COVID-19's Impact on FLET'S Traffic

3.1 Introduction

The COVID-19 situation prompted the closure of Japan's schools nationwide from March, resulting in a sharp rise in people working remotely from home. The changes in many people's Internet usage patterns put a strain on individual services and communication links, and social media was filled with people observing this phenomenon and expressing dissatisfaction. Yet there is not much information out there on the macro situation. As such, we report on the impact on traffic on IIJ's FLET'S-based services as a bellwether of broadband services used mainly in the home.

COVID-19 began spreading in Japan in mid-February. Remote work was still experimental at that point, but in late February, companies like Dentsu and Shiseido embarked on large-scale remote work programs. Schools closed nationwide on March 2, and that same week, many companies initiated remote work, and as more and more people began staying in, there was a sudden paucity of faces on the streets. Trends in FLET'S traffic underwent a clear change from March 2. Later, on March 25, the Tokyo government began urging people to stay indoors. Japan declared a state of emergency covering seven prefectures on April 7, and this was expanded nationwide on April 16. These events greatly altered the societal landscape. Although the number of people staying at home has undoubtedly increased, we have not seen that large a change in FLET'S traffic volume.

3.2 About the Data

The traffic volume data is collected from the interface counters on routers that accommodate the fiber-optic and ADSL customers on IIJ's personal and enterprise broadband services. We use data collected via Sampled NetFlow to study the origin of traffic (sender organizations). Further details about the data are available in last year's Broadband Traffic Report[*1].

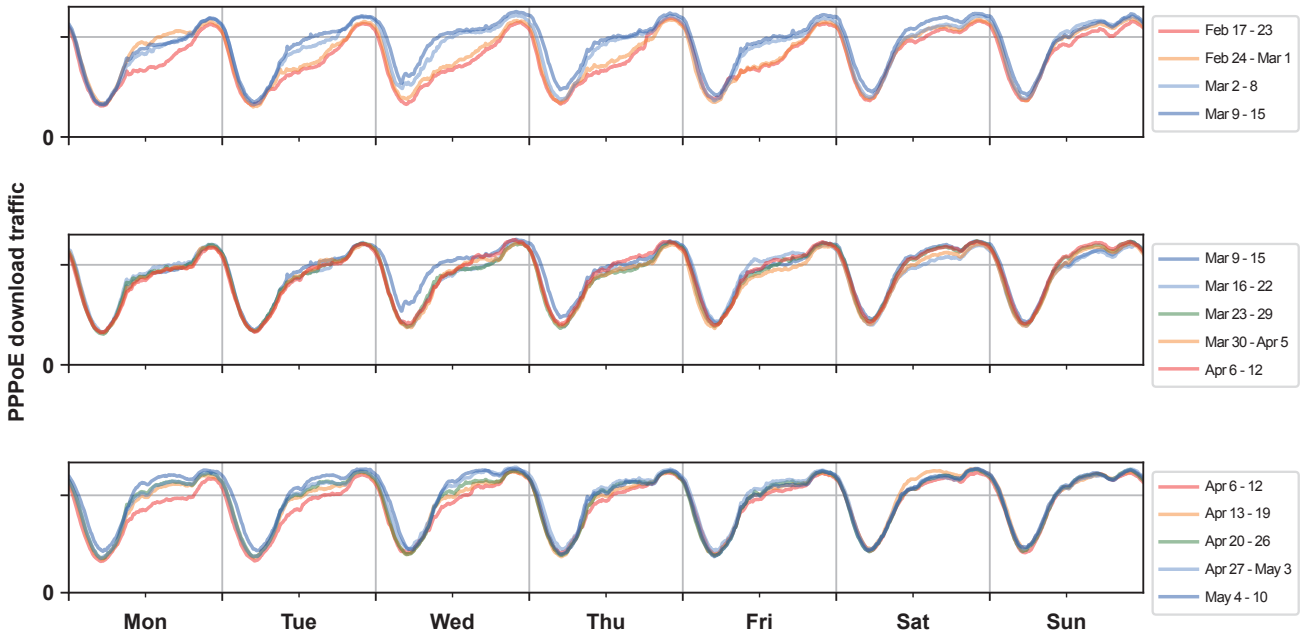

Figure 1: FLET's Traffic
Download: Feb 17 – Mar 15 (top), Mar 16 – Apr 12 (middle), Apr 13 – May 10 (bottom)

*1 Kenjiro Cho, Broadband Traffic Report: Moderate Growth in Traffic Volume Ongoing, Internet Infrastructure Review, Vol.44. pp4-9, November 2019.

3.3 Traffic Condition

IIJ's FLET'S services include IPv6 IPoE in addition to conventional PPPoE. IIJ's IPv6 IPoE service uses Internet Multifeed Co.'s transix service, and the traffic does not pass directly through IIJ's network. The volume of traffic here is currently around 20% of that on PPPoE. Congestion on network termination equipment has become a problem with PPPoE in the past few years, and an increasing number of ISPs are recently recommending the use of IPoE.

3.3.1 FLET'S Traffic (PPPoE)

Figures 1 and 2 overlay IIJ's total FLET'S traffic week by week. This is PPPoE traffic and does not include IPv6 IPoE. Figure 1 shows download and Figure 2 upload traffic.

The chart covers 12 weeks from the week of February 17, broken into three four-week subplots. The middle and bottom subplots contain five weeks of data as they include the final week from the previous subplot for comparison. The holidays in this period are February 24 (Mon), March 20 (Fri), April 29 (Wed), May 4 (Mon), May 5 (Tue), and May 6 (Wed), and the traffic patterns on these days do differ from other weekdays.

Downloads usually peak in the evening and fall off sharply after midnight, with the lowest point coming in the early morning. Daytime traffic is high on weekends/holidays. Upload traffic is almost an order of magnitude smaller than download traffic, and there are no clear peaks.

First, we look at download traffic in Figure 1. Comparing the two weeks represented by the red and orange series with those represented by the aqua and blue series (i.e., before and after March 2) in the top subplot shows that weekday download traffic increased after March 2. Volumes were still a bit lower than on ordinary weekends. The peak values

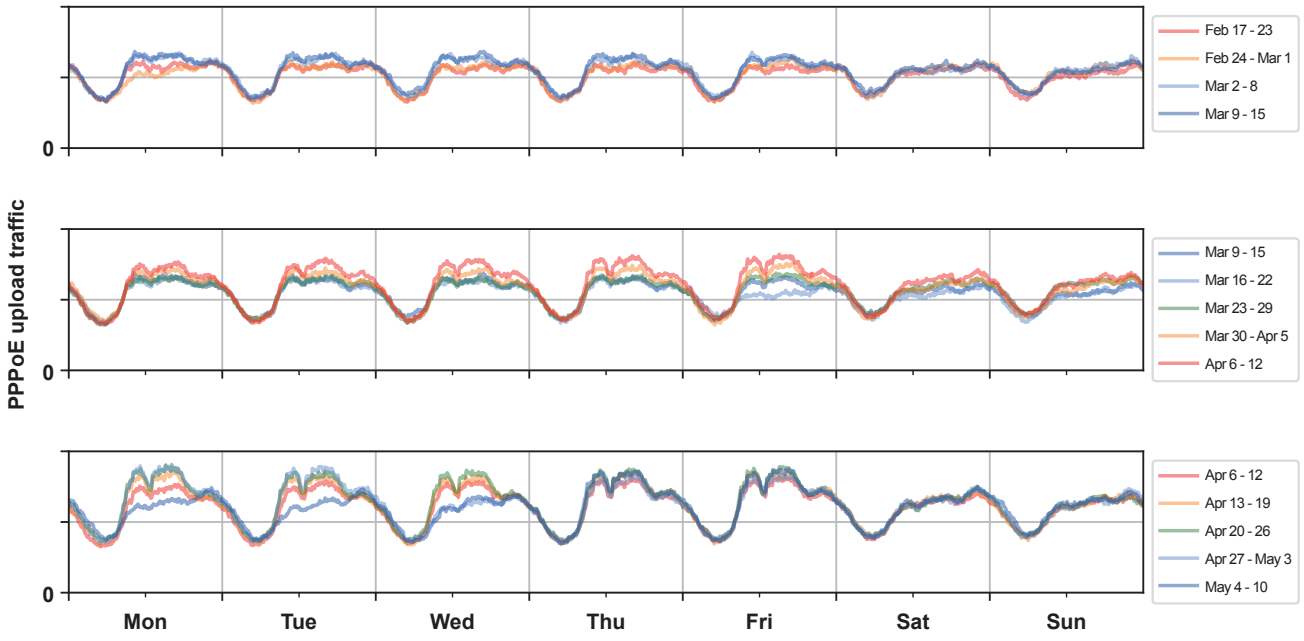

Figure 2: FLET's Traffic
Upload: Feb 17 – Mar 15 (top), Mar 16 – Apr 12 (middle), Apr 13 – May 10 (bottom)

also increased just slightly. Not much changes in the middle subplot, but the bottom subplot shows that weekday daytime traffic began increasing again in April. The increase in traffic from early in the morning on March 11 (Wed) is likely due to the release of the popular video game Call of Duty: Warzone. Microsoft released a monthly update on the same day, and this also probably contributed.

Next, we look at upload traffic in Figure 2. The top subplot shows that daytime traffic on weekdays rose slightly through mid-March, but the increase eased off in the evenings, so it is probably related to video conferencing and other remote work applications. The middle and bottom subplots show a progressive rise in weekday daytimes from April, likely a reflection of remote work arrangements gradually coming together. The dip around lunchtime is probably due to a lull in video conferencing. Through mid-March, upload traffic only increased on weekdays, but thereafter evening and weekend/holiday traffic also rose. We think this is probably due to an increase in video conferencing for private gatherings, like afterwork drinks, as people became accustomed to the tools. The upload peak value, however, is only about 1/7th the download peak value, so upload traffic certainly did not rise as much as download traffic.

To determine whether the increase in weekday daytime traffic was due to specific services, we also looked at Sampled NetFlow data. A comparison of the Tokyo area data for February 26 (Wed) and March 4 (Wed) shows an overall 1.19-fold increase in download volume. By sender

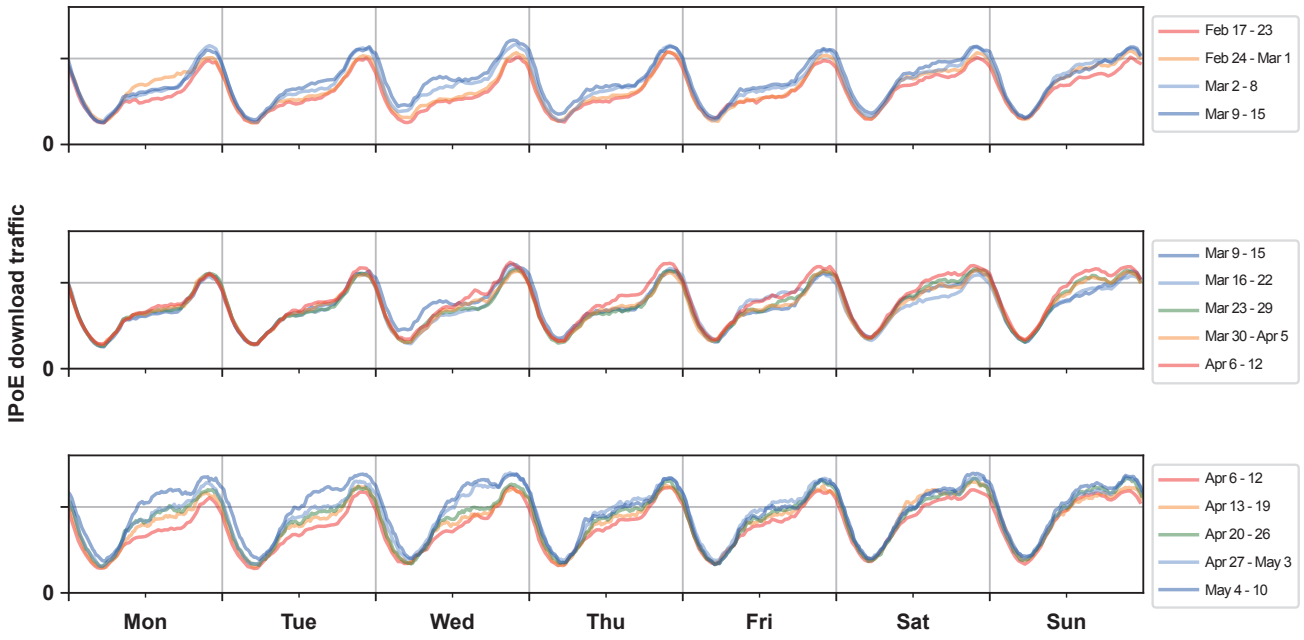

Figure 3: IPv6 IPoE traffic
Download: Feb 17 – Mar 15 (top), Mar 16 – Apr 12 (middle), Apr 13 – May 10 (bottom)

organization (AS), the data show a decent increase in the proportion of traffic from CDN operators, with the breakdown among major content providers remaining largely the same. Specifically, the figures were Google 1.16x, Amazon 1.16x, Netflix 1.17x, Facebook 1.10x, and Microsoft 1.23x. So this was overall growth that was roughly equivalent across different sources of popular content, with no particular service being a clear standout.

To examine the changes that followed, we now compare February 26 (Wed) and April 22 (Wed). Overall download volume was up 1.20 fold, only a slight increase over March 4, but the breakdown among major content providers shifted a little. Specifically, Google was unchanged at 1.16x, while Amazon had 1.63x, Apple 1.00x, Netflix 1.36x, Facebook 1.32x, and Microsoft 2.40x. This points to growth in full-length video content, such as movies, and content tied to business applications.

3.3.2 IPv6 IPoE Traffic

The reason PPPoE peak traffic is not rising could be that the FLET'S network is congested, so here we look at IPv6 IPoE, which should have ample capacity. Figures 3 and 4 plot IPv6 IPoE traffic volume. The download chart certainly shows the peaks rising, by a few percent in the top subplot, barely at all in the middle subplot, and then again by a few percent in the bottom subplot. And compared with PPPoE, weekday daytime traffic is lower relative to its peak. The increase in weekday daytime upload traffic is also smaller than for PPPoE.

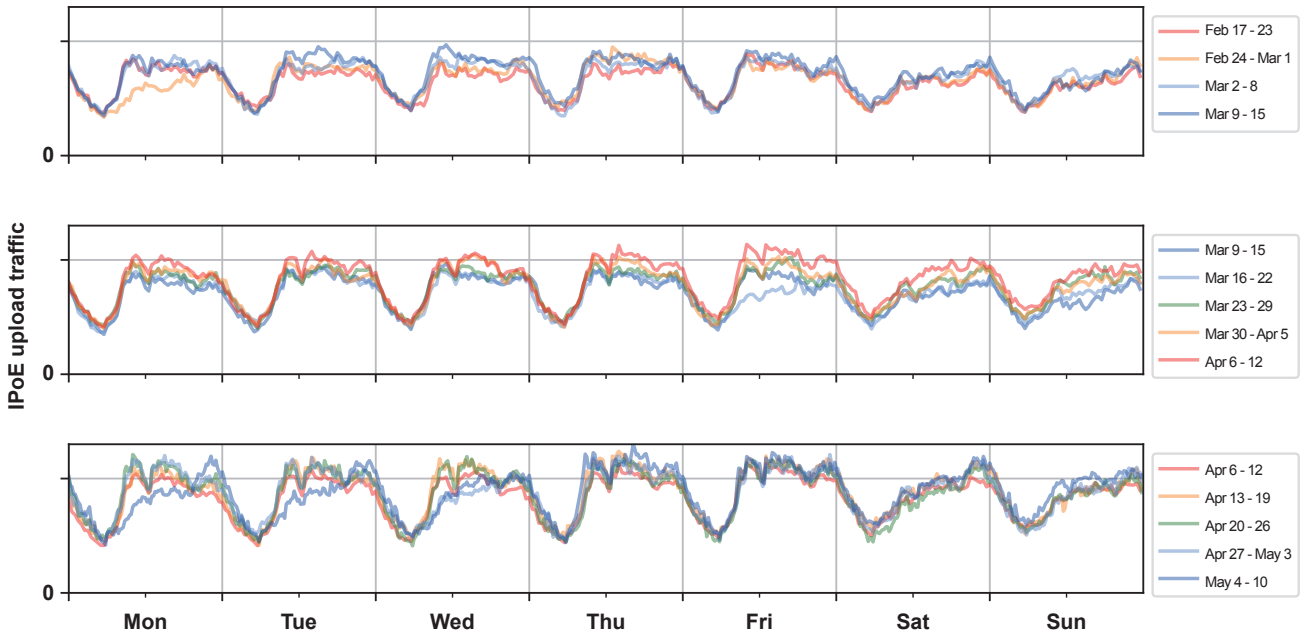

Figure 4: IPv6 IPoE traffic
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3.4 Discussion

We were only able to take observations from IIJ services on this occasion, which tells us nothing about trends at other companies. In mid-April, however, NTT East[*2], NTT West[*3], and NTT Communications[*4] released data on FLET'S traffic volumes. Figure 5 plots the changes in weekday traffic based on IIJ's PPPoE data in the same manner as the graphs published by the NTT companies. The plot shows average download (DL) and upload (UL) traffic for the weeks of February 25 and April 20. It almost matches the observations of the NTT companies, so we think the same trends basically held for FLET'S-based broadband services. We also think the situation on non-FLET'S networks with sufficient available bandwidth is close to what we observe for our IPoE traffic.

From a macro view, weekday daytime traffic clearly increased after March 2. On weekdays, daily upload traffic was up about 6% and download traffic about 15%. A 15% increase in daily downloads is about the same as the difference between weekdays and weekends, but another way to look at it is that an increase that would normally take six months happened in a single day. But the peak values did not rise much, so from an ISP perspective, the former interpretation makes sense. The reason the peaks did not rise much may be due to capacity shortages on the FLET'S network's PPPoE network termination equipment. There may also be congestion at FLET'S network optical splitters or on consumer devices and wiring in apartment buildings. But such problems arise at the individual device level, so the peaks should be rising where there is ample capacity, but we did not observe any such differences over our observational range.

IPoE peak traffic is increasing, but IPoE traffic depends on the availability of content over IPv6, so the content breakdown differs from that for PPPoE and is not directly comparable. Also, the number of PPPoE contracts has hit a ceiling, whereas the ongoing shift to IPoE to avoid the congestion on PPPoE means that IPoE contract numbers are also growing. In overall terms, while the growth in IPoE download peak levels seems to indicate that PPPoE is running out of capacity, the potential room for an increase in PPPoE peaks is probably smaller than the amount by which IPoE has increased.

Some changes are apparent in March and April too. In March, it looks like overall Internet usage increased as the number of people at home during the daytime on weekdays increased. Then in April, it looks like traffic related to movie streaming and remote work increased as users got their systems set up properly and became accustomed to the tools. As a characteristic effect of remote work, the increase in weekday daytime upload traffic is probably due mainly to video conferencing. But the volume is not all that large through the latter half of March, likely because the number of people video conferencing from home was still limited. Working efficiently when remoting in requires not only a decent home network setup and equipment, including a PC, but also some level of experience. Companies

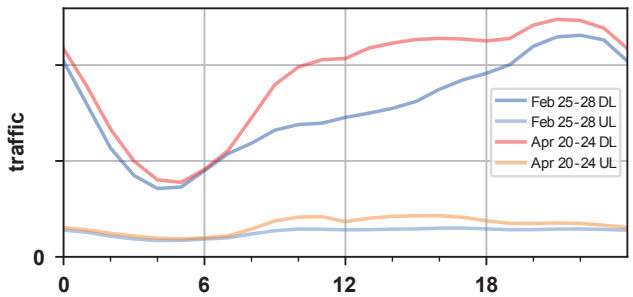

Figure 5: Average Weekday Traffic by Time of Day: February vs. April

*2 NTT East, "NTT East's efforts in response to COVID-19" (https://www.ntt-east.co.jp/aboutus/COVID-19.html#traffic, in Japanese).
*3 NTT West, "NTT West: Download traffic across all areas" (https://www.ntt.co.jp/topics/important/covid19_west.html, in Japanese).
*4 NTT Communications, "Internet traffic time series data" (https://www.ntt.com/about-us/covid-19/traffic/, in Japanese).

were apparently experiencing problems on their end, including a shortage of VPN licenses and bandwidth. And many people were probably not fully set up for video conferencing when initially trying it out. The breakdown in growth by operator shows a uniform rise in traffic from the major content providers in March, followed by growth for movie content providers and providers of remote work-related services in April.

It is also clear that traffic falls when the weather is good and rises when it is bad. People are thought to have relaxed and thus ventured out more amid favorable weather over the March 20–22 (Fri–Sun) long weekend, and as if to back this up, traffic was low over that period. Eastern Japan and the Tohoku region had stormy weather on April 18 (Sat), and traffic increased on this day. Traffic was also on the high side in Kanto on April 13 and 20, perhaps because these consecutive Mondays were both rainy.

Growth in broadband traffic was actually accelerating even before COVID-19 spread. Factors potentially behind this include households becoming better equipped to stream video as people replaced old PCs ahead of the Windows 7 end-of-life and Japan's consumption tax hike, the progressive introduction of remote work arrangements as part of work-style reforms and efforts to cope with the Olympics, and increasing interest in video streaming fueled by expectations for online streaming of the Olympics and TV broadcasts, 5G mobile services, and the like.

Video overwhelms other types of content in terms of sheer volume, however, so usage trends for non-video content are not really evident from the traffic observations because video streaming dominates download traffic and video conferencing dominates upload traffic. There are limits to what traffic alone can tell us about trends in Internet usage.

3.5 Conclusion

The spread of COVID-19 has fueled a rapid shift toward remote work. This has revealed problems with individual communication links and services, yet on a macro level, although weekday daytime traffic has increased, it has recently settled at levels within the bounds of existing capacity.

Remote work and remote education were rolled out on a huge scale from March. Until now, remote work had been an experimental affair carried out by a select few, but we are now finding out whether everyone can do it at once. And although the quality of Internet-based video conferencing, remote classes, video streaming, and the like is currently sufficient when only some people are engaged, it will take years to build systems that can cope with large numbers of people all at once. Present circumstances have made clear that society as a whole depends on online systems when push comes to shove. Our hope is that this will provide a strong impetus for reaffirming the importance of developing Internet infrastructure.

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