Research Report

sandvine
Intelligent Broadband Networks

2009 Global Broadband Phenomena

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The research also shows that over an average month the top one percent of subscribers account for 25 percent of total Internet traffic, showing a vast difference between the data needs of most network users and the consumption kings.

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Other notable findings include:

- Broad-based adoption of on-demand applications drives peak network utilization globally
- The network influences subscriber behavior
- On a per-subscriber basis, North Americans consume the most YouTube videos
- Storage and Back-Up services are becoming mainstream, lead by one-click download services
- Gaming consoles are increasingly used as sources of "traditional" entertainment such as movies and TV shows
- BitTorrent has emerged as by far the leading peer-to-peer filesharing network, but P2P filesharing has dropped by 25 percent as a share of total traffic to account for just over 20.4 percent of all bytes

Study Details

The 2009 Global Broadband Phenomena study consisted of analyzing data from more than 20 cable modem and digital subscriber line (DSL) broadband service providers' networks totalling 24 million subscribers. These networks were distributed across five regions: North America, Europe, Caribbean and Latin America, Asia-Pacific and Africa. Data was gathered between September 1st and 22nd, 2009, and captured the bits per second per protocol and the number of active hosts per protocol on the network at each hour. The same data was gathered for the top 500 users on each network, which was then averaged to create a profile of a "Top Subscriber". Data also included the total upstream and downstream bytes, from the subscriber's perspective, attributable to each subscriber for the 30 days, 7 days and 1 day preceding the time of collection.

The data gathered in Sandvine's global Internet traffic report is completely subscriber-anonymous. No identifiable information of any kind, including IP addresses, was collected during this study. Sandvine's network equipment analyzes data from an application utilization level and is not content aware.

The data sets were used to create a 24-hour profile of each network, normalized by the number of active subscribers at each hour in the day. These profiles were then aggregated in a hierarchical manner:

- First, all networks sharing a common access technology (DSL or cable) in a particular region were combined by means of a weighted average, weighted by subscriber count per network, to develop profiles of an average cable or average DSL subscriber in each region
- Second, these two profiles were combined in a weighted average, this time weighted by market share for each access technology, to create a picture of an average broadband subscriber in each region
- Third, each profile of a regional cable or DSL subscriber was used in a weighted average, weighted by cable or DSL subscribers per region, to determine a global average for a subscriber on each access technology
- Fourth, the global DSL subscriber and global cable subscriber averages were combined, again weighted by total market share, with the result being the global average subscriber

Technology and regional market share data was provided by a leading industry analysis company, with Q3 2009 data used in this report. This method ensured fair and correct influence from each customer and region in all averages.

The upstream and downstream bytes per subscriber data sets were used to create independent percentile rankings of all subscribers on a network based on a combination of data direction (upstream, downstream, aggregate) and data period (day, week, month), for a total of nine ranked lists ordered by total byte usage. These lists enabled consumption analysis based on percentile ranking and cast light on the widely varying data needs of individual subscribers.

Key Findings

Report findings include a dramatic shift in consumer behavior towards real-time "experience now" applications and away from bulk download "experience later" behavior. Compared to last year's results, real-time entertainment traffic (streaming audio and video, peercasting, place-shifting, Flash video) has exploded to now account for 26.6 percent of total traffic in 2009, up from 12.6 percent in 2008. This jump represents a doubling in the share of total bytes attributable to real-time entertainment applications and highlights the shifting nature of Internet traffic.

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Other notable findings include:

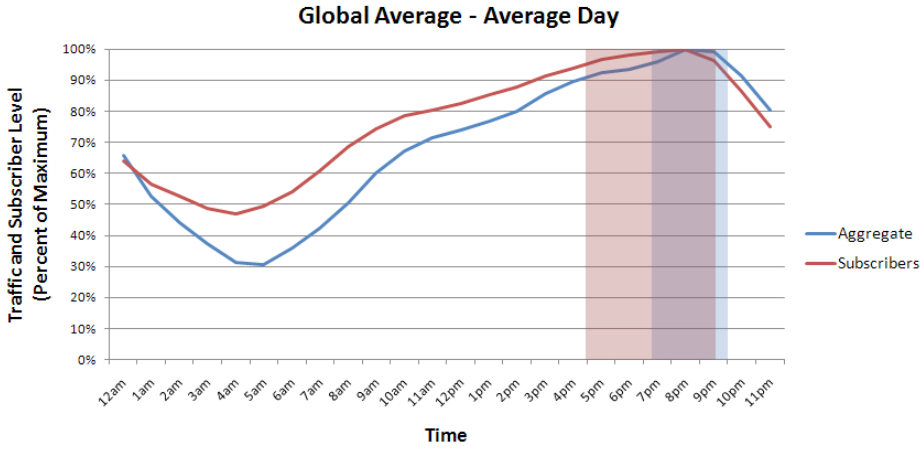
- **Not the usual suspects:** broad-based adoption of on-demand applications drives peak network utilization globally. Peak-time usage is only slightly influenced by the top network users as measured over the previous month, suggesting that usage management and congestion management are distinct objectives.
- **The network influences subscriber behavior.** Mature broadband markets have embraced on-demand entertainment applications, while emerging markets still rely on peer-to-peer as the primary source of content.
- **Where do all those YouTube minutes flow?** On a per-subscriber basis, North Americans consume the most YouTube videos followed closely by subscribers in Africa; but by geography Europe is the destination for more YouTube minutes than any other region.
- **Storage and Back-Up services are becoming mainstream.** In 2009, networks are transporting almost 56% more data per subscriber to and from storage and back-up services than in 2008, led by one-click download services like Rapidshare and MegaUpload and continuing a trend that first came to prominence last year.
- **Are they "game consoles" or "entertainment consoles"?** Traffic to and from gaming consoles increased by more than 50% per subscriber, demonstrating not only the popularity of online gaming, but also the growing use of game consoles as sources of "traditional" entertainment such as movies and TV shows.
- **Are the P2P wars over?** BitTorrent has emerged as by far the leading peer-to-peer filesharing network both in terms of number of users and total bytes worldwide, although there are still regional variations.
- **At a global level, P2P Filesharing declined by 25 percent as a share of total traffic, to account for just over 20 percent of total bytes.** However, the decline is not consistent in every region - North America experienced a 20 percent relative decline, while the Caribbean and Latin America actually experienced an increase of more than 30 percent.

A Day in the Life…of a Network

By examining how network usage varies over the course of an average day, broadband service providers are able to make informed engineering and maintenance decisions to maximize service quality and minimize network disruptions. The graph below represents a global average of aggregate traffic and subscriber variation over an average day and shows the interplay between subscriber numbers and traffic levels.

The shaded areas represent the period during which activity is above the 95th percentile. Any overlap between the shaded regions can be considered the network's "peak hours", as both the subscriber and traffic loads are near their maximum values.

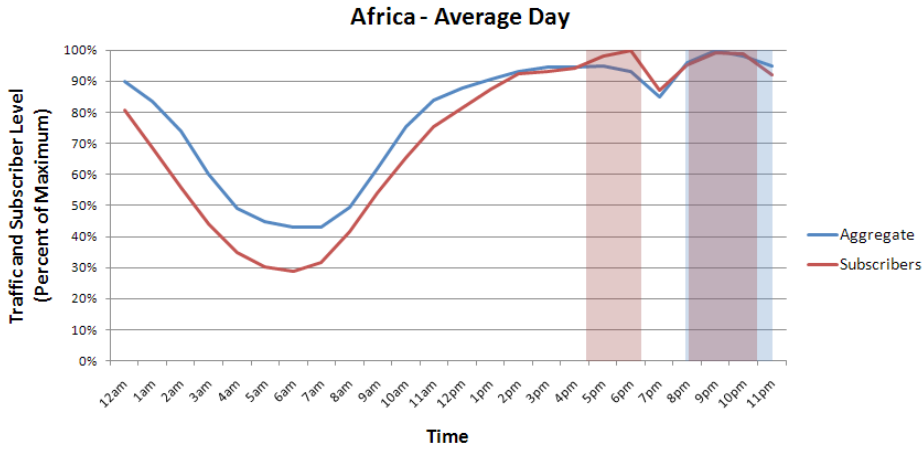
We see that the subscriber curve is actually above the 95th percentile for nearly five hours, from 4:30pm to just after 9pm. However, the bandwidth peak is much tighter, ranging from about 7pm to 10pm. We can also see that the bandwidth peak actually occurs after the subscriber peak.



Regionally, the daily subscriber and aggregate bandwidth utilization curves follow a similar cycle to the global average, but there are certainly variations in the peak periods.

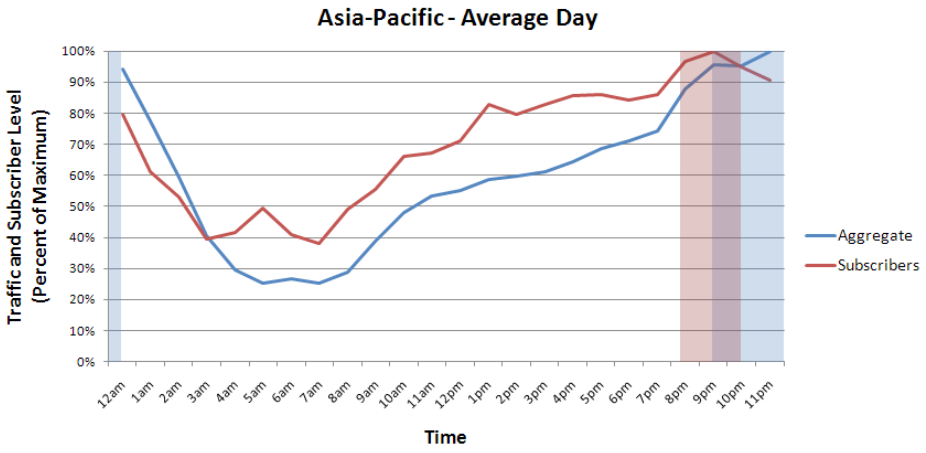
The average daily Internet usage pattern for Africa stands out in the crowd due to the drop in both traffic and subscribers that occurs at 6pm before recovering to normal levels later in the evening; however, there is an interesting explanation for this phenomenon – the shift in lifestyle and routine during the month of Ramadan.

Data for this report was gathered between September 1st and September 22nd, 2009, which overlapped with the last three weeks of the Islamic month of fasting. During Ramadan, at sunset, Muslims break the day's fast with a meal (Iftar) and presumably are not using the Internet, which likely accounts for the dip. From 8pm to about 10:30pm, the traffic and subscriber levels are near their peaks and are closely aligned.



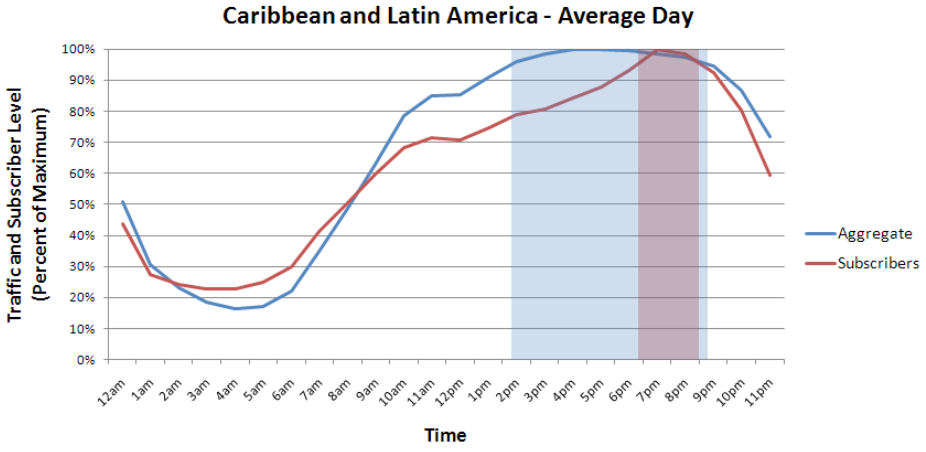
In Asia-Pacific, shown below, we see an interesting subscriber curve that is unique to this region; the curve has three separate peaks occurring during the early morning, early afternoon, and mid-evening hours. Perhaps in Asia-Pacific, there is greater separation between work and recreational Internet use, so subscribers engage in personal use before the work day begins and over lunch.

During the evening hours, the period of peak subscriber usage is 2 hours in length, ranging from 8pm to 10pm. We also see that the peak bandwidth utilization lags behind the subscriber curve, ranges from 9pm to midnight, and peaks at 11pm. Consequently, subscribers who are active late at night have higher individual bandwidth utilization than those who are active in the evening.

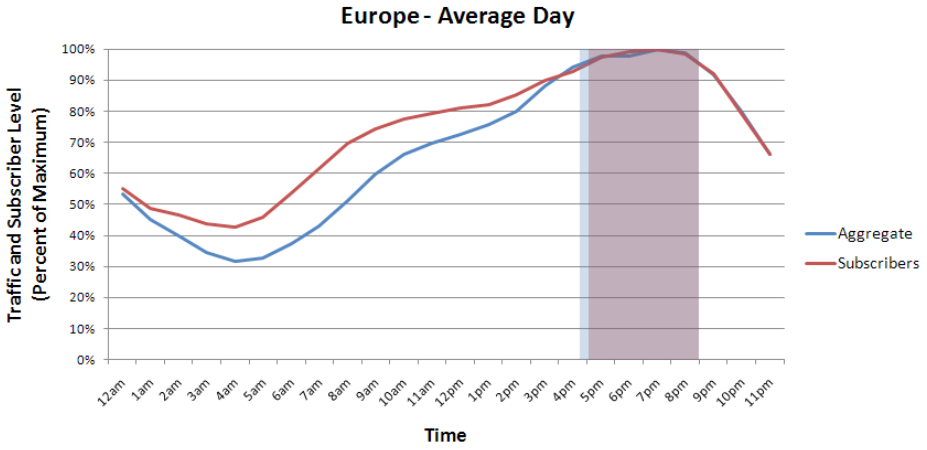


In the Caribbean and Latin America, we see a large time period during which the network is near peak bandwidth utilization. From 2pm to 9pm, aggregate traffic is above the 95 percent line. Curiously, the subscriber peak does not match the bandwidth utilization, and is near peak from about 6:30pm to 8:30pm.

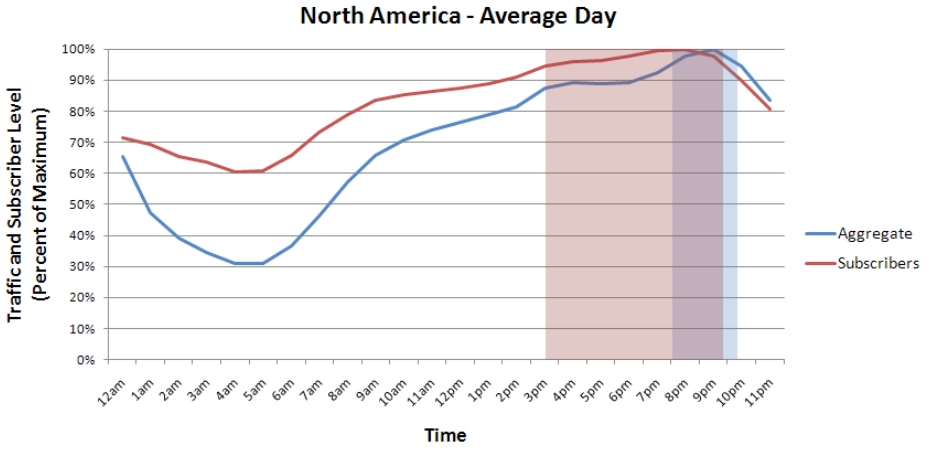
It is worth noting that in the Caribbean and Latin America there is a mid-day plateau in both subscribers and traffic. Until this point in time, the two curves are steadily rising before everyone turns their attention elsewhere (perhaps to lunch).



In Europe, the peak periods for traffic and subscriber levels both run from 4:30pm to 8:30pm, with the actual peak occurring at 7pm. Also, between about 3:30pm and midnight the curves are directly proportional, meaning that they rise and fall by precisely the same amount at each measurement point. To the end consumer, the result is that the average utilized bandwidth per subscriber remains constant during this period.

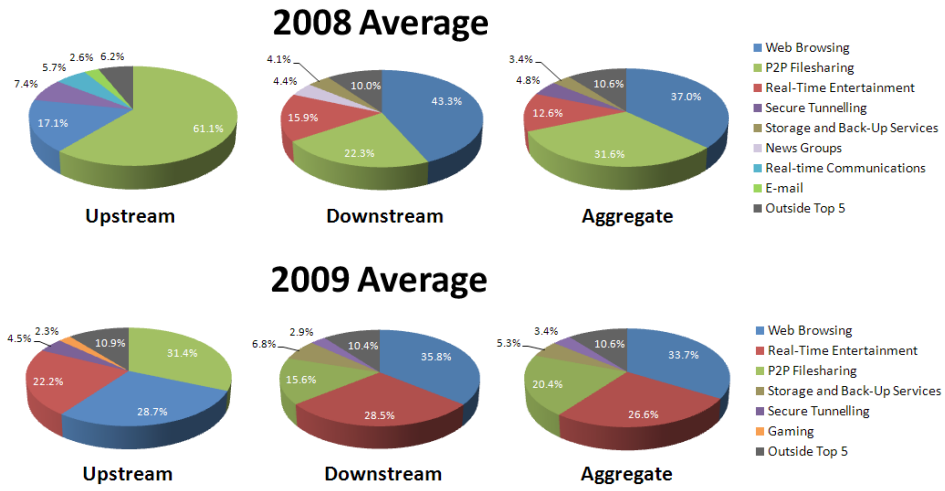


Of all the regions in this study, North America has the smallest variation between the high and low subscriber numbers over the course of an average day. In fact, the lowest point in subscriber numbers still represents about 60 percent of the peak, showing that many computers remain connected and active overnight. Contrast this observation with the Caribbean and Latin America, where the low subscriber count is only slightly more than 20 percent of the peak. Also, we see that while the network is near peak subscriber load for a period of 6 hours, peak traffic is much more condensed (around 2.5 hours). This fact indicates that subscribers may be logging on in the early evening, but don't start engaging in high-bandwidth activities until later in the evening, from about 7:30pm to 10pm.

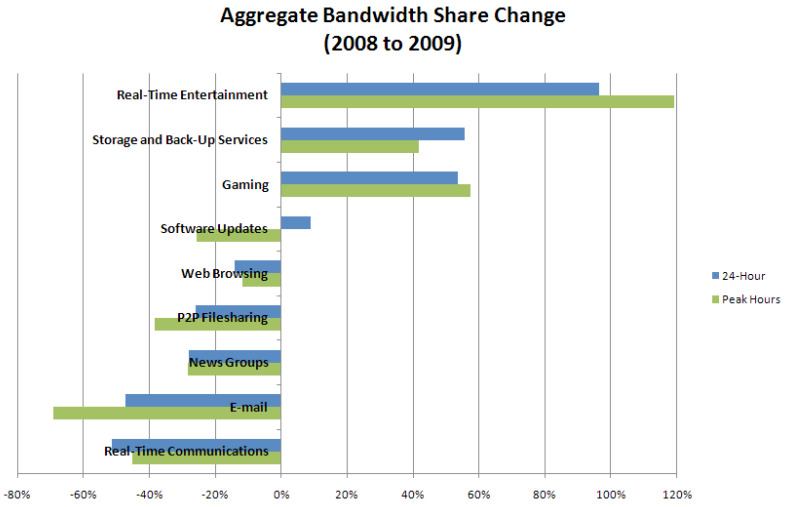


The Ongoing Evolution of Internet Traffic

We are in the midst of a massive shift in subscriber behavior from a reliance on "download now, use later" content acquisition to an on-demand mentality where bytes are consumed as they arrive. Almost two-thirds of all Internet traffic in 2009 is enjoyed on arrival, including Web Browsing, Real-Time Entertainment such as video and audio streaming and peercasting applications, Gaming, and Real-Time Communications. We've also seen the widespread acceptance of Storage and Back-Up Services as sources of content, continuing a trend highlighted in the 2008 report.

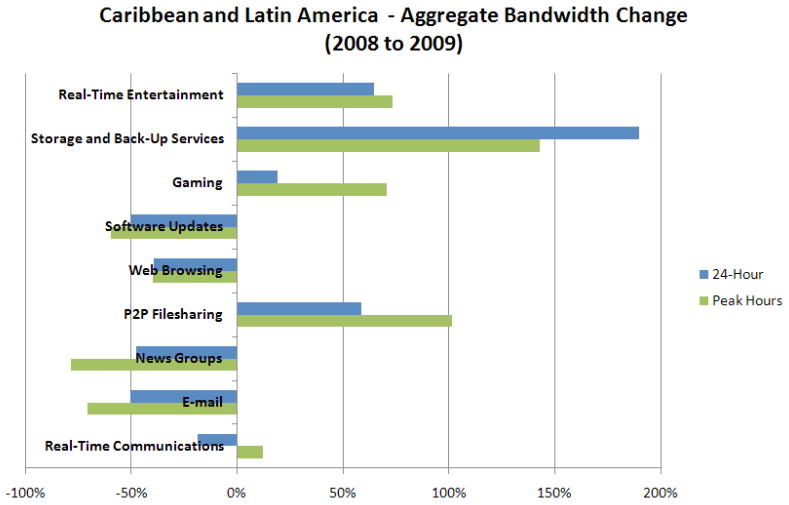


The success of these applications comes at the expense of traditional bulk data acquisition, most notably P2P Filesharing and News Groups. During peak hours, the explosion in popularity of Real-Time Entertainment and Gaming applications has resulted in an even larger yearly increase than that witnessed in the 24 hour average.

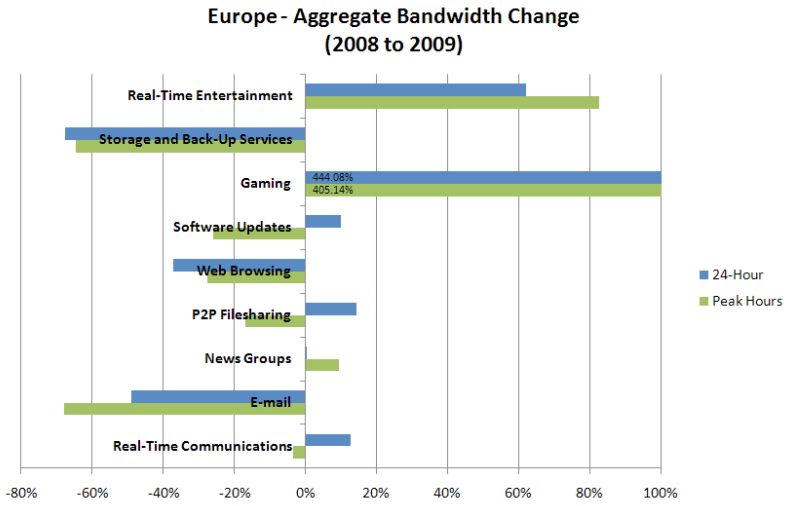


Where there is sufficient 2008 data to make a valid comparison with this year's results, we can examine the regional changes in bandwidth composition.

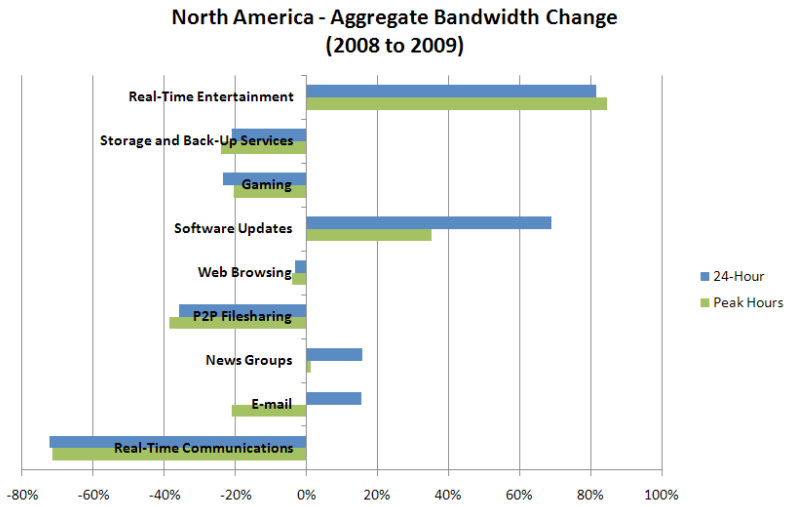
In the Caribbean and Latin America, Storage and Back-Up Services was the biggest gainer, almost tripling its share of daily traffic year-over-year. During peak hours the gain was less substantial but still represented more than a doubling of last year's share. On a 24-hour average, Real-Time Entertainment increased its share of total traffic by 65 percent, demonstrating that subscribers in this region have a definite appetite for on-demand entertainment content. Interestingly, P2P Filesharing also experienced substantial growth in the Caribbean and Latin America, increasing by almost 60 percent as a share of daily traffic, and actually doubling as a share of peak-hours bandwidth. So, while subscribers are embracing real-time services, they aren't yet ready to move away from the P2P networks when it comes to content acquisition.



From 2008 to 2009, Europe saw some significant shifts in traffic composition. In terms of absolute levels of traffic, the most significant change was the huge increase exhibited by Real-Time Entertainment, which grew by more than 60 percent as a share of daily traffic and more than 80 percent as a share of peak-hours traffic. In relative terms, the biggest gainer by a massive margin was the Gaming category, which actually experienced greater than 400 percent increases for both the daily average and the peak hours average. Note that because of the sheer magnitude of the increase, rather than show the surge graphically (at the expense of compressing all the other categories) we've elected to simply label the values for the Gaming category in the graph below. Interestingly, P2P Filesharing in Europe now consumes a larger slice of the daily traffic pie than in 2008, but the category's share of the peak-hours pie has decreased.



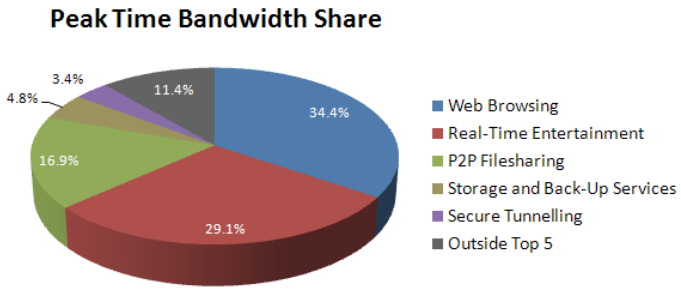
As was the case in Europe, the year-over-year change in North American traffic was led by Real-Time Entertainment which experienced an 80 percent relative increase over its 2008 bandwidth share, outpacing all other categories. Interestingly, Gaming experienced relative declines, but this observation isn't unreasonable when one considers that North America is a mature gaming market, and Gaming doesn't represent a large portion of the traffic pie (roughly 2 percent in North America).



It is instructive to note that Real-Time Entertainment increased both its daily and peak-hours shares of bandwidth across all three regions. Similarly, Web Browsing is the only category that experienced a drop in both daily and peak-hours bandwidth shares across all three regions. The relative decline in Web Browsing is likely the combined result of a number of factors. First, Web Browsing is an interactive activity in the sense that the user is very much engaged in the experience (clicking, reading, navigating, etc); consequently, it is limited more by the user than by the network. Conversely, Real-Time Entertainment is limited by both the user (number of minutes you can actually watch) and the network (for instance, the ability to support high resolutions). Second, the bandwidth demands of Web Browsing are not all that intense and are unlikely to change significantly (text and images won't suddenly become many times more byte-intensive), whereas other categories can experience massive growth quite easily.

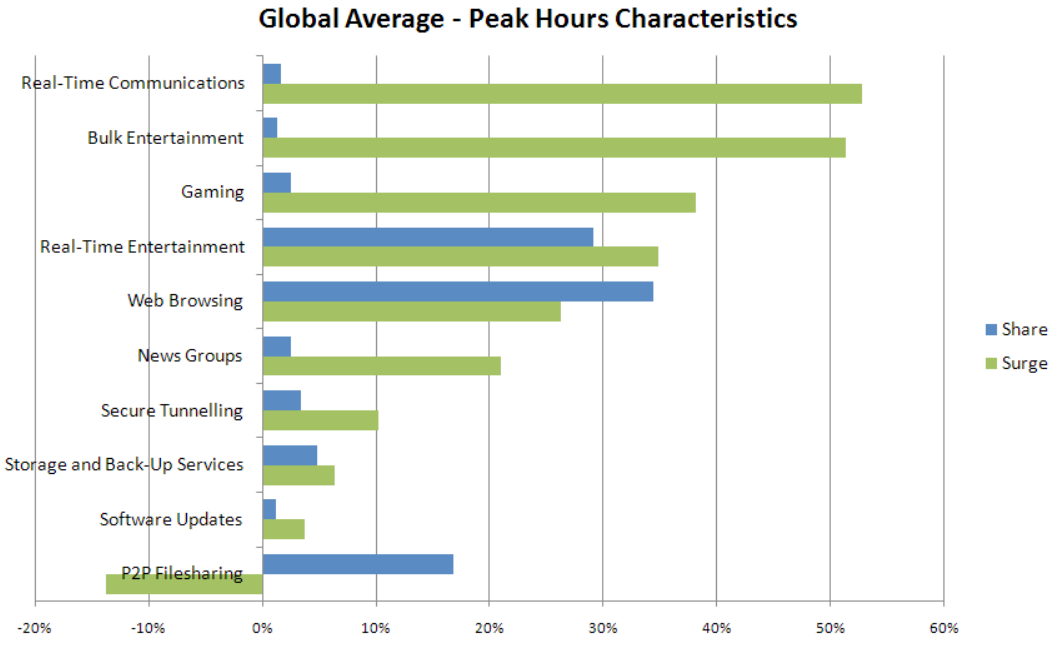
Peak Time is Interactive

The composition of broadband networks during peak hours differs somewhat from the average throughout the day. Interactive applications such as Real-Time Communications and Gaming, and all entertainment categories see their slices of the bandwidth pie increase, even as the pie itself grows in the evening hours.



The peak-time bump in traffic is almost completely attributable to the surging evening popularity of Real-Time Entertainment and Web Browsing – not only do both of these categories experience huge per-subscriber increases in bandwidth demand (rising by almost 35% and 26%, respectively), but these categories also make up a significant portion of the overall utilized bandwidth. Consequently, the increase places a much greater demand on the network in terms of total bytes than an increase in a category such as Gaming.

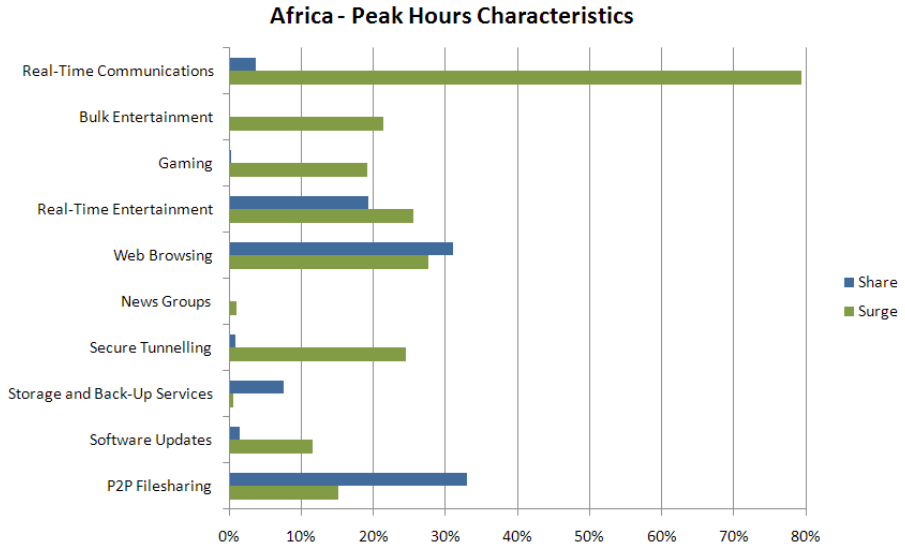
"Share" refers to the relative amount of utilized bandwidth during peak hours that is attributable to a particular category; "Surge" shows by how much the absolute traffic per category has varied from the daily average to the average taken from 7pm to 10pm. For instance, if a category was 10 percent of daily bandwidth, and 15 percent of peak hours bandwidth, then that category has experienced a 50 percent surge. Likewise a category that accounts for 1 percent of daily bandwidth and 3 percent of peak hours bandwidth has experienced a 200 percent surge. A category that has a large share and a large surge is very influential on the over-all traffic composition during peak hours.



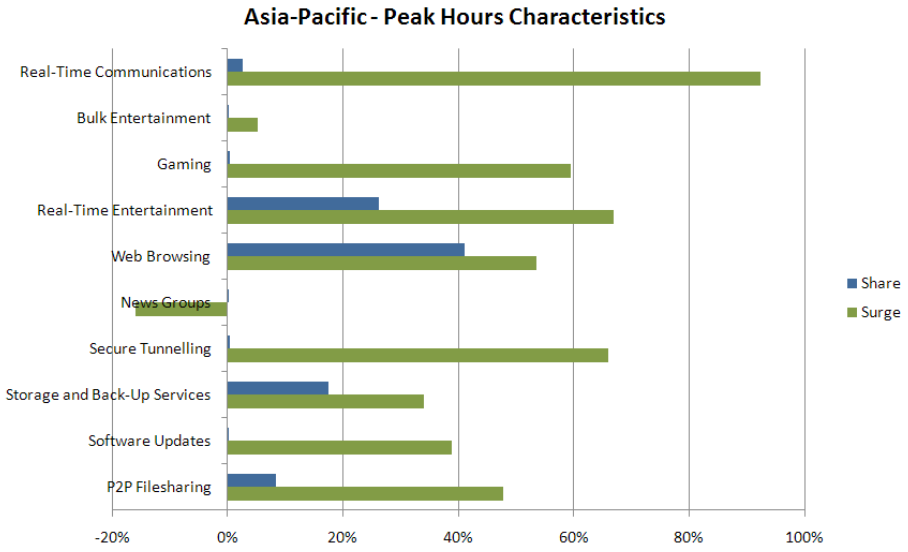
Regionally, this pattern holds true but is still subject to local variations. The graphs below show the characteristics of the peak period from 7pm to 10pm throughout the world.

Where there were sufficient data sets available to make statistically significant conclusions, we have broken out the Cable and DSL access technologies, allowing another level of comparison.

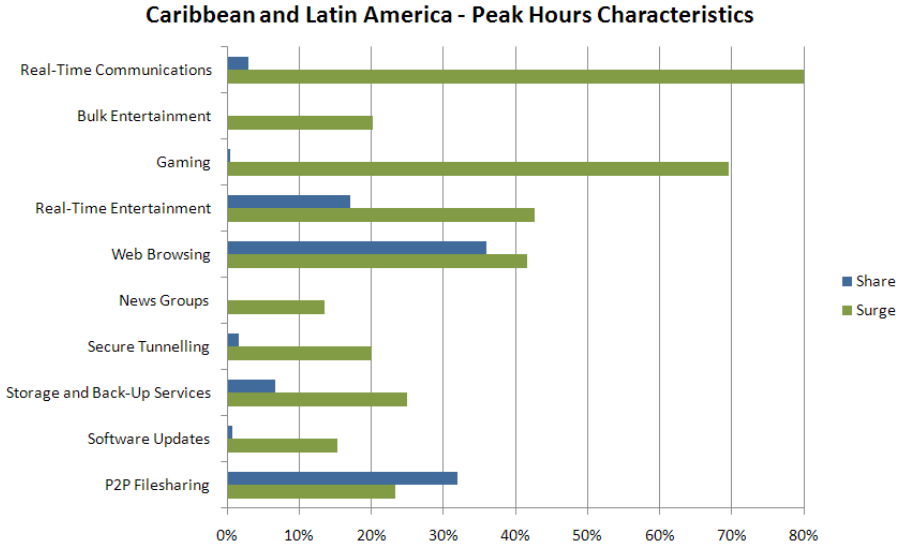
Peak time traffic in Africa is roughly 20 percent higher than the 24-hour average, and owes the increase to the trio of Web Browsing, P2P Filesharing, and Real-Time Entertainment. Real-Time Communications showed the largest surge, growing by almost 80 percent over the daily levels. Web Browsing, which had the second largest surge, grew by a relatively modest 27 percent.



In Asia-Pacific, absolute traffic levels are roughly 50 percent higher during peak hours than during the rest of the day, with the change primarily attributable to much higher levels of Web Browsing and Real-Time Entertainment. Real-Time Communications experienced the largest growth of any category, but is still less than 3 percent of total traffic. In contrast, News Groups is the only category that experienced a relative decrease.



In the Caribbean and Latin America, over-all traffic during peak hours is 34 percent higher than the daily average, and is largely the result of increases in Web Browsing, P2P Filesharing, and Real-Time Entertainment. Real-Time Communications and Gaming experienced the most significant increases, while no single category declined (but News Groups had the smallest increase).

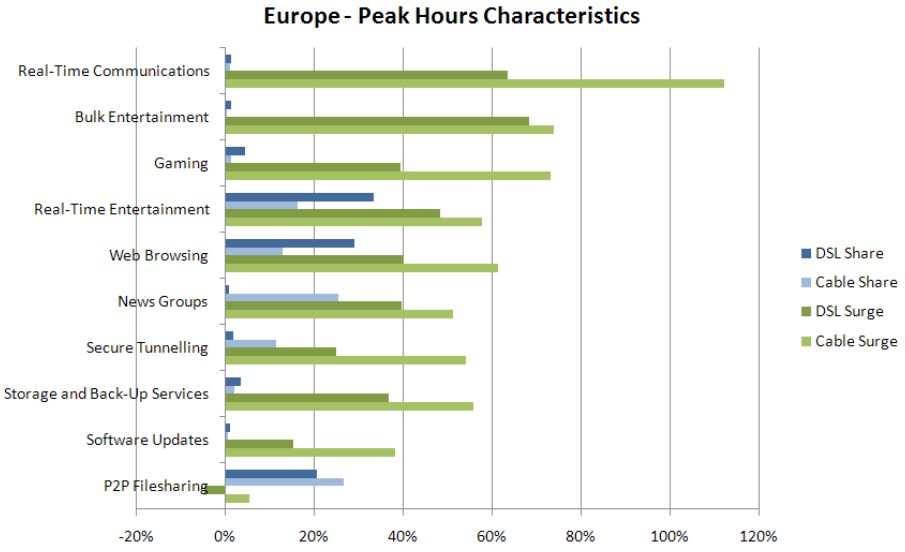


In Europe, utilized bandwidth during peak periods exceeded the daily average by 30 percent. There was little variation in over-all traffic levels between cable and DSL networks; however, the category shares and surges were not consistent across the access technologies.

The increased traffic levels on cable networks were primarily attributable to the surges experienced by News Groups, Real-Time Entertainment, and Web Browsing. P2P Filesharing remained a significant component of peak time bandwidth usage, but the category only surged by 5 percent.

In contrast, the surge on DSL networks is almost entirely based upon increases in the levels of Real-Time Entertainment and Web Browsing. P2P Filesharing on DSL networks actually exhibited a decrease of 5 percent.

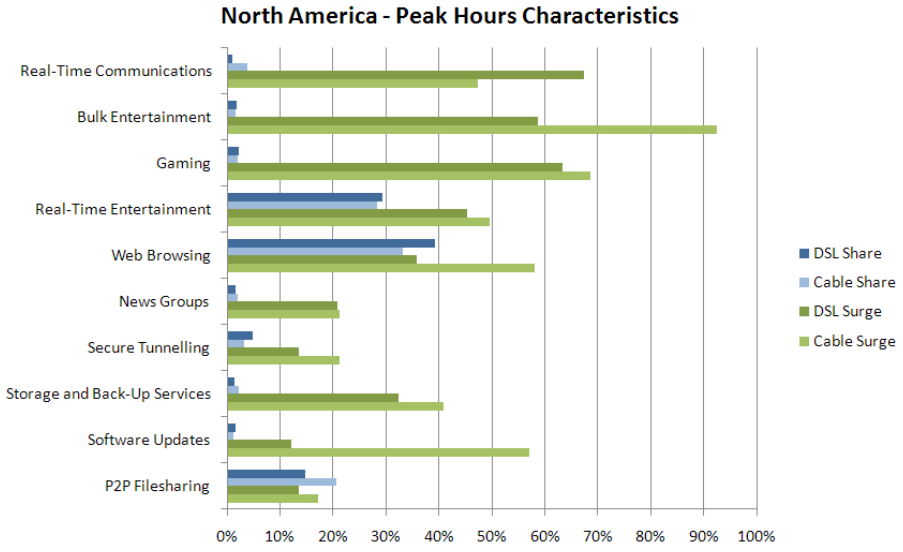
The over-all composition of peak hours traffic also varies by access technology. P2P Filesharing and News Groups dominate the cable networks, while Real-Time Entertainment and Web Browsing are the largest categories on DSL networks.



Across cable and DSL networks in North America, peak hours traffic is 36 percent higher than the daily average, with no significant differences in over-all surges between the two technologies. Unlike Europe, however, the factors leading to the increases are consistent regardless of access technology.

In both cable and DSL networks, peak hour traffic levels are mostly the result of increased amounts of Web Browsing, Real-Time Entertainment, and P2P Filesharing.

Again, unlike Europe, the over-all bandwidth composition is largely consistent regardless of the network technologies being used. The top three categories, in order, are Web Browsing, Real-Time Entertainment, and P2P Filesharing, and the only significant variation is the discrepancy in the total share attributable to P2P Filesharing (roughly 15 percent on DSL networks and 20 percent on cable networks).

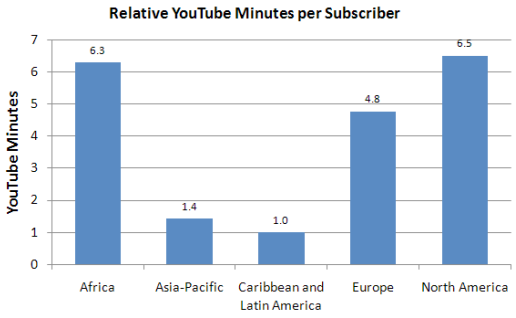


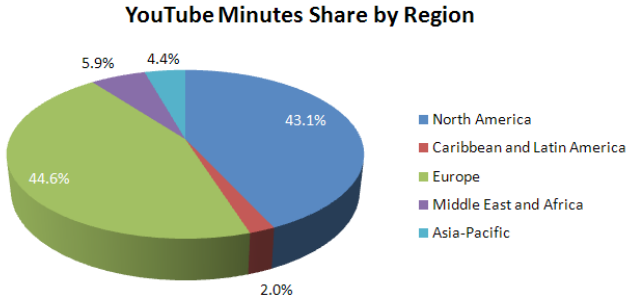
In every region examined in this report, Web Browsing and Real-Time Entertainment are primary drivers of peak hours bandwidth consumption. Globally, these two categories represent 63.5 percent of Internet traffic between 7pm and 10pm. When combined with other interactive categories (Gaming, Real-Time Communications), we find that two-thirds of all bytes are consumed (seen, heard, experienced) on arrival. This reality represents a tremendous departure from years past, when “download now and consume later” applications dominated the Internet landscape.

The implication for the network providers of the world is that not only are more people online during the evening hours, but the applications these people are using are arguably the ones most sensitive to network characteristics. Simply by shifting their behavior by showing a preference for interactive and sensitive applications, broadband subscribers are driving up the expected quality of service of the Internet.

Who is Entertained the Most?

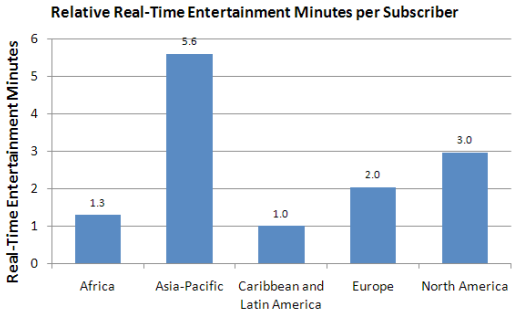
For every one YouTube video that a subscriber in the Caribbean and Latin America watches, a subscriber in North America has watched 6.5, a subscriber in Africa has watched 6.3, a subscriber in Europe has watched 4.8, and a subscriber in Asia-Pacific has watched 1.4. When weighted by the total number of subscribers in each region, however, Europe emerges as the destination of the most YouTube traffic (just edging out North America).

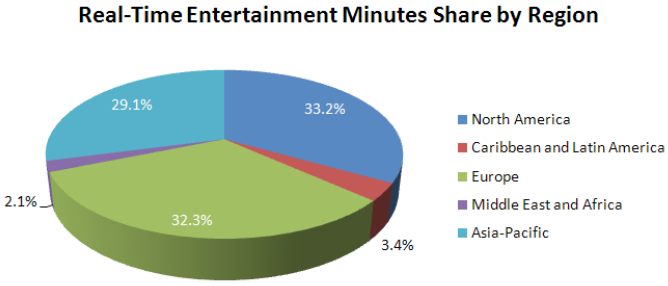




When one considers Real-Time Entertainment as a whole, Asia-Pacific subscribers truly are in a class of their own. On a per-subscriber basis, an Internet user in Asia-Pacific consumes nearly double the minutes of a subscriber in North America, triple the minutes of a European Internet user, and roughly five times more than a subscriber in the Caribbean and Latin America or Africa.

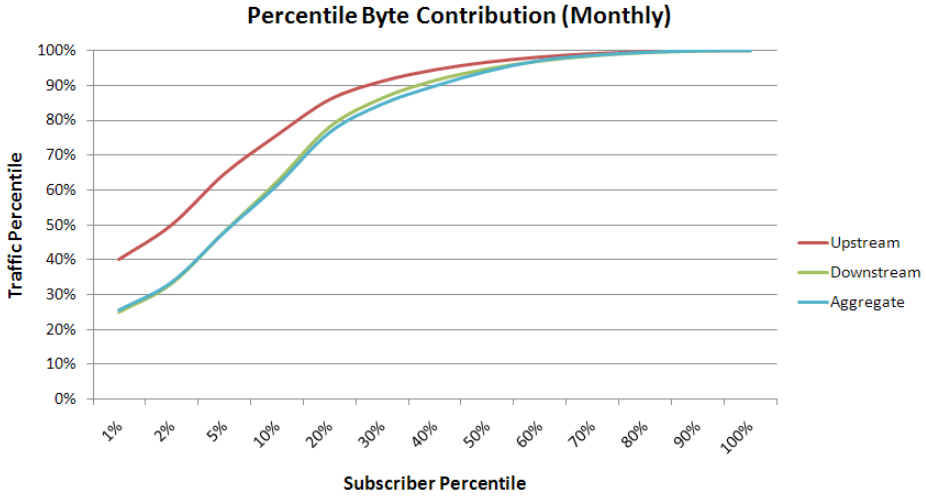
Again, taking the total number of subscribers into account, a slightly different picture emerges – one in which Asia-Pacific, North America, and Europe are all vying for regional leadership in terms of total minutes consumed.



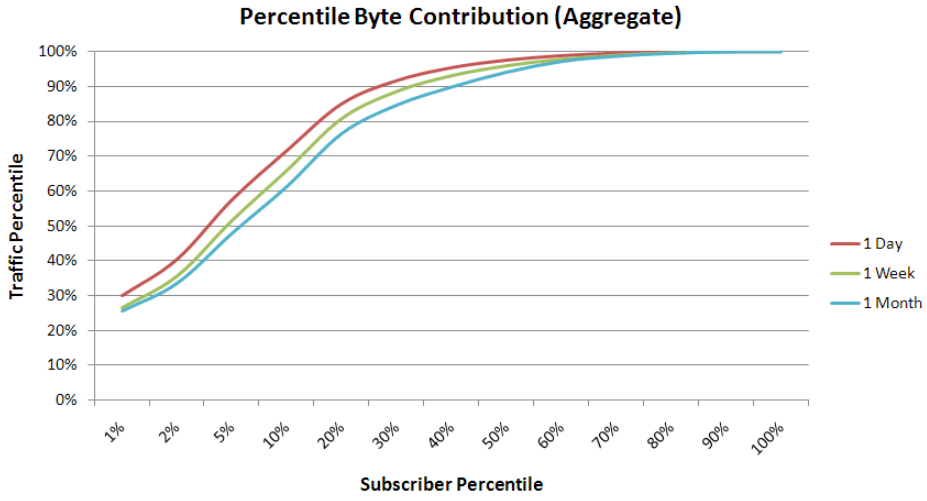


How does Subscriber Usage Vary?

When subscribers are ranked in order of total consumption and then the contribution of each percentile is computed and compared, it becomes apparent that the heaviest network users account for a hugely disproportionate amount of total Internet traffic. Over a month, the top 1 percent of subscribers are responsible for 25 percent of total bytes on the network. In the upstream, the top 1 percent account for 40 percent of total bytes, showing an even greater disparity in demand for network resources. Furthermore, the top 20 percent of subscribers account for fully 80 percent of total Internet traffic.



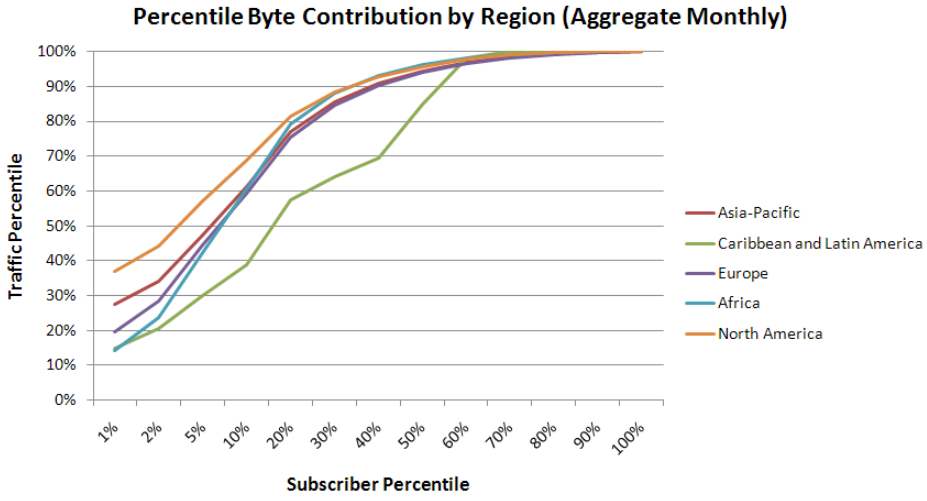
The same dataset also reveals that as the observation window decreases, the total percentage of bytes attributable to heavier network users increases. For instance, the consumption kings for any particular day account for 30 percent of total bytes, and represent a distinct (but over-lapping) set of subscribers when compared against the consumption kings for a month or a week. Similarly, past research conducted by Sandvine has demonstrated that in any peak-time hour, the top users during that hour are responsible for an even higher percentage of total bandwidth, but again are largely distinct from the consumption kings of the preceding month. This observation supports the assertion that the heaviest users over a month only have a marginal impact on peak-time traffic levels.



This study also demonstrates that the monthly data consumption of a heavy Internet user exceeds that of an average user by a factor of about 200.

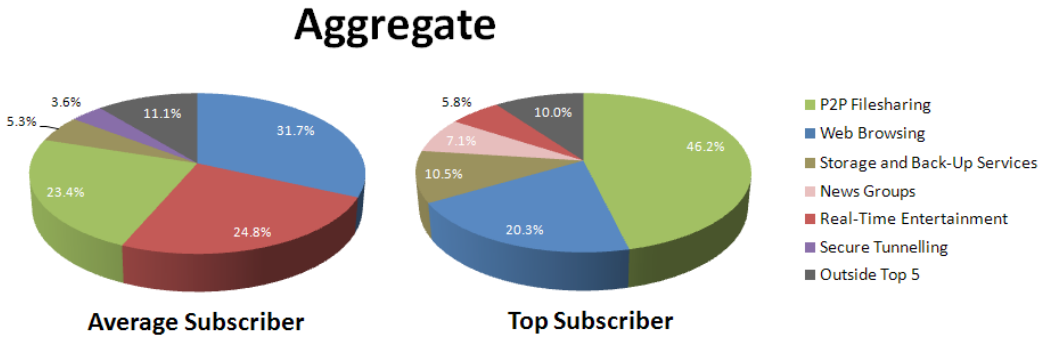
On a regional level, there are variations in the amount of traffic attributable to the top users, but in all but one region the 80/20 observation still applies. Examination of the graph below shows an interesting observation. The mature markets of North America and Asia-Pacific (the bulk of subscribers are in mature markets, but certainly there is much growth remaining) have the highest percentage of traffic attributable to the network's top users, while the emerging markets of Africa and the Caribbean and Latin America are at the opposite end of the spectrum. Europe, with its mix of mature and emerging countries, falls neatly in the middle.

It seems that as a market matures, there is a growing disparity between the top users and the average subscriber.



Two key factors contribute to this enormous variation in individual network requirements:

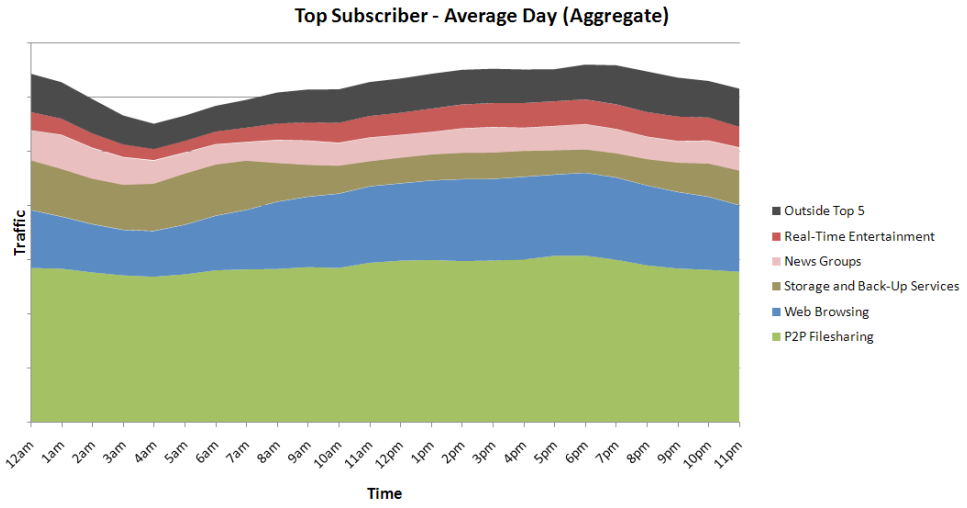
1. The network's top users exhibit relatively little change throughout the day, with constant heavy usage; conversely, most subscribers pop online and offline throughout the day and over the course of a month
2. Top subscribers still rely heavily on bulk download applications like P2P Filesharing, Storage and Back-Up Services, and News Groups – applications that are responsible for massive amounts of traffic with very little user involvement.



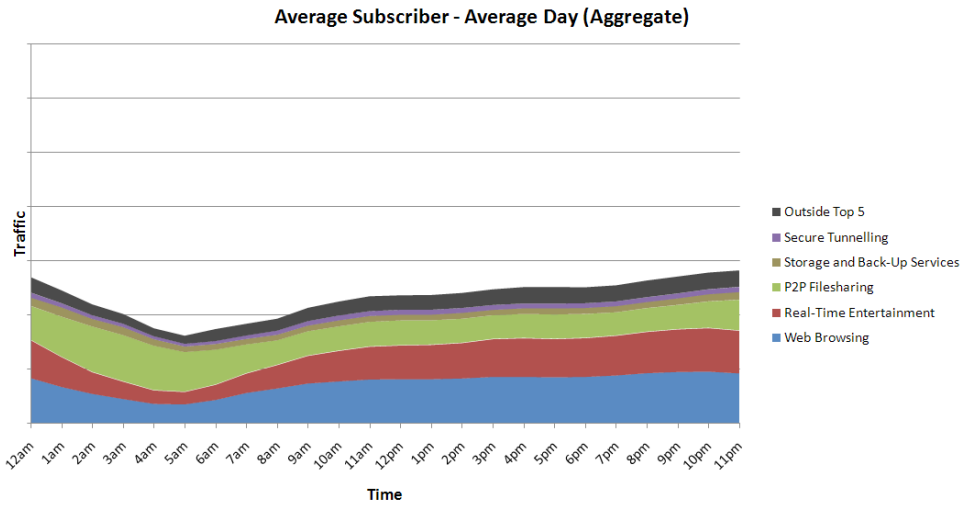
The graphs below show the top 5 categories for a Top Subscriber and an Average Subscriber over the course of the day. The two aggregate bandwidth graphs share a common y-axis scale, so visual comparisons between them are valid. Likewise, the four graphs showing upstream and downstream traffic profiles have a common scale.

Note that while it is likely that a Top Subscriber will be online 24 hours a day 7 days a week, in reality an actual subscriber will pop on- and offline throughout the day and over the week. Rather than looking at the Average Subscriber chart and equating it with a single user, consider it a tool for determining the bandwidth profile of an average user online at any particular time during the day.

Consider the graphs of the aggregate bandwidth profiles shown below. Since the scales are consistent, we know that at any instant in time, a Top Subscriber is likely to be using more bandwidth for P2P Filesharing than an Average Subscriber uses in total for all categories.

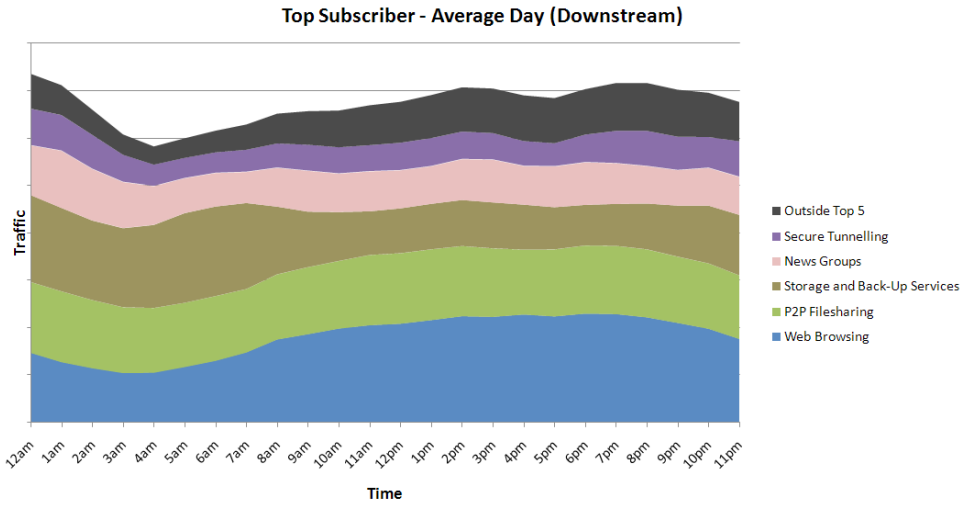


Examining the Top Subscriber aggregate bandwidth profile alone, it is readily apparent that the P2P Filesharing curve exhibits remarkably little variance over the day. Similarly, the level of News Groups activity is consistent and is another key difference between a Top Subscriber and an Average Subscriber.

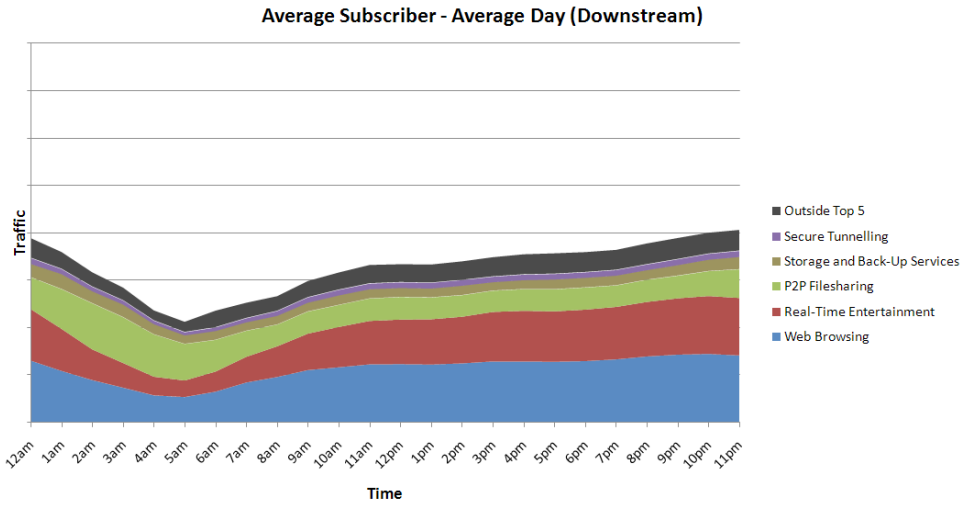


In contrast with a Top Subscriber, for whom P2P Filesharing accounts for almost half of all traffic, an Average Subscriber favors the on-demand nature of Web Browsing and Real-Time Entertainment. Also, while P2P Filesharing is still present in the Average Subscriber's profile, it accounts for less than a quarter of daily bytes.

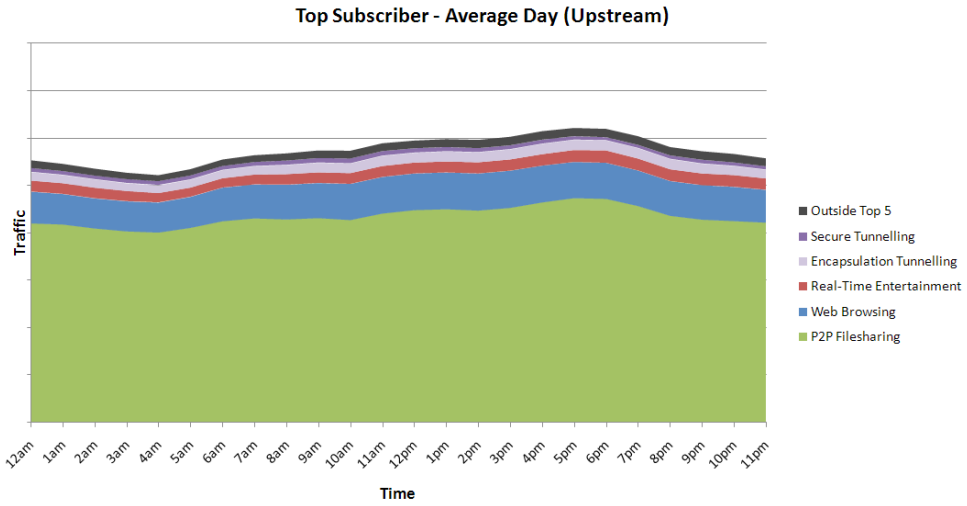
In the downstream direction, again we observe major differences between the behavior of Top Subscribers and Average Subscribers. While more than half of a Top Subscriber's downstream traffic is associated with content acquisition in the form of P2P Filesharing, Storage and Back-Up Services, and News Groups (a reasonable argument could be made that Secure Tunnelling is also part of this use-case), an Average Subscriber's daily profile reveals a preference for interactive content delivery.

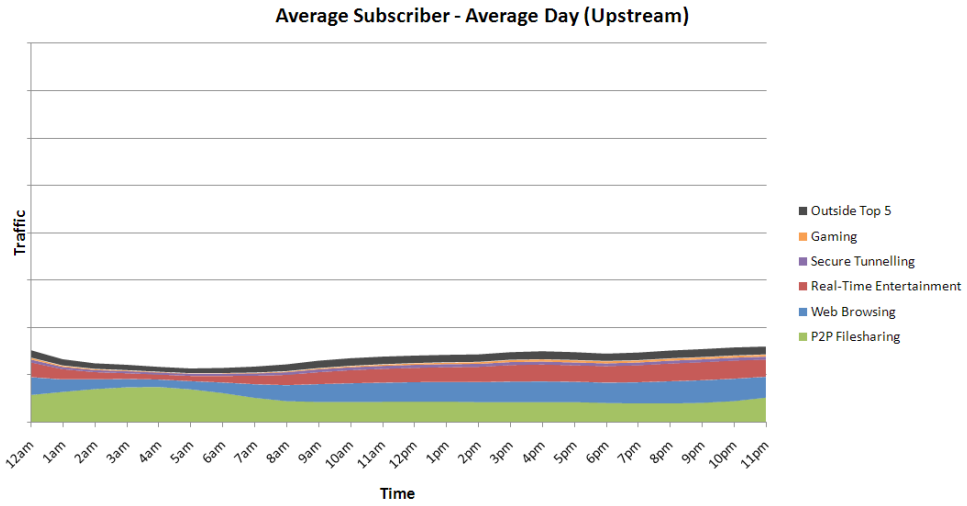


Notice the complete absence of Real-Time Entertainment from the top 5 categories profile for a Top Subscriber, and contrast that with its significant presence in the traffic profile for an Average Subscriber. Perhaps moreso than any other, this simple observation highlights the difference between the Top Subscribers, who still make use of bulk content acquisition and hoarding, and Average Subscribers, who favor "click-now, experience now" entertainment applications.



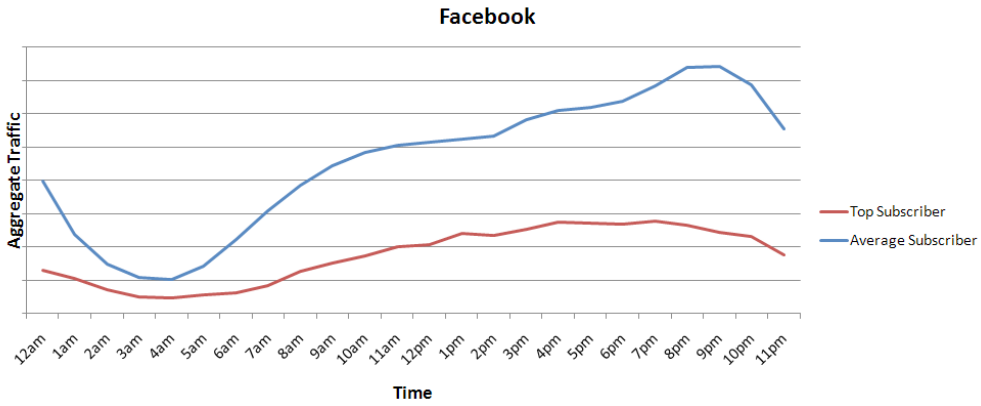
The upstream profiles are fairly self-explanatory. Top Subscribers make extensive use of the upstream capabilities of their broadband connection, continually serving content to network peers (and likely seeding many of the Average Subscribers!). We can also see the nearly symmetrical bandwidth demands of Top Subscribers (downstream-to-upstream ratio is 1.17) and contrast with the downstream-centric profile of an Average Subscriber (ratio of 2.38).



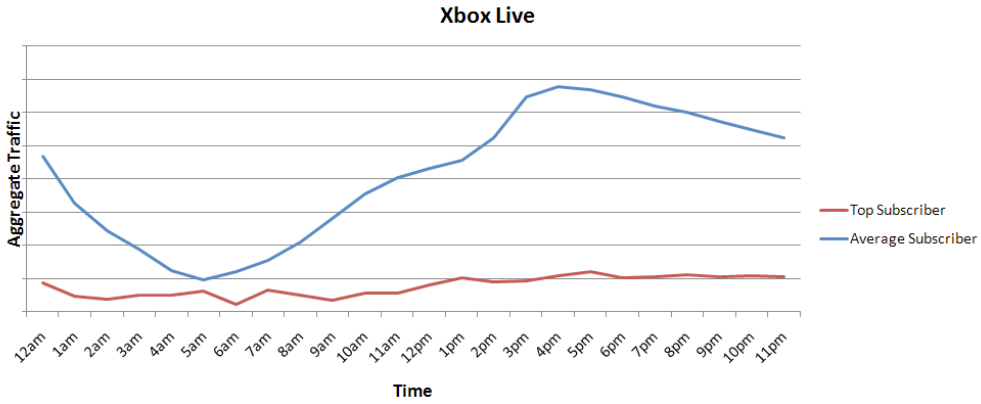


Digging deeper into the application level, we can further examine the differences in online behavior between a Top Subscriber and an Average Subscriber. The graphs below show the upstream and downstream requirements for a Top Subscriber and an Average Subscriber for a number of popular applications. These graphs are constructed so as to preserve the relative traffic levels of upstream versus downstream, and of the two classes of subscribers.

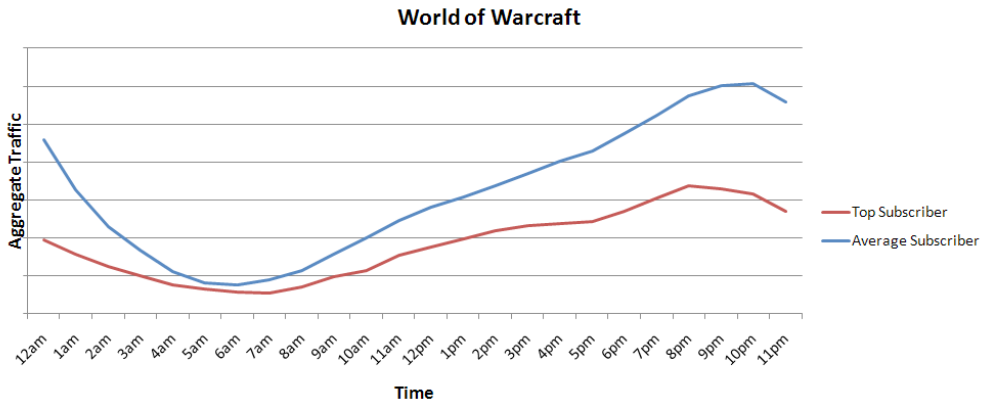
Let's begin our examination with Facebook. This social networking service has experienced massive growth since expanding beyond post-secondary institutions and now accounts for roughly 1 percent of all Internet traffic. It wouldn't be unreasonable to expect a Top Subscriber to exhibit similar Facebook usage characteristics as those of an Average Subscriber. However, what we see is that average subscribers make far more use of Facebook than do the top subscribers. In fact, an Average Subscriber uses about twice as much downstream bandwidth for Facebook than a Top Subscriber, and about three times as much bandwidth in the upstream. Not only are average subscribers consuming more Facebook content, but they are also generating more.



Similarly, one might expect the online gaming habits of subscribers to be fairly consistent regardless of monthly usage, but we see that in reality an Average Subscriber devotes much more bandwidth to Xbox Live than does a Top Subscriber.

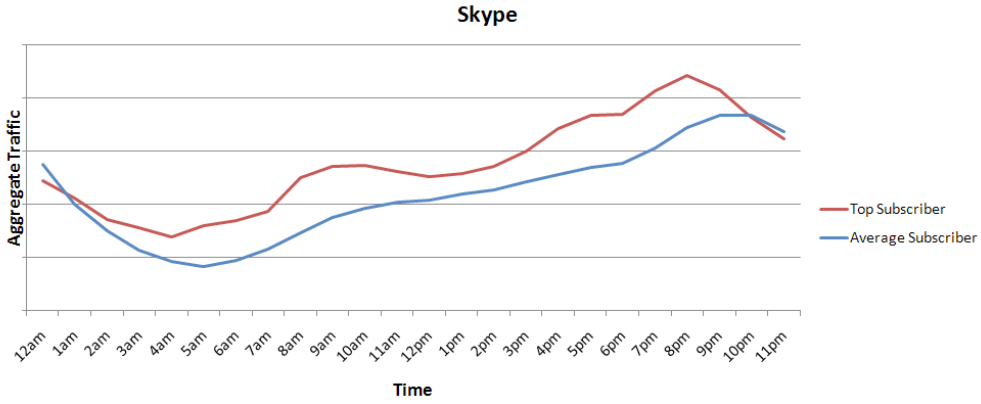


The phenomenon isn't limited to console gaming, as we see from the graph below that shows how the computer game World of Warcraft's usage varies. It is interesting to note that while Xbox Live usage peaks around 4pm, World of Warcraft usage reaches a maximum much later in the evening.

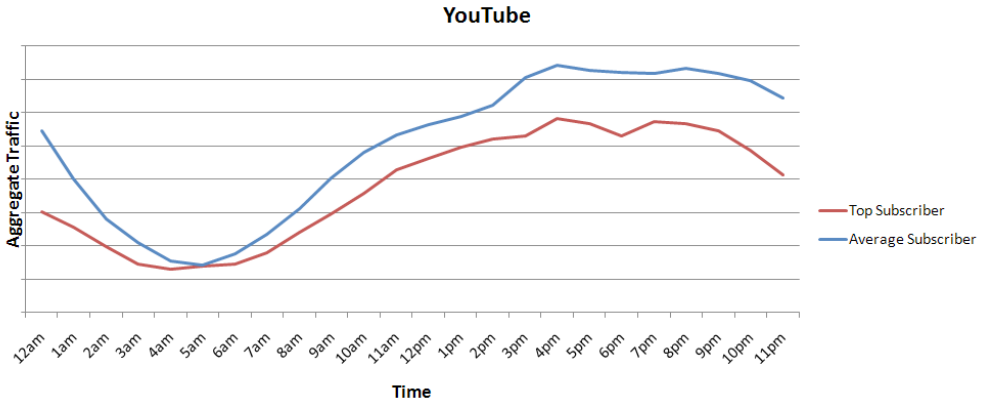


We've seen that average subscribers use more gaming and social media applications than top subscribers, but what about things like communications and entertainment?

Skype, without a doubt, has massive appeal and a large global install base, so it is reasonable to expect fairly consistent usage characteristics across all subscribers. The graph below shows that this expectation is correct – in fact, both the upstream and downstream curves show little variation across top subscribers and average subscribers. Finally, we've found an application that is equally popular regardless of over-all byte consumption.

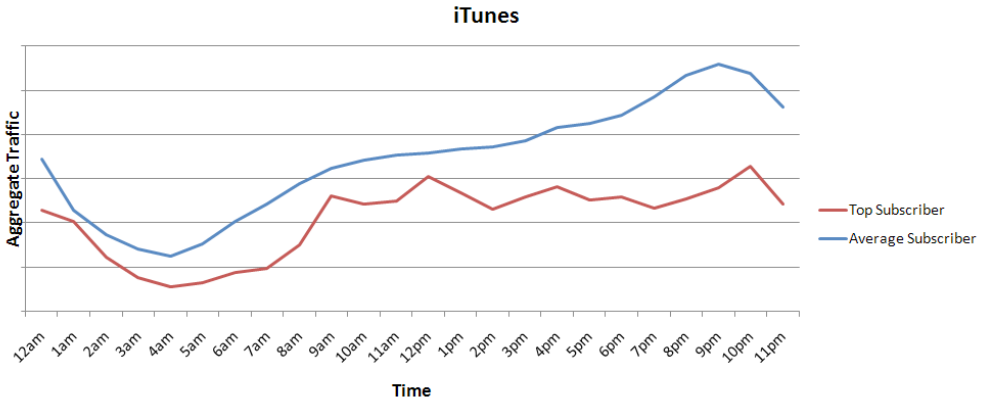


Shifting our attention to YouTube, we find that the aggregate bandwidth requirements for the two classes of subscriber are quite similar. However, there is a significant variation in the upstream requirements - top subscribers have a small fraction of the upstream YouTube traffic exhibited by average subscribers. Perhaps this is evidence that average subscribers are more likely to contribute to interactive services (via video uploads or comments) than the top subscribers.

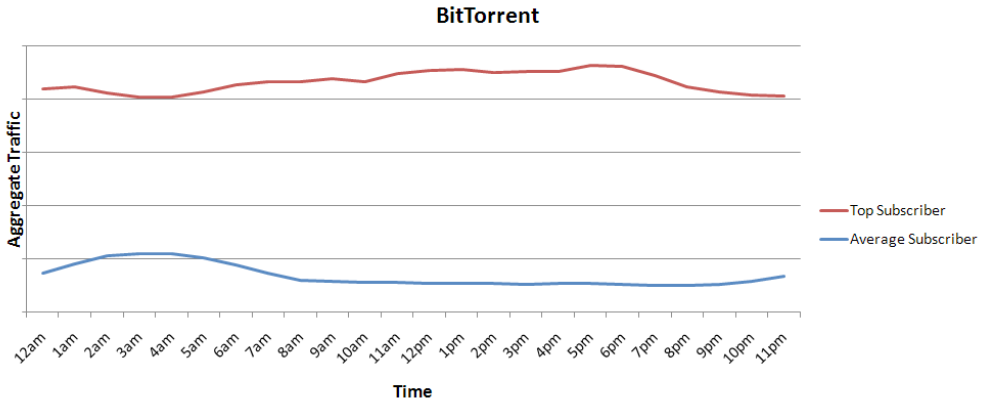


So far we've examined interactive and on-demand traffic – let's focus now on the traditional "download now and consume later" applications like iTunes, P2P Filesharing and one-click download services.

Apple's iTunes service is the clear leader in the online music marketplace, but does it appeal to the Top Subscribers, who are presumed to get most of their content illegally? The graph below shows that while an Average Subscriber relies on iTunes more than a Top Subscriber does, heavy network users nevertheless are still purchasing content.

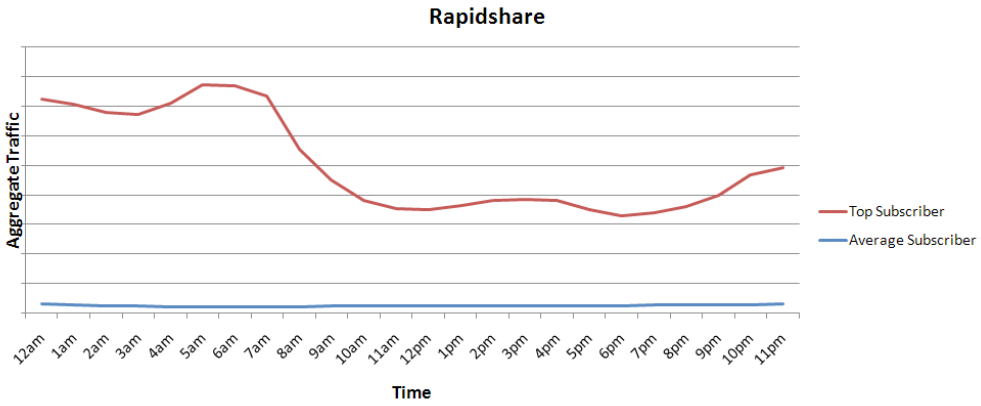


It should come as no surprise that the network's top consumers exhibit tremendous levels of BitTorrent traffic, particularly since we've already seen the significance of the P2P Filesharing category as a component of a Top Subscribers' over-all bandwidth. What might surprise some readers is that the upstream traffic for a Top Subscriber dwarfs the downstream. An Average Subscriber, for comparison, has roughly equal upstream and downstream BitTorrent usage characteristics. It is considered good BitTorrent etiquette to upload at least as much as one downloads, but it seems that Top Subscribers are extremely good Samaritans when it comes to contributing to the swarm.



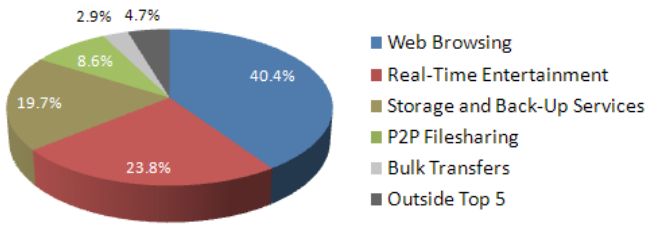
BitTorrent is an interesting example due to its massive appeal and increasing mainstream acceptance (for instance, many companies rely on the BitTorrent protocol to distribute large software packages or patches, and independent media producers rely on the network to cost-effectively distribute movies and music), but there are certainly services available that are employed by Top Subscribers but remain relatively unknown among the wider broadband masses.

A prime example of such a service is Rapidshare, a one-click hosting site used by some for back-up storage and by others for acquisition of content. The usage graph for Rapidshare highlights a disparity between top subscribers and average subscribers. Clearly, Rapidshare is used primarily for data acquisition (there is relatively little upstream traffic) and is generally not popular with average broadband subscribers.

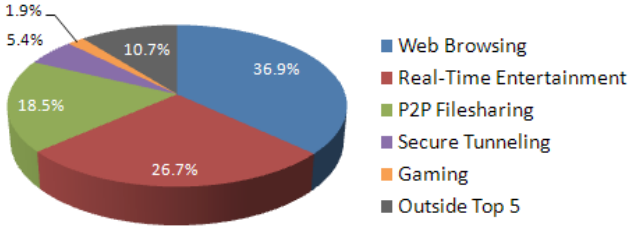


How do Regions Compare?

In Asia-Pacific and North America, we see the dominance of Web Browsing and Real-Time Entertainment, which when combined account for almost two-thirds of total traffic. The biggest difference between these two regions is the preference shown in Asia-Pacific for Storage and Back-Up Services, while North Americans continue to rely on P2P Filesharing for a large portion of content.

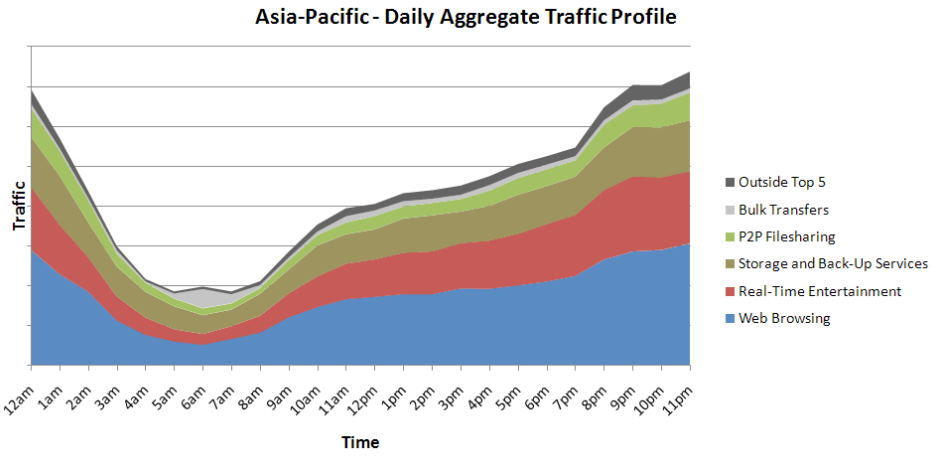


Asia-Pacific

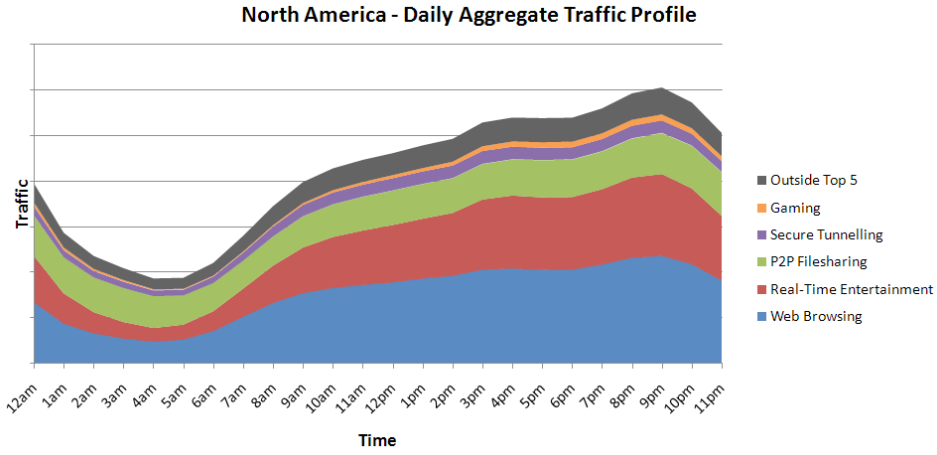


North America

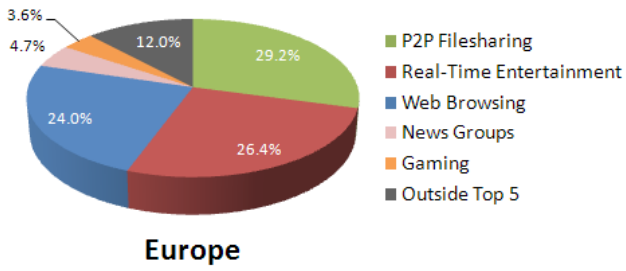
The population density in many parts of Asia-Pacific have led to high broadband penetration and access speeds, which in turn have influenced subscriber Internet behavior. The daily profile of this region shows the prevalence of Storage and Back-Up Services like PDBox and the relative lower levels of P2P Filesharing traffic, which averages less than 10 percent of aggregate bandwidth usage.

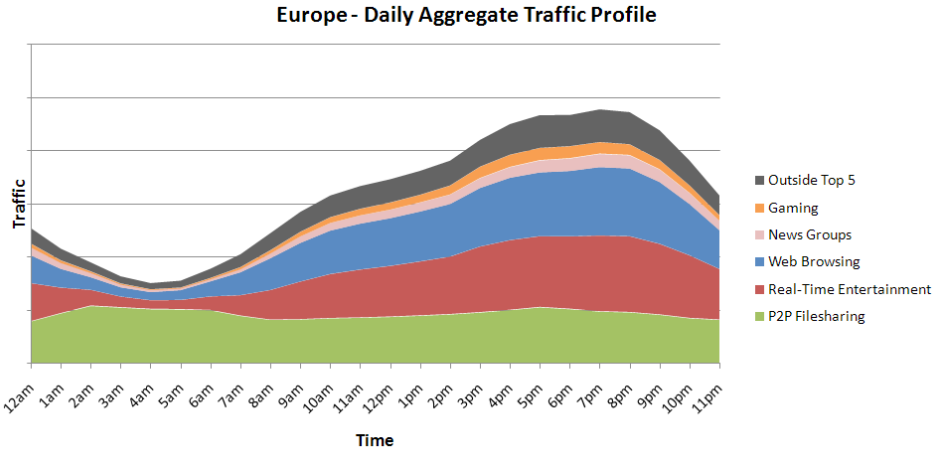


In North America, P2P Filesharing accounts for just 18.5 percent of total aggregate traffic, having been cannibalized by Real-Time Entertainment services. Nevertheless, the levels of P2P Filesharing remain fairly consistent throughout the day and don't exhibit the overnight drop-off observed in the other application categories. North America is one of two regions (Europe being the other) where Gaming traffic is high enough to enter the list of the top 5 categories. The increasing penetration of gaming consoles and mass-market appeal of online gaming ensures that on an absolute level, Gaming traffic will continue to experience significant growth. Also, with devices now offering movie streaming, game trailer downloads, expansion packs and other content, the majority of traffic to consoles will not correspond to a game actually being played.



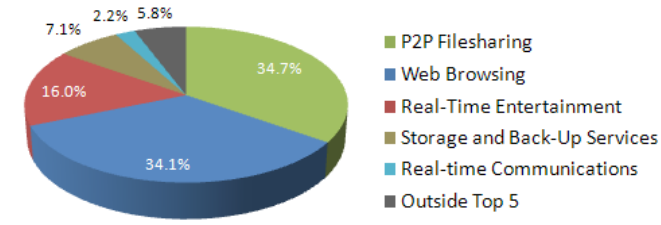
In Europe, we see a transition period in which P2P Filesharing, Real-Time Entertainment, and Web Browsing are all vying for leadership. Europe represents an interesting mix of emerging and mature markets and that is reflected in the composition of the continent's bandwidth.



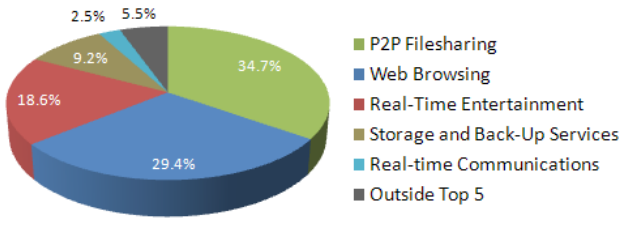


While P2P Filesharing levels remain fairly flat throughout the day, they do experience a peak in the early morning hours. Contrast this characteristic with interactive categories like Real-Time Entertainment, Web Browsing, and Gaming, which decrease to extremely low levels overnight. Over a 24 hour period, P2P Filesharing remains the dominant category in Europe, but during peak hours it accounts for a much smaller share of total bandwidth, as Real-Time Entertainment and Web Browsing grow to dominance.

In the Caribbean and Latin America, as well as in Africa, we see the significant presence of P2P Filesharing and only the early stages of the emergence of Real-Time Entertainment as a source of content. As these regions continue to mature, Real-Time Entertainment will continue to grow, primarily at the expense of P2P Filesharing but also somewhat by cannibalizing Web Browsing as networks become better equipped to deliver latency- and jitter- sensitive content.



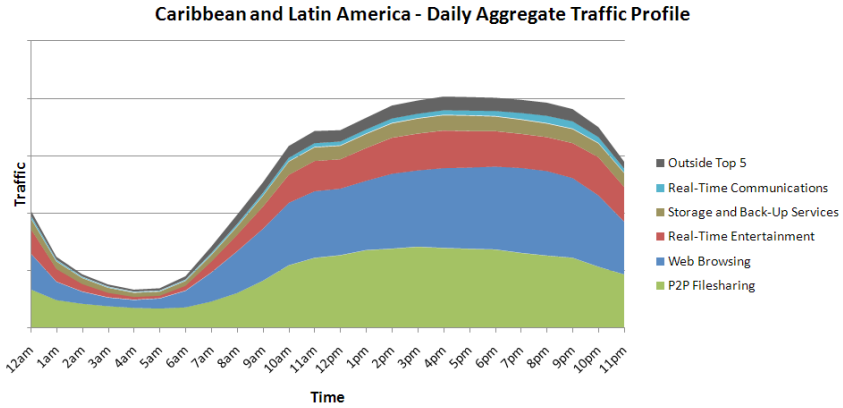
Caribbean and Latin America



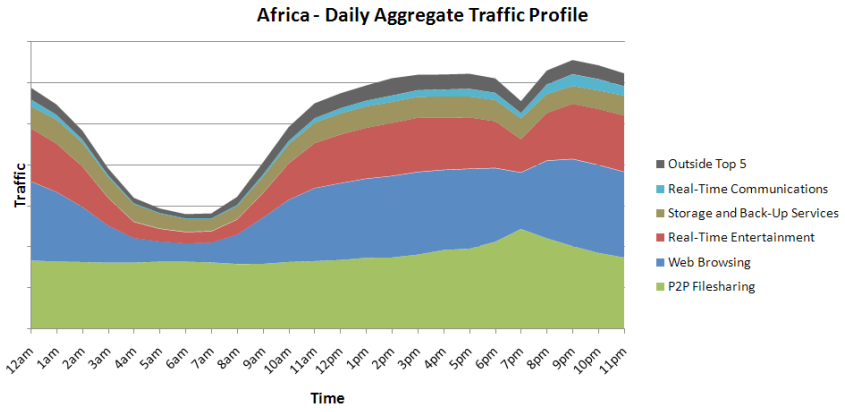
Africa

In both of these regions, Real-Time Communications is significant enough to be the fifth largest category, a feat not repeated anywhere else.

Of all the regions examined in this report, the Caribbean and Latin America is the only region where levels of P2P Filesharing drop significantly overnight. The likely explanation for this phenomena is twofold: first, recall from the "A Day in the Life…of a Network" section that subscriber levels in this region drop off significantly overnight; second, while BitTorrent is the dominant P2P Filesharing network globally, Ares is actually dominant in the Caribbean and Latin America. Consequently, while time-of-day doesn't significantly impact BitTorrent levels globally (a computer online at 4am in Europe might well be uploading to a computer online at 10pm in North America), time-of-day very much impacts levels of Ares traffic. When people go offline overnight in the Caribbean and Latin America, there is no one from whom to download content, since no other regions are online to upload.



The “Ramadan Effect” is plainly visible in the daily profile from Africa. Interestingly, were it not for the uptick in P2P Filesharing from 6pm to 8pm, the drop-off during Iftar would be even more significant. It is curious but logical that P2P Filesharing would be the only category to benefit from less competition on the network during the evening meal.



While the general use-case for P2P Filesharing and Storage and Back-Up Services is arguably the same (acquire content), the network behavior of the two categories is different. Storage and Back-Up Services are essentially download-only, and speeds are most significantly influenced by the content server, so extra network capacity will cause no increase in uploads and no increase in download rates. However, P2P Filesharing behaves very differently and is most significantly impacted by local network conditions. Extra capacity on the last-mile means that both downstream and upstream bandwidth utilization can increase, which is precisely what we observe when levels of Real-Time Entertainment and Web Browsing decrease to free up last-mile capacity.

Analysis of Application Categories

The following subsections show the daily profile of aggregate bandwidth, at a global level, of a number of application categories. The graphs present three curves:

- Normalized – total network traffic divided by the total number of subscribers at each point in time
- Top Subscriber – the daily profile of an average Top Subscriber
- Network – absolute traffic on the network, no normalization

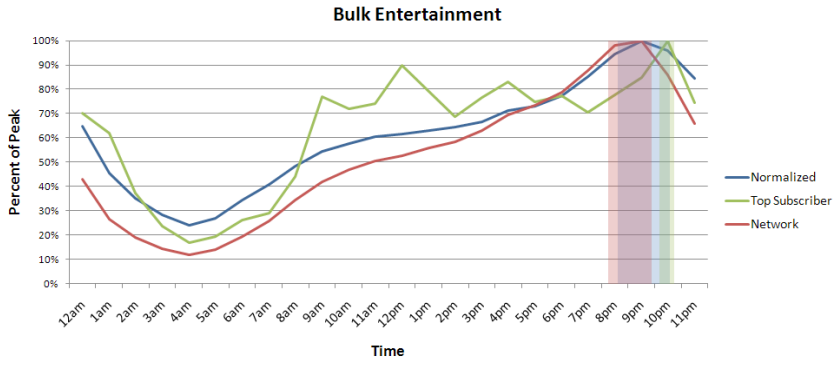
As we've done in previous graphs, we have shaded the regions during which each curve is within 5 percent of its peak value.

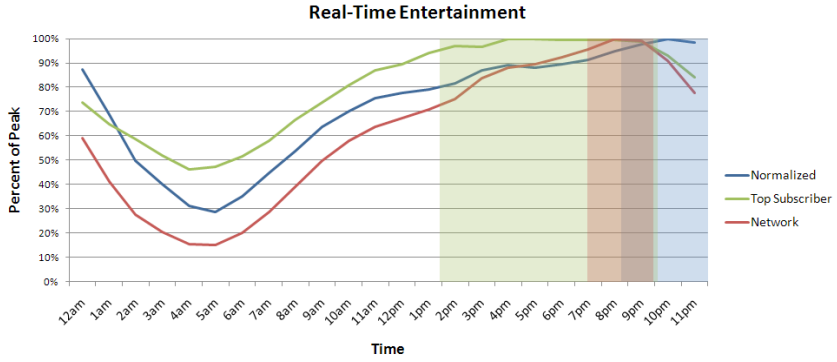
Audio and Video Entertainment

For many, the Internet has become the primary source of entertainment content, while for others it simply augments that which is available through traditional mechanisms such as television, radio, cinemas, and movie rental services.

For this study, we have broken up online audio and video services into Real-Time Entertainment (data is consumed on arrival) and Bulk Entertainment (content is downloaded and then consumed later).

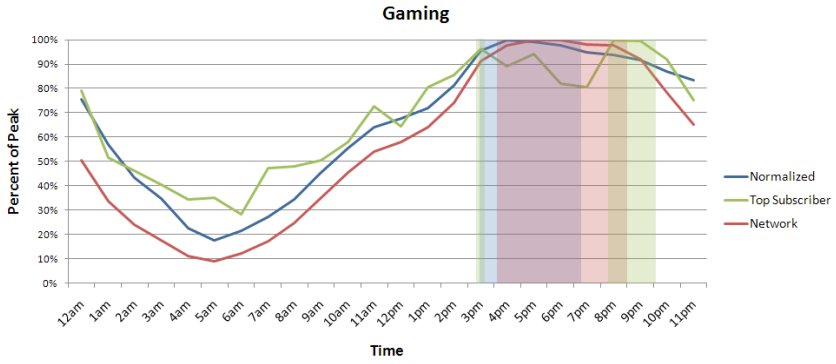
The primary difference between the two graphs below is the length of the peak periods. While Bulk Entertainment shows a tight period of near-peak usage, Real-Time Entertainment is more evenly spread throughout the evening. Both categories have nearly identical periods of overlap when the network and normalized levels are both near their maximum. Interestingly, Top Subscribers experience an 8-hour period of peak Real-Time Entertainment usage, from 1:30pm to 9:30pm.





Gaming

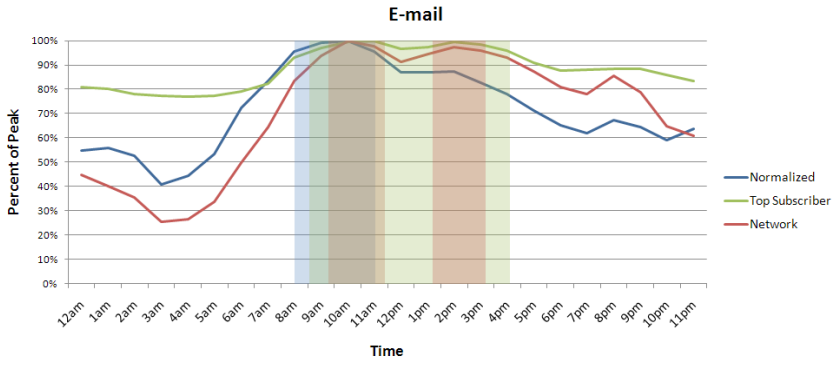
Online gaming has quickly become a massive industry, as broadband technologies have delivered the network quality required to match today's high-powered gaming consoles and PC rigs. Previously, we highlighted a difference between the daily bandwidth patterns of the Xbox console and the PC game World of Warcraft. When we examine the Gaming category as a whole, we see a long period of near-peak usage. From 3:30pm to 6:30pm, both the network and the per-subscriber traffic levels are within 5 percent of their peak, while Top Subscribers actually have two peaks (which correspond closely with the individual peaks of Xbox Live and World of Warcraft). It is also interesting to note how the peak period occurs earlier in the evening than the over-all network peak, and suggests that gaming traffic is largely driven by the "after-school" and "after-work" crowd.

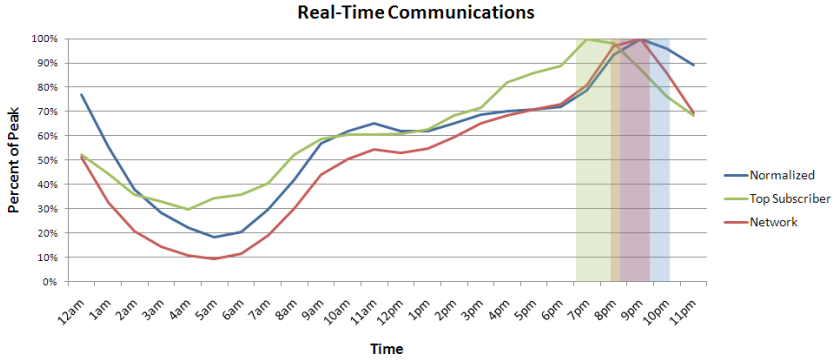


Communications

For this study, we separated the E-mail category (including webmail services) from Real-Time Communications like voice and video calls and instant messaging. Doing so allowed us to identify the vastly different usage patterns experienced by the two categories.

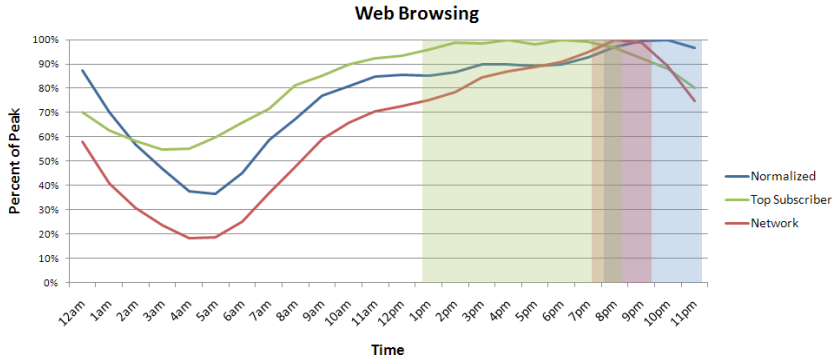
While e-mail usage is somewhat erratic, with many local peaks throughout the day and a primary peak in the late morning, use of real-time communications applications shows a massive jump during the late evening hours.





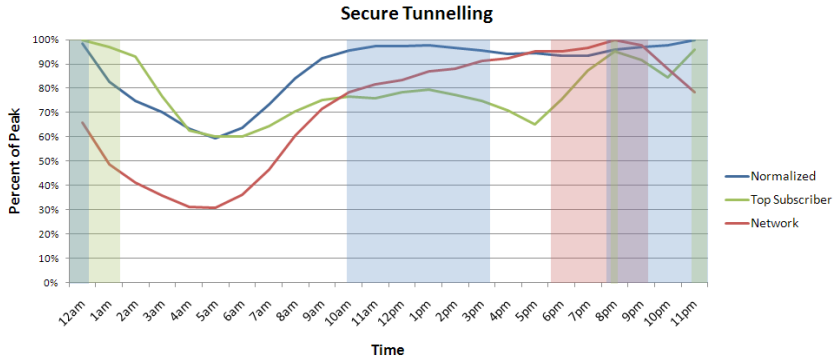
Web Browsing

As one of the Internet's dominant categories in terms of over-all share of traffic and mass-market use, it isn't a surprise that the Web Browsing category closely matches the daily characteristics of the network as a whole. Furthermore, visual examination reveals that the graphs for Web Browsing and Real-Time Entertainment are almost indistinguishable.



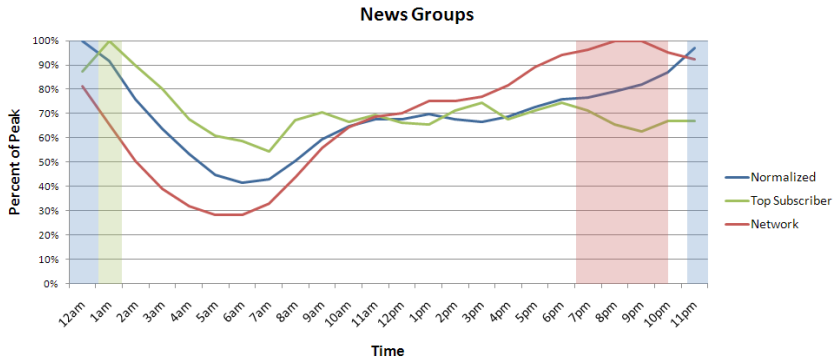
Telecommuting and Secure Browsing

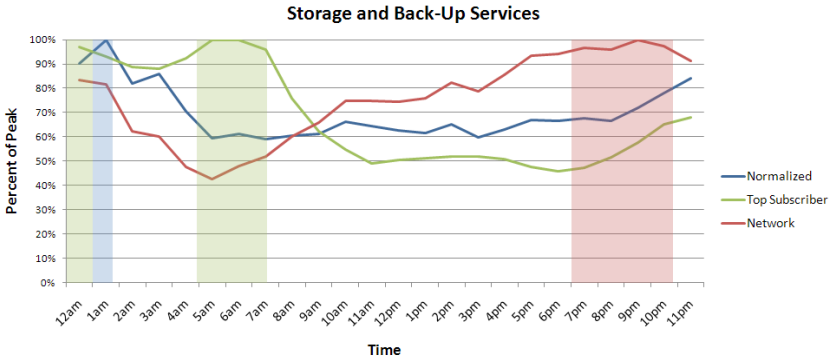
Secure tunnels are used for activities such as telecommuting (connecting to company VPNs) and for web activities that require guarantees of data integrity and privacy such as online banking and shopping. These applications have been grouped into the Secure Tunnelling category, and employers everywhere will be happy to see the steep curves that occur in the morning hours as remote workers connect to the workplace. It is also interesting to see the length of the periods of peak usage – in fact, the normalized usage is within 10 percent of peak for a period spanning 15 hours, much longer than any other category can boast.



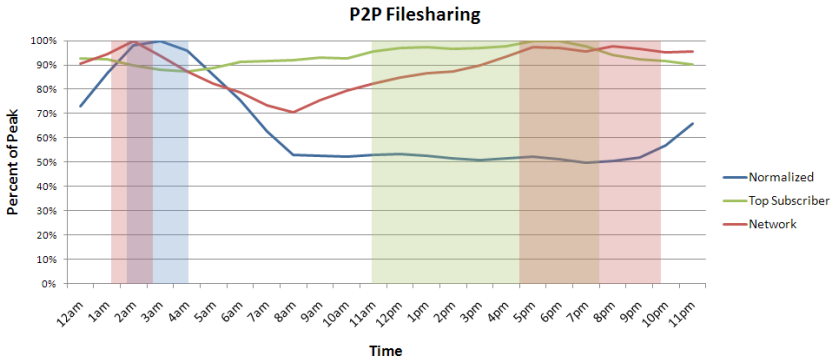
Bulk Content Acquisition

The graphs below show the daily usage patterns exhibited by P2P Filesharing, Storage and Back-Up Services (including one-click download services), and News Groups – the three categories most commonly associated with bulk acquisition of content. Keep in mind that the files on these services aren't limited to illegal movies and music – ebooks, software applications, open-source material and a myriad of other types of content are readily available. News Groups and Storage and Back-Up Services actually display very similar usage characteristics over the day, with nearly identical periods of peak network activity. This observation supports the assertion that the use-cases for the two categories are similar.





The P2P Filesharing category stands as unique among all the categories we've examined by having its network peak in the early hours of the morning when most interactive traffic has reached its minimum. The category also exhibits a very flat pattern throughout the day, broken up only by the early morning peak – this speaks to the autonomous nature of P2P Filesharing applications, which can function quite happily for days on end without actual user intervention. We can also see how the relatively flat Top Subscriber usage curve is distinct from the Network and Normalized curves, which show much greater variation.



Explanation of Categories

The table below describes each of the categories used in the 2009 Global Broadband Phenomena study. There are a few differences between the categorization for this year's study versus the categories used in 2008; most notably:

- Web Media and Peercasting/Placeshifting from 2008 have both been included in Real-Time Entertainment in 2009
- Instant Messaging and VoIP from 2008 have both been included in Real-Time Communications in 2009
- Bulk Entertainment and Bulk Transfers have become individual categories in 2009

These changes were introduced to better reflect 2009's Internet landscape and to place an increased focus on the behavior and motivations of individual subscribers when engaged in online activities.

Note that for all comparisons between 2008 and 2009, we recalculated 2008's results with the new categorization, so all year-over-year analysis is completely accurate.

As described previously, all data sets were gathered on a protocol basis, as opposed to a category basis. This per-protocol data was subsequently rolled up into the appropriate categories for high-level analysis.

Category	Description	Example Applications and Protocols
Anonymity	Protocols that mask or obfuscate application or individual identity	Tor
Bulk Entertainment	Entertainment that is acquired in bulk then consumed some time after arrival	iTunes, movie download services
Bulk Transfers	Large data transfers using the File Transfer Protocol or its derivatives	FTP
E-mail	Service-provider and webmail e-mail services	SMTP, POP3, webmail (Hotmail, Gmail, etc)
Encapsulation Tunnelling	Tunnels used for wrapping traffic	L2TP, GRE, Teredo, 6 to 4
Gaming	Console and PC gaming, console download traffic, game updates	Nintendo Wii, Xbox Live, Playstation 2, Playstation 3, World of Warcraft
Network Administration	Protocols and services used to administer the network	DNS, ICMP, NTP, SNMP
News Groups	Network news services (where "news" means "data" – it doesn't have to be actual news)	NNTP, NNTP over SSL
P2P Filesharing	File-sharing applications that use a peer-to-peer distribution model	BitTorrent, eDonkey, Gnutella, Ares, Winny, Share, Foxy
Real-Time Communications	Applications and protocols that allow interactive chat, voice, and video communication	Skype, MSN Messenger, ICQ, SIP, MGCP, AIM, IRC, Oovoo, Jabber, Gadu-Gadu
Real-Time Entertainment	Applications and protocols that allow "on-demand" entertainment that is consumed (viewed or heard) as it arrives	Streamed or buffered audio and video (RTSP, RTP, RTMP, Flash), peercasting (PPStream, Joost, Octoshape), placeshifting (Slingbox)
Remote Connectivity	Protocols and services that allow remote access to network resources	Remote Desktop, VNC
Secure Tunnelling	Encrypted tunnels typically used for Virtual Private Networks and secure web transactions	SSL, SSH
Software Updates	Application updates for software, firmware, and operating systems	Windows Update, anti-virus updates
Storage and Back-Up Services	Services that provide file hosting, network back-up, and one-click downloads	PDBox, Netfolder, Rapidshare, MegaUpload
Web Browsing	Web protocols and specific websites	HTTP, Facebook, MySpace

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