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Report on New Zealand Broadband Quality

Three months to June 2009

Published on 23 September 2009

This report is part of a continuing series measuring changes in New Zealand broadband performance over time. The Commission undertakes this reporting as part of its monitoring of competition in New Zealand telecommunications markets.

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EXECUTIVE SUMMARY

1. There was an improvement in the average New Zealand broadband performance in the June quarter, according to the testing undertaken by Epitiro for the Commission. A key reason was full implementation of caching solutions for international traffic by Telecom in particular.

2. Despite the improvements in performance attributable to increased investment in caching undertaken in the previous quarter, there are still only three ISPs, Telecom, TelstraClear and Slingshot, that are using caching to improve the speed of accessing international content. Many ISPs are delaying or foregoing the implementation of caching for a variety of reasons, including security issues and capital constraints.

3. National web browsing speeds were highest for those test sites located near Auckland and, with the exception of Hamilton, gradually become poorer the further the test site is from Auckland. The best performing ISPs recorded speeds of up to 6Mbps in Auckland. At the other end of the spectrum, those in Dunedin showed the slowest average speeds of little more than 3 Mbps. As almost all ISPs have their core network in Auckland, the difference in performance is likely to be attributable to the need to route traffic from the user location through to Auckland. Some ISPs are reputedly putting in place new backhaul arrangements for South Island cities, which may bring South Island speeds closer to those recorded in the North Island.

4. Some improvement in the results for the quarter arise from a decision by an ISP to turn off a transmission setting known as interleaving[1] for the Epitiro test sites. Users who live reasonably close to an exchange (within several kilometres) may experience an increase in performance by requesting their ISP to turn off interleaving. Most ISPs leave the interleave setting on unless otherwise requested in order to improve stability. Users should consult with their ISP as to whether they may receive a performance boost by turning their interleaving off.

5. The availability of broadband is improving, with Telecom achieving a May average of 99.99 percent internet availability. Four ISPs (Snap, TelstraClear Cable, Woosh and WorldxChange) achieved better than 99.99 percent availability in July.

6. Testing this quarter showed most ISPs had relatively little variability in web browsing performance over the course of the day or the week. However, variability appears to be particularly significant for several of the smaller ISPs.

[1] Interleaving is a method of transmitting data packets in a way that corrects transmission faults and provides stability. However, this process increases latency and can slow download speeds. It was designed to increase the reliability of connections a long way from the exchange, but it is of less value to users who are close to an exchange and have good transmission.

INTRODUCTION

7. This report is part of a continuing series measuring changes in New Zealand broadband performance over time. Previously Epitiro, together with IDC, has been publishing this report on contract for the Commission, largely relying on a proprietary index populated with data from its ISP-I platform. With this report, the Commission has undertaken the analysis of the index results and underlying data provided by Epitiro.

8. The report continues to utilise data from Epitiro's ISP-I platform. The ISP-I platform gathers data from twelve Internet Service Providers (ISPs) in five cities from eleven test sites located relatively close to various Telecom exchanges. The ISP's premium residential broadband DSL plans (or equivalent) are measured on seven key performance variables (KPVs) that impact broadband performance to generate the information contained in these reports.

9. The specific plans tested and their default interleaving status are shown in Table 1. The test plan is normally the residential full speed (both upstream and downstream) DSL plan (or equivalent) that each ISP being tested offers but in some situations Epitiro have had to purchase an equivalent business DSL plan. Table 1 also shows the price of the monitored plan or its residential equivalent when consuming at least 20 GB of data, which reflects the maximum data requirements of the ISP-I testing methodology.

10. The Epitiro data provides a useful comparison of changes in broadband ISP performance over time under controlled conditions as well as a fair comparison between ISP's located at the same site. However, it should not be seen as representing what individual users may expect from their broadband experience in the home. This is because it does not capture all the variables that influence residential performance, such as a home's distance from the Telecom exchange, the quality of computer equipment and home wiring, and the number of users on the same broadband connection. Individual users will also experience large variations in performance depending on the websites they visit.

11. This is the third quarter in which the performance of the higher speed ADSL2+ technology has been included in the results. ADSL2+ offers theoretical speeds of up to 24Mbps and typical synchronisation (sync) speeds up to 15Mbps for users of premium plans within a kilometre from the exchange or cabinet that serves them. Sync speed is reported by the modem after connection to the ISP has been initiated and represents an upper limit on the customer experience. Sustained data rates are slower than the sync speed. ADSL2+ can only be received by broadband users with an ADSL2+ modem. Over 60% of broadband lines are now capable of delivering ADSL2+, and it has a growing mass market subscriber base.

12. Further details of Epitiro's methodologies are included in the Appendix at the end of this report.

13. Two providers, Vodafone and Woosh, offered DSL plans only as part of a bundle including a phone line so only the bundled price can be shown in Table 1. When calculating the price of the other plans it was assumed that tolls were also purchased. Telecom offers two residential full speed DSL plans.

Table 1: Broadband Plans Tested

ISP	Plan Tested by Epitiro for Q2 09	Default Interleaving Status	Best residential broadband non LLU plan with at least 20GB of data	Cost (inc GST) assuming tolls also purchased
Actrix	CyberJet FS/FS	On	CyberJet FS/FS 20GB	69.95
Compass	Net Jet FS/FS	On	Net Jet FS/FS 20GB	57.95
Inspire	Bitstream FS-FS	Choice	Bitstream FS-FS 20GB	72.50
Maxnet	Dash MX/MX	On	Dash MX/MX 20GB	79.95
Orcon	Pro Max/Max	Off	Purple FS 26GB	69.95
Slingshot	CallPlus Pro	Off	Inferno 1 15GB + 5GB	69.95
Snap	Broadband FS/FS	On	Snap Advanced 25GB	69.95
TelstraClear	BizBroadband Swift	On	PDQ Max 20GB (as of part bundle)	67.90
TCL Cable	Lightspeed 20G	N/A	Lightspeed 20G	79.95
Telecom	Pro	Off	Pro 40GB	79.95
Vodafone	Ultimate pack	On	Ultimate pack 20GB (with phone)	100.00
Woosh	Orbit Pro 20GB	On	Bundle of Joy 20GB (with phone)	94.00
WXC	HSI Flood	On	HSI Flood 20GB	70.47

NEW ZEALAND BROADBAND PERFORMANCE

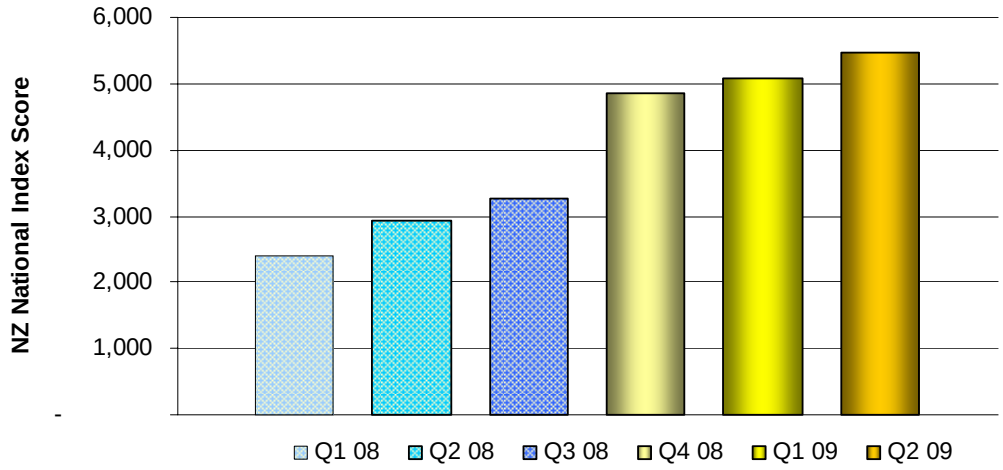
New Zealand National Broadband Index

14. In the December 2008 quarter, the Epitiro ISP-I modems were upgraded from ADSL1 to the higher-speed ADSL2+ broadband technology, which led to a step-change in the New Zealand National Index Score from the December 2008 quarter onwards as shown in Figure 1 below. In all the relevant figures, the ADSL1 quarters are shown with hatching.

15. ADSL2+ can deliver a theoretical top download speed of up to 24Mbps. Epitiro test sites experience sync speeds ranging from 9Mbps to 15Mbps.

16. The national broadband index score showed further improvement in the June quarter after the incremental improvement achieved in the March quarter.

Figure 1: New Zealand Industry Average Q2 08 to Q2 09



Source: Epitiro

17. The New Zealand National Index Score is calculated by converting various broadband performance measures into index scores and then converting a total of these scores into a further national index. More detail on the indexing process is provided in the Appendix.

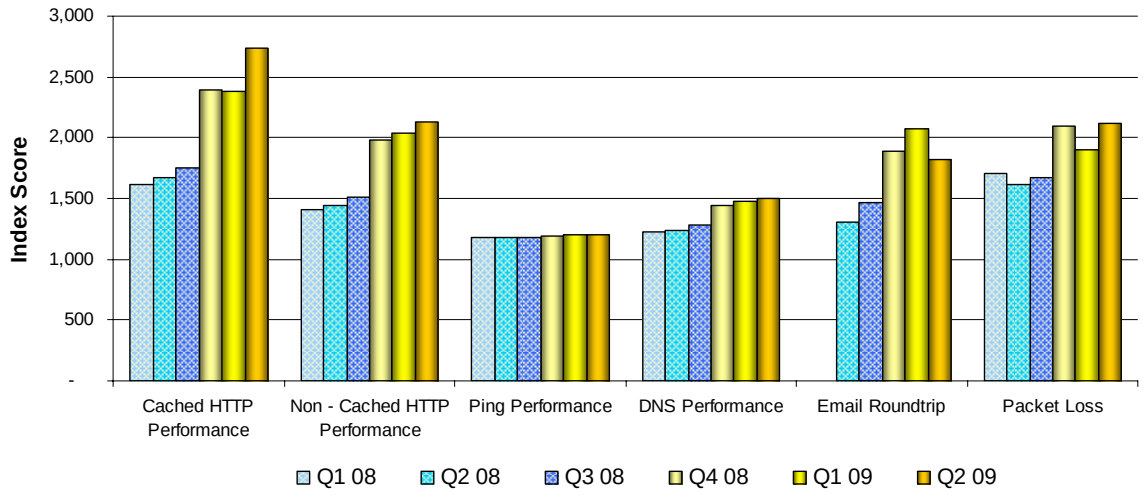
National Key Performance Variables

18. The ISP-I platform measures ISPs on seven metrics known as key performance variables (KPVs). Tests are run every 15 minutes on a 24/7 basis over the quarter.

19. All the KPV results apart from synch speed are shown as index scores below. It is important to note that these KPV scores cannot be compared one to another – they each measure entirely different metrics. The value lies in assessing the quarterly changes within each KPV. Rising values means improving performance.

20. The step increase between Q3 2008 and Q4 2008 for most KPVs marks the change from measuring ADSL1 performance to ADSL2+ performance.

Figure 2: National Key Performance Variable Scores



Source: Epitiro

21. Most KPVs showed little change this quarter, which reflects the lack of major new investments. The main exception was Cached HTTP performance which did show a material improvement. Possible reasons for this include Telecom's full implementation of its caching investments completed last quarter and changes in interleaving settings discussed further below.

22. The other exceptions were as Email roundtrip performance which had a noticeable deterioration and packet loss performance which rebounded to slightly below its Q4 08 level.

ISP PERFORMANCE BY CITY

Overview

23. This section shows the changes in ISP broadband index scores by city.

24. There are a number of factors that have a material impact on ISP performance that are highlighted by this section, including:

- Investment in primary and secondary backhaul;
- Distance to the exchange; and
- Interleaving settings.

The Backhaul Factor

25. The backhaul portion of a network includes the link between the Telecom exchange and the service provider's network. Backhaul can be further divided into two types: primary (also known as local) links, which take traffic from the Telecom exchange to the nearest data switch, and secondary links, which take traffic from the data switch to the service providers network. Secondary links are often a national link. A backhaul network that is not provisioned to cope with the volume of users and traffic at both the local and national level will create a bottleneck that slows performance.

26. The majority of service providers purchase wholesale backhaul services from third parties. At least Telecom Wholesale, Kordia, Vector and TelstraClear provide backhaul services in some areas, although only Telecom Wholesale can currently provide backhaul services nationwide.

The Distance from the Test Site to the Exchange

27. Some Epitiro test sites are closer to Telecom exchanges than others, which causes a higher sync test speed from those sites. The Hamilton site, for example, is within 800m of the Hamilton Central exchange and has an average 14.72 Mbps sync speed. This makes performance from this site very good. In Auckland the test sites are around twice as far - approximately 1.5 km from Telecom exchanges. This is the likely reason why the average sync speed in Auckland is the lowest of all the main centres.

28. Sync speed is reported by the modem after connection to the ISP has been initiated and represents an upper limit on the customer experience. Sustained data rates are slower than the sync speed. Average site specific sync speeds for each city are shown in Table 2 below.

Table 2: Average Sync Speeds by City

City	Average Sync Speed
Auckland	9.09 Mbps
Hamilton	14.72 Mbps
Wellington	10.43 Mbps
Christchurch	10.17 Mbps
Dunedin	13.51 Mbps

Source: Epitiro

Impact of Interleaving

29. Another factor affecting performance is the way in which service providers choose to manage data transmission through a process called 'interleaving'. Interleaving is a method of transmitting data packets in a way that corrects transmission faults and provides stability. However, this process increases latency and can slow download speeds. It was designed to increase the reliability of connections a long way from the exchange, but it is of less value to users who are close to an exchange and have good transmission. As Epitiro's platform is measuring DSL providers over relatively short loop lengths, the removal of interleaving provides a significant boost to performance.

30. Epitiro's policy has been to accept the default interleaving status of the plans it has been testing. This meant interleaving was turned off for the whole quarter for the Telecom, Slingshot and Orcon plans tested.

31. Interleaving was turned off for the remaining plans being tested in late July 2009 and therefore did not affect index scores for the June quarter. However, Vodafone turned off interleaving for its plans being tested at the test sites in mid June so this had some affect on its index scores for the quarter. The impact of these changes can be seen in Figure 11 onwards.

32. Users are advised to check with their ISP to identify if they have their interleaving on or off if they believe their browsing speed is below what they would expect. However, interleaving may not be the cause of slow speeds – it may be distance to the exchange, house wiring, cordless phone interference or other interference.

Unbundling

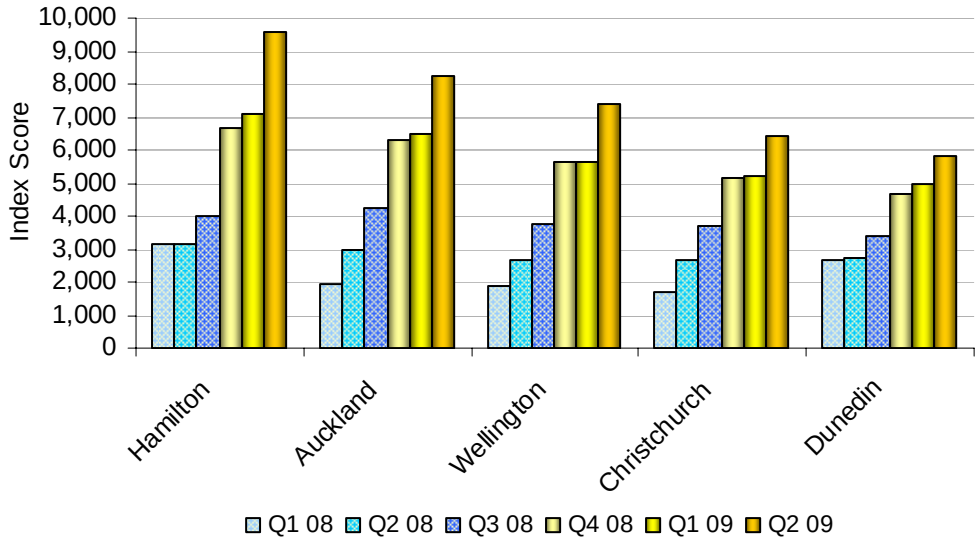
33. This report does not currently include any testing of UCLL services even though they are widely available in Auckland.

34. All the Epitiro test sites in Auckland have had their local exchange unbundled. This means that nearly all the Orcon, Vodafone and Slingshot broadband customers in those areas are likely to be getting a service provided by way of unbundled copper local loop (UCLL). However, Epitiro is currently continuing to test the original plans provided by way of Telecom's wholesale bitstream service in these areas. In addition, Epitiro has now started testing UCLL plans for Orcon, Vodafone and Slingshot from two of its Auckland sites. The results of the additional testing will be reported in the September quarter report.

Telecom's Quarterly Performance by City

35. Telecom's broadband index score rose significantly for all cities this quarter. This appears to be attributable to the full implementation of its caching investments completed last quarter.

Figure 3: Telecom's Index Score by City



Source: Epitiro

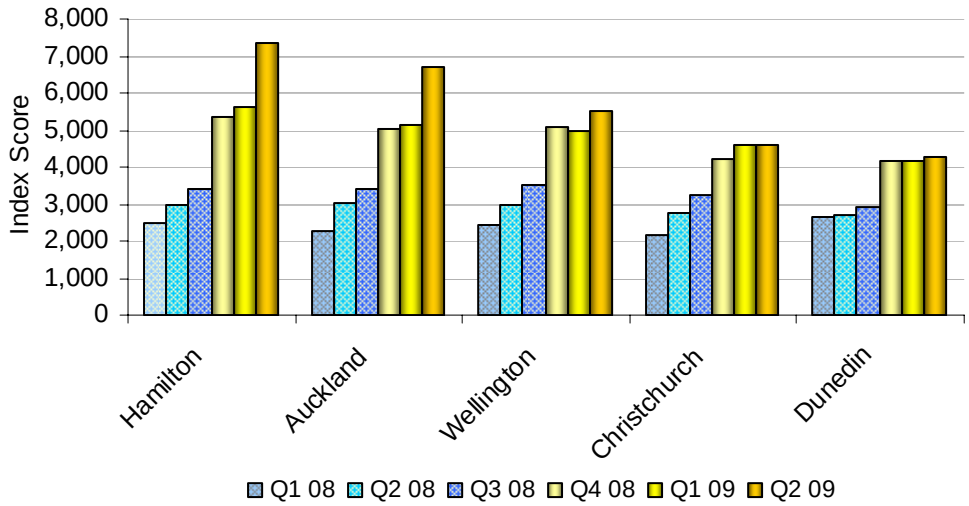
TelstraClear

36. The Commission did not report TelstraClear's index scores for the March quarter, and for similar reasons is not reporting them for the June quarter. The Commission will recommence reporting TelstraClear's results where relevant in the September quarter.

Vodafone's Quarterly Performance by City

37. Vodafone's broadband index score rose significantly for Auckland and Hamilton this quarter. As mentioned above, part of the improvement is likely to be attributable to the change in interleaving settings that occurred in June.

Figure 4: Vodafone's Index Score by City

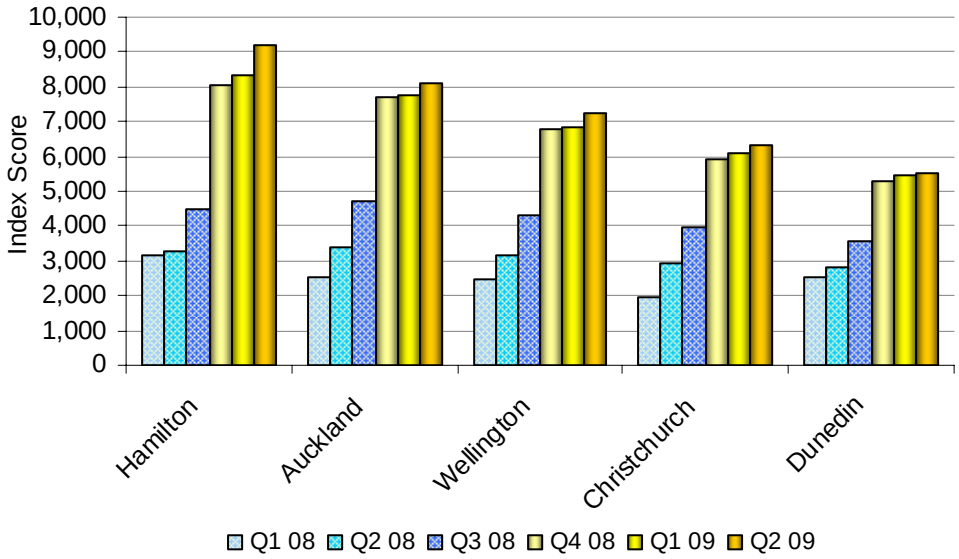


Source: Epitiro

Slingshot's Quarterly Performance by City

38. Slingshot had at least an incremental improvement in its broadband index score this quarter for all the cities where testing was carried out.

Figure 5: Slingshot's Index Score by City

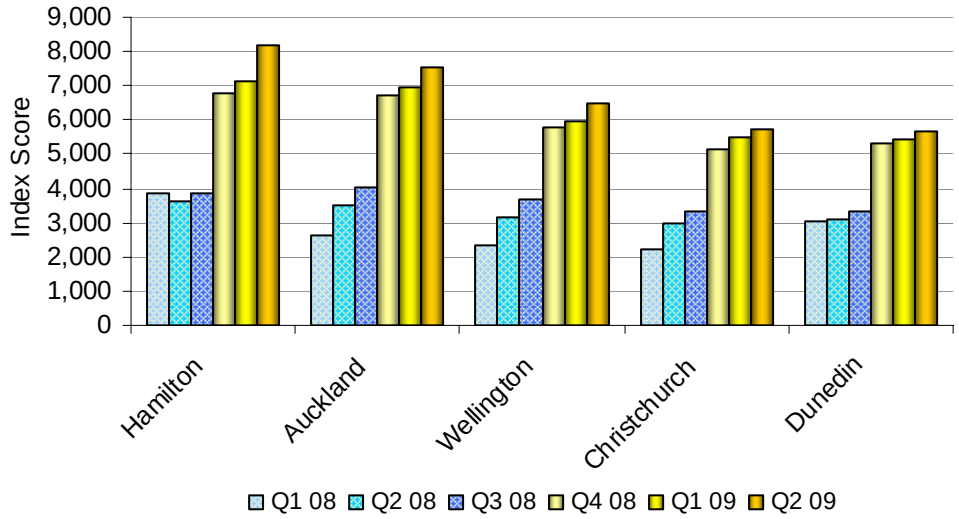


Source: Epitiro

Orcon's Quarterly Performance by City

39. Orcon also had at least an incremental improvement in its broadband index score this quarter for all the cities where testing was carried out.

Figure 6: Orcon's Index Score by City



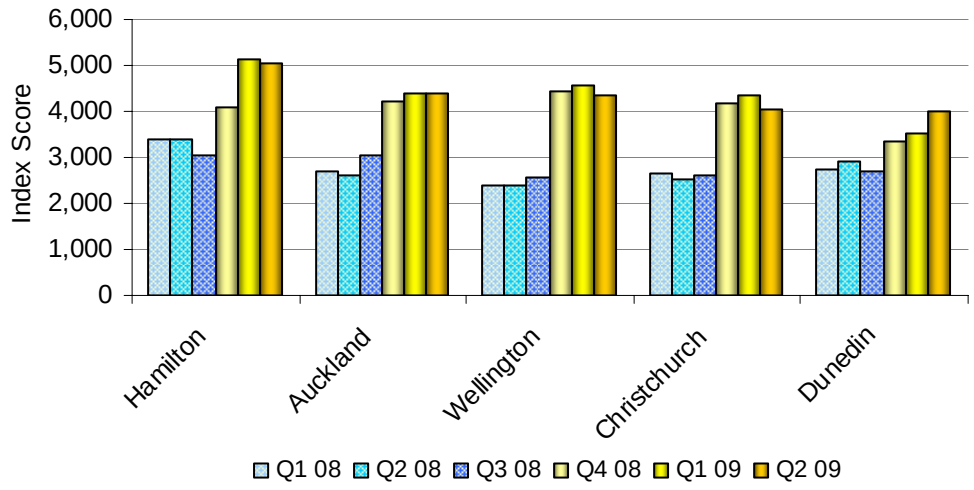
Source: Epitiro

Other ISP Quarterly Performance by City

40. The Commission reports individually on five ISPs. Data from a number of other ISPs, most of them smaller and some operating only at a regional level rather than nationwide, is aggregated to capture changes across the industry as a whole. As this is an aggregate figure, performance by any one provider may be substantially different than the reported average.

41. There was a mixed result for the Other ISP index s this quarter with a slight deterioration in performance in three cities and a material improvement in Dunedin.

Figure 7: Other ISP Index Score by City



Source: Epitiro

SERVICE VARIABILITY AND AVAILABILITY

Variability

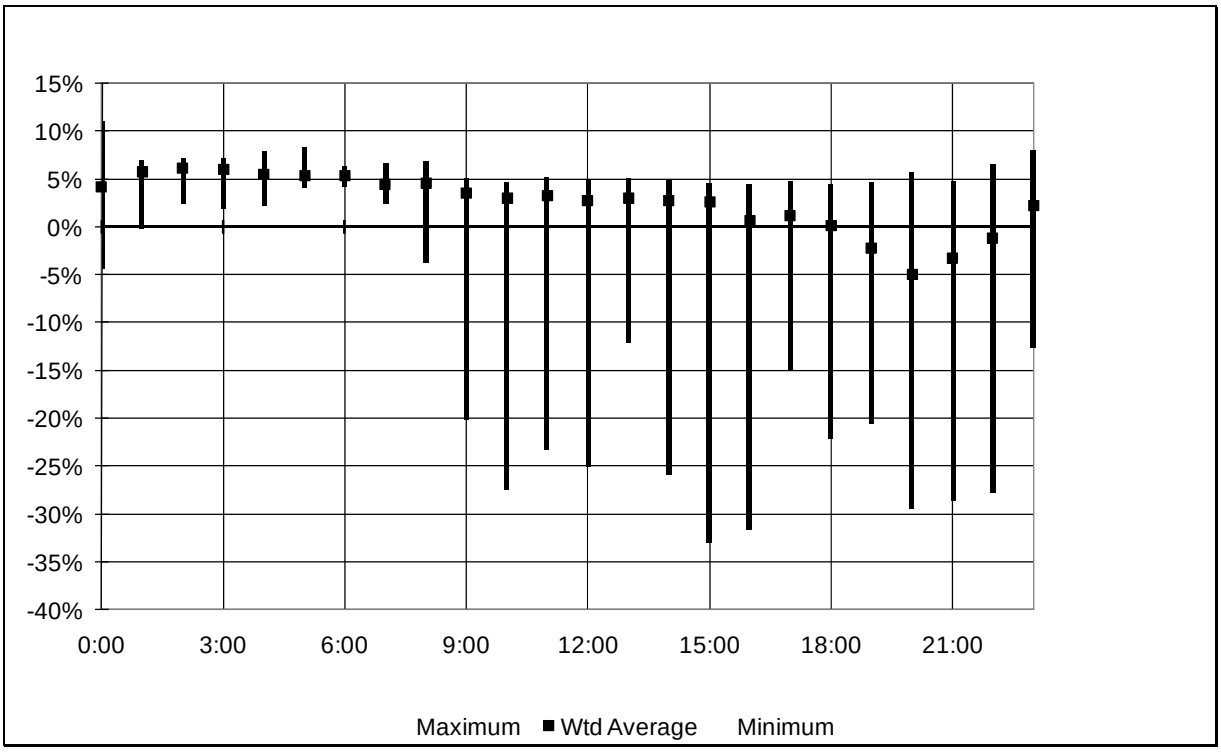
42. Consistency and reliability of service are critical features of broadband performance. A user's broadband experience will be disrupted if there are frequent outages or reduced performance at certain periods of the day.

43. Service variability data shows how broadband performance can change over the course of the day. The variability is usually driven by the number of users and volume of traffic on the network at any one time.

44. The service variability graph, Figure 8, shows maximum, weighted average (by number of customers) and minimum HTTP download (web browsing) speeds for the industry at multiple time points during an average weekday. These are expressed as variation from 'normal' performance. The maximum points represent the peak performance for any ISP in that hour, Monday to Friday, of the sample week. Minimum points show the worst performance at that time on a day.

45. Figure 8 gives the weekday average for the week ended 21 June. The HTTP download speeds are those measured from all sites to a national test site.

Figure 8: Variability of ISP HTTP Download Speeds by Time of Day



Source: Epitiro

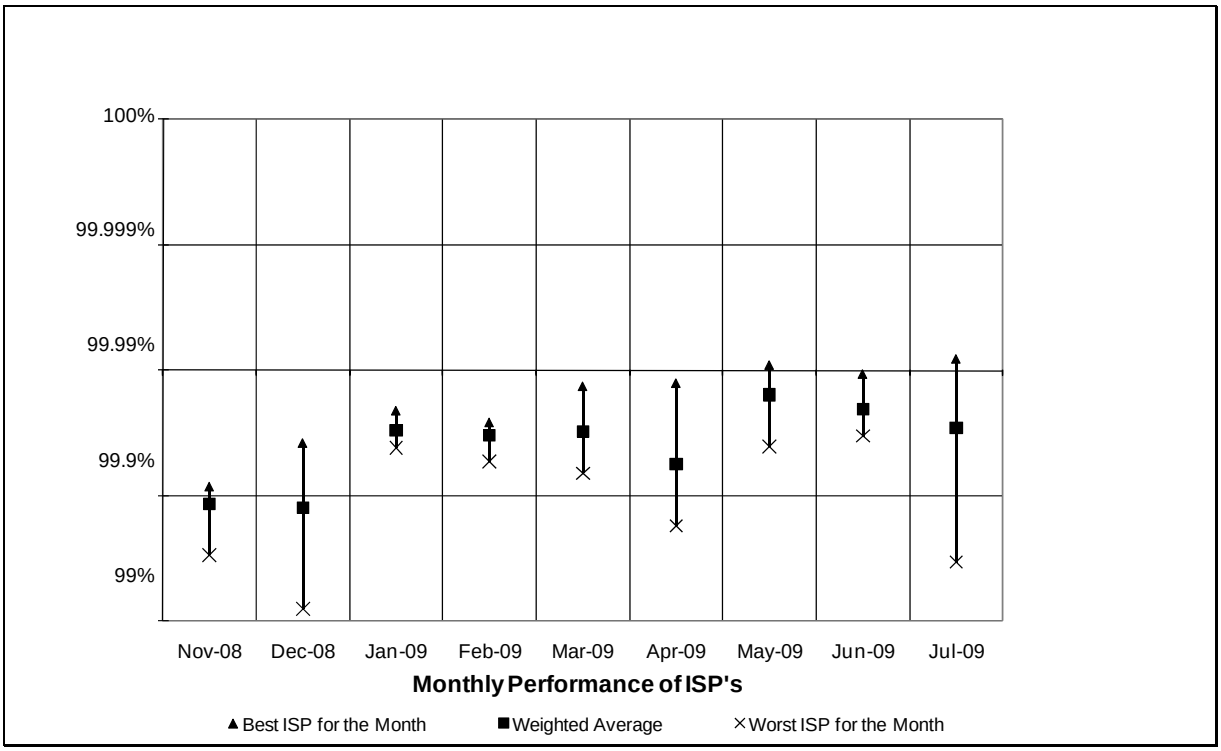
46. For almost all ISPs, speed is relatively consistent throughout the day. For a small number of ISPs, however, the average speed drops significantly at various points in the day. Their customers are likely to notice a degradation in performance. These ISPs either have insufficient capacity or lack the necessary caching to provide a consistent service.

Availability

47. Service availability is a difficult metric to capture accurately. The nature of broadband service and delivery makes it difficult to match the very high 99.999 percent availability standards of the traditional telephony world. Failure of an internet request is often outside service provider's control.

48. One parameter largely within the service provider's control is that of internet availability. Availability is measured as the percentage of times a common group of websites are able to be successfully downloaded from each ISP over a large number of tests (>4m tests per month). Figure 9 illustrates internet availability for all ISPs tested. Availability is shown as a maximum, minimum and weighted average percentage of internet availability for each month.

Figure 9: ISP Average Availability



Source: Epitiro

49. Internet availability has generally been improving, although has shown considerable variation from month to month, as shown in Figure 9. One ISP, Telecom, was able to achieve 99.99 percent availability during May, and four separate ISPs (Snap, TelstraClear Cable, Woosh and WorldxChange) were able to achieve it in July. To offer POTS equivalent services over VoIP, with reliability at a level suitable for emergency services, consistent availability at or above the 99.99 percent, and preferably close to 99.999 percent is desirable.

50. In July, one ISP brought the worst ISP performance down to below 99.9 percent.

INTERNET BROWSING PERFORMANCE

Overview

51. Internet usage in New Zealand today is primarily concerned with the downloading of web-based content that occurs when browsing the internet. This means the speed and reliability of HTTP content downloads shapes the user's internet experience.

52. This report again includes data on industry HTTP download speeds for national and international traffic. No individual ISPs have been identified. Instead, the emphasis is on defining trends with the reporting of industry maximum, minimum and weighted average (by customer numbers) outcomes.

53. Two test sites (one national and one international) have been selected to provide a fair representation of typical HTTP download performance.

54. This reported data provides insight into actual local and international HTTP download speeds achieved from within a controlled test environment (although it doesn't capture all the factors that might impact a typical user’s experience). It also highlights how caching and investment in international bandwidth impacts performance.

Impact of Caching

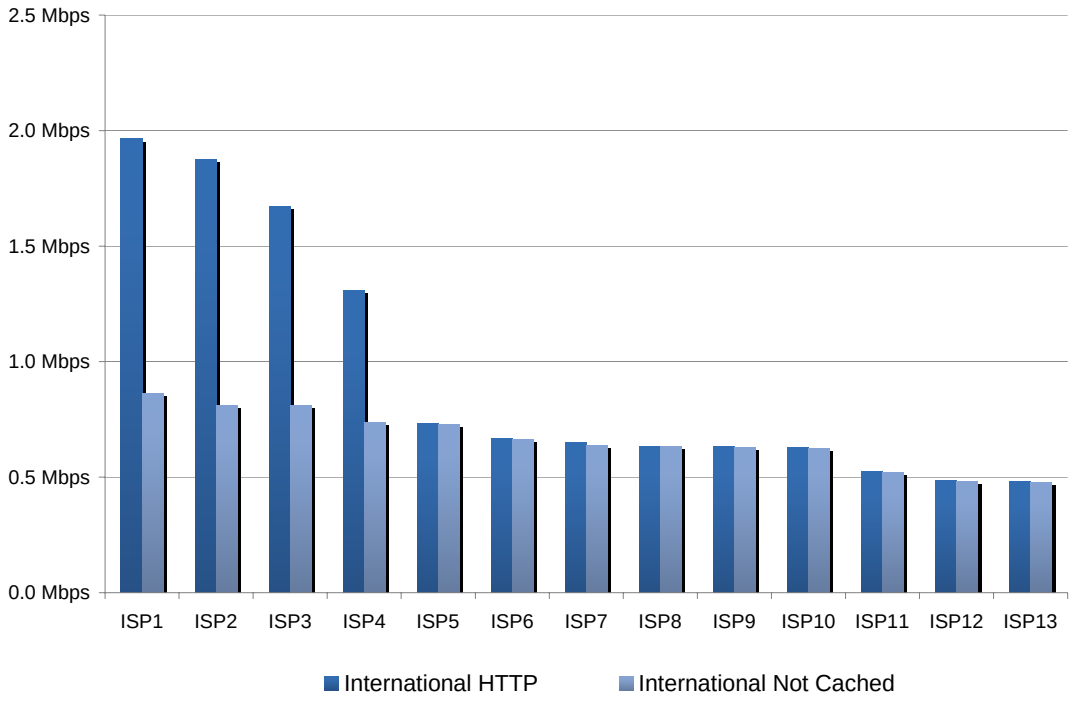
55. Caching of international content is an important factor in the performance of New Zealand broadband services. Caching stores international (and sometimes national) content locally, which enables subsequent users of the same international content to download it at local or national speeds. The impact of caching international content on performance can be significant. However, caching has little impact on national speeds as found in the March quarter report so this has not been reported.

56. A comparison of international HTTP download speeds across cached and non-cached content is given in Figure 10. Telecom, TelstraClear and Slingshot are the only ISPs tested that are caching international content successfully. TelstraClear appears twice because its DSL and cable broadband test results are shown separately.

57. It was expected that more ISPs would install caching to improve the performance experienced by their customers. Enquiries suggest that this has not happened because of:

- Capital constraints; and/or
- Caching is complex and has to be handled carefully to address security issues so is still under consideration by some ISPs.

Figure 10: Cached v Non Cached International HTTP Performance, April – June 2009



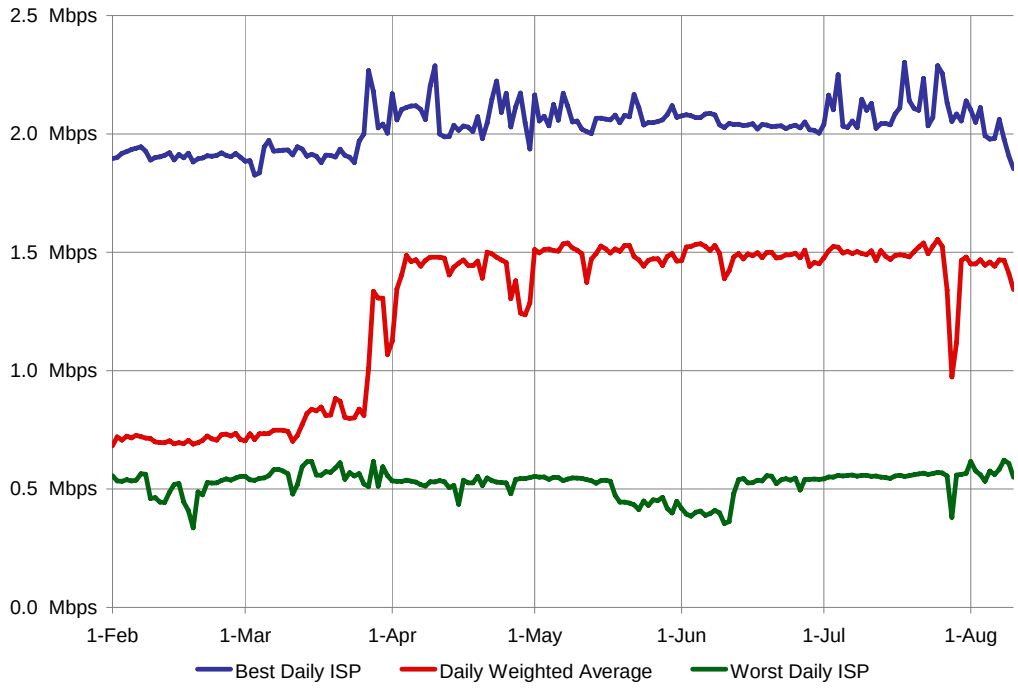
Source: Epitiro

International Browsing Speeds

58. International performance by city is not reported on this quarter because there is little difference in international browsing performance between cities. In general, international performance is more influenced by the distance to the international server, the upload speeds at the remote server, and sometimes the capacity of the ISP.

59. Figure 11 shows the variation in ISP performance using all New Zealand sites and tests to a single international website. It shows average international HTTP download speeds for cached content and is plotted using a smaller scale than that used in the national charts to enable a clear comparison between best and worst ISP. The gap between the best and worst performing ISPs appears to be relatively consistent with that of the previous quarter.

Figure 11: Overall International Cached HTTP Performance



Source: Epitiro

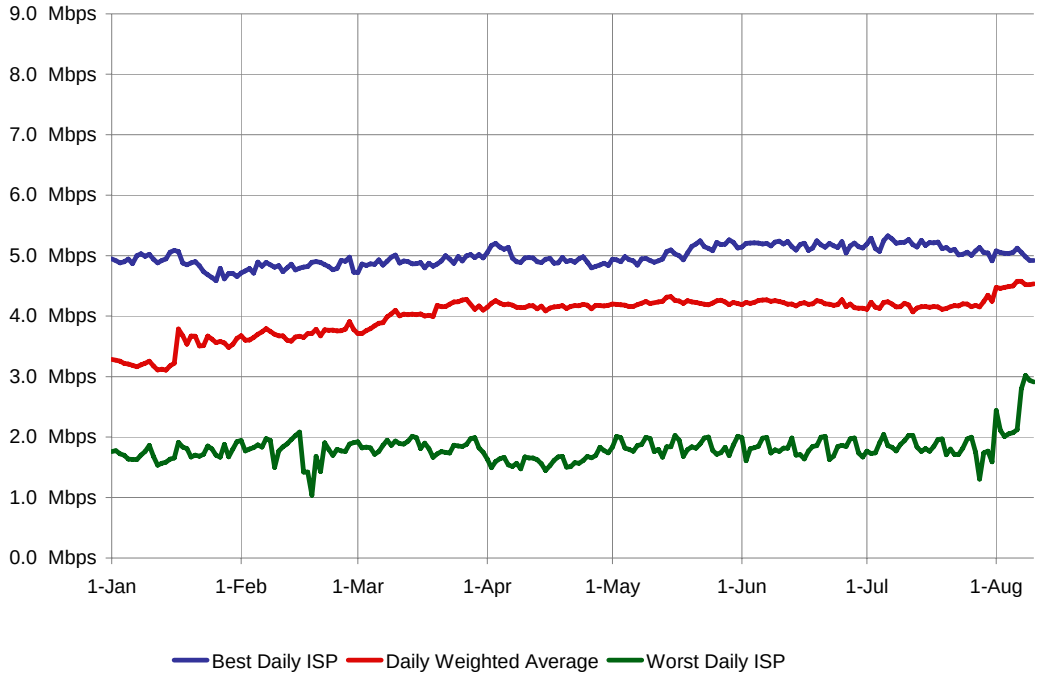
60. International download speeds are limited by the distance from New Zealand to the international server. The distance creates delays for the control packets for each download packet, and the more control packets there are the more delay. Control packet numbers increase for multiple reasons; operating system window size and website file size being critical. Caching tends to reduce the need to seek some files offshore for each page, increasing the download speed of that page.

National Browsing Speeds

61. Figure 12 indicates that there was very little change in national browsing speeds during the quarter (1 April to 1 July). A sharp rise in the last week shown is attributable to interleaving being turned off.

62. ISPs managing to be the best ISP on at least one day during the June quarter include; Orcon, TelstraClear Cable, Telecom and Slingshot.

Figure 12: Overall National HTTP Performance



Source: Epitiro

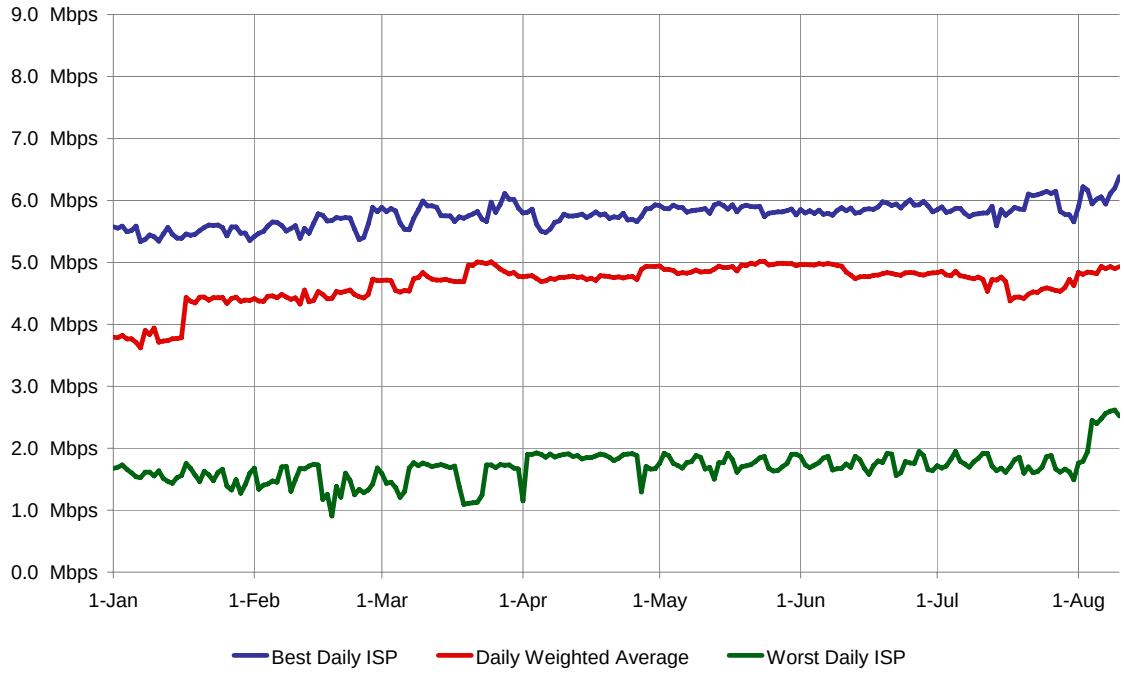
National Browsing Performance by City

Auckland National Browsing Performance

63. Auckland test sites are generally further from the local exchanges than the test sites in other cities, so the average national browsing speed of the three Auckland test sites is limited by ADSL's decrease in performance over distance. This limitation shows up in browsing speeds shown in Figure 13, with the "best ISP" managing to achieve around 6 Mbps during the June quarter.

64. The removal of interleaving on 31 July from all ISP's test connections has improved the performance of the "worst ISP" from that date. Minor improvements to the "best ISP" performance are also visible in late July.

Figure 13: Auckland National HTTP Performance



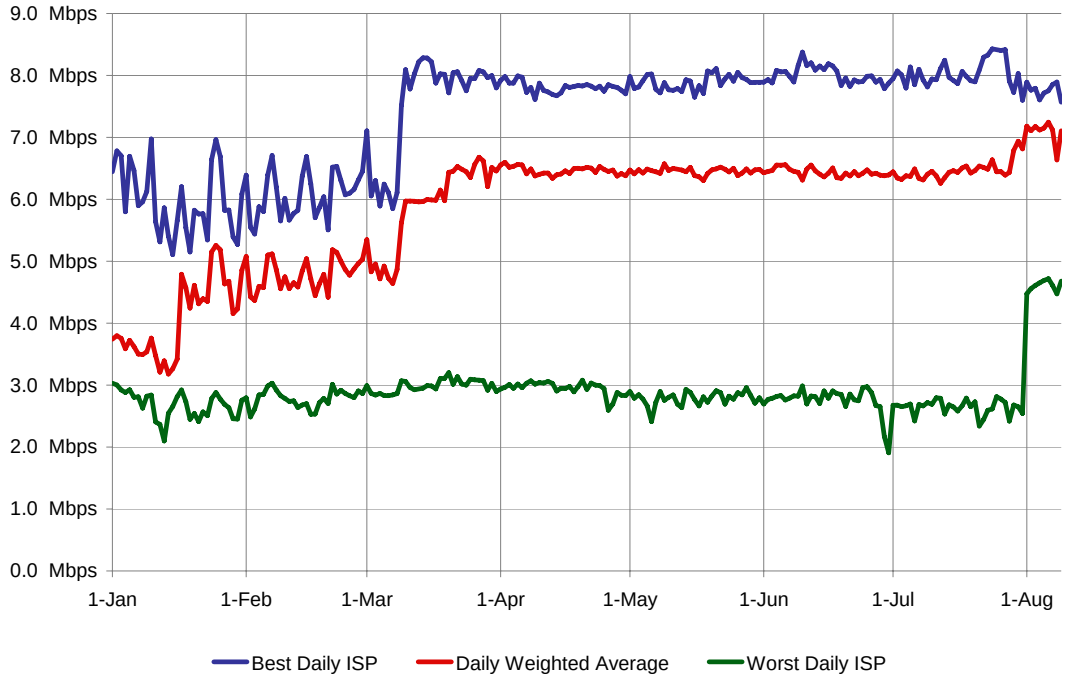
Source: Epitiro

Hamilton National Browsing Performance

65. The Hamilton test site is the closest to the local exchange as well as being close to Auckland so it is not unexpected that its performance is the best, as shown in Figure 14. National browsing speed for the "best ISP" was around 8 Mbps for the June quarter.

66. The impact of interleaving being turned off on 31 July is most clear for connections close to the exchange such as this one.

Figure 14: Hamilton National HTTP Performance



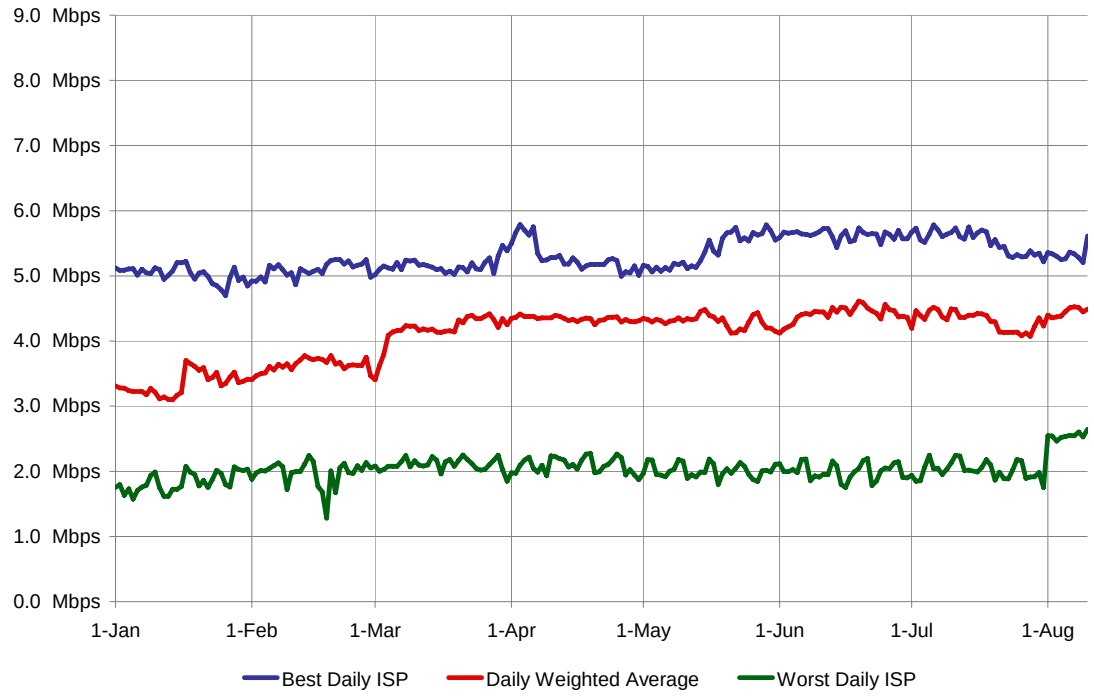
Source: Epitiro

Wellington National Browsing Performance

67. Improvements in browsing speed of the "best ISP" seen in mid-May in Wellington seem to have been only a temporary as evidenced by the fall back to April levels in mid July, as shown in Figure 15.

68. The regular weekly variation in speed of the worst performing ISP is most likely due to lack of capacity creating bottlenecks that vary by day of the week. The variation shows improved speeds every weekend, suggesting this is caused by an ISP with a high proportion of business users.

Figure 15: Wellington National HTTP Performance



Source: Epitiro

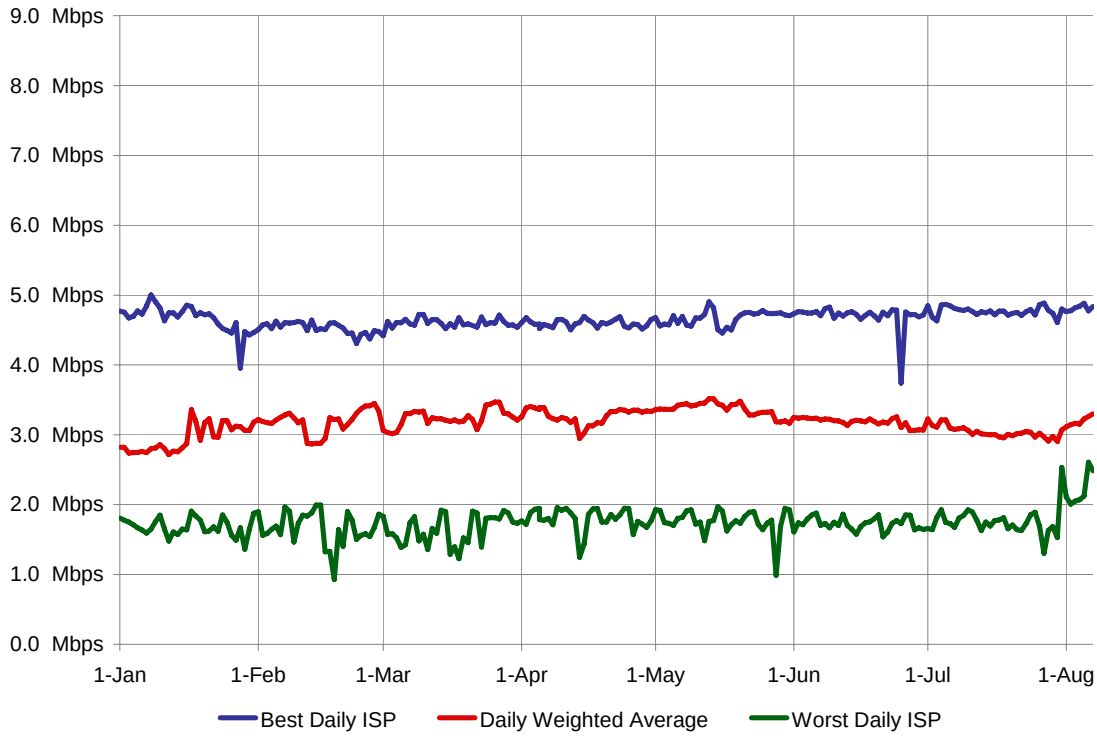
Christchurch National Browsing Performance

69. National browsing speeds in Christchurch, shown in Figure 16, appear to be influenced by the distance from the exchange (10.1Mbps average sync speed) as well as the distance from Christchurch to Auckland. For most ISPs, their core network is located in Auckland. A South Island customer is likely to have a slightly slower speed due to the core network being located in Auckland. To overcome this, more ISPs could invest in the installation of supporting equipment in Christchurch.

70. Christchurch looks nearly as good as Wellington in the performance of the best ISP in spite of Christchurch's more remote location. However, one ISP performs best for national browsing speed in Christchurch by a significant margin compared to a closer contest between ISPs for the top spot in Wellington.

71. Again, the worst performing ISP shows evidence of capacity constraints during the week.

Figure 16: Christchurch National HTTP Performance



Source: Epitiro

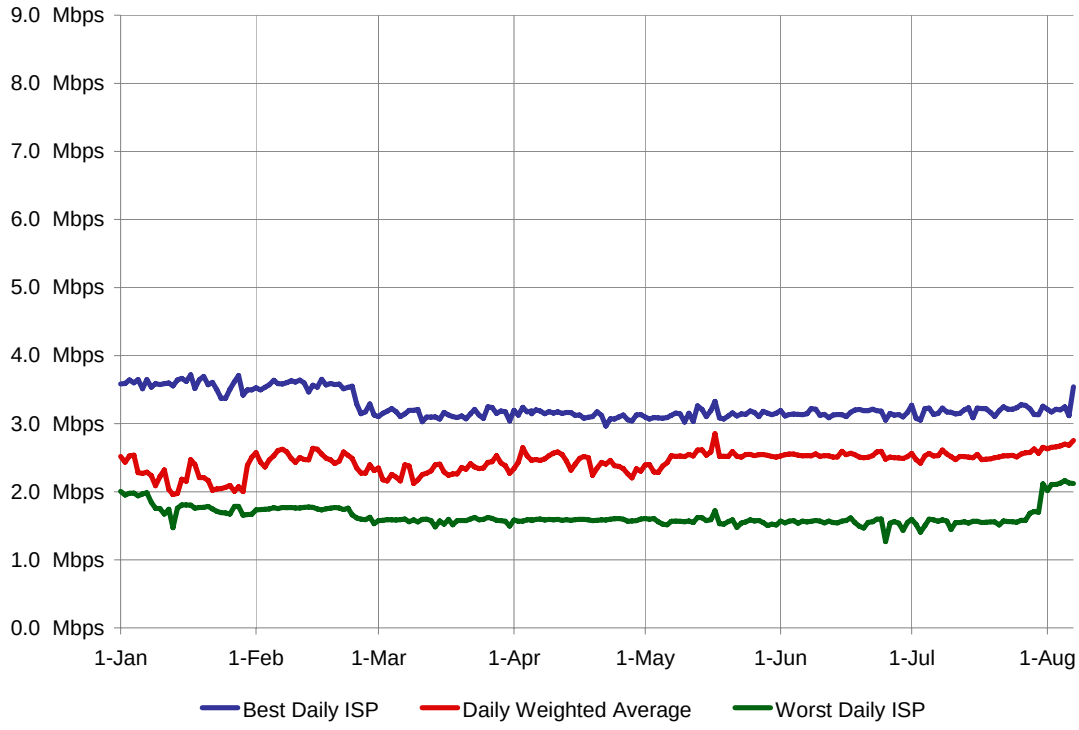
Dunedin National Browsing Performance

72. Dunedin appears to suffer the most from being remote from Auckland because its test site is relatively close to the exchange and enjoys a relatively high sync speed of 13.5Mbps. Despite this, its best ISP could manage national browsing speeds of little more than 3 Mbps for the quarter, as shown in Figure 17. Epitiro do not measure any ISP who has their core network located in Dunedin.

73. Dunedin's national browsing speeds show little variation over time, apart from the usual improvement in the worst performing ISP in late July due to the interleaving changes.

74. The Commission understands that some ISPs are putting in place new backhaul arrangements for South Island cities. This may bring the average speed recorded at test sites in the South Island closer to those in the North Island.

Figure 17: Dunedin National HTTP Performance



Source: Epitiro

APPENDIX – EPITIRO METHODOLOGY

Overview

The data used in this report is collected using Epitiro's ISP-I technology. The data provides a robust and independent perspective of broadband performance in New Zealand as seen from the Epitiro measurement platform. This platform is believed to be a good proxy of optimum customer experience.

The ISP-I data is gathered from twelve ISPs measured across five cities at eleven sites located relatively close to various Telecom exchanges. ISPs are measured on the premium consumer broadband package available at the site of each of Epitiro's 11 test sites.

At each site, there are approximately 7 to 10 separate modems coupled to their own PC running the broadband quality tests. These tests are all completed on separate lines to the Telecom exchange. Interference between these lines may be higher than normally experienced in a household due to the multiple lines going to the same site, and may explain why sync speeds can vary significantly between lines. Lines are randomly allocated to ISPs.

Tests are conducted on seven key performance variables (KPVs) that impact the user's experience when browsing and downloading content, exchanging email, gaming online or streaming video. These are explained below.

The ISP-I data provides a useful comparative view of broadband service performance, with its greatest strengths being its comparisons of ISPs under controlled conditions, and the analysis of this data over time.

Report Collation Methodology

There are three principle steps in the formulation of this report:

Data Gathering

The data is collected and managed via Epitiro's ISP-I service. The ISP-I platform consists of a centralised database and reporting system along with geographically diverse deployment of ISP-I-configured PCs or 'satellites' that are responsible for collecting data on the performance of the monitored network services. Testing is maintained 24x7, with each ISP's service tested every 15 minutes. Tests are performed using PCs that are of a specification typical of those available for home use and which run the ISP-I software.

A consistent specification is maintained across the ISP-I network. All satellites are installed with Microsoft Windows XP Professional SP2, with the Windows Firewall enabled. In order to test each ISP's services, Epitiro has subscribed to the premium broadband service available from each ISP at each of its physical testing sites.

Epitiro's ISP-I Satellite software runs on Windows and employs Microsoft's .NET framework to control the connectivity and execute tests as and when required. The ISP-I Satellite integrates very closely with the Windows Operating System, which means it uses exactly the same underlying mechanisms as an end user connecting to the Internet and to the services made available via their ISP. More detail on how the ISP-I Satellite software performs its tests is given below.

Data Indexing

This stage of the process is managed by Epitiro, and involves the indexation of the raw data. Indexation occurs for two reasons:

- To allow the data to be aggregated and manipulated. Because the tests involve a variety of measures including milliseconds, kilobits per second and percentages, the results exist in a myriad of orders of magnitude. To allow greater flexibility in analysing and viewing all of this data as one dataset, all of the raw values are converted into an index score of a consistent order of magnitude; and

- Depending on the statistic being measured, a high result will, in some cases, be an indicator of good performance and in others suggest a worse performance. For example, a high HTTP download speed is positive, whereas high packet percentage loss is negative. In order to make the report easier to read and to create consistency, indexed numbers have been re-weighted. As a result, a high index score always indicates a positive performance in this report.

Converting the raw values into index values is carried out as follows:

1. An average of KPV values for a period of 3 months is taken from ISP-I.

Table 3: Converting raw data to index value

	Sync Speed	HTTP - C	HTTP - NC	Ping	DNS	Email RTT	Packet Loss
Typical ISP raw data	6592.42	45.27	44.104	196.000	84.2	7.66	0.626
Conversion factor	21.54	0.08	0.09	0.47	0.24	0.01	0.0011937
Typical ISP index	306.0	600.6	494.8	420.6	350.3	537.9	524.4

Source: Epitiro, March 2009

2. Using a conversion factor (usually a divisor) these values are converted into numbers of a similar order of magnitude as can be seen from Table 3.

3. To ensure these factors conform to the relative weightings as agreed with the industry, the conversion factors are adjusted until the new values total and average to the same amount (3,000 and 500 respectively), as depicted in Table 4. At the request of the industry, sync speed has been weighted at half the significance of the other variables (1,500 and 250 respectively) given this is a KPV beyond the control of ISPs, and is therefore not as indicative of their performance as the other KPVs.

Table 4: Index Parameters

	Sync Speed	HTTP - C	HTTP - NC	Ping	DNS	EMAILRTT	Packet Loss
TOTAL POINTS AVAILABLE	1,500.00	3,000.00	3,000.00	3,000.00	3,000.00	3,000.00	3,000.00
Average per ISP	250.0	500.0	500.0	500.0	500.0	500.0	500.0

Source: Epitiro, March 2009

4. A value of 3000 is then added to the ISP scores to prevent negative values occurring should ISP performance degrade in certain KPVs or quarters. 1500 is added to the KPV scores.

5. Each KPV score for each ISP is then cumulatively calculated, with the KPV index value being either added or subtracted, depending upon whether a high score is good (sync speed, HTTP), or bad (ping, DNS, ERTT, packet loss).This gives the final score for each ISPs' KPV performance, and each ISPs' overall performance.

Data Analysis

Analysis of the raw data and indexed data collected is now undertaken by the Commission.

Key Performance Variables tested

There are seven key performance variables (KPV's) analysed in this report, with two additional parameters assessing consistency of service performance and traffic management. The KPVs are defined as follows:

Synchronisation Speed

Synchronisation speed is one measure of the speed of broadband service supplied to a customer. Line connect speed is the synchronisation speed reported by the modem after connection to the ISP has been initiated. It represents an upper limit on the customer experience; sustained data rates are often slower than the synchronisation speed. When connecting to a service via a modem (this includes dial-up, ADSL, fixed wireless and mobile / HSDPA / GPRS broadband connections), the ISP-I Satellite software employs the Windows RAS APIs to initiate the connection. This is the same underlying mechanism that an end user would be using when they manually initiate a connection to their ISP. In the case of connections that use the Satellite's ethernet connection, such as cable or router connections, the Satellite software is able to confirm existence of an active connection, but does not capture any timings, synchronisation speeds or specific failures as the connection itself is managed by the cable modem or router.

Cached HTTP

Web pages are stored on servers that are often located in foreign countries. To improve retrieval speed and reduce international transit costs, content fetched by users may be locally cached on NZ-based servers. The cached HTTP download speed test indicates how quickly

an ISP can distribute content over the New Zealand portion of their network by testing how fast specific web pages are downloaded. The HTTP test makes a request to the specified URL and records the time taken and the amount of data downloaded, from which the speed of the download is derived. Depending on the configuration of the test, the satellite is also able to download the embedded content, such as images on a web page, in any HTML that results from the HTTP request. Any additional content downloaded is reflected in the captured timings and size of data downloaded. Epitiro has selected a basket of the websites most frequently accessed by local users.

Non-cached HTTP

The HTTP test can be configured to run in one of two modes of operation: cached and non-cached. When the test downloads from the specified URL in "cached" mode, the speed of the download can be impacted by any caching mechanisms used by the network provider/ISP connected to the PC satellite. The non-cached HTTP download speed test ensures that the web page request bypasses any caches present in the network, and so goes all the way back to the original website, making use of international bandwidth where necessary. This download speed test therefore provides an estimate of the user experience in downloading web pages from foreign locations. Short times equate to a better experience. If a failure occurs then the HTTP status code is recorded. This can be used as an indicator as to whether the error resulted from the network or from a problem with the web server hosting the URL. Epitiro has selected a basket of popular URLs located in the various regions of the world – the US, Asia and Europe particularly – to test the quality of each ISP's international connectivity.

Ping Performance

A 'ping' is the time taken for a device on the Internet to send a request to a remote server and for that server to respond with an acknowledgement. The ping time test is a measure of how quickly the ISP's network can respond to a request, so it is also known as a measure of latency. Shorter ping times are better. The Ping test measures network latency by sending an ICMP echo request to the specified server. The time recorded by the ISP-I Satellite is the total round trip time (in milliseconds) from the request to the echo response being received from the server. The ping test is conducted on the same basket of URLs used in the HTTP tests.

Domain Name Server Performance

A Domain Name Server (DNS) fulfills a function similar to a telephone directory. A DNS server takes an address readable by humans (e.g. www.comcom.govt.nz) and converts the address to an IP address, or a specific set of numbers which identifies a particular website. In technical terms, the DNS test records the time taken (in milliseconds) to resolve a domain name to a corresponding IP address. The DNS servers used for the query are those primary and secondary servers dynamically assigned by the service provider when the network connection is initiated. Alternatively a specific DNS server can be configured for use during DNS tests. The ISP-I Satellite delegates responsibility for DNS resolution to the underlying operating system, thus using the same DNS resolution mechanism employed when a user enters a URL into a web browser. More details of the specific DNS resolution algorithm used by Microsoft Windows can be found in the Windows XP Resource Kit (Configuring IP Addressing and Name Resolution). Satellites ensure that the DNS query is performed on the DNS servers, and not returned from any local cache, by disabling the Windows DNS Client Service responsible for caching the results of DNS requests.

Email Round Trip Time

The email roundtrip test measures the time that it takes for an email to be sent over the Internet using the ISP's mail servers. If these servers are busy then they may take a longer time to send a message: a shorter time therefore provides a better experience. In technical terms, email testing within ISP-I consists of SMTP tests that run from the Satellite and POP3 tests that are run centrally to retrieve the emails from the POP3 mailboxes. The SMTP test executed by the Satellite can be configured to send an email using the service provider's SMTP server to one or more recipients. Each email sent can be uniquely identified by an ID transmitted in one of the email's headers. The Satellite records the time taken to send the email using the SMTP server, and also any SMTP error codes that result during the course of the conversation with the server. The POP3 component of the ISP-I platform's email testing is performed from centrally managed servers that are configured to poll the mailboxes of each POP3 account once every minute. Whenever an email is retrieved that was sent from an ISP-I Satellite, the time of retrieval is recorded. Any errors that occur while attempting to connect to a POP3 server are also recorded.

Packet Loss Performance

The packet loss test records the average package loss percentage experienced during individual tests and an overall packet loss test. The packet loss test is not an individual test in the same sense as the other tests that the ISP-I Satellite is capable of executing. Instead, the Satellite records TCP packet loss during all the individual tests executed, as well as an overall packet loss measure over the course of entire network connection during which the tests were being run. Thus, as well as measuring the packet loss present in a network, ISP-I is able to indicate whether packet loss is occurring for a particular protocol or service. The ISP-I Satellite measures packet loss by utilising the Performance Counters for TCP available within Windows. Packet loss is recorded as the percentage of TCP segments transmitted from the Satellite machine that contain retransmitted bytes.

ISP Service Variability

Given the potential for significant performance variability, it is useful to try to quantify the undulating nature of broadband services, specifically around performance over peak and off-peak periods, as this "natural" fluctuation can impact upon customer experience.

The best variable for measuring this variability is HTTP download speeds. For the purposes of the graph used in this report, national cached download speeds were taken for a week and averaged by the hour.

Other Factors affecting Broadband Service Experience

The service an ISP delivers to a consumer is not only affected by network–related issues, as measured above; there are factors within the home or business environment that can also play a significant role in repressing broadband service performance. Epitiro's testing has revealed these factors to include:

- The individual's choice of broadband plan, including speed and size of data cap. This is particularly critical with ADSL2+, where full benefits are only achieved on a 'maximum download, maximum upload' data plan.

- Satellite television services, when the decoder is plugged into a telephone jack without an ADSL filter;

- Faxes attached to the telephone jack, even if they are not operating and have a ADSL filter;
- PC hardware specification;
- PC operating system configuration;
- Extent of applications and malicious software or viruses that may be running in the background on a user's PC;
- Telephone line wiring quality;
- Number of cable pairs bundled together (when serving multiple tenancies, for example blocks of flats), and the number of those running broadband services.

The ISP-I data included in this study is collected in a way to standardise the impact of these factors, to ensure like for like performance from each ISP is measured.

Reporting on Other ISPs

A total of twelve ISPs are measured, but a number were only measured in one site or one city. Broadband index scores are reported for the top five service providers measured across all cities and sites (less TelstraClear in this report) while the remaining ISPs have been aggregated into an 'other ISP' category.

The remaining ISPs and sites measured during the quarter were:

- WorldxChange (11 sites)
- MaxNet (3 sites)
- Inspire (3 sites)
- Compass (2 sites)
- Actrix (3 sites)
- Snap (1 site)
- Woosh DSL (4 sites)

Disclosure Statement

The data used in the preparation of this report is provided to the Commission under contract by Epitiro (NZ) Limited, a part of Epitiro, a technology-focused customer experience management and benchmarking company operating world-wide. Epitiro is committed to providing information and analysis that is objective, reliable, and unbiased.

Epitiro provides a range of services to other parties, including ISPs, that are or may be the subject of analysis in this report, including: Telecom, Vodafone and Slingshot. Epitiro has made commitments to the Commission to ensure that its contractual relationships with other parties do not undermine the reliability of the data used in this report.

Other parties that receive Epitiro services may publish their own conclusions or analyses based on the information provided by Epitiro, which may differ from the analyses and conclusions reached by the Commission in this report. Differences in reported results or the conclusions drawn may arise from:

- The methodology used to analyse the information;
- The source of the information; and
- The time period being analysed.