten of the top 50 sites were associated with software updates and downloads

Source: VNI Usage, 2010

Trends in Bandwidth Symmetry

With all the video uploading being done by consumers today, it is often assumed that upstream bandwidth must be growing faster than downstream, and that symmetric bandwidth will be a requirement for the typical Internet user within a few years. However, this does not appear to be the case: upstream traffic has been flat as a percentage for several years. Table 8 shows the historical data for the North American participants in the Cisco VNI Usage program.

Table 8. Upstream Traffic as a Percentage of Total Broadband Traffic

Upstream Residential Broadband Traffic in North America, 2007-2010				
	2007	2008	2009	2010
Upstream as a percentage of total traffic	31%	24%	25%	23%

Source: VNI Usage, 2010

Why has traffic not become more symmetric? The explanation lies in the decreasing importance of P2P as a component of overall traffic and the increasing importance of video applications. Peer-to-peer, by definition, is highly symmetric traffic, with between 40 to 60 percent of P2P traffic consisting of upstream traffic. For every high-definition movie downloaded, approximately the same amount of traffic is uploaded to a peer. Now, however, video is beginning to take over, and most of the video streams that cross the network today have a highly asymmetric profile, comprised mostly of downstream traffic, except in areas where P2P TV is prevalent (for example, in China). The consumer-as-content-producer is an extremely important social, economic, and cultural phenomenon, but people still consume far more video than they produce.

Table 9. P2P Traffic is More Symmetric than Other Forms of Traffic

Upstream Residential Broadband Traffic in North America by Application, 2007-2010	
	2010
Upstream as a percentage of P2P traffic	44%
Upstream as a percentage of all other traffic	12%
Upstream as a percentage of total traffic	23%

Source: VNI Usage, 2010

Rather than wondering why traffic has not become more symmetric, we might wonder why it is not become even less symmetric, given the pronounced decline of P2P as a percentage of traffic. Here the importance of video sharing, uploads, and video communications can be seen. The application mix of upstream traffic has shifted so that while over 70 percent of upstream traffic was due to P2P in early 2007, today less than 60 percent of upstream is P2P. The slack has been taken up by the growth of video in the upstream.

It appears likely that residential Internet traffic will remain asymmetric for the next few years. However, there are a number of scenarios that could result in a move towards increased symmetry:

- Content providers and/or distributors could adopt P2P as a distribution mechanism. There has been a strong case for P2P as a low-cost content delivery system for many years, yet most content providers and distributors have opted for direct distribution. An exception is applications such as PPStream and PPLive in China, which offer live video streaming via P2P, and have had great success. If content providers in other regions follow suit, traffic could rapidly become highly symmetric.
- High-end video communications could accelerate, requiring symmetric bandwidth. PC-to-PC video calling is gaining momentum, and the nascent mobile video calling market appears to have promise. If high-end video calling becomes popular, this will drive traffic toward symmetry again.

Generally, if service providers provide ample upstream bandwidth, applications that use upstream capacity will begin to appear.

Data Sources

Cisco receives anonymous, aggregate network usage data that is submitted from global service providers who have chosen to participate in the Cisco VNI Usage program. Participating service providers collect their network usage data using Cisco Service Control Engines (SCEs) that are strategically installed at network peering points and broadband hubs. Standard network usage reports are submitted to Cisco on a monthly basis (Cisco does not own or operate the equipment in any participants' network). The Cisco SCEs operate in anonymous subscriber mode, and submitted data does not include any IP or MAC addresses, or any other personally identifiable information. The Cisco SCEs used for this program do not include policy control modules, and therefore the equipment is not able to apply different policies to different types of traffic. The equipment is configured exclusively for passive reception.

Under the terms of the Cisco VNI Usage partner program, Cisco may not share the identities of any service provider participants or publish network data from any single participant. The data will always be represented in anonymous, aggregate form.

About Subscriber and Content Privacy

The network usage data submitted as part of the Cisco VNI Usage program is both anonymous and aggregate. Anonymous data is distinct from “anonymized” data, which is raw data in which individual IP addresses have been replaced with random identifiers. Anonymous data, on the other hand, contains no raw usage records, only aggregate statistics describing those records.

Examples of the types of information included in and excluded from the data collection effort are listed in Table 10.

Table 10. Types of Information Included and Excluded in VNI Usage Results

Included	Excluded
The total traffic volume associated with video usage	The identity of subscribers who watched video
The top URLs by volume and number of hits	The identity of subscribers who visited the top URLs
The number of subscribers who watched video and the number of subscribers who used file sharing	The number of subscribers who generated both video and file sharing traffic
The number of subscribers active at any given time	The IP addresses, MAC addresses, or subscriber IDs of active subscribers

Source: VNI Usage, 2010

For More Information

If you have questions or need more information, write to traffic-inquiries@cisco.com.

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