Broadband Traffic Report
Looking Back on the Past Five Years

1.1 Overview

In this report, we analyze traffic over the broadband access services operated by IIJ and present the results each year[*1*2*3*4*5]. Here, we again report on changes in traffic trends over the past year, based on daily user traffic and usage by port. Then in the latter part of this report, we take a look back at changes in traffic over the past five years, encompassing the COVID-19 pandemic.

Overall, traffic continued to grow steadily this year, similar to last year. We see no notable changes in the trends at this point.

Figure 1 plots the overall average monthly traffic trends for IIJ's fixed broadband services and mobile services. IN/OUT indicates the direction from the ISP perspective. IN represents uploads from users, and OUT represents user downloads. Because we cannot disclose specific traffic numbers, we have normalized the data, setting the OUT observations for January 2020, just before the pandemic, for both services to 1.

Over the past year, broadband IN traffic increased 14% and broadband OUT traffic increased 12%. The corresponding year-earlier figures were 11% and 18%.

The broadband figures include IPv6 IPoE traffic. IPv6 traffic on IIJ's broadband services comprises both IPoE and PPPoE traffic. As of June 2024, IPoE accounted for a bit under 50% of all traffic, at 43% of IN and 48% of OUT broadband traffic overall, year-on-year increases of 1 percentage point for IN and 4 points for OUT. As is evident from the graph, PPPoE traffic has been range-bound since 2020, and IPoE is driving the increase in traffic.

Mobile services traffic was largely range-bound in the first year or so of COVID as people went out less, but it has subsequently been in an uptrend. Over the past year, mobile IN traffic increased 29% and mobile OUT traffic increased 20%. The year-earlier figures were 27% and 31%. This year, OUT reached 2.1x the January 2020 level, and as Figure 1 shows, post-COVID growth has caught up with that for broadband.

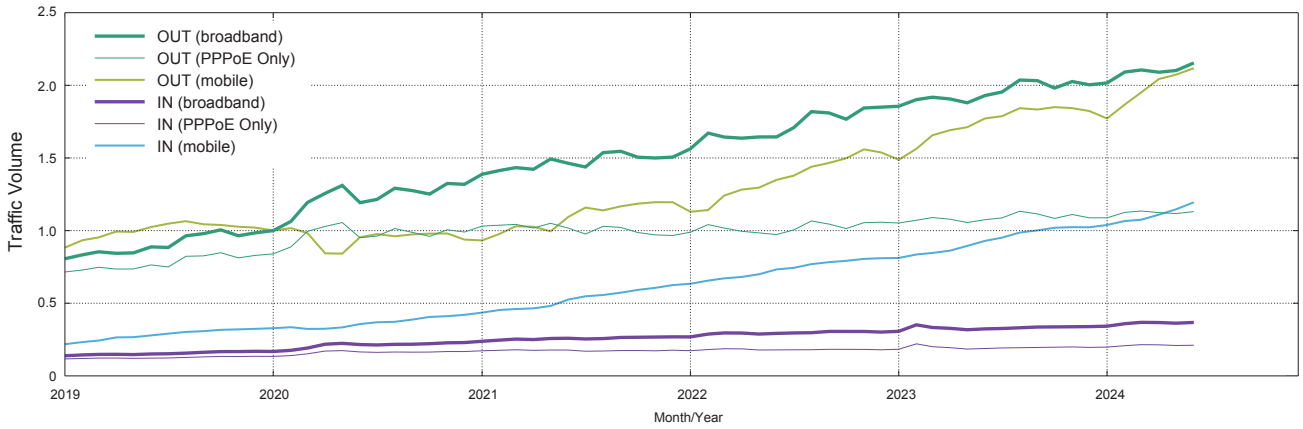

Figure 1: Monthly Broadband and Mobile Traffic

*1 Kenjiro Cho. Broadband Traffic Report: Broadband Traffic Report: Traffic in a Stable Uptrend Post-COVID. Vol. 60. pp4-9. September 2022.
*2 Kenjiro Cho. Broadband Traffic Report: Broadband Traffic Report: COVID's 3rd Year Brings Lull in Traffic. Vol. 56. pp4-11. September 2022.
*3 Kenjiro Cho. Broadband Traffic Report: Broadband Traffic Report: COVID-19's Impact in its 2nd Year. Vol. 52. pp4-11. September 2021.
*4 Kenjiro Cho. Broadband Traffic Report: The Impact of COVID-19. Vol. 48. pp4-9. September 2020.
*5 Kenjiro Cho. Broadband Traffic Report: Moderate Growth in Traffic Volume Ongoing. Vol. 44. pp4-9. September 2019.

Mobile services IN traffic accounts for a high proportion of total because of the high volume of uploads on services for enterprise customers. Looking solely at personal services, IN accounts for around a tenth of the total, similar to the situation for broadband.

We now look at broadband traffic by time of day on weekdays over the past year. Figure 2 plots hourly average traffic volume for Monday–Friday for four one-week blocks selected at intervals of roughly four months since May 2023. Weekday daytime traffic volumes have increased during school holiday periods in recent years, so we selected school weeks. Traffic volume here is the sum of PPPoE and IPoE. The dotted lines in the lower part of the plot represent uploads for each week, but focusing again on download volumes in this edition, we see that traffic volumes were up across all times of the day.

1.2 About the Data

As with previous reports, for broadband traffic, our analysis uses data sampled using Sampled NetFlow from the routers that accommodate the fiber-optic and DSL broadband customers of our personal and enterprise broadband access services. For mobile traffic, we use access gateway billing information to determine usage volumes for personal and enterprise mobile services, and we use Sampled NetFlow data from the routers used to accommodate these services to determine the ports used.

Because traffic trends differ between weekdays and weekends, we analyze traffic in one-week chunks. In this report, we look at data for the week of June 3 – 9, 2024, and compare those data with data for the week of May 29 – June 4, 2023, which we analyzed in the previous edition of this report.

Results are aggregated by subscription for broadband traffic, and by phone number for mobile traffic as some subscriptions cover multiple phone numbers. The usage volume for each broadband user was obtained by matching the IP addresses assigned to users with the IP addresses observed. Note that IPoE traffic is not included in the analysis of traffic by port, as detailed data are not available because we use Internet Multifeed Co.'s transix service for IPoE.

1.3 Users' Daily Usage

First, we examine daily usage volumes for broadband and mobile users from several angles. Daily usage indicates the average daily usage calculated from a week's worth of data for each user.

Since our 2019 report, we have used daily usage data only on services provided to individuals. The distribution is heavily distorted if we include enterprise services, where usage patterns are highly varied. So to form a picture of overall usage trends, we determined that using only the personal user data would yield more generally applicable, easily interpretable conclusions. Note that the analysis of usage by port in the next section does include enterprise data because of the difficulty of distinguishing between individual and enterprise usage. Note also that we have included IPoE user data in the broadband figures since 2021, so the broadband data comprise both PPPoE and IPoE*6.

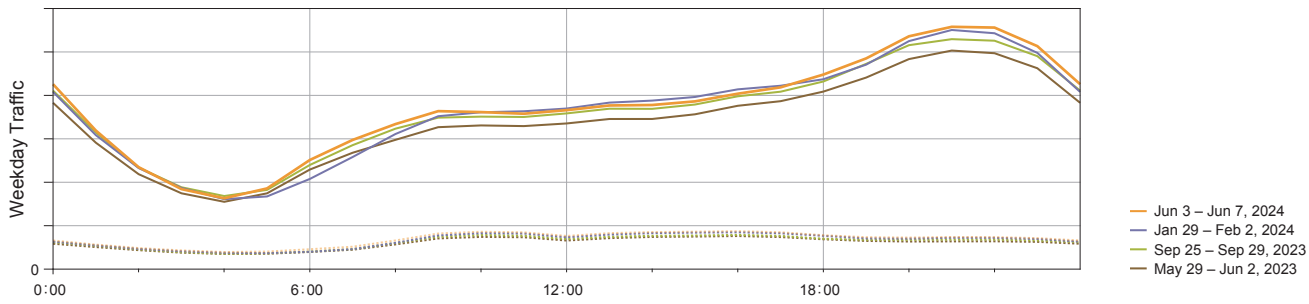

Figure 2: Hourly Average Broadband Traffic on Weekdays in the Past Year

*6 The PPPoE and IPoE usage figures of users who use both protocols are treated as coming from separate users.

Figures 3 and 4 show the average daily usage distributions (probability density functions) for broadband and mobile users. Each compares data for 2023 and 2024 split into IN (upload) and OUT (download), with user traffic volume plotted along the X-axis and user frequency along the Y-axis. The X-axis shows volumes between 10KB (10^4) and 100GB (10^{11}) using a logarithmic scale. Most users fall within the 100GB (10^{11}) range, with a few exceptions.

The IN and OUT traffic distributions in the figures are close to a log-normal distribution, which looks like a normal distribution on a semi-log plot. A linear plot would show a long-tailed distribution, with the peak close to the left. The OUT distribution is further to the right than the IN distribution, indicating that download volume is more than an order of magnitude larger than upload volume.

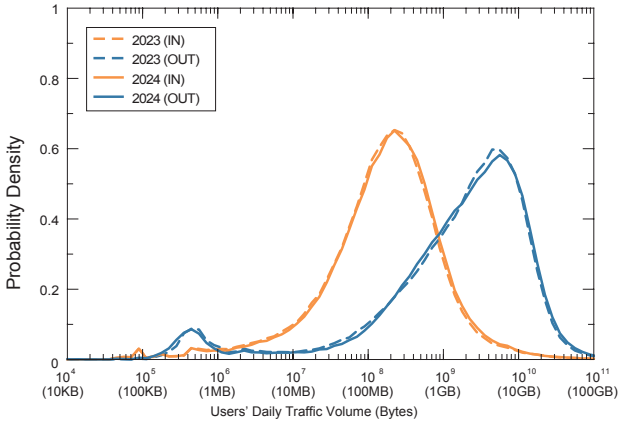

Figure 3: Daily Broadband User Traffic Volume Distribution Comparison of 2023 and 2024

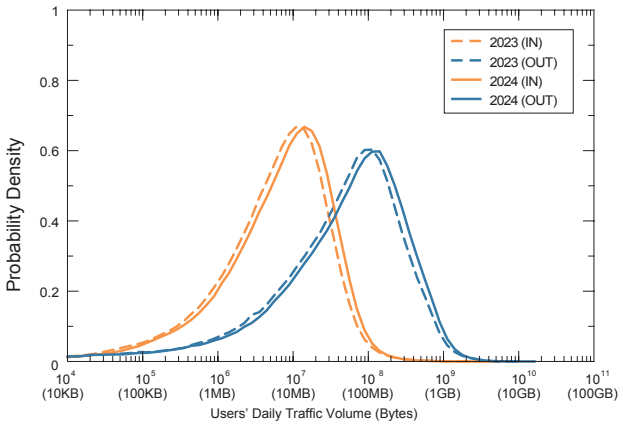

Figure 4: Daily Mobile User Traffic Volume Distribution Comparison of 2023 and 2024

First, we look at the broadband distributions in Figure 3. Comparing 2023 and 2024, both the IN and OUT distributions have moved ever so slightly to the right, but you can see that overall traffic volume is largely unchanged.

The peaks of the mobile distributions in Figure 4 have moved a little to the right since last year, indicating that overall traffic has increased. Mobile usage volumes are significantly lower than for broadband, and limits on mobile data usage mean that heavy users, which fall on the right-hand side of the distribution, account for only a small proportion of the total. There are also no extremely heavy users. The variability in each user's daily usage volume is higher for mobile than for broadband owing to there being users who only use mobile data when out of the home/office as well as limits on mobile data.

Table 1 shows trends in the mean and median daily traffic values for broadband users as well as the mode (the most frequent value, which represents the peak of the distribution). When the peak is slightly off the center of the distribution, the mode is adjusted to bring it toward the center. Comparing 2023 and 2024, the IN mode remained

Table 1: Trends in Mean and Mode of Broadband Users' Daily Traffic Volume

	IN(MB/day)			OUT(MB/day)		
Year	Mean	Median	Mode	Mean	Median	Mode
2007	436	5	5	718	59	56
2008	490	6	6	807	75	79
2009	561	6	6	973	91	100
2010	442	7	7	878	111	126
2011	398	9	9	931	144	200
2012	364	11	13	945	176	251
2013	320	13	16	928	208	355
2014	348	21	28	1124	311	501
2015	351	32	45	1399	443	708
2016	361	48	63	1808	726	1000
2017	391	63	79	2285	900	1259
2018	428	66	79	2664	1083	1585
2019	479	75	89	2986	1187	1995
2020	609	122	158	3810	1638	3162
2021	714	143	200	4432	2004	3981
2022	727	142	178	4610	2010	3981
2023	804	166	224	5456	2369	5012
2024	834	178	224	5743	2372	5620

at 224MB while the OUT mode rose from 5,012MB to 5,620MB, translating into growth factors of 1.00 for IN and 1.12 for OUT. Meanwhile, because the means are influenced by heavy users (on the right-hand side of the distribution), they are significantly higher than the corresponding modes, with the IN mean at 834MB and the OUT mean at 5,743MB in 2024. The 2023 means were 804MB and 5,456MB, respectively. As mentioned, up to 2020 the data covered only PPPoE users, and since 2021 the data have covered both PPPoE and IPoE users.

Table 2 shows the mobile traffic metrics. In 2024, the IN mode was 14MB and the OUT mode was 112MB, while the means were IN 16MB and OUT 150MB. The 2023 modes were IN 11MB and OUT 100MB, and the means were IN 14MB and OUT 129MB.

Table 2: Trends in Mean and Mode of Mobile Users' Daily Traffic Volume

	IN (MB/day)			OUT (MB/day)		
Year	Mean	Median	Mode	Mean	Median	Mode
2015	6.2	3.2	4.5	49.2	23.5	44.7
2016	7.6	4.1	7.1	66.5	32.7	63.1
2017	9.3	4.9	7.9	79.9	41.2	79.4
2018	10.5	5.4	8.9	83.8	44.3	79.4
2019	11.2	5.9	8.9	84.9	46.4	79.4
2020	10.4	4.5	7.1	79.4	35.1	63.1
2021	9.9	4.7	7.9	85.9	37.9	70.8
2022	12.8	6.0	10.0	113.7	49.2	89.1
2023	14.1	6.8	11.2	129.2	56.0	100.0
2024	16.3	8.2	14.1	150.4	66.7	112.2

Figures 5 and 6 plot per-user IN/OUT usage volumes for random samples of 5,000 users. The X-axis shows OUT (download volume) and the Y-axis shows IN (upload volume), with both using a logarithmic scale. Users with identical IN/OUT values fall on the diagonal.

The cluster spread out below and parallel to the diagonal in each of these plots represents typical users with download volumes an order of magnitude higher than upload volumes. Variability between users in terms of usage levels and IN/OUT ratios is wide, indicating that there is a diverse range of usage styles. For mobile traffic, the pattern of OUT being an order of magnitude larger also applies, but usage volumes are much lower than for broadband. For both broadband and mobile, there appears to be almost no difference between these plots and those for 2023.

Traffic is heavily skewed across users, such that a small proportion of users accounts for the majority of overall traffic volume. For example, the top 10% of broadband users account for 50% of total OUT and 75% of total IN traffic, while the top 1% of users account for 15% of OUT and 46% of IN traffic. On mobile, the top 10% of users account for 48% of total OUT and 45% of total IN traffic, while the top 1% of users account for 12% of OUT and 13% of IN traffic.

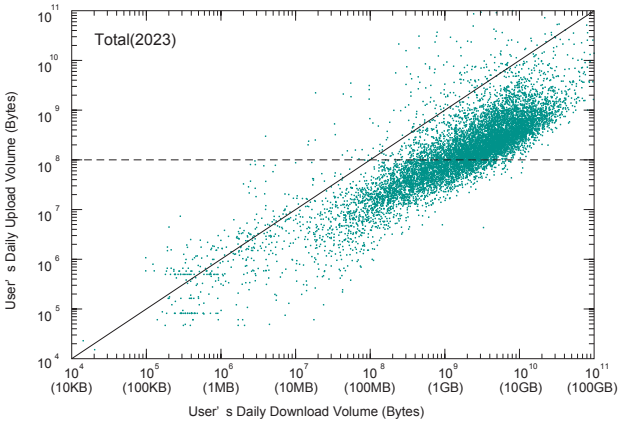

Figure 5: IN/OUT Usage for Each Broadband User

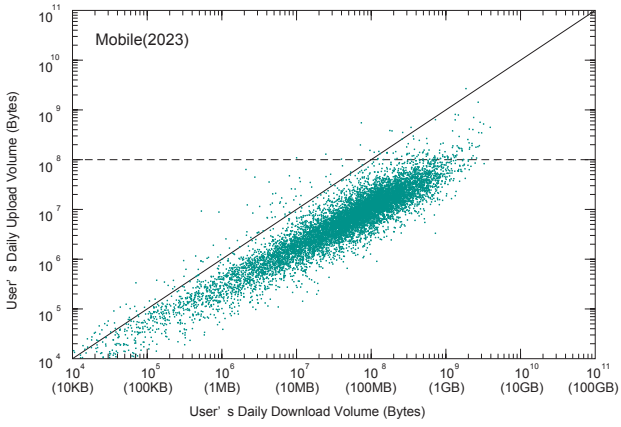

Figure 6: IN/OUT Usage for Each Mobile User

1.4 Usage by Port

Next, we look at a breakdown of traffic and examine usage levels by port. Recently, it has become difficult to identify applications by port number. Many P2P applications use dynamic ports on both ends, and a large number of client/server applications use HTTP ports like port 80 to avoid firewalls. Hence, generally speaking, when both parties are using a dynamic port numbered 1024 or higher, the traffic is likely to be from a P2P application, and when one of the parties is using a well-known port lower than 1024, the traffic is likely to be from a client/server application. In light of this, we take the lower of the source and destination port numbers when breaking down TCP and UDP usage volumes by port.

Table 3 shows the percentage breakdown of broadband users' usage by port over the past five years. In 2024, 68% of all traffic was over TCP connections, down 3 points from 2023. The proportion of traffic over port 443 (HTTPS) was 54%, a 3-point drop from last year. The proportion of traffic over port 80 (HTTP) was 7%, having declined ever so slightly. The figure for UDP port 443, which is used by the QUIC protocol, was up 3 points to 21%.

TCP dynamic port traffic rose ever so slightly to 6%. Individual dynamic port numbers account for only a tiny portion, with the most commonly used port 31000 only making up 1.2%.

Table 4 shows the percentage breakdown by port for mobile users. The figures are close to those for broadband on the whole. This is possibly because apps similar to those for PC platforms are now also used on smartphones, and because the proportion of broadband usage on smartphones is rising.

The broadband port data only include PPPoE, not IPoE, and so do not necessarily reflect the trend in fixed broadband overall. Comparing IPv4 and IPv6 on mobile, port 443 accounts for a higher proportion of both TCP and UDP usage on IPv6, and there is probably a similar trend in the case of IPoE.

Table 3: Broadband Users' Usage by Port

year	2020	2021	2022	2023	2024
protocol port	(%)	(%)	(%)	(%)	(%)
TCP	**77.2**	**71.9**	**71.6**	**70.5**	**67.5**
(< 1024)	70.5	65.8	65.4	64.8	61.1
443 (https)	52.4	53.5	55.7	56.9	53.8
80 (http)	17.2	11.6	8.9	7.2	6.5
183	0.0	0.1	0.2	0.2	0.2
993 (imaps)	0.2	0.1	0.1	0.1	0.1
22 (ssh)	0.2	0.2	0.1	0.1	0.1
(>= 1024)	6.7	6.1	6.2	5.7	6.4
31000	0.4	0.6	0.9	1.1	1.2
1935 (rtmp)	0.4	0.2	0.2	0.2	0.3
8080	0.4	0.4	0.3	0.4	0.3
UDP	**19.4**	**24.5**	**24.3**	**25.4**	**28.2**
443 (https)	10.5	15.9	16.3	18.2	21.0
4500 (nat-t)	0.6	0.8	0.8	1.0	0.9
8801	1.1	0.9	0.6	0.4	0.4
ESP	**3.2**	**3.3**	**3.8**	**3.8**	**4.0**
GRE	**0.1**	**0.2**	**0.2**	**0.1**	**0.2**
IP-ENCAP	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**
ICMP	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

Table 4: Mobile Users' Usage by Port

year	2020	2021	2022	2023	2024
protocol port	(%)	(%)	(%)	(%)	(%)
TCP	**75.5**	**70.3**	**71.6**	**71.0**	**71.0**
443 (https)	50.7	44.4	42.3	42.1	42.2
80 (http)	7.4	5.0	4.1	3.5	1.8
993 (imaps)	0.2	0.2	0.1	0.1	0.1
1935 (rtmp)	0.1	0.1	0.1	0.2	0.1
UDP	**18.0**	**23.8**	**24.4**	**26.5**	**27.5**
443 (https)	9.3	16.3	17.9	20.9	22.5
4500 (nat-t)	1.8	3.7	2.7	2.5	1.8
51820	0.0	0.0	0.1	0.2	0.3
53 (dns)	0.1	0.2	0.2	0.2	0.2
8801	1.4	0.7	0.3	0.2	0.1
ESP	**6.4**	**5.8**	**3.9**	**2.4**	**1.4**
GRE	**0.1**	**0.1**	**0.0**	**0.0**	**0.0**
ICMP	**0.0**	**0.0**	**0.0**	**0.1**	**0.0**

Figure 7 compares overall broadband traffic for key port categories across the course of the week from which observations were drawn in 2023 and 2024. We break the data into four port buckets: TCP ports 80 and 443, dynamic TCP ports (1024 and up), and UDP port 443. The data are normalized so that peak overall traffic volume on the plot is 1. The overall peak is around 19:00–23:00. There are no major changes overall relative to 2023, but traffic on UDP port 443 increased a little.

Figure 8 shows the trend for TCP ports 80 and 443 and UDP port 443, which account for the bulk of mobile traffic. As was the case with broadband, mobile traffic on UDP port 443 was up slightly compared with 2023. Comparing the plots with those for broadband, usage times evidently differ, with mobile having three separate traffic peaks on weekdays: morning commute, lunch break, and evening.

1.5 Looking Back on the Past Five Years

Let's take a look back at trends in broadband traffic volumes over the past five years, which encompassed the COVID-19 pandemic.

First, we'll look at average monthly traffic volume on IIJ's fixed broadband services overall, as shown in Figure 1. Over the five years from June 2019 to June 2024, IN traffic increased 1.72x and OUT traffic increased 2.01x, which work out to annual growth rates of 1.11x and 1.15x.

Next, Figure 9 displays five years of data for the weekday broadband traffic volumes shown in Figure 2. Since we only have hourly data remaining for weeks we have analyzed in the past, Figure 9 only compares those specific weeks, starting with February 2020 just before the COVID-19 pandemic, and then weeks covering periods in late May to mid-June in each year thereafter. It is evident from the graph that traffic has increased fairly evenly across all time periods.

Figure 10 is an enlarged view of the upload data from Figure 9. The proportion of traffic occuring during the daytime on weekdays has clearly increased vs. before COVID. While download traffic peaks from evening through to nighttime, uploads peak in the early afternoon. While it is difficult to tell from the graph because the values for each hour are

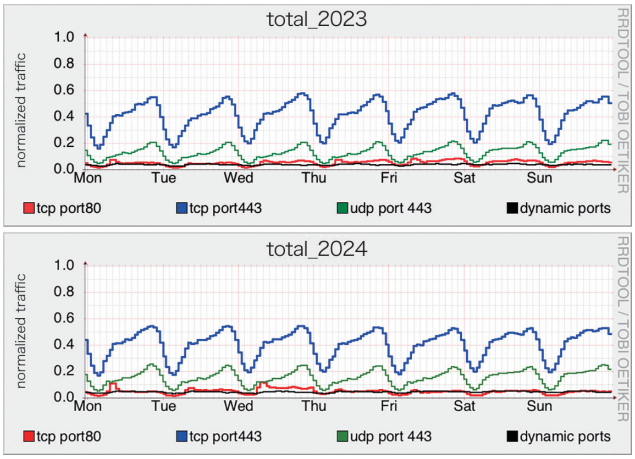

Figure 7: Broadband Users' Port Usage Over a Week
2023 (top) and 2024 (bottom)

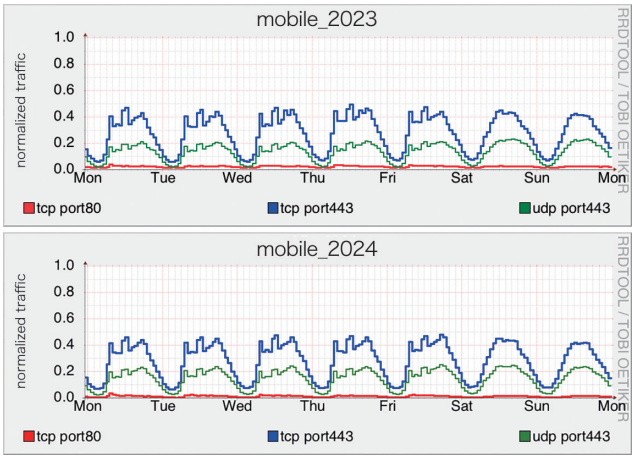

Figure 8: Mobile Users' Port Usage Over a Week
2023 (top) and 2024 (bottom)

displayed using a discrete line plot, traffic declines from 12:00 to 13:00 on weekdays. This drop during lunchtime probably reflects a drop in remote work-related usage, especially video conferencing. The annual increase in upload traffic has also been fairly constant.

Figure 11 shows five years of data for the distribution of daily traffic volume, which we looked at in Figure 3. These are the values for end-May through early June each year that we analyze in this report. The largest increase was from 2019 to 2020, with a particularly large increase in uploads. Since 2020, however, we have seen a relatively stable increase. Over the five years from 2019 to 2024, the mode (the most frequent value, which represents the peak of the distribution) has increased 2.8x for OUT (download), from 2.0GB to 5.6GB, and 2.5x for IN (upload), from 89MB to 224MB.

In past reports from the COVID days[*3*4], we reported that traffic volumes fluctuated heavily in response to changes in rates of people staying at home amid the spread of infections. During the first State of Emergency Japan declared during COVID, restrictions on leaving the home meant that people were only able to engage in activities online, and the rapid uptake of video conferencing and video streaming resulted in a large increase in traffic volumes. At first, there were concerns this would put a strain on the Internet infrastructure. Looking at the long-term trend, however, traffic volume has increased almost uniformly each year, and the rate of increase is by no means large. Yet it is evident that some changes in our daily lives have also taken hold—for instance, traffic that may reasonably be attributed to remote working on weekdays and video streaming during long school holidays is increasing year after year.

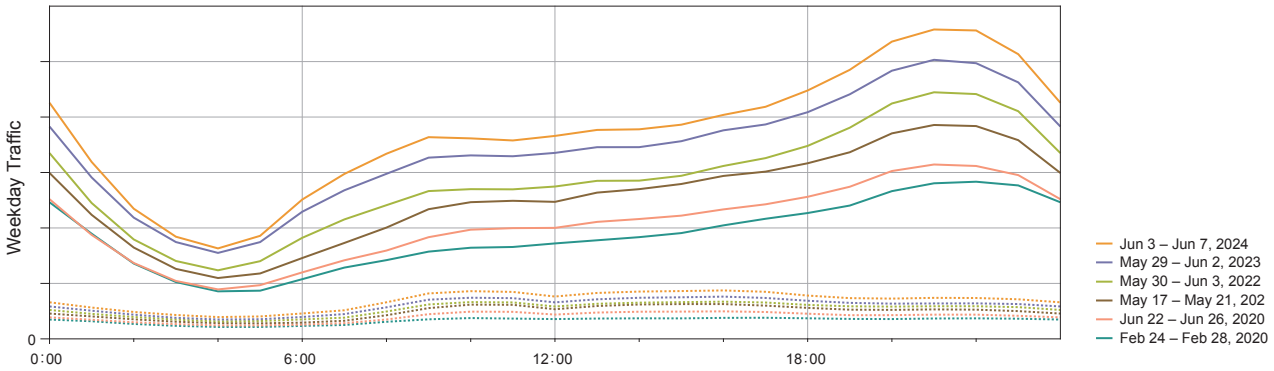

Figure 9: Hourly Average Broadband Traffic on Weekdays in the Five Past Years

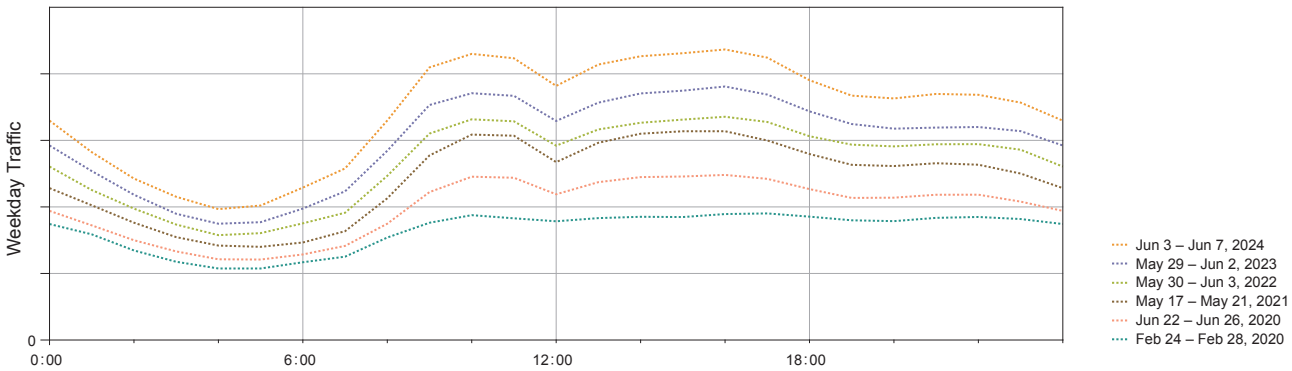

Figure 10: Hourly Average Broadband Traffic (Uploads) on Weekdays in the Five Past Years

1.6 Conclusion

Broadband traffic has been increasing relatively steadily over the past few years, with very little change in the overall trend. But while the changes from year to year may be small, over the span of five years, the cumulative changes do have an impact.

I am writing this report in mid-July, just before the Paris Olympics. When writing my installment of this report five years ago, I never dreamed that something like COVID would befall us. I just had a vague idea that online streaming would probably increase the following year with the Tokyo Olympics set to take place. Today we take things like online sports broadcasts, remote working, and the idea of doing all sorts of clerical tasks online for granted, but that wasn't the case five years ago. We are now able to do more over the Internet than we could have imagined back then. Much still needs to be improved, of course, but as I write this I am again reminded that the Internet continues to change the way we live.

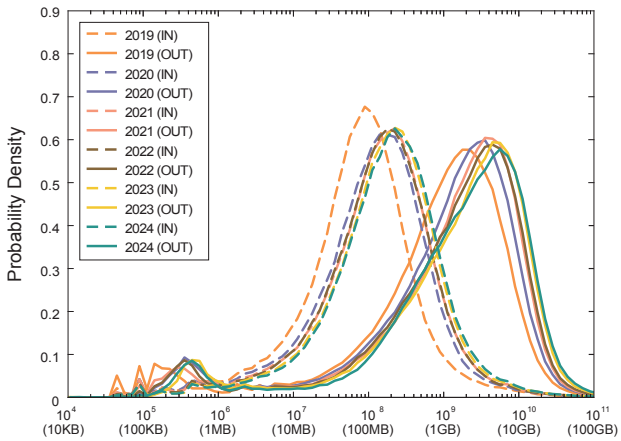

Figure 11: Daily Broadband User Traffic Volume Distributions in the Past Five Years

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