# REPORT ON NEW ZEALAND BROADBAND QUALITY

## JULY TO DECEMBER 2009

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COMMERCE COMMISSION

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## EXECUTIVE SUMMARY

The Commission has been publishing reports on New Zealand broadband quality since June 2008. This report covers the six months from 1 July 2009 to 31 December 2009.

There are a number of different tests that can be carried out to measure the broadband performance of internet service providers (ISPs). This report focuses on web browsing speed because web browsing is the most common activity undertaken by internet users. The report also looks at the variability of web browsing speed over an average day and internet availability expressed as the percentage of time that internet access is available each month.

Since the beginning of 2009, all cities tested have shown an improvement in national web browsing speed. Additionally, there has been a large improvement in international web browsing speed. The main reason for that improvement is increased use by ISPs of caching techniques, which is the local storage of international content bringing content closer to end-users.

The latest results show that national web browsing speeds are good in Auckland but slow markedly the further away test sites are from Auckland. This decline in speed appears to be caused by ISPs generally locating key equipment only in Auckland. Testing shows Domain Name Server (DNS) response times are generally much slower in cities remote from Auckland (see DNS Performance, page 31) so web browsing speeds in those cities may be improved by locating a DNS and other key equipment in those cities.

Internet availability has been good in some months of the reporting period and not as satisfactory in others. All the ISPs tested had internet access available to their customers for 99.9 per cent of the time or greater (unavailable for up to 43 minutes a month) in at least three out of the six months covered.

The variability of web browsing speeds over the course of a day varies considerably among ISPs. Some ISPs are managing to keep their variation in web browsing speed within reasonable bounds while others have considerably slower speeds at peak times.

In conclusion, while some aspects of broadband performance continue to show improvement, the need for additional investment in backhaul and core infrastructure outside Auckland continues to be a barrier to improving broadband performance outside of Auckland. It is understood that such investments are being carried out by some ISPs but had not been completed in time to affect the test data analysed for this report.

To get a better indication of whether the quality of broadband service being delivered by individual ISPs is adequate, the Commission has set benchmarks to measure ISP broadband performance measures against. The Commission consulted with industry before finalising these benchmarks and it was requested by the TCF (Telecommunications Carrier Forum) that the names of individual ISPs not be shown. The current expectation is that ISP names will be shown in the next report.

How the broadband performance of ISPs as a group measures up against the benchmarks is summarised in Table 1. The performance of individual ISPs against the benchmarks is summarised in Table 2.

**Table 1: Reported Tests, Benchmarks and Results Summary**

| Test | Purpose | Benchmark | Service achievement against benchmarks for Q3 & Q4 2009 |
|---|---|---|---|
| National browsing speed | Demonstrates national browsing performance as a consequence of investment in backhaul, local infrastructure and caching. | 60% of minimum sync[1] speed for that city | |
| | | Auckland | Met by all ISPs in Q3 and 6 out of 8 ISPs in Q4 |
| | | Hamilton | Met by 1 out of 7 ISPs tested in Hamilton in Q3, but none in Q4 |
| | | Wellington | Met by 5 out of 9 ISPs in Q3, but only 2 in Q4 |
| | | Christchurch | Met by 1 ISP |
| | | Dunedin | Not met by any ISP tested in Dunedin |
| International browsing speed | Demonstrates the performance of international browsing as a consequence of investment in backhaul, international capacity and caching. | Better than 1.5Mbps on average for the quarter. | Met by 4 out of 7 ISPs in Q4. |
| Availability of service | Demonstrates the reliability of the connection to the internet through an ISP's network. | Greater than 99.9% internet availability for any month. | Met by all ISPs in 3 out of 6 months, but 3 ISPs had significant outages during a month |
| Variability of speed by time of day | Demonstrates the level of investment made to meet the peaks in demand. | Less than 20% variation in weekly average national browsing speed. | Five out of 13 ISPs achieved the target |

[1] Sync speed is synchronisation speed reported by the modem at the test site after connection to the ISP has been initiated, and represents the upper limit of performance.

**Table 2: Individual ISP Performance against Benchmarks**

| | Browsing | | | | | | Availability | Variability | Caching* | DNS** |
|---|---|---|---|---|---|---|---|---|---|---|
| ISP | Auckland | Hamilton | Wellington | Christchurch | Dunedin | International | | | | |
| ISP 1 | | ☒ | ☒ | ☒ | ☒ | | ✓ | ✓ | | |
| ISP 2 | ✓ | | | | | | ✓ | | | ✓ |
| ISP 3 | ☒ | ☒ | | ☒ | ☒ | | ✓ | | | ✓ |
| ISP 4 | ☒ | ☒ | | ☒ | ☒ | | ✓ | | ✓ | |
| ISP 5 | | ☒ | ☒ | ☒ | ☒ | | ✓ | | | ✓ |
| ISP 6 | ☒ | | ☒ | ☒ | ☒ | | ✓ | | ✓ | |
| ISP 7 | ✓ | | | | | ✓ | | ✓ | ✓ | ✓ |
| ISP 9 | ✓ | | ✓ | | | ✓ | | ✓ | ✓ | ✓ |
| ISP 10 / Other | | | | | | | ✓ | ✓ | | |
| ISP 11 | ☒ | ☒ | ✓ | ✓ | ☒ | ✓ | | ✓ | ✓ | |
| ISP 12 | ✓ | | | | | | ✓ | | ✓ | ✓ |
| ISP 13 | ✓ | | | | | ✓ | ✓ | | ✓ | ✓ |
| ISP 14 | ✓ | | | | | | ✓ | | | ✓ |
| ISP 15 | ☒ | ☒ | ☒ | | ☒ | | ✓ | ✓ | | |

√ Meets benchmark for quarter 4 2009.

☒ Not tested at these locations.

* Clearly using own caching successfully.

** Provisional benchmark, but this column is only for the ISP hometown. Few achieve the proposed benchmark outside their hometown.

# INTRODUCTION

## Background

The Report on New Zealand Broadband Quality is a regular report which is part of a continuing series measuring changes in New Zealand performance over time.

The Commission's objective is to provide a reliable comparison of the optimal technical performance of ISPs in delivering broadband services in the major cities. The intention is that ISPs will be able to see their relative performance against their competitors in different locations and identify methods to improve that performance for the benefit of end-users. To help achieve this, the Commission has developed a range of what it considers achievable performance benchmarks to replace the index that had been used in previous reports.

The Commission chose to delay the publication of test results for the third quarter of 2009 to allow time to consult with the industry via the Telecommunication Carriers Forum (TCF) over the introduction of benchmarks. As a result of the consultation, some of the benchmarks were adjusted and individual ISP results are shown without naming the particular ISPs.

## Data Sources

The report utilises test data from Epitiro's ISP-I platform. The ISP-I platform consists of 11 test sites in five cities, running tests to each of the ISPs tested. The tests are run every 15 minutes.

The five main providers of broadband service in New Zealand, Telecom, TelstraClear Vodafone, Slingshot and Orcon, are tested at all locations, with TelstraClear's cable broadband service tested separately in locations where it is available. In addition, seven second tier ISPs are tested at a lesser number of sites which was reduced to one site each by the end of the reporting period, apart from WordxChange which is tested at one site in each city. For reporting purposes, these seven smaller ISPs are sometimes amalgamated and shown as "Other" or "ISP 10".

## Performance Benchmarks

The benchmarks for each test are set at a standard which is considered by the Commission as desirable 'best practice' for the industry, although some ISPs are not currently able to meet them. The Commission expects that over time most ISPs will improve their performance sufficiently to be able to meet all the benchmarks.

The performance measure results demonstrate that service delivery performance is highly complex. Top performance in one measure may not be matched by top performance in another. Overall performance may be a compromise to enable targeted markets to get the best performance in the measure most valued in those markets.

# SUMMARY OF RESULTS

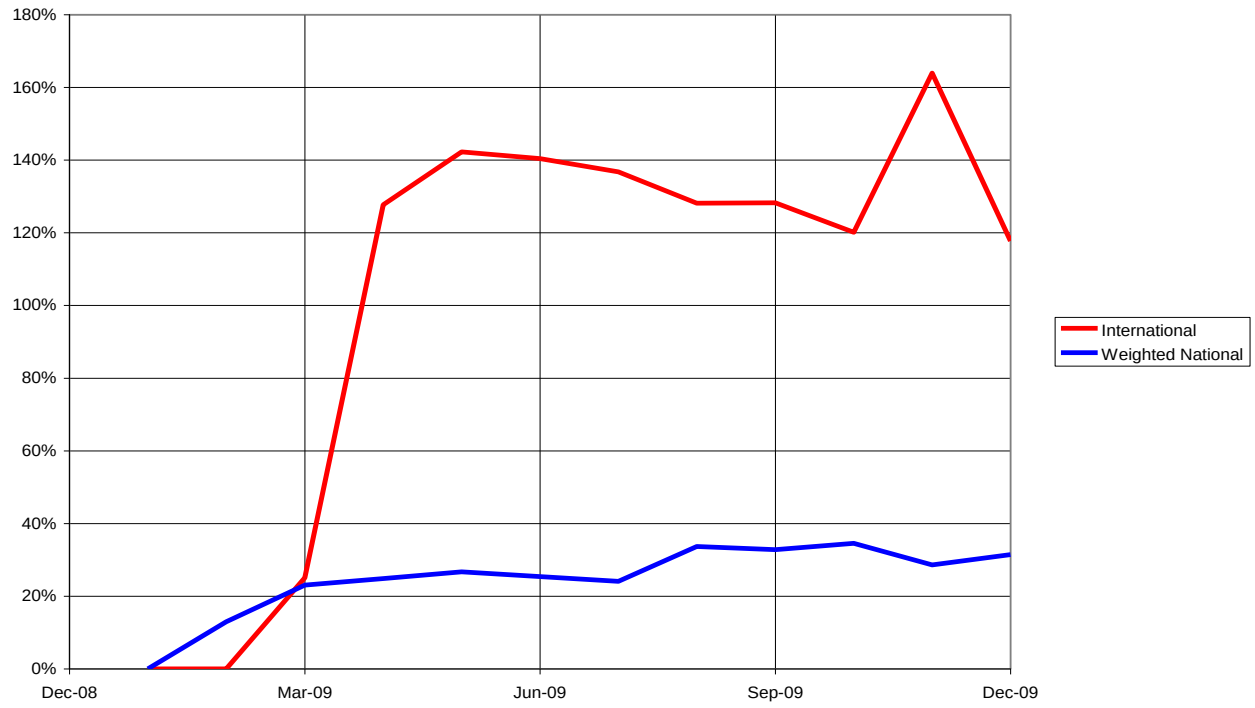
## Average Web Browsing Performance

In order to assess whether overall web browsing performance has improved over the 2009 year, web browsing speeds have been indexed to a starting point of January 2009. The index was also adjusted to compensate for a slow-down in the test website in October and November.

Figure 1 shows the improvements in web browsing performance for international and national web browsing. The graph is designed to show relative improvements in browsing speeds and is not a measure of absolute performance.

The weighted average national web browsing speed performance shows significant improvement over 2009. In the underlying data, all the cities tested showed an improvement in national web browsing speed. There has been a more significant improvement in international web browsing speed, due largely to the increased use of caching by some ISPs commencing earlier in the year. Caching stores international content locally and so brings content closer to end-users.

**Figure 1: Relative Web Browsing Speed Improvements**




## Performance against Benchmarks

How the broadband performance of ISPs as group compared to the benchmarks was shown in Table 1. The performance against the benchmarks by anonymous individual ISPs was shown in Table 2.

For national web browsing speed, the performance in Auckland was good, with most ISPs achieving the benchmark. Two ISPs also met the benchmark in Wellington in the quarter

ending 31 December 2009. However, the national browsing performance of other ISPs failed to meet the benchmarks in the December quarter in all remaining cities with test sites.

TelstraClear Cable is compared with the average ISP speeds delivered by ADSL in both Wellington and Christchurch. Cable is faster than ADSL from the test sites in both cities. However, cable is not significantly faster, since it is slower than speeds achieved with ADSL from sites closer to exchanges such as Hamilton. The distance to the exchange has little effect on cable speed.

Caching of international content is clearly being undertaken by four ISPs, but may also be contributing to the performance of two other ISPs. Caching appears to be a critical factor in achieving good international browsing performance.

The comparison of broadband services purchased by the retailer from Telecom Wholesale compared to those provided via the unbundled copper local loop (UCLL) service purchased from Chorus (where the ISP provides their own equipment in the exchange to connect directly to the copper loop to the premises) generally shows little difference in speed. Backhaul may be a factor that changes the speed achieved by the ISP purchasing the UCLL service via another provider.

Slow DNS lookups appear to be a significant factor affecting the speed of web browsing in the southern cities and probably the entire South Island.

# WEB BROWSING PERFORMANCE

## Web Browsing Speed

Web browsing speed is a measure of the speed at which a webpage loads, and is calculated by taking the size of a specific webpage and dividing it by the time taken to download it. A speed measure for web browsing is considered easier to understand and compare than a download time.

The speed of a page download is significantly affected by the distance between the test site and the local exchange or cabinet where the telecommunications equipment is housed.

The distance between the exchange or cabinet and the location of the ISP's key equipment can also affect performance, but only if the distance is significant. In New Zealand, the distance between Auckland and Wellington is a significant influence on browsing speed. International distances are always an important influence.

Apparent speeds are improved by some ISPs using various data management techniques. A fuller explanation of the impact of distance is included in Appendix 2.

## National Browsing Speed Benchmarks

Low web browsing speed has a major impact on the user experience and much web browsing is of New Zealand websites. It is reported that 66 per cent of visits to the top 20 websites browsed by New Zealanders are to New Zealand websites. The top 20 websites attract 36 per cent of all visits[2].

Browsing speed is affected by more factors than the ISP's network. The website being browsed may have an upload speed limit less than the download speed of the tester or the type of content may delay the process, or the website may be connected via an international link if the ISP is not peered with other New Zealand ISPs. To eliminate these variables, the Commission used a reliable website with ample capacity, connected to the peering network, www.airnz.co.nz.

The Commission has set a national web browsing benchmark of 60 per cent of the minimum sync speed from the Epitiro test sites for each city. Sync speed is synchronisation speed reported by the modem after connection to the ISP has been initiated, and represents the upper limit of performance.

Distance is the predominant factor affecting performance on any ADSL link. Epitiro test sites vary considerably in distance from the exchange so it would be unfair to apply a uniform benchmark to all test sites.

[2] http://www.hitwise.com/nz/datacentre//main/dashboard-190.html for 22 November 2009.

**Table 3: Epitiro Test Site Characteristics and Calculated Benchmarks**

| City | Distance from Local Exchange | Average Sync Speed | Benchmark (60% of Worst Sync Speed) |
|---|---|---|---|
| Auckland | 1.3km, 1.6km & 1.6km | 8.7 Mbps | 4.1 Mbps |
| Hamilton | 600m | 15.3 Mbps | 7.9 Mbps |
| Wellington | 400m, 1.2km & 1.9km | 11.7 Mbps | 4.5 Mbps |
| Christchurch | 800m, 1.2km & 1.7km | 8.6 Mbps | 3.9 Mbps |
| Dunedin | 700m | 13.5 Mbps | 6.4 Mbps |

Test performance from two sites with a similar sync speed in the same city should be roughly equal.

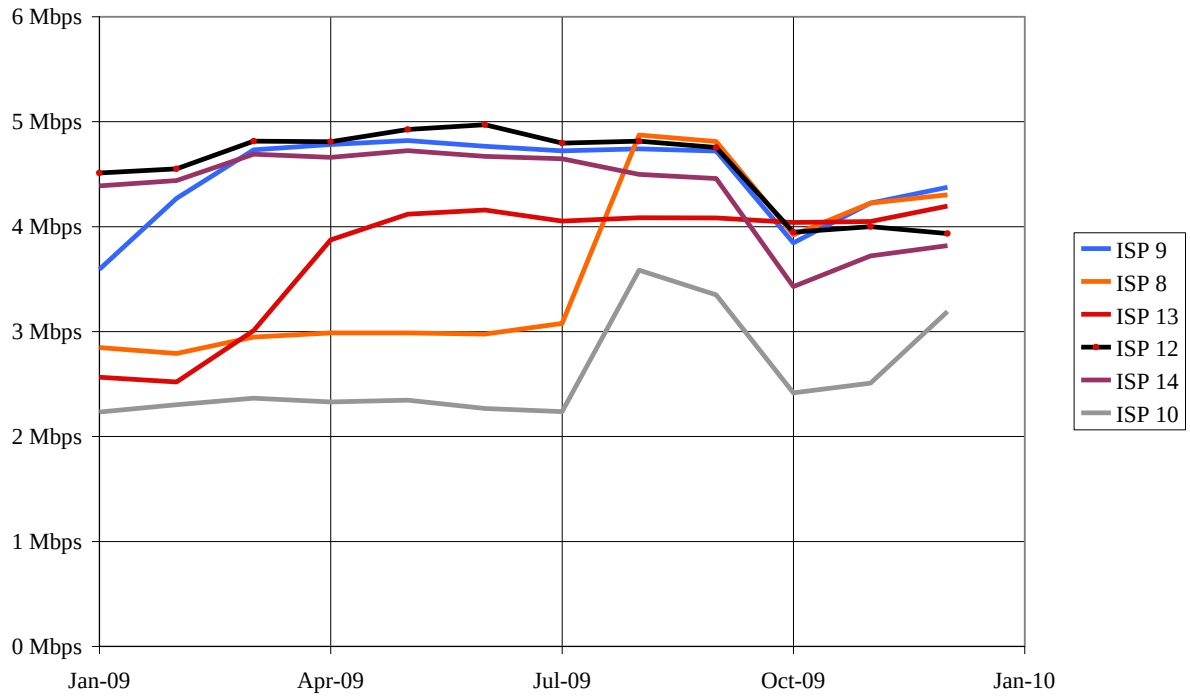
While the tests are intended to demonstrate the performance a user could expect to get in a similar situation, most users will be located at different distances from the exchange compared to Epitiro test sites and will probably have differences in equipment and set-up. It is therefore not possible to compare these results directly with any particular user or the average user. Epitiro tests are designed to compare ISPs tested at the same site, and can be used to indicate the differences between the urban centres in New Zealand.

The 60 per cent of synch speed factor allows for the extra processing needed when web browsing (downloading a webpage) compared to downloading a data file. The 60 per cent factor is considered realistic as it was able to be met by all the major ISPs tested in Auckland. More background on benchmark setting is given in Appendix 4.

## National Web Browsing Average Speeds

The average web browsing speed for all test sites to the national website www.airnz.co.nz is presented in Figure 2. For TelstraClear, the results for cable and DSL are averaged for this test. ISP 10 is an average of all ISPs not tested in all five cities.

**Figure 2: Average National Web Browsing Speed**




Source Epitiro

The Epitiro testing uses real websites, and to present performance to a reliable website in New Zealand, Air New Zealand's website was chosen. This website is not only extremely reliable (the tests to the site hardly ever fail) but also has a very high upload capacity, which means that even during very high customer loads, e.g. a special advertising period by Air New Zealand, the tests continue to deliver consistent speeds.

Air New Zealand updated their website during October, as website owners are liable to do. This update was typical of many websites, incorporating software improvements. Most, but not all, ISPs showed slower web browsing speeds for loading the test website home webpage after the change. The web browsing speed benchmark set for each city takes account of the slowing down in reported web browsing speeds because of the change.

As previously reported, the marked jump in reported speeds for some ISPs in July was due to interleaving being turned off for those ISPs.

## Auckland National Web Browsing Performance

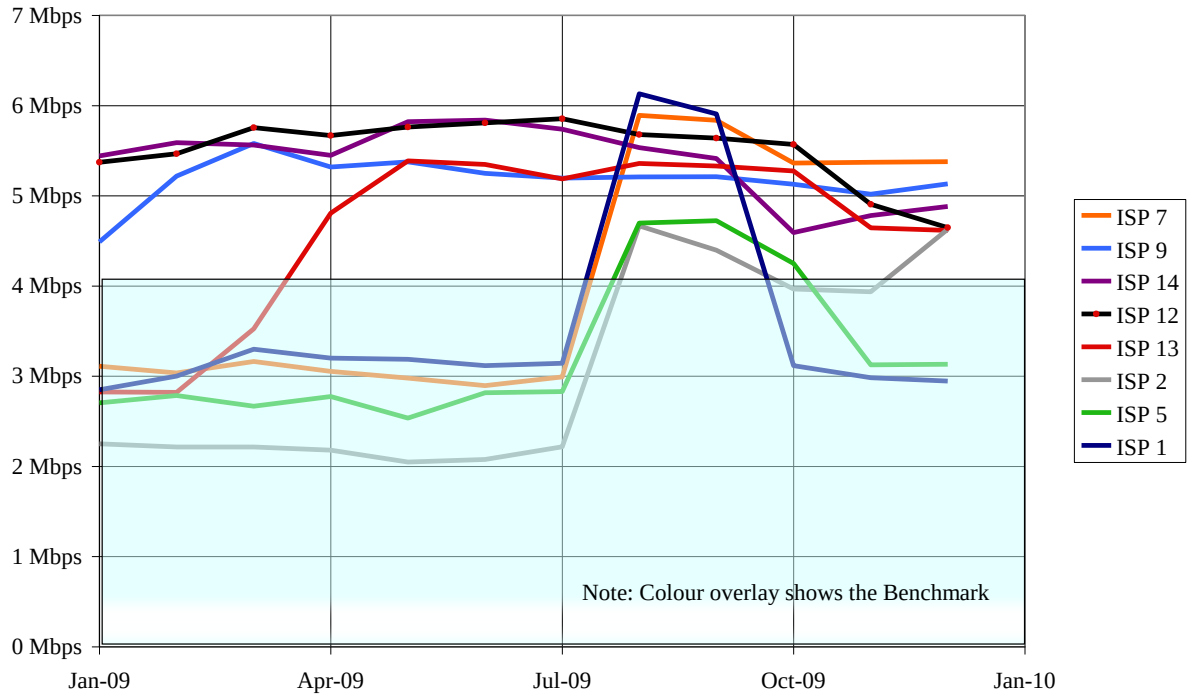
| Test | Purpose | Benchmark | ISP achievement against benchmarks for Q3 & Q4 2009 |
|---|---|---|---|
| National web browsing speed | Demonstrates national browsing performance as a consequence of investment in backhaul, local infrastructure and caching. | 60% of min sync speed which was 4.1Mbps for Auckland | Met by all ISPs in Q3 and 6 out of 8 in Q4 |

The minimum sync speed from any of the Auckland Epitiro sites was 6.7Mbps so the national web browsing benchmark for Auckland was set at 4.1Mbps (being 60% of 6.7Mbps).

All ISPs met this target at some stage during the six months and most ISPs met it throughout the period.

National web browsing performance in Auckland is very good for the premium plans of most ISPs in Auckland.

**Figure 3: Auckland National Web Browsing Performance**




Source: Epitiro

The absolute speeds achieved in Auckland are lower than some other centres due to the distance between the Auckland test sites and their local exchanges. DSL speeds are quite dependent on distance, and the Epitiro test sites in Auckland are around 2km from their local exchanges. The large speed increase for some ISPs shown at the end of June was due to interleaving being turned off for those ISPs.

## Hamilton National Web Browsing Performance

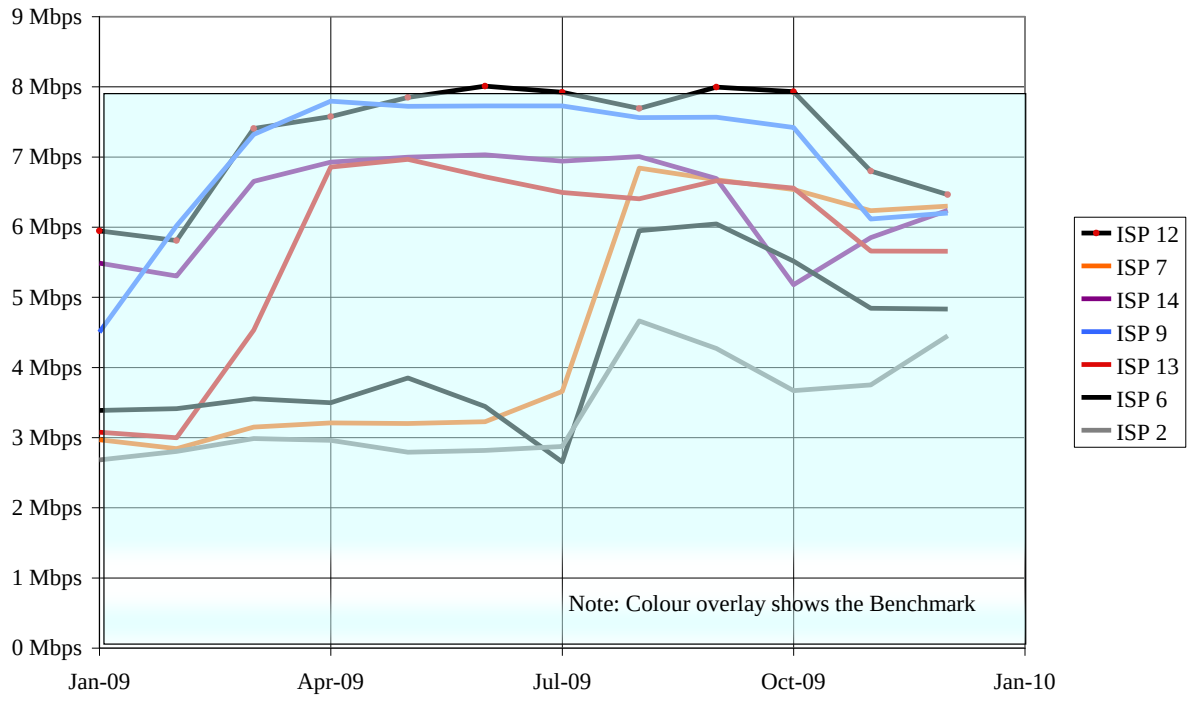
| Test | Purpose | Benchmark | ISP achievement against benchmarks for Q3 & Q4 2009 |
|---|---|---|---|
| National web browsing speed | Demonstrates national web browsing performance as a consequence of investment in backhaul, local infrastructure and caching. | 60% of min sync speed which was 7.9Mbps. | Met by 1 out of 7 ISPs tested in Hamilton in Q3, but none in Q4 |

The minimum sync speed for the Hamilton Epitiro site was a very high 13.1Mbps so the benchmark for Hamilton was set at 7.9Mbps.

The Hamilton test site is one of the closest to the local exchange as well as being close to Auckland so it is not surprising that sync speeds are higher than elsewhere. However, the browsing speeds for all ISPs for the December quarter were too far below the minimum sync speed to meet the performance benchmark. After the website update, performance was considerably lower although the spread of ISP performance was less.

Despite Hamilton being close to Auckland, investment in local infrastructure may still be a constraint on Hamilton's broadband performance.

**Figure 4: Hamilton National Web Browsing Performance**




Source: Epitiro

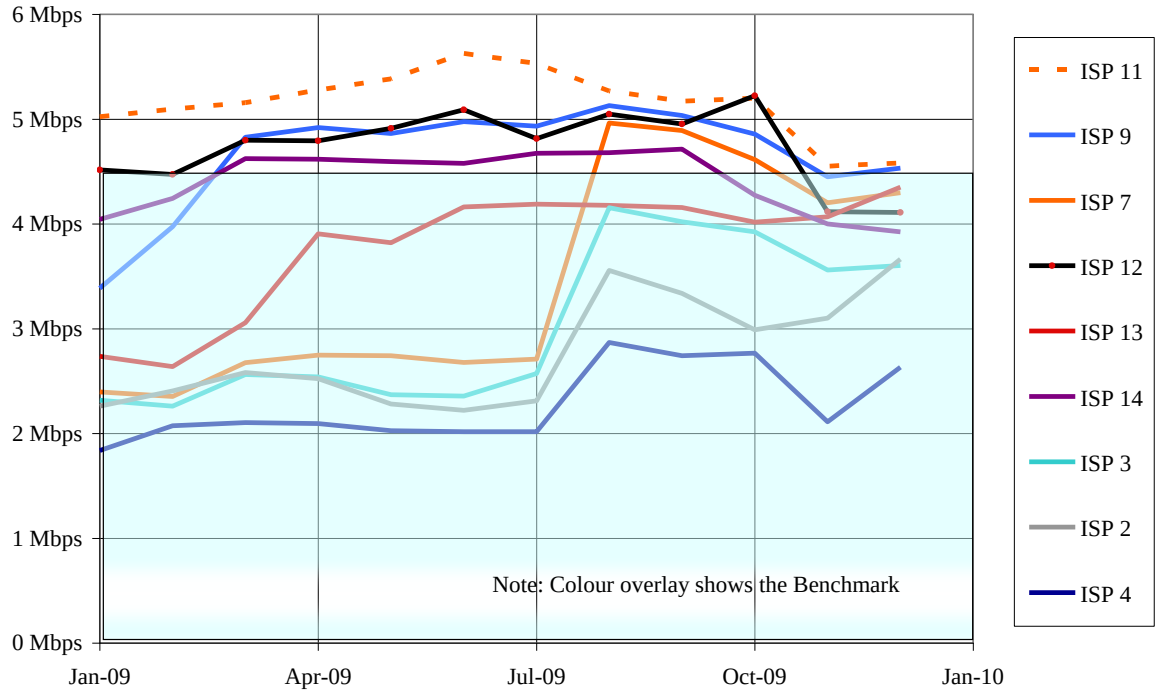
## Wellington National Web Browsing Performance

| Test | Purpose | Benchmark | ISP achievement against benchmarks for Q3 & Q4 2009 |
|---|---|---|---|
| National web browsing speed | Demonstrates national web browsing performance as a consequence of investment in backhaul, local infrastructure and caching. | 60% of min sync speed which was 4.5Mbps for Wellington | Met by 5 out of 9 ISPs in Q3, but only 2 in Q4 |

The minimum sync speed from any of the Wellington Epitiro sites was 7.4Mbps so the benchmark for Wellington was set at 4.5Mbps. Wellington has two sites where cable broadband services are measured and a benchmark is required for these. It is considered that with a target speed of 10Mbps for the tested cable service and the need to compare cable with DSL services, the DSL benchmark was appropriate to apply to cable also.

Three ISPs exceeded the benchmark in the December quarter. As in Hamilton, performance fell off for some ISPs after the website update and the spread of performances reduced.

**Figure 5: Wellington National Browsing Performance**




Source: Epitiro

## Christchurch National Web Browsing Performance

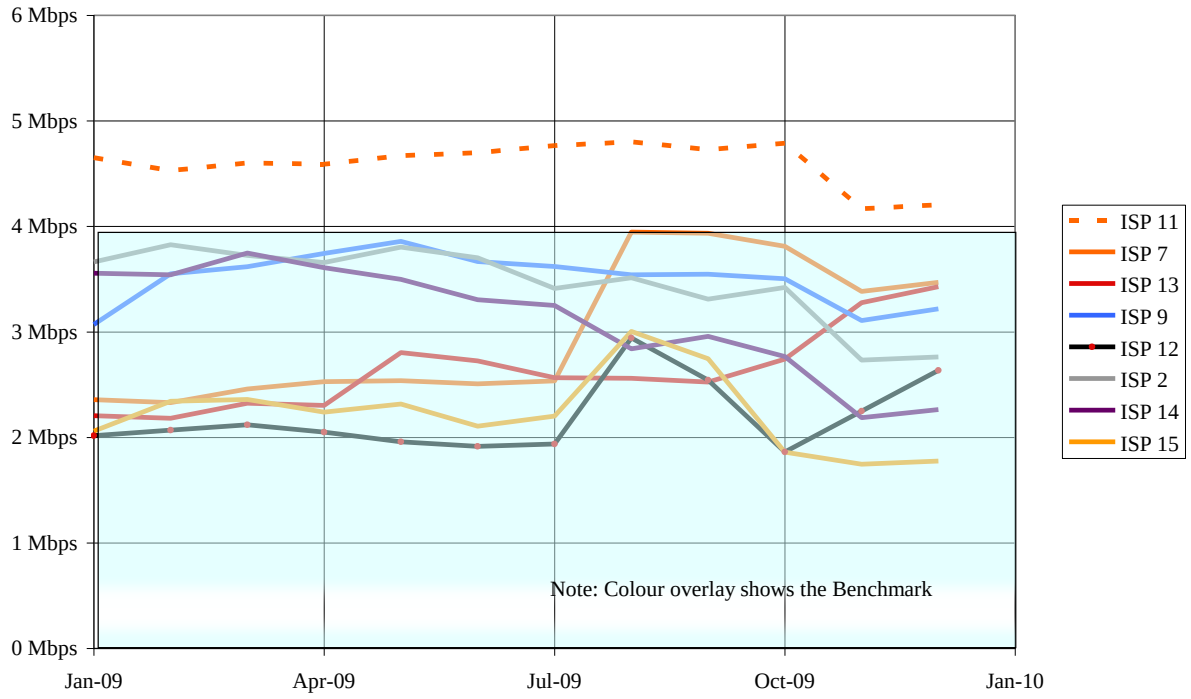
| Test | Purpose | Benchmark | ISP achievement against benchmarks for Q3 & Q4 2009 |
|---|---|---|---|
| National web browsing speed | Demonstrates national web browsing performance as a consequence of investment in backhaul, local infrastructure and caching. | 60% of min sync speed which was 3.9 Mbps for Christchurch. | Met by 1 ISP |

The minimum sync speed from any of the Christchurch Epitiro sites was 6.4Mbps so the benchmark was set at 3.9Mbps. Like Wellington, Christchurch has two sites where cable services are measured and the benchmark was applied to them as well.

One ISP exceeded the benchmark on average for the entire period.

No other ISP met the benchmark either on average or on any single day during the December quarter, although one met it briefly in the September quarter.

**Figure 6, Christchurch National Browsing Performance**




Source: Epitiro

## Dunedin National Web Browsing Performance

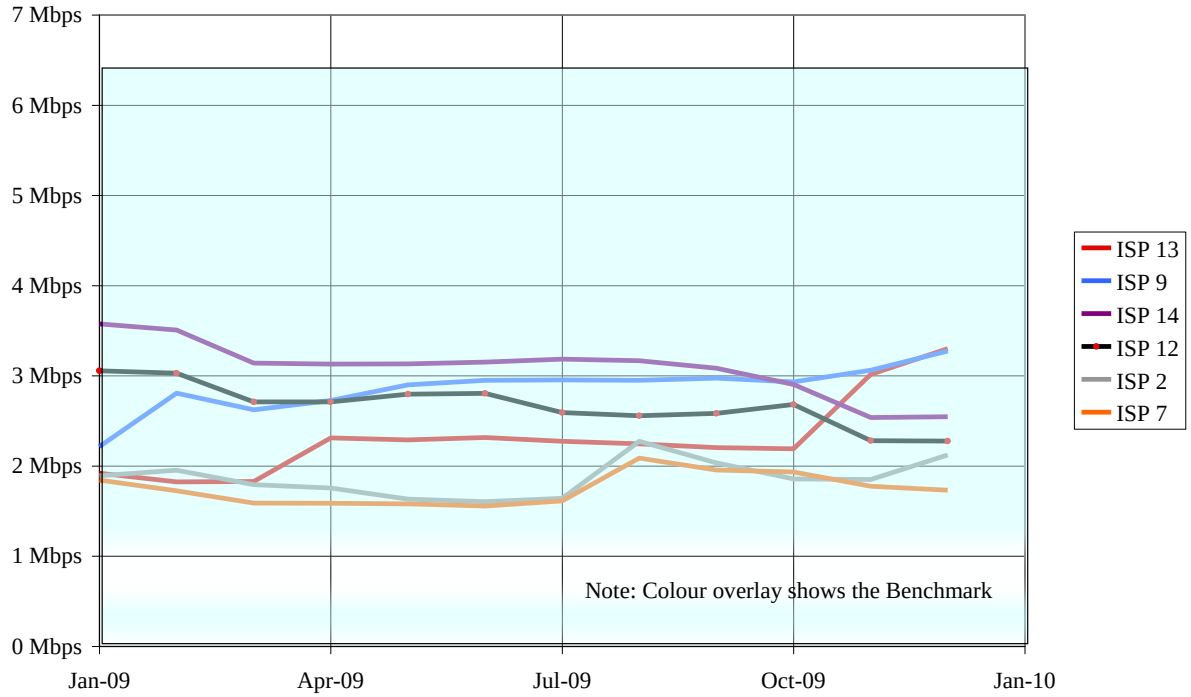
| Test | Purpose | Benchmark | ISP achievement against benchmarks for Q3 & Q4 2009 |
|---|---|---|---|
| National web browsing speed | Demonstrates national web browsing performance as a consequence of investment in backhaul, local infrastructure and caching. | 60% of min sync speed which is 6.4Mbps for Dunedin | Not met by any ISP tested in Dunedin |

The minimum sync speed from the Dunedin Epitiro site was 10.6Mbps so the benchmark for Dunedin was set at 6.4Mbps.

The Dunedin test site is the furthest away from Auckland. However, because the test site is very close to the Dunedin central exchange, it has a relatively high sync speed. Despite this, the best ISPs achieved little more than 3 Mbps, as shown in Figure 7.

No ISP came close to meeting the benchmark either on average or on any day in the whole six months, with the best performance being 3.5Mbps.

**Figure 7: Dunedin National HTTP Performance**




Source: Epitiro

## International Web Browsing

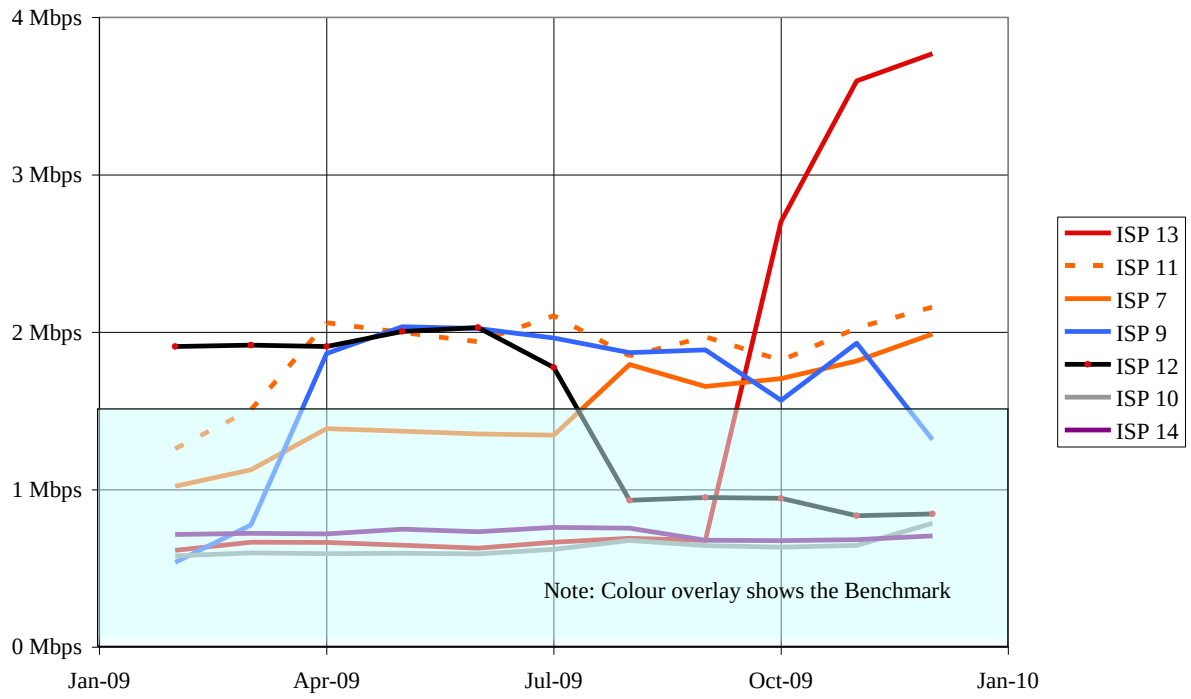
| Test | Purpose | Benchmark | ISP achievement against benchmarks for Q3 & Q4 2009 |
|---|---|---|---|
| International web browsing speed | Demonstrates the international web browsing performance as a consequence of investment in backhaul, international capacity and caching. | Better than 1.5Mbps on average for the quarter. | Met by 4 out of 7 ISPs in Q4. |

Many websites viewed by users are situated overseas so the speed to access these websites is important to the user experience. Even websites with names ending in '.nz' may be based overseas.

International web browsing speed is limited by the significant distance the traffic has to travel and also by any restraint of international capacity. However, caching of international content so it is stored locally can get around these limitations and raises the benchmark performance for international web browsing.

Figure 8 shows the range of international web browsing speeds that have been achieved in the last 12 months.

**Figure 8: Overall International Cached HTTP Performance**




Source: Epitiro

The Commission has set a benchmark of 1.5Mbps as a reasonable speed for international web browsing. This will be reviewed upwards if necessary to take account of changing circumstances such as improved broadband technology, better caching, etc.

Five ISPs achieved the benchmark performance level for international web browsing at some stage during the six months, and one almost met the benchmark for the entire period. One ISP dropped below the benchmark in the December quarter and its place was taken by another ISP later in the quarter. That ISP's international web browsing speed increased significantly from mid September and now almost equals their national web browsing speed.

## Comparison between Cable and DSL Technologies

Cable broadband is available in parts of both Christchurch and Wellington. Many parts of a cable network are similar to a DSL network, including the backhaul and the ISP core network. However, there are significant differences that could show up in comparisons. A summary of the similarities and differences and their effect on speed is shown in Table 4.

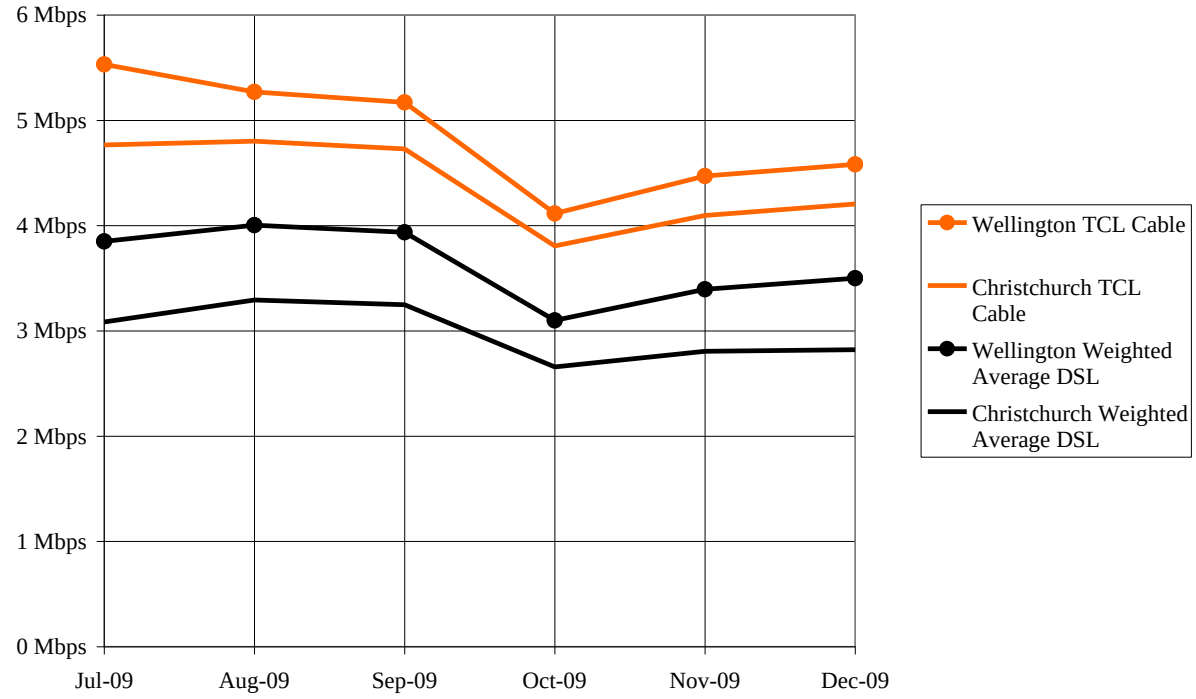
**Table 4: Cable vs DSL**

| | **ADSL1, ADSL2+ or VDSL** | **Coaxial Cable (HFC/DOCSIS)** |
|---|---|---|
| Core ISP Network | Standard | Standard |
| Backhaul | Fibre | Fibre |
| Local (Last mile) | Copper pair per user | Coax cable per sector (typically a street, or neighbourhood) |
| Distance impact | Speed reduces significantly as distance from the exchange or cabinet increases | Speed is largely unaffected by distance |
| Contention over Backhaul | Subject to individual ISP choices, either Telecom contention or own backhaul contention | Subject to TelstraClear backhaul contention choices |
| Contention over last mile | None, as each connection is unique between a DSL user and the DSLAM | All users on a route contend for the total 10Mbps capacity |

A comparison between cable and DSL national browsing in Wellington and Christchurch is shown in Figure 9. In both Wellington and Christchurch the test sites are mostly over a kilometre from the exchange, limiting sync speeds for DSL due to those distances (11.7Mbps for Wellington and 8.6Mbps for Christchurch). The cable broadband service purchased at these sites has an advertised maximum of 10Mbps in both cases. These characteristics enable a reasonable comparison between DSL services, with their speeds limited by distance, and the cable service with its speed limited by last mile contention.

TelstraClear achieved consistently better web browsing speeds with their cable service, even during the period when the airnz.co.nz site was undergoing changes.

**Figure 9: Cable vs DSL in Christchurch and Wellington**




Source: Epitiro

# NETWORK MANAGEMENT

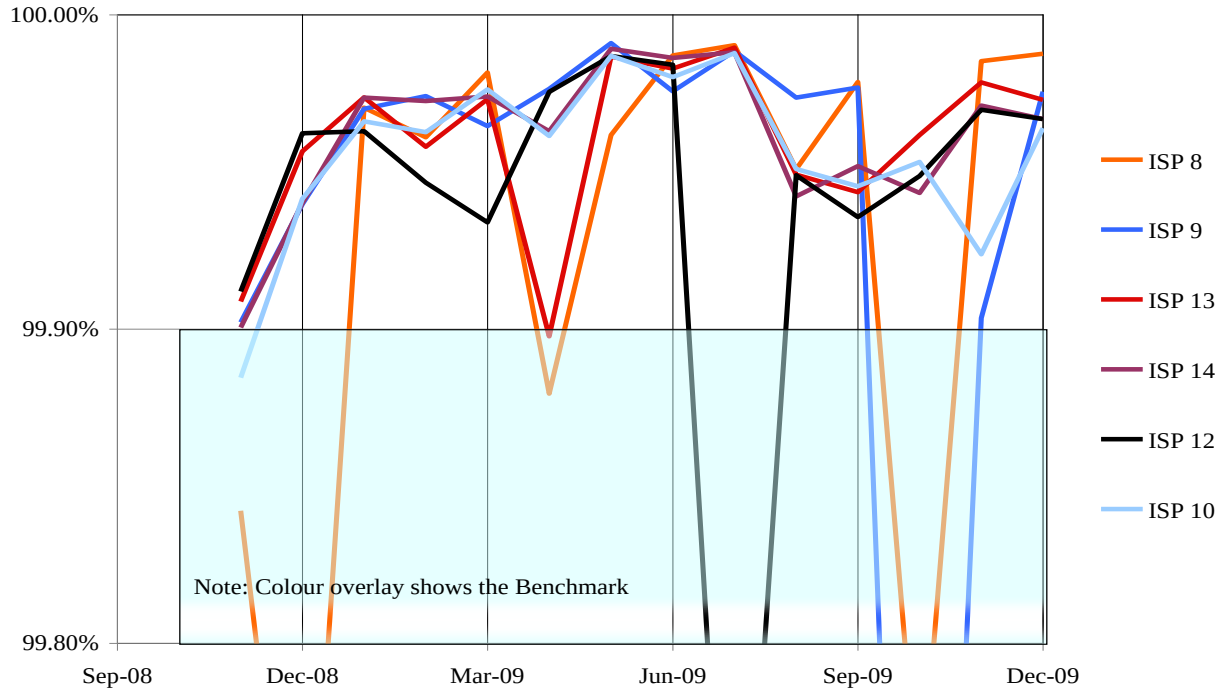
## Availability of Internet

| Test | Purpose | Benchmark | ISP achievement against benchmarks for Q3 & Q4 2009 |
|---|---|---|---|
| Availability of service | Demonstrates the reliability of the connection to the internet through an ISP's network | Greater than 99.9% internet availability for any month. | Met by all ISPs in 3 out of 6 months, but 3 ISPs had significant outages during a month |

Availability is measured as the percentage of the time reference websites are able to be successfully downloaded. Tests are run every 15 minutes for each ISP at each site which equates to over three million tests per month. Figure 10 illustrates overall internet availability across all ISPs tested. Minor ISPs are collected together under "ISP 10" to provide a similar number of tests to those of the major ISPs. The TelstraClear results average cable and DSL so appear only once.

Users want their ISP to have internet service available whenever they need it. This measure is intended to show if ISPs are providing reliable connections and whether the reliability is improving or not. The benchmark of 99.9 per cent represents a network being unavailable for up to 43.2 minutes a month. The range of outages in December 2009 was 5 minutes (ISP 8) to 15 minutes (ISP 10) which is an excellent performance by all ISPs.

**Figure 10: ISP Average Availability**




Source: Epitiro

Only two ISPs achieved the benchmark for the entire six month period. With ISP 10 the samples are too small to be as confident, however on the limited data; all but one of the smaller ISPs making up ISP 10 achieved the benchmark for the full six months.

The Commission notes that all ISPs were able to achieve the benchmark in three of the six months reported here. However, October 2009 was a poor month with two ISPs failing to achieve 99.9 per cent availability.

Availability has improved significantly since the first reporting of the measure in November 2008, apart from the period in the middle of the latest report - the causes of which remain unknown.

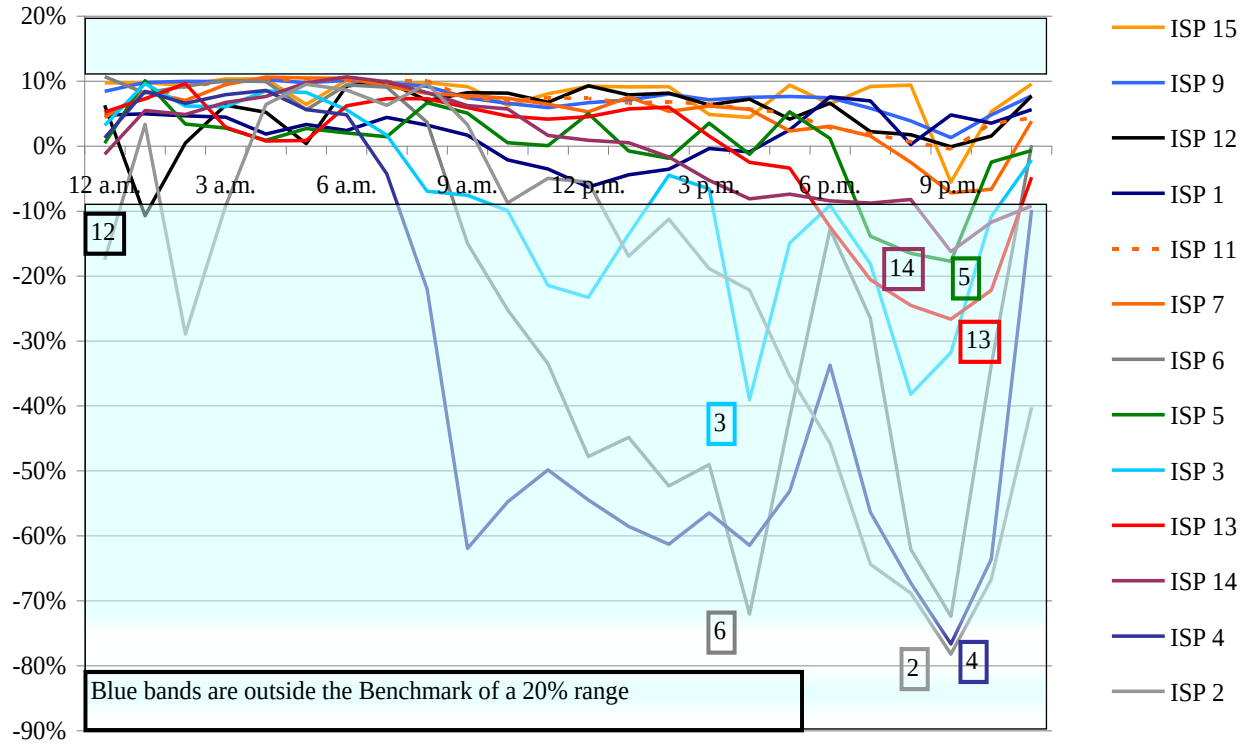
## Variability of Speed by Time-of-Day

| Test | Purpose | Benchmark | ISP achievement against benchmarks for Q3 & Q4 2009 |
|---|---|---|---|
| Variability of speed by time of day | Demonstrates the level of investment made to meet the peaks in demand. | Less than 20% variation in weekly average national browsing speed. | Five out of 13 ISPs achieved the target |

Consistency of service is an important feature of broadband performance. A user's broadband experience could be adversely affected if there is reduced performance at certain periods of the day. The Commission's view is that a reasonable benchmark is that the variability of national web browsing speeds is no greater than twenty per cent. However, lower speeds are less of a concern during periods when most consumers are unlikely to use the service.

Figure 11 shows the performance by hour averaged over a selected week for all ISPs tested. The peak performance was indexed to enable a common comparison, which means that a particular performance for variability is not related to a particular speed. The week chosen to analyse was one during which few interruptions to service were evident from either the ISPs or the testing methods, to help ensure a fair comparison. However, the week chosen may not reflect the variability of performance of individual ISPs for every week of the reporting period. The week reported was from the 16th to the 20th of November 2009 inclusive.

**Figure 11: Variability by ISP over the Test Week**




Source Epitiro

Variability performance has improved in the last two years but continues to fluctuate, and for some ISPs is excessive.

Variability is affected by a number of factors. Many of these are under the ISPs' control, e.g. capacity of a connection to the internet as well as the implementation of caching. Table 5 shows some ISPs are able to deliver an excellent service with little variation throughout the day.

Five ISPs met the benchmark of less than 20 per cent variation as highlighted in Table 5.

**Table 5: Variability averaged over Weekdays**

| | |
|---|---|
| ISP 3 | 49% |
| ISP 6 | 83% |
| ISP 4 | 85% |
| ISP 1 | 14% |
| ISP 14 | 27% |
| ISP 12 | 21% |
| ISP 15 | 16% |
| ISP 11 | 11% |
| ISP 7 | 18% |
| ISP 9 | 9% |
| ISP 13 | 36% |
| ISP 5 | 28% |
| ISP 2 | 88% |

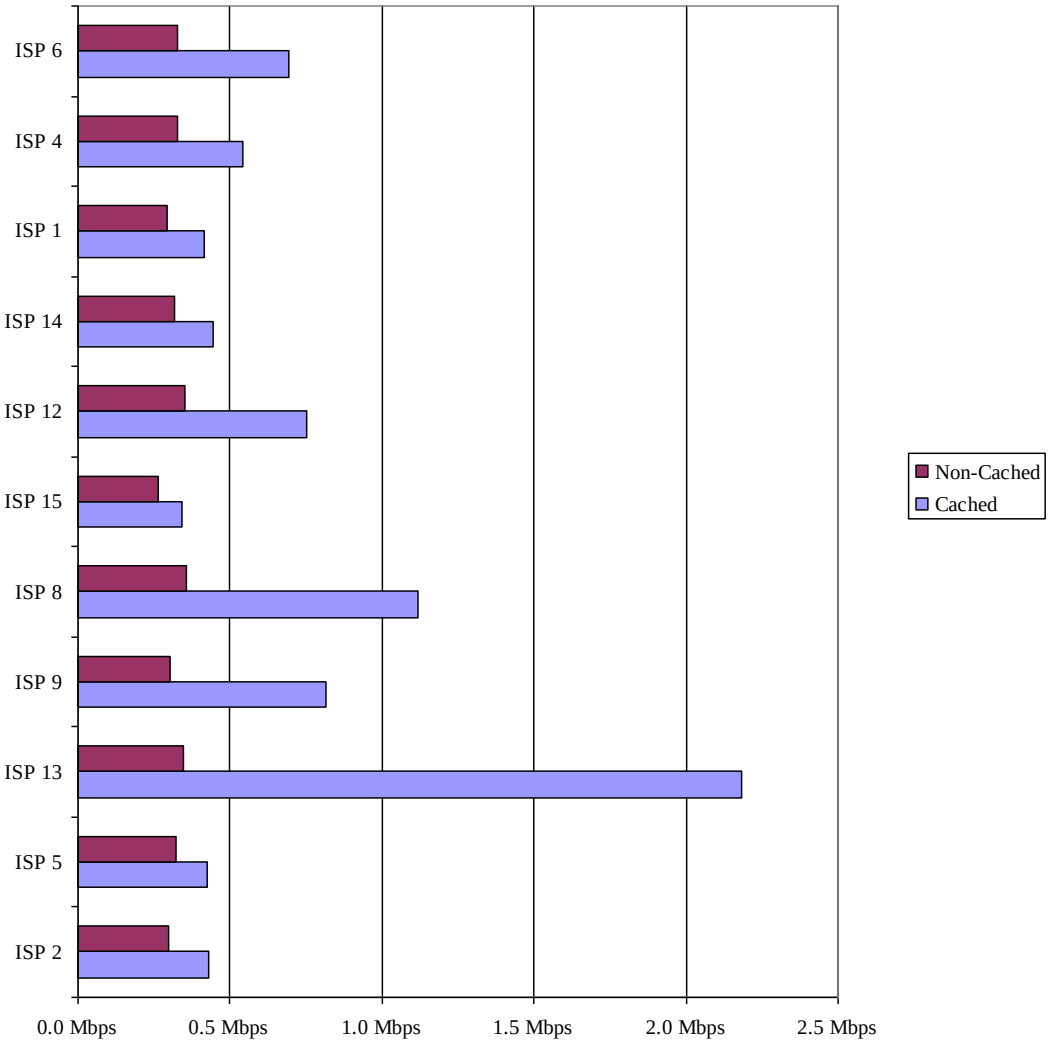
## Caching

The speed and reliability of web browsing is one of most important factors affecting user internet experience. Around 40 per cent of internet traffic in the Asia Pacific region is generated by web browsing.[3]

Caching of international content is an important factor affecting international web browsing performance in New Zealand. Caching stores international (and sometimes national) content locally which enables users of this content to download it at local or national speeds. The improvement in performance from caching international content can be significant.

The Epitiro test measures both cached content and non-cached content from the same website. Figure 12 demonstrates the difference between these measures for each ISP.

**Figure 12: Cached v Non-Cached International Browsing Performance, December 2009**




Source: Epitiro

[3] Sandvine 2009, http://www.sandvine.com/news/global_broadband_trends.asp

Cached vs non-cached performance varies widely between ISPs. Some ISPs appear to have undertaken little caching of international content, while the results demonstrate that for others significant caching of international content is occurring. The differences should show up as noticeable improvements in speed for customers browsing popular international websites.

## Backhaul & Unbundled Copper Local Loop Comparisons

### *UCLL penetration*

Orcon and Vodafone's roll-out of UCLL services in Auckland started around June 2008 and Vodafone effectively resold its UCLL service to Slingshot. Orcon has extended its coverage to the two Wellington CBD exchanges. Epitiro testing of Orcon, Vodafone's and Slingshot's UCLL services started in late June 2009.

TelstraClear's UCLL service was launched in October 2009 and TelstraClear are rolling it out in Auckland and other cities throughout the country. Testing of TelstraClear's UCLL service started in December 2009 and a very short period of performance data is available but it is not presented in order to allow TelstraClear time to 'fine tune' its service.

Slingshot and Compass have announced their intention to roll-out UCLL in some centres outside Auckland but had not started providing a UCLL service during the testing period.

### *UCLL Performance vs Telecom Wholesale Service*

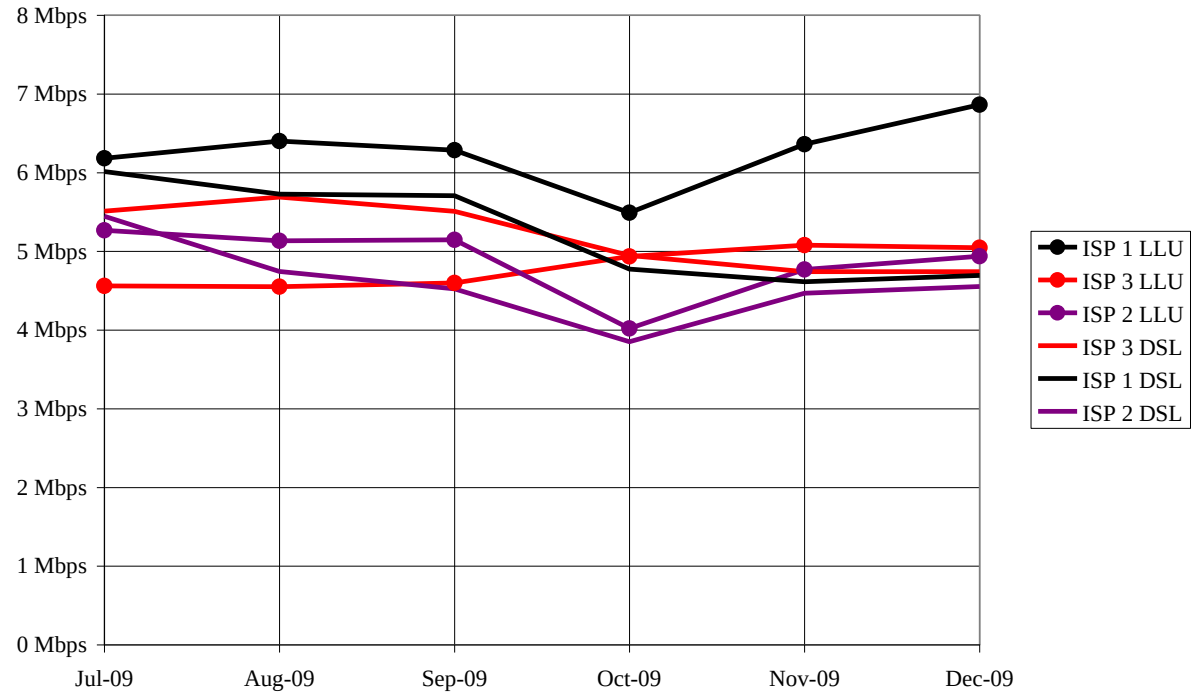
For the first time, testing of the UCLL (Unbundled Copper Local Loop) services sold in Auckland by Orcon and Vodafone, along with Slingshot's resale of Vodafone's UCLL service, is being reported. The UCLL service is tested at the Auckland Central and Auckland South test sites. Epitiro is also continuing to test the Orcon, Vodafone and Slingshot broadband plans provided at those same sites via the Telecom Wholesale bitstream service.

Most broadband connections in New Zealand are provided from the local exchange over an ADSL connection supplied by Telecom Wholesale as an unbundled bitstream service (UBA[4]). Until UCLL was made available, nearly all residential ADSL connections not retailed by Telecom were provided via Telecom's UBA service. With UBA, Telecom Wholesale maintains control over the line going from the users' premise through to the local exchange or cabinet (where the Telecom DSL access module or DSLAM is housed) and the backhaul link to the point of interconnection with the ISP, most often in Auckland.

In 2007, the Commission issued a determination for a UCLL service which enabled ISPs to rent the local loop (the pair of copper wires that run between the user's premise and the local exchange) from Telecom's local access network operator Chorus and house their own equipment in the local exchange. Broadband performance for users receiving a UCLL DSL service could be different to the alternative Telecom Wholesale DSL service.

[4] Technically the service may be either the regulated unbundled bitstream access known as UBA or the no longer regulated unbundled bitream service known as UBS.

**Figure 13: UBA vs UCLL Browsing Speeds at Auckland Central**




Source: Epitiro

These UCLL comparisons are specifically for web browsing speed, which requires multiple requests to the server for information, slowing the speed significantly. Throughput speed, or the speed to download a single file, will be higher.

### *Backhaul*

DSL services provided from Auckland Central have no backhaul requirement for ISPs using UCLL. National browsing speed test results for UCLL services provided from this exchange should be affected largely by differences in equipment (DSLAM) set-up at the exchange, since everything else is equivalent.

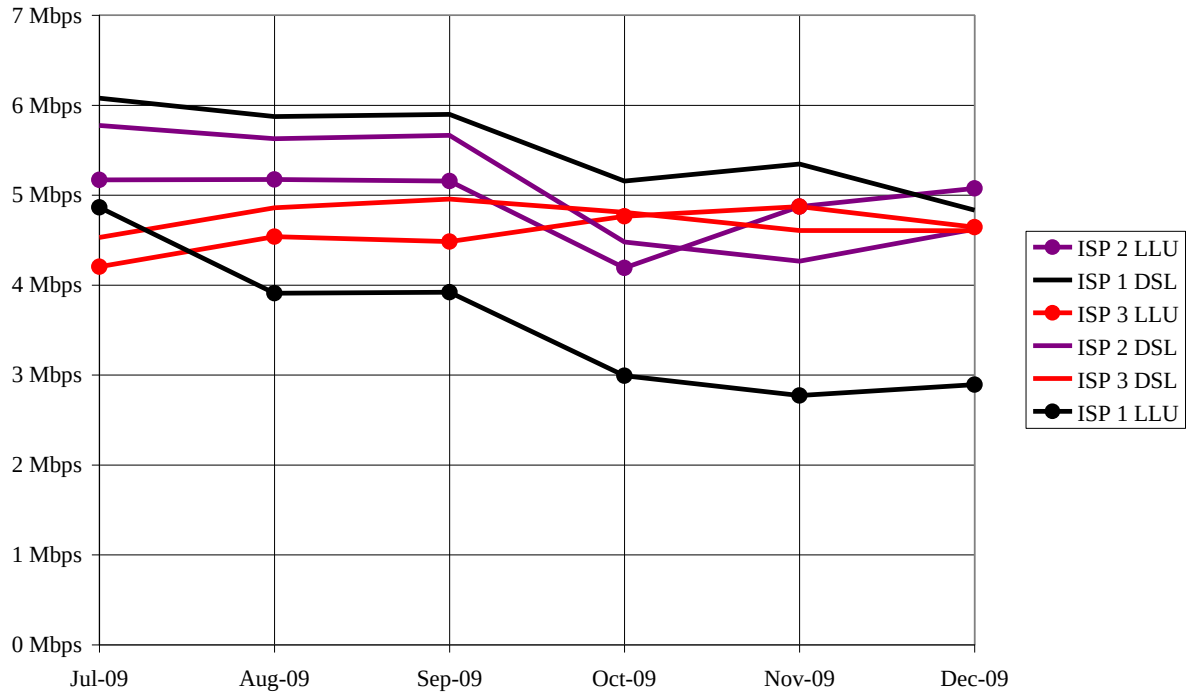
The test results shown in Figure 13 indicate that one ISP is providing a significantly better UCLL service for customers off the Auckland Central exchange. The difference between UCLL and Telecom Wholesale DSL services for both of the other ISPs is insignificant.

A similar comparison from the Auckland South site demonstrates the impact of local backhaul. DSL services provided via Telecom's bitstream service use different (Telecom) backhaul to UCLL services. The browsing speed comparison should, therefore, demonstrate if the type of backhaul makes any difference.

Test results in Figure 13 show that ISP 1 has a slower speed for their UCLL service than the Telecom Wholesale DSL, in contrast to the results from Auckland Central. This difference is likely, although not necessarily, due to backhaul differences between the Telecom Wholesale supplied backhaul (DSL) and the ISP's own-supplied backhaul for UCLL.

The similarity of Telecom Wholesale DSL vs UCLL results for the other two ISPs in both exchanges strongly suggests that their backhaul for UCLL performs at least as well as that of Telecom Wholesale.

**Figure 14: UCLL vs UBA Browsing Speeds at Auckland South**




Source: Epitiro

# DNS PERFORMANCE

The Epitiro tests include some detailed tests of performance that the Commission has not previously been reporting. These include tests known as ping and DNS. The DNS test records the time taken (in milliseconds) to resolve a domain name to the corresponding IP address. This report provides a first look at the DNS test results.

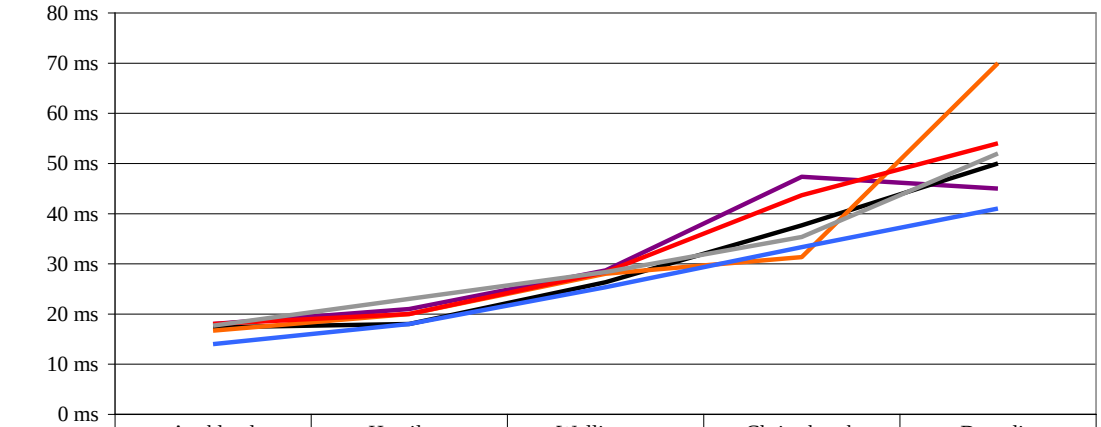
Browsers such as Firefox, Internet Explorer or Safari, send a request to a DNS server for the internet address of each file on a web page. This request can be delayed by either a slow DNS server or the distance to the server (long distances lengthen the time taken to send a packet, despite its high speed). Most webpages have many files, often 60 to 100, so a tiny delay in answering numerous DNS requests could materially delay the page load. Such a delay is often referred to as latency.

A benchmark has yet to be set for DNS performance, although if 20ms can be achieved in Auckland by most ISPs based in Auckland, then this would appear to be a suitable benchmark for all cities.

## DNS Performance of ISPs Tested in all Cities

The DNS performance from remote test sites to the ISPs tested in all cities shows that webpage loading is slower the further the user is from the Auckland based DNS. The test results shown in Figure 15 demonstrate DNS delays of 41ms to 70ms for Dunedin users. Subject to browser type, that could mean, for example, a delay of 70ms x 100 files, or 7 seconds, before a page completes loading. For an Auckland based user, delays for the same page should be less than 2 seconds. Some browsers help to overcome this delay by requesting more than one DNS at a time, but the major browsers are yet to implement such a change.

**Figure 15: DNS Performance for the Major ISPs – all based in Auckland**




| | Auckland | Hamilton | Wellington | Christchurch | Dunedin |
|---|---|---|---|---|---|
| ISP 14 | 18 | 21 | 29 | 47 | 45 |
| ISP 12 | 17 | 18 | 26 | 38 | 50 |
| ISP 7 | 17 | 20 | 28 | 31 | 70 |
| ISP 9 | 14 | 18 | 25 | 33 | 41 |
| ISP 13 | 18 | 20 | 28 | 44 | 54 |
| ISP 2 | 18 | 23 | 28 | 35 | 52 |

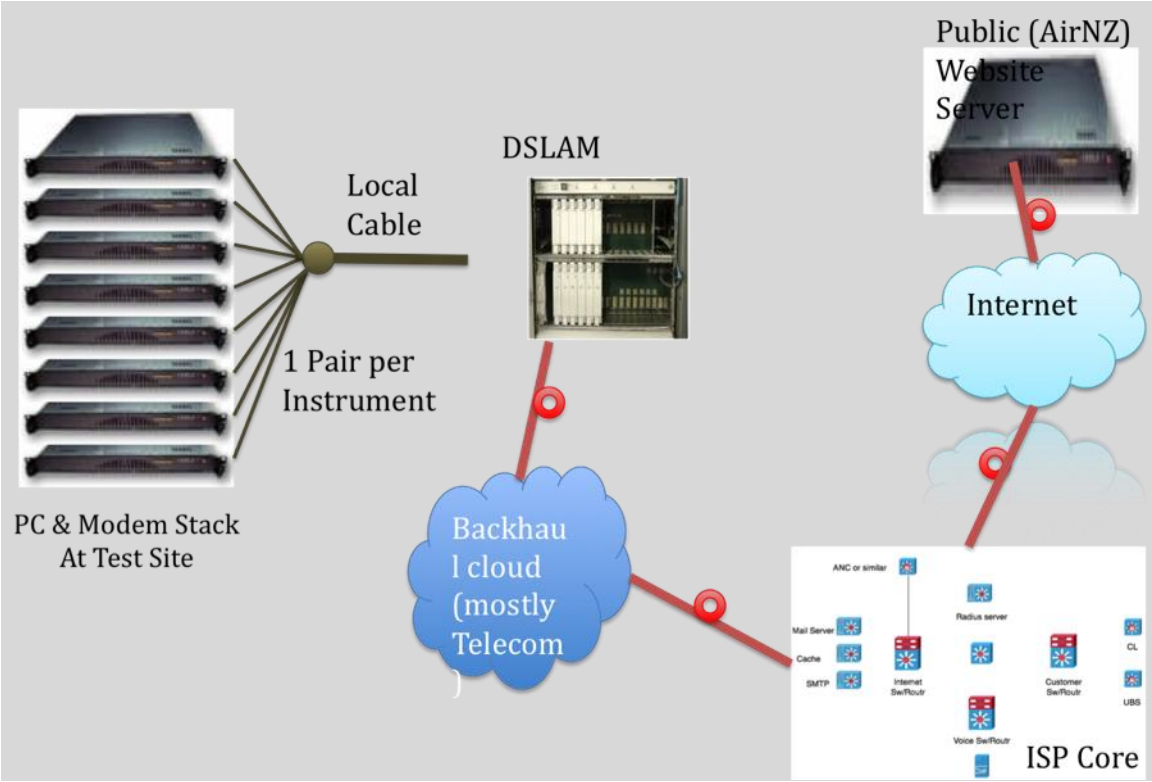
Source: Epitiro

# APPENDIX 1 - THE TEST 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.

The ISP-I test platform and network setup is illustrated in Figure 16.

**Figure 16: Test Network Setup**




The strengths of this setup are;

- each ISP is measured with known and consistent computers and modems;
- there is no interference from users on the same connection;
- the distance from the exchange is the same for each tester at a site, ensuring that distance is less of an issue for ISP to ISP comparisons at that site; and
- the live website testing is exactly the same as a user would experience.

The weaknesses of this setup are;

- the interference from cross-talk is more than expected, probably due to the co-location of modems at the test site; and
- the use of a live website makes testing subject to the risk of changes to the website.

The specific plans tested are shown in Table 6. The test plan is normally the premium residential full speed (both upstream and downstream) DSL plan (or equivalent) that each ISP being tested offers, but in some instances Epitiro had to purchase an equivalent business DSL plan. This should not affect results.

Table 6 also shows the price of the monitored plan or its residential equivalent when consuming at least 20 GB of data, which is the maximum data requirement of the ISP-I testing methodology. Some providers are now offering broadband services only as part of a bundle of services including a phone line (particularly UCLL plans). To try to fairly compare the price of all plans in Table 6, the Commission has used an imputed price of $36.95 per month for a phone line and deducted this from the bundled price where applicable to get a broadband price. The imputed phone line price is the price TelstraClear charges for a residential phone line where it uses its own network. When calculating the price of the other plans it was assumed that tolls were also purchased from the ISP.

**Table 6: Broadband Plans Tested and Comparative Prices**

| ISP | Principal Plan Tested by Epitiro for Q3 09 | Equivalent residential broadband plan with at least 20GB of data assuming tolls or line are also wanted | Price (inc GST) assuming tolls also purchased |
|---|---|---|---|
| Actrix | CyberJet FS/FS | CyberJet FS/FS 20GB | 69.95 |
| Compass | Net Jet FS/FS | Net Jet FS/FS 20GB | 57.95 |
| Inspire | Bitstream FS-FS | Bitstream FS-FS 20GB | 72.50 |
| Maxnet | Dash MX/MX | Dash MX/MX 20GB | 79.95 |
| Orcon | Pro Max/Max | Purple FS 26GB | 69.95 |
| Orcon LLU | Purple + | Bronze + 26GB (part of bundle) | 57.95 |
| Slingshot | CallPlus Pro | Slingshot Pro 25GB (part of bundle) | 57.95 |
| Slingshot LLU | The Big Thing #2 | The Big Thing #2 25GB (part of bundle) | 53.00 |
| Snap | Broadband FS/FS | Broadband C 20GB (part of bundle) | 56.00 |
| TelstraClear | PDQ Max | Call Local with Broadband25GB (part of bundle) | 73.05 |
| TCL Cable | Lightspeed 20G | Lightspeed 20G | 79.95 |
| Telecom | Pro | Pro 40GB | 79.95 |
| Vodafone | Ultimate pack | Ultimate pack 20GB (part of bundle) | 63.05 |
| Vodafone LLU | Ultimate pack | Ultimate pack 20GB (part of bundle) | 53.05 |
| Woosh | Orbit Pro 30GB | Bundle of Joy 20GB (part of bundle) | 62.05 |
| Xnet (WorldxChange) | HSI Flood | HSI Flood 20GB (no tolls requirement) | 70.47 |

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 ISPs located at the same site. However, it does not represent what individual users may expect from their broadband service. This is because it does not capture all the variables that influence residential performance. These include:

- a home's distance from the Telecom exchange;
- the quality of computer equipment and home wiring;
- the number of users on the same broadband connection; and
- the large variations in performance of the websites users visit.

Further details of Epitiro's methodologies are included in the Appendix 4.

Telecom offers two residential full speed DSL plans with data caps of 20GB or more but the Pro plan is tested because its default is to have interleaving off. TelstraClear changed the name and pricing of its broadband plans in October 2009 when it started offering broadband using unbundled copper local loop (UCLL) services purchased from Chorus.

Epitiro is moving to testing the naked DSL variants of the broadband plans tested where these are available. The first plan changes started to be made in September 2009.

# APPENDIX 2 - BROWSING TEST TECHNICAL DETAILS

## Overview

There are a number of ways of measuring the speed of the broadband service provided by ISPs. These include:

- HTTP or web browsing speed which measures the size of a specific web page and divides that by the time taken to download it;
- Throughput or download speed measures the speed of a file being downloaded;
- Streaming speed measures the speed of viewing a video or listening to audio.

The Commission is currently measuring browsing speed only as this is the most common use of the internet. A global internet traffic report by Sandvine[5] found web browsing made up the largest category of internet traffic, and in the Asia-Pacific region accounted for 40 per cent of traffic.

There are a number of factors that have a material impact on ISP performance that the report continues to highlight, including:

- Investment in primary and secondary backhaul;
- Distance to the exchange;
- Sync speed of the copper local loop used for each connection – i.e. the top speed possible; and
- Investment in local infrastructure.

### *The Backhaul Factor*

The backhaul portion of a network includes the link between the Telecom exchange and the service provider's network. A backhaul network is provisioned to cope with the volume of users and traffic at both the local and national level. Correctly provisioned backhaul will ensure that there are no capacity bottlenecks that could restrict peak performance. Backhaul can be further divided into three types:

- Interconnection link, the connection between the service provider and the network provider;
- 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 and may be provided by one or more network providers on behalf of the service provider.

The majority of broadband service providers purchase wholesale backhaul services from third party network providers.

[5] http://www.sandvine.com/downloads/documents/2009%20Global%20Broadband%20Phenomena%20-%20Executive%20Summary.pdf

### *The Effect of Distance on Web Browsing Speed*

Sync speed is reported by a DSL modem after connection to the ISP has been initiated and is the upper limit of broadband download speeds. Web browsing speeds are necessarily slower again than download speeds. Sync speed is significantly affected by the length of the copper local loop serving the customer.

**Table 7: Average Sync Speeds by City**

| City | Lab Distance from Local Exchange | Average Sync Speed |
|---|---|---|
| Auckland | 1.3km, 1.6km & 1.6km | 8.7 Mbps |
| Hamilton | 600m | 15.3 Mbps |
| Wellington | 400m, 1.2km & 1.9km | 11.7 Mbps |
| Christchurch | 800m, 1.2km & 1.7km | 8.6 Mbps* |
| Dunedin | 700m | 13.5 Mbps |

Source: Epitiro

* One site in Christchurch was moved in the quarter from the very closest to any exchange to almost the most distant, lowering the average Sync speed for this quarter in Christchurch.

Some Epitiro test sites are closer to Telecom exchanges than others, and the sync speeds for those sites are therefore higher. The Hamilton site, for example, is within 800m of the Hamilton Central exchange and has an average 15.3 Mbps sync speed from all the testers present on the site. In Auckland the test sites are approximately 1.5 km from Telecom exchanges.

There is a considerable variation in sync speed by site, so the benchmark selected is selected based on the lowest site sync speed. This benchmark is adequate for comparison purposes with cable.

Since the Hamilton sync speed average is 15.3Mbps, and it might be expected that downloads would likely be close to 15Mbps, yet browsing speeds, due to latency etc, are just 7-8Mbps for the airnz.co.nz website, which now includes Java files.

Since data travels at the speed of light in glass over fibre optic cable, there is a very small delay in the transmission of data, even over very large distances. However, web browsing requires many small files to be transmitted and the small delay on each file for 60+ files becomes a significant delay and is the reason why web browsing speeds are necessarily lower than download speeds.

Distance from core infrastructure becomes an impediment to web browsing performance for remote cities. At up to 100ms of extra delay per request in Dunedin, duplicated for all 60 files, the delay is getting close to six seconds for the test website, and this would be worse when browsing websites with more files.

Investment in core infrastructure such as a local DNS server may lessen the data transmission delay. The Commission will continue to test to identify any improvements made.

### *Impact of Interleaving*

Interleaving is a method of transmitting data packets in a way that corrects transmission faults and improves the reliability of a connection. However, interleaving increases latency and can slow download speeds. It is of little 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 generally provides a significant boost to performance.

The September 2009 quarter was the first quarter where interleaving has been turned off for all the plans being tested. The plans, which still had interleaving turned on at the beginning of the quarter, had it turned off in late July 2009. As a result, poorer performing ISPs in particular often showed considerable improvements compared to previous quarters.

Users are advised to check with their ISP to identify if they have their interleaving on or off if their browsing speed is below what they 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.

### *International Web Browsing*

International web browsing speed is most affected by the distance to the international server, the upload speeds at the remote server, caching, the capacity of the international connection and the capacity of the ISP backhaul network.

### *The Difference between Browsing and Download Performance*

Latency over large distances creates a speed limit on downloads of small files used in web browsing. Latency is the time taken for an IP packet to return from a remote site. Each file on a webpage requires a packet to identify the file name, identify where it is stored and then the file itself, all in sequential transmissions.

A typical website uses large numbers of small files to make rendering the page quick, but that slows downloads because of the time taken for communication about each file. When distances are large, the time taken for all packets to return (Latency) becomes significant even at the speed of light.

ISPs are concerned that the Commission's use of web browsing speeds as a measuring tool is clearly defined to enable a good understanding of why reported speeds are not the maximum available.

**Browsing**; The Epitiro Browsing speed is a calculation based on the time taken to download a webpage – in most cases www.airnz.co.nz, which is around 200kB. A webpage is made up of multiple files, each file requiring details of it's location to be transmitted first (DNS lookup), it is this activity that lowers the net speed.

**DSL Downloading**; If the Commission reports downloading, it will be a calculation based on the time taken to download a single file. A single file has few overheads (a single DNS lookup) and usually downloads at the maximum possible speed capable on the service at the time of download.

A benchmark of 60% of sync speeds for DSL services, which enables time for the file details to be transmitted, with Download speeds, the benchmark will need to be higher, say 90% of sync speed.

**Cable Download**; A download speed benchmark would need to be very close (say 90%) to the maximum available, i.e. 10Mbps for the services Epitiro purchase, but in this case how

often the maximum speed can be obtained will be the key metric due to the impact of local congestion on the coaxial cable.

# APPENDIX 3 – DOWNLOAD SPEED TESTING

## Download Speed

Download speed or throughput is the speed at which a file, e.g. a software update, is downloaded. This is the type of speed test most commonly used by internet users when they want to test the speed of their broadband connection. Many ISPs have their own download speedtest available on their website or have a link to a speedtest for their customers to use. However, ISPs normally ensure that traffic used for such speedtest testing does not have to pass through the full extent of the ISPs network in order to give a more favourable result.

The Commission is considering measuring ISP performance by download speed. This would probably require a test for each ISP at each test site that downloads a large file every hour to identify the speed achieved during a typical download.

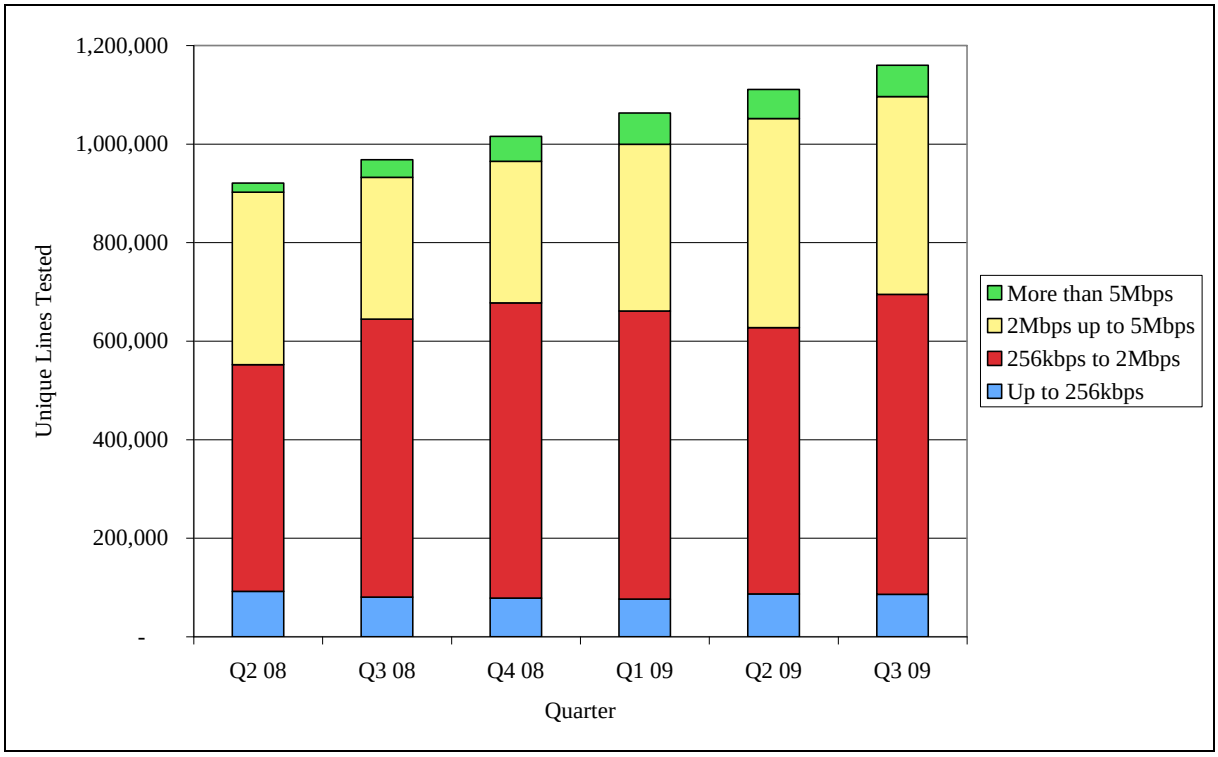
Akamai already produce a reliable comparison by country of speeds to download their cached content, from servers based within ISPs. Speedtest produce a less reliable survey from users own tests to their speedtest server, which could be biased by user selection. However, both tests demonstrate the net speed, which is the speed available from a combination of network performance, distance limitations, user choice of package and in the case of speedtest, measures of cap constrained speeds.

The Epitiro ISP-I testing used by the Commission to monitor ISP broadband performance tests premium broadband plans from test sites in locations that achieve good performance so inevitably any average download test speeds obtained would be much faster than the New Zealand average speed performance reported by Akamai. The download speed test results may be 30 to 50 percent better than the equivalent web browsing speeds already being observed.

### *New Zealand average speed performance (from Akamai)*

Akamai produce a study of internet speeds using data from their cache servers located within many ISP's core networks. These measure the download speed of users and effectively take into account speed limitations due to the type of plan purchased (see Figure 17) as well as any limits due to distance. The data will include tests from dial-up (within Blue on Figure 17), mobile (Blue & Red), Wi-Fi (Any colour) and potentially tethered mobile (Blue & Red). All these services tend to have lower speeds than wired broadband. They will also include tests from very high speed broadband plans including fibre at corporate, ISP and other high capacity nodes (Green).

**Figure 17: Akamai Speed Test Results**




Source; Akamai "State of the Internet" reports

## Range of Speeds

ISPs offer various speeds for different prices. The range of speeds offered by each ISP tested is shown in Table 8. These speeds are the maximum download speed each line can achieve. Full Speed is a concept based on DSL technology, which has a range of capabilities (ADSL1=8Mbps, ADSL2+ = 24Mbps and VDSL = 50Mbps), however the actual speed delivered is dependent on the distance of the modem from the exchange or cabinet.

Typically the speed reduces quickly over the first few meters due to electrical interference between wires, so within a kilometre the speeds are rarely above 15Mbps. The test site connections used vary in sync speed from 6.5Mbps to 16.5Mbps on ADSL2+, although vary to a lesser extent within each test site.

**Table 8: Line speed Standard Plan Offers**

| ISP | 256k/128k | FS/128k | FS/FS (with limits) | FS/FS |
|---|---|---|---|---|
| Telecom | | | ✓ (Managed) | ✓ |
| TelstraClear DSL | ✓ (Launch) | | | ✓ |
| TelstraClear Cable | | | | 4, 10 or 25Mbps |
| Orcon | ✓ (Wireless) | ✓ | | ✓ |
| Slingshot | ✓ | ✓ | | ✓ |
| Vodafone | | ✓ | | ✓ |
| WorldXchange | | ✓ | ✓ (Xnet < 7Mbps) | ✓ (Xnet Fusion) |
| Snap | | | | ✓ |
| Actrix | ✓ | ✓ | | |
| Inspire | ✓ | ✓ | | ✓ |
| Compass | | ✓ | | ✓ |
| Maxnet | ✓ | ✓ | | ✓ |
| Woosh | | | | ✓ |

*FS means your connection speed will be as fast as your line will allow. (Referred to variously as Full Speed, FS, FLS, Max and MX on ISP websites)

# APPENDIX 4 – SETTING A BENCHMARK FOR BROADBAND PERFORMANCE

Determining what is a reasonable benchmark for broadband performance is a subject of considerable debate around the world. Various international bodies are trying to define and measure it to satisfy political and economic expectations.

The Commission decided it needed to set benchmarks for broadband performance measures as an indicator of whether New Zealand ISPs are providing a good quality of service to their customers or not.

The decision on determining a benchmark needs to account for the service being measured. For speed measures, the alternatives include web browsing, video and file download. Currently, only web browsing speed is being measured for the Commission.

The problems in determining an appropriate benchmark are shown by the difficulty other regulators have in deciding on benchmarks for broadband. Table 9 shows universal download speeds that have been set in other countries while Table 10 shows downloads speeds that expected to be obtainable by the majority of the population in some of these countries at a future date. Note that these are download speeds and not the, somewhat slower, web browsing speeds currently being measured for the Commission.

**Table 9: Universal Benchmark Speeds[6]**

| Country | Benchmark Speed | Date | Distribution |
|---|---|---|---|
| UK | 2Mbps | 2012 | Universal |
| Finland | 1Mbps | 2010 | Universal |
| Germany | 1Mbps | 2010 | Universal |
| France | 0.5Mbps | 2012 | Universal |
| Northern Ireland | 2Mbps rural, 10 Mbps urban | 2011 | Universal |

[6] Berkman report for FCC, Feb 2010, Final Report page 18-21
http://www.fcc.gov/stage/pdf/Berkman_Center_Broadband_Study_13Oct09.pdf

**Table 10: Target Benchmark Speeds for Majority of Population**

| Country | Benchmark Speed | Date | Distribution |
|---|---|---|---|
| Germany | 50Mbps | 2015 | 75% |
| Finland | 100Mbps | 2015 | Within 2km |
| USA | 50Mbps affordable | 2015 | 100 million homes[7] (85%) |
| Telecom NZ | 10Mbps | 2012 | 80% |

Epitiro's test sites should easily achieve better than 2Mbps download speed when this is tested. This is mostly due to the fact that the test sites are relatively close to exchanges. To be fair, the download performance benchmark therefore should take account of the proximity of the test site to the exchange.

Since browsing is being tested and this requires more files to be loaded than a download speed test, a benchmark browsing speed of 60% of sync speed has been chosen. Sync speed is synchronisation speed reported by the modem after connection to the ISP has been initiated, and represents the upper limit of performance. For ease of calculation and fairness, the minimum sync speed at any site is used. This benchmark can also be used for cable broadband tests.

International comparisons of speed often use data from random users, including users who choose slower speeds offered as a low-cost entry point for broadband services. The commission considers this a consumer choice, so has limited tests to measuring unlimited speed services to find a fair comparison between ISPs and ultimately with the rest of the world.

Speed is a very recognizable measure, but other broadband parameters are equally important for instance latency and jitter, features that can control the quality of a voice call. Users of Skype or games will be more familiar with latency and jitter when they can cause significant problems.

[7] Connecting America, The National Broadband Plan, page 9, Goal #1

# APPENDIX 5 – EPITIRO METHODOLOGY

## Overview

The data used in this report is collected using Epitiro's ISP-I technology. The data provides an 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 sites where they are tested.

At each site, there are approximately 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.

## 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 ISPs 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.

The DSL modem used is a Thomson ST546 modem/router in all instances except for TelstraClear Cable, for which the modem is the standard supplied by TelstraClear.

## Measurements Available from the Epitiro Test Laboratories

There are nine measurements available for this report. The commission uses these to develop the key performance variables listed in Table 1. The measurements are defined as follows:

### *Synchronisation Speed*

Synchronisation speed is one measure of the speed of broadband service supplied to a customer. Also known as line connect speed, it 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 times and reduce international transit costs, content fetched by users may be locally cached on New Zealand-based servers. The cached HTTP download 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 performance 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 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 test therefore provides an estimate of the user experience in downloading web pages from foreign locations. Short times equate to a better experience. The test manages to identify cached content correctly in a large percentage of cases, but may allow cached content through as non-cached. 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.

### *TCP Retransmits Performance*

The TCP Retransmits test records the average TCP Retransmits percentage experienced during individual tests and an overall TCP Retransmits test. The TCP Retransmits 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 Retransmits during all the individual tests executed, as well as an overall TCP Retransmits measure over the course of entire network connection during which the tests were being run. Thus, as well as measuring the TCP Retransmits in a network, ISP-I is able to indicate whether TCP Retransmits are occurring for

a particular protocol or service. The ISP-I Satellite measures TCP Retransmits by utilising the Performance Counters for TCP available within Windows. TCP Retransmits are 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.

### *ISP Average Availability*

The ISP Average Availability test measures the percentage of time that the reference website is able to be successfully downloaded from each ISP over a large number of tests (run every 15 minutes per ISP). The results provided by ISP-I are grouped into the various types of errors that were encountered while the tests were run over the specified timeframe; including HTTP status codes and errors returned by the satellite software. The results that are reported on in the ISP Average Availability graph specifically focus on those errors returned by the satellite software only to ensure that ISPs are not adversely affected if the reference site becomes inaccessible for reasons beyond their control.

## 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. TelstraClear Cable is measured where it is available in Wellington and Christchurch.

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 from Epitiro

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 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.