P3 Insights Separate T-Mobile "Binge On" Fact from Fiction

P3 Group's Analysis of Crowdsourced Data Reveals Unlimited Mobile Video Plans Can Result in Win-Win-Win for Carriers, Consumers and Content Providers

INTRODUCTION

T-Mobile recently introduced "Binge On," an option that allows customers with qualifying plans to stretch their data buckets by streaming video from participating providers for free. Mobile video consumption has skyrocketed in recent years and now is the Number 1 way Americans use smartphone data. The T-Mobile unlimited video streaming program has ignited a heated discussion because, when enabled, Binge On limits the data rate available for video streaming not only for participating (free) video providers, but also for video providers not participating (and the user still needs to pay for watching their content). Critics raise questions about net neutrality and allege data throttling.

In its original announcement, the company said its Binge On program is "powered by new technology built in to T-Mobile's network, which optimizes video for mobile screens, minimizing data consumption while still delivering DVD or better quality (e.g. 480p or better)."

In a January 4, 2016 blog post, the Electronic Frontier Foundation (EFF), an Internet advocacy group, presented the results of tests they performed related to Binge On. The blog, which prompted a video response from T-Mobile CEO John Legere, created such a stir that our P3 engineers decided to take an independent, analytical look at the technology. The following report is based on real data collected across the United States and compares the six weeks before and six weeks after the November 15, 2015 introduction of Binge On independent of whether users opted out or not. Our report draws on the experiences of more than 1,000 T-Mobile customers who participate in our crowdsource panel by downloading an app with P3's proprietary measurement software that records real, everyday smartphone use including the speed, duration and quality of voice and data usage.

P3, a leading provider of international consulting, engineering and testing services, has used proprietary measurement tools and advanced analytics to conduct similar crowdsourced studies to improve network quality around the world. This report provides the first independent, broad-based real life study of the effect Binge On has on the actual app and video usage of T-Mobile customers.

OVERVIEW

The P3 study confirms the finding of the EFF that the bandwidth for the downlink transmission of any content that can be identified as video content is limited to about 1.5 Mbit/s, independent of the kind of app or service being used and independent of the underlying cellular technology. Depending on the particular type of traffic, the available bandwidth for some apps is reduced down to about half or even less of the bandwidth

available before Binge On. The resulting video data rate of popular video apps still achieves a level of about 60% or more of what was achieved before Binge On. Apps with a lower portion of video traffic are less affected with a remaining bandwidth closer to pre-Binge On levels. Other apps are not affected at all.

More significant, however, is that our findings reveal that, apart from any concerns about net neutrality, this throughput limitation isn't necessarily a bad thing. Looking at the positive effects, this can be interpreted as a win-win-win situation for customers, video service providers and T-Mobile.

Win #1 - Customers: First of all, the average time users spend with a single video app session increased significantly -- 15% to 50% depending on the particular app. Interestingly, it was not only Binge On partner apps which showed increased usage times, but also YouTube, which is not a Binge On partner. We also found that in general T-Mobile customers used video slightly more often after the introduction of Binge On. The Binge On subscribers in our panel recorded 5% to 10% more app sessions per day, per user. A drawback, of course, is that the video data rate is limited due to the reduced bandwidth. We found that the effectively available video bandwidth for streaming services decreased to about 60% to 75% of pre-Binge On levels. While this does have some impact on video resolution and/or frame rate, the effect on the user experience is hard to quantify as this depends on the particular video content and device on which it is played. It also needs to be mentioned that the throughput limitation also applies for downloading pre-encoded video files.

Win #2 - Video Providers: Because Binge On partner video traffic is not charged by volume, T-Mobile customers have more of their data plans left for non-Binge On services. All video providers – not only Binge On partners – benefit from the increased usage of video services, though deprived of the ability to offer high-definition (HD) content via cellular to T-Mobile Binge On subscribers.

Win #3 - What's in it for T-Mobile? The increased use of video apps indicates that Binge On does attract customers. In addition, capping the bandwidth available for the transmission of video content allows T-Mobile to mitigate the risk of congestion in its network. Our analysis shows that T-Mobile customers are using video apps more often and much longer than before. However, due to the reduction in bandwidth, the average amount of data transmitted per video app session decreased. For some apps, that decrease in data traffic per session is even greater than the increase in usage frequency. At the same time, we found that the average data volume per user and day remained about constant. Assuming that the number of users remained constant as well, this means that T-Mobile has successfully managed to carry more video traffic, while maintaining or even decreasing the load on its network.

ANALYSIS

Bandwidth Reduction

Binge On limits the data rate available for the transmission of video content. Apart from video apps like YouTube, Netflix or Hulu, there are a number of other popular apps that provide some video content but are not focused on video only. This applies to social networks like Facebook, Instagram and Tumblr, as well as many other apps that transfer little or no video content.

Binge On's impact on video and, in fact, all apps used in everyday life, is clearly visible. Figure 1 shows the Cumulative Distribution Function (CDF) and average LTE throughput as perceived by smartphone apps. This

data rate is calculated from all app sessions assuming that any period of continuous data transmission can be interpreted as a speed test. Looking at everyday usage of apps on smartphones, we observed that the LTE data rate averaged over all apps declined by about 43% - from about 4.2Mbit/s to about 2.4Mbit/s.

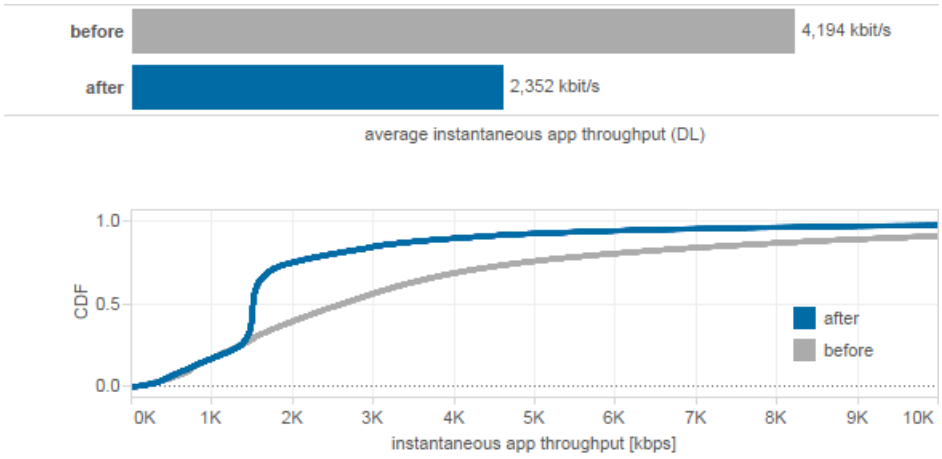

Figure 1: LTE Throughput as perceived by smartphone apps

The effect of capping the bandwidth available to video content becomes visible when looking at the Cumulative Distribution Function in Figure 1. About 35% of the speed samples are very close to the barrier of 1.5Mbit/s.

Although Binge On traffic shaping has the greatest effect on fast LTE networks, it is also affecting 3G traffic on UMTS/HSPA, as shown in Figure 2 for YouTube sessions. The effect of Binge On on YouTube is, of course, more significant compared to the overall population of apps sessions because YouTube transmits mainly video content. In 3G and 4G about 80% of the speed samples are affected while Binge On has no effect on Wi-Fi.

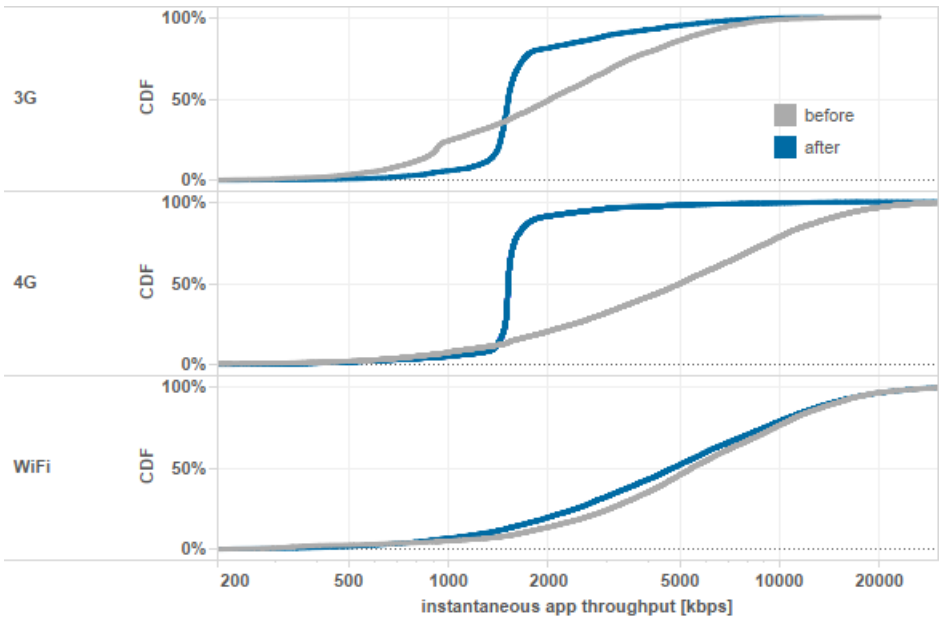

Figure 2: Cumulative Distribution Function of app throughput [in Kbit/s] for YouTube on T-Mobile in 3G, 4G and Wi-Fi

Which apps and services are affected? What services are affected although not part of Binge On?

Our data shows that all apps that download video content one way or another are affected. This applies to well-known video streaming apps like Netflix, Hulu and YouTube, as well as to mixed media (text, picture, video) apps like Facebook, Tumblr, Viggle and the Web browser. It also doesn't matter whether or not content is streamed or downloaded. Looking at our data, we found that a number of gaming apps also are affected, as they obviously download video content, e.g. ads the user can watch in order to earn gaming points instead of buying them via in-app purchase.

How strongly are video apps affected?

T-Mobile caps the transmission speed of video content at around 1.5 Mbit/s, independent of the underlying cellular radio technology (i.e. 3G or 4G). Non-video content is not affected. Browsing the video catalogue of a video service might be as fast as before, while the transmission of the video content itself does not get faster than 1.5Mbit/s. Thus, the resulting average instantaneous throughput experienced by different apps depends on the mix of video and non-video content.

Figure 3 shows the resulting average instantaneous throughput available to different video apps as experienced in real life in the T-Mobile network before and after Binge On was introduced.

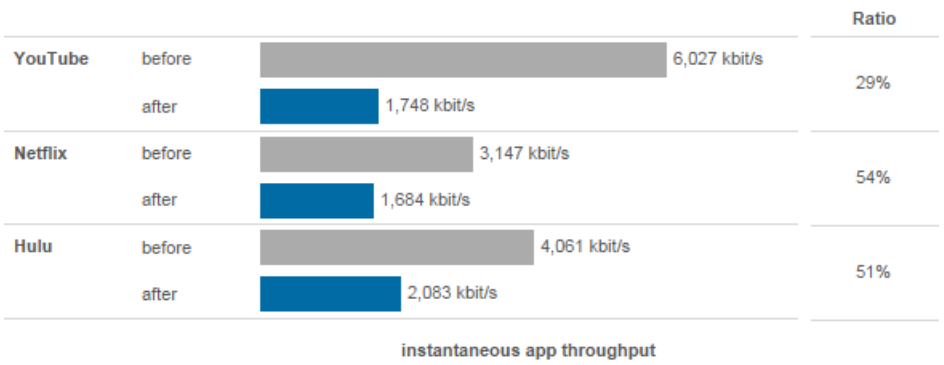

Figure 3: Average instantaneous throughput of video apps

We observed that before Binge On, YouTube relied on significantly higher instantaneous throughput than Netflix or Hulu. This doesn't mean that the resulting video data rate was higher for YouTube because the throughput shown is the one for periods of continuous data transmission used to fill the video buffer. The instantaneous throughput does not show the data rate at which video is played.

All video apps show an overall reduced average instantaneous throughput between approximately 1.6Mbit/s and 2Mbit/s. This average is higher than the above mentioned 1.5Mbit/s because it indicates the overall app throughput, which includes the video portion that is capped at 1.5Mbit/s. Furthermore, in this study we take into account all users in our panel, whether they use Binge On or opted out. The fact that the instantaneous throughput is reduced doesn't necessarily mean the video data rate is reduced, but it certainly means that the video buffer is filled slower than before Binge On.

Looking at YouTube sessions, we found that with Binge On the average instantaneous throughput available to the YouTube app drops dramatically -- to about 1.7 Mbit/s from about 6 Mbit/s -- just 29% of pre-Binge On levels.

To gauge the influence of capping throughput on video quality, we looked at the video data rate approximated by the average session throughput, i.e. the amount of data transferred over the whole duration of an app session. Figure 4 shows the average session throughput of video apps.

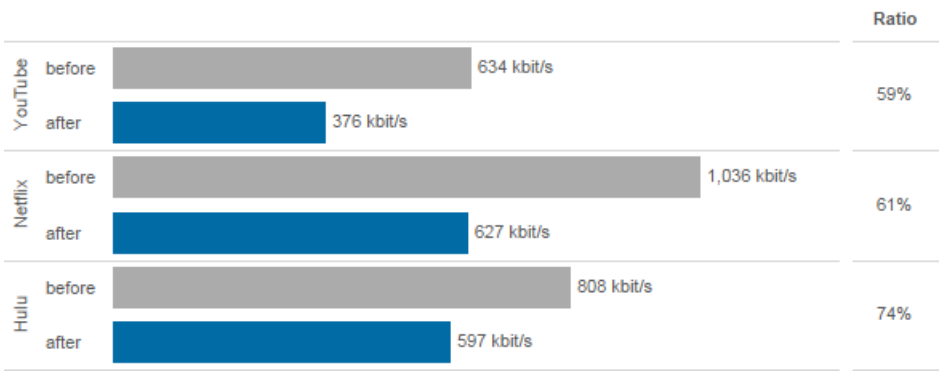

Figure 4: Average video app session throughput

The session throughput is reduced to about 60% to 75% of pre-Binge On levels. Assuming that all app sessions transmitted only video content, we can estimate that the video data rate is similarly reduced.

The effect of Binge On on instantaneous throughput is thus much greater than on the resulting video data rate. The reason is that streaming servers typically transmit data to the client only until the video buffer is full and restart the transmission when the video buffer is emptied to a certain amount. So a lower instantaneous throughput results in fewer or shorter pauses between those buffer fills and, if the resulting bandwidth is insufficient, also results in a lower video data rate and thus lower video quality.

The impact on the video quality is hard to quantify. Modern video services automatically adjust video resolution and frame rate to the available bandwidth. Meaning that for streaming services with adaptive encoding, video quality should be sufficient, corresponding to the DVD-like quality advertised by T-Mobile. However, video services are deprived of the ability to offer HD content. Under changing network conditions, the granted throughput of 1.5 Mbit/s might not be sufficient to fill the video buffer fast enough following a period of poor conditions with low throughput. In these cases, the video playout would stall until the video buffer is filled again.

How are social media apps affected?

Figure 5 shows the average instantaneous throughput available to different social network apps as experienced in real life in the T-Mobile network before and after Binge On was introduced.

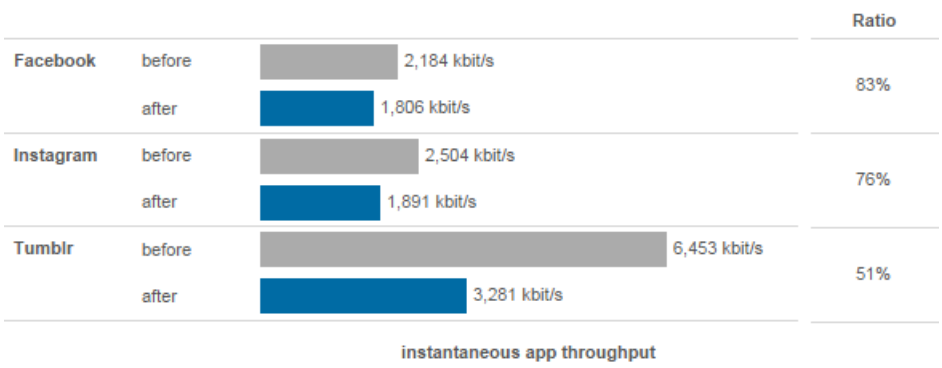

Figure 5: Average instantaneous throughput of social network apps

Because the capping of throughput only affects video content, the effective reduction of the bandwidth available to those apps depends on the degree and data rate at which video content is downloaded by social media apps. Obviously, Tumblr bandwidth is affected most, followed by Instagram and Facebook. We see that, due to the mix of video and non-video content, the effective bandwidth of social media apps is reduced less (to about 50% to 80%) than for video apps (to about 30% to 50%).

How are other apps affected?

Apps that download video content are affected unless it is technically not possible to identify the respective content as video (e.g. when HTTPS is used). It doesn't matter whether or not the content is streamed or downloaded. Any video content embedded in a Web page or just downloaded via a Web browser is affected as well. When looking at our data, we also found that a number of gaming apps are also affected, as they obviously download video content, e.g. ads the user can watch in order to earn gaming points instead of buying them via in-app purchase.

Figure 6 shows the average instantaneous throughput for different browsers and gaming apps as experienced in real life in the T-Mobile network before and after Binge On was introduced.

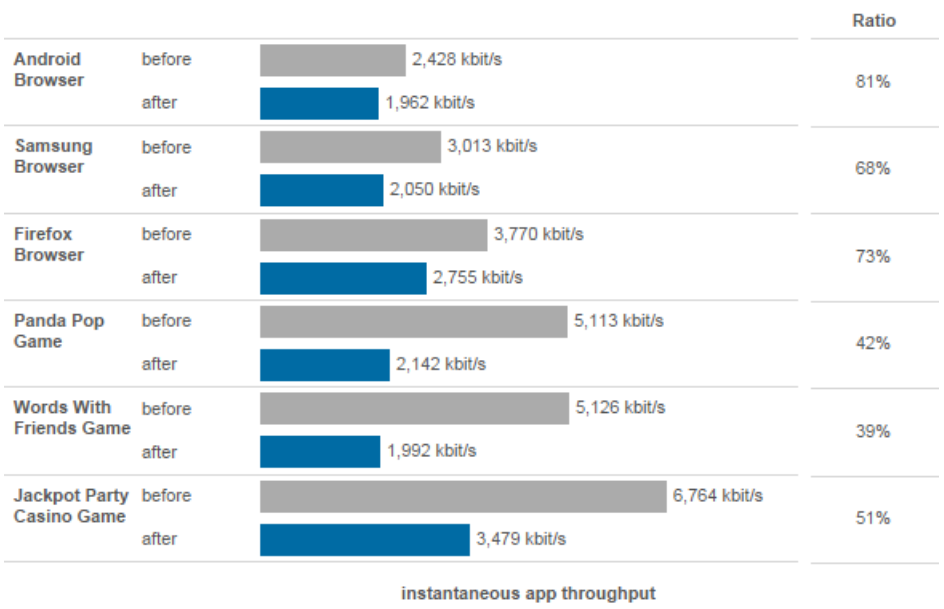

Figure 6: Average instantaneous throughput of browsers and games with video

As with social media apps, the average instantaneous throughput available to the respective apps results from the mix of the bandwidth available for non-limited, non-video content and throughput-limited video content. For the average Web browsing session with popular browsers this means an effective bandwidth reduction to between about 70% and 80%. The effects on games that include video content are similar to video apps. However, because video content within games is typically advertisements, the bandwidth reduction most likely does not influence the gaming experience in any way.

How did Binge On change user behavior?

After Binge On was introduced, T-Mobile customers in our panel used video apps slightly more often than before. Figure 7 shows how often they used video apps on average per day before and after Binge On was introduced. While for the period of this study the frequency with which users started the Netflix app stayed about constant, there is a slight increase (10%) in the frequency of YouTube and Hulu usage.

At the same time, once one of these three video apps was started, it was used significantly longer than before Binge On was introduced. Especially Netflix and Hulu, both Binge On partners, which are used up to 50% longer per app session. But even the average duration of a YouTube session increased by about 16%.

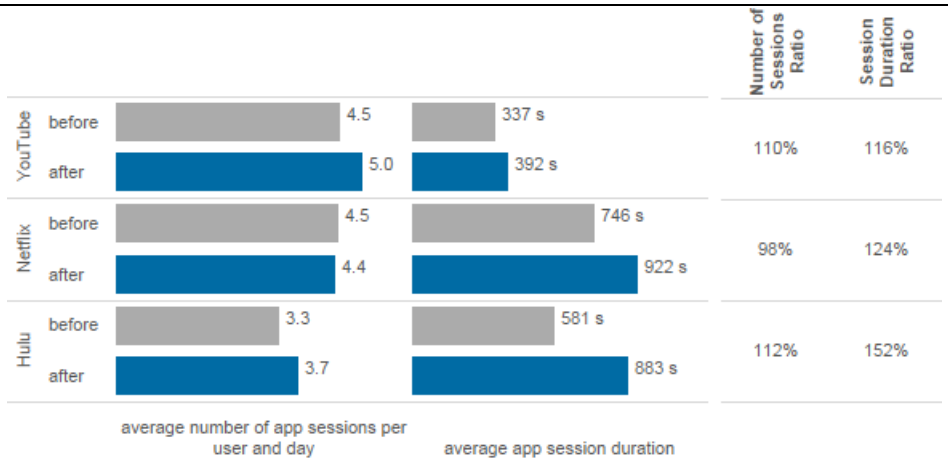

Figure 7: App usage frequency and duration

Impact on T-Mobile Network

Increased consumption of video content on smartphones usually means a significantly higher load on the network. In order to quantify the effects of more frequent and longer usage of video apps on the T-Mobile network, we looked at the average volume of data transmitted per app session. Figure 8 shows that for YouTube and Netflix the average amount of data transmitted per app session decreased by about 25%, but for Hulu it increased by about 25%. Obviously, the capping of the video throughput can offset increased session volumes of YouTube and Netflix. But the Hulu usage pattern, that increases so significantly (app used much longer) cannot be offset by the current throughput reduction as applied by T-Mobile. However, the average data volume of a Hulu session is just about 57% of a Netflix session. At the same time, Netflix and YouTube are used more often than Hulu. Overall, the resulting mean volume per session averaged over all Netflix, Hulu and YouTube sessions decreased to 72MB compared to 83MB before Binge On.

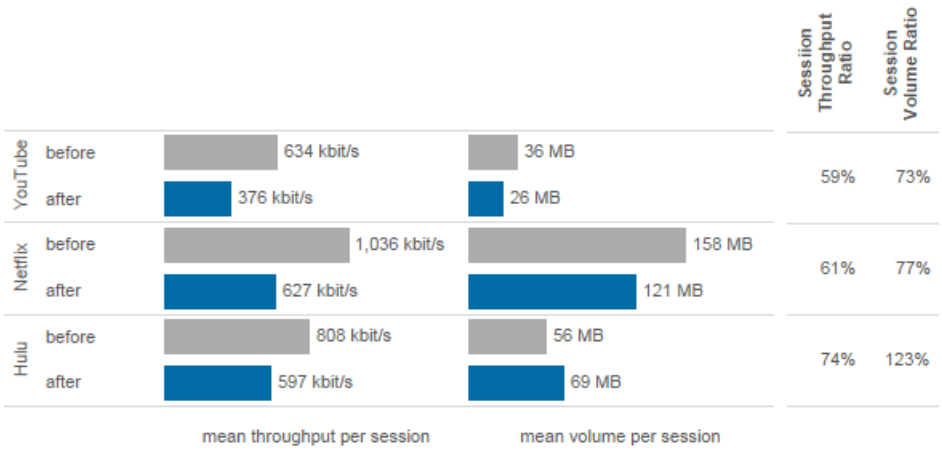

Figure 8: Mean session throughput and volume

In summary, Binge On has two major opposing effects that influence the load in the T-Mobile network: first, customers use video apps *more often and longer*. At the same time, the bandwidth available for the transmission of video content is *reduced*.

We also found that the average data volume a user spends per day with any apps remained about constant. This indicates that the different effects seem to compensate each other to some extent. Assuming that the number of users remained constant as well, this means that T-Mobile has successfully managed to carry more video traffic, while maintaining or even decreasing the load on its network.

About P3

P3 Group is a leading international consulting, engineering and testing services company with a team of over 3,000 consultants and engineers across 50 countries. The company provides a broad portfolio of independent technical and management consulting services including network planning, engineering, end-to-end optimization, market intelligence, security, QoS and QoE testing, international benchmarking, device testing and acceptance services. It is recognized worldwide as the completely neutral authority on network quality. Our unique differentiation lies in our strategic consulting expertise combined with deep technical and engineering skills to offer management solutions to complex problems. P3 telecommunications clients include wireless carriers, infrastructure vendors, device manufacturers, public safety organizations and regulatory authorities. In the Americas, P3 has offices in Detroit, Mich.; Newport Beach and San Jose, Calif.; Morristown, N.J.; Portland, Ore; Greenville, S.C.; Durham, N.C.; Dallas, Texas; Mississauga, Ontario; and Mexico City, Mexico. For more information please visit www.p3-group.com

U.S. Contact

P3 communications, Inc.
412 Mt. Kemble Ave, Suite G20s
Morristown, NJ 07960
Phone: +1 (973) 984 6050
info.communications.inc@p3-group.com

Morristown, NJ
January 15, 2016