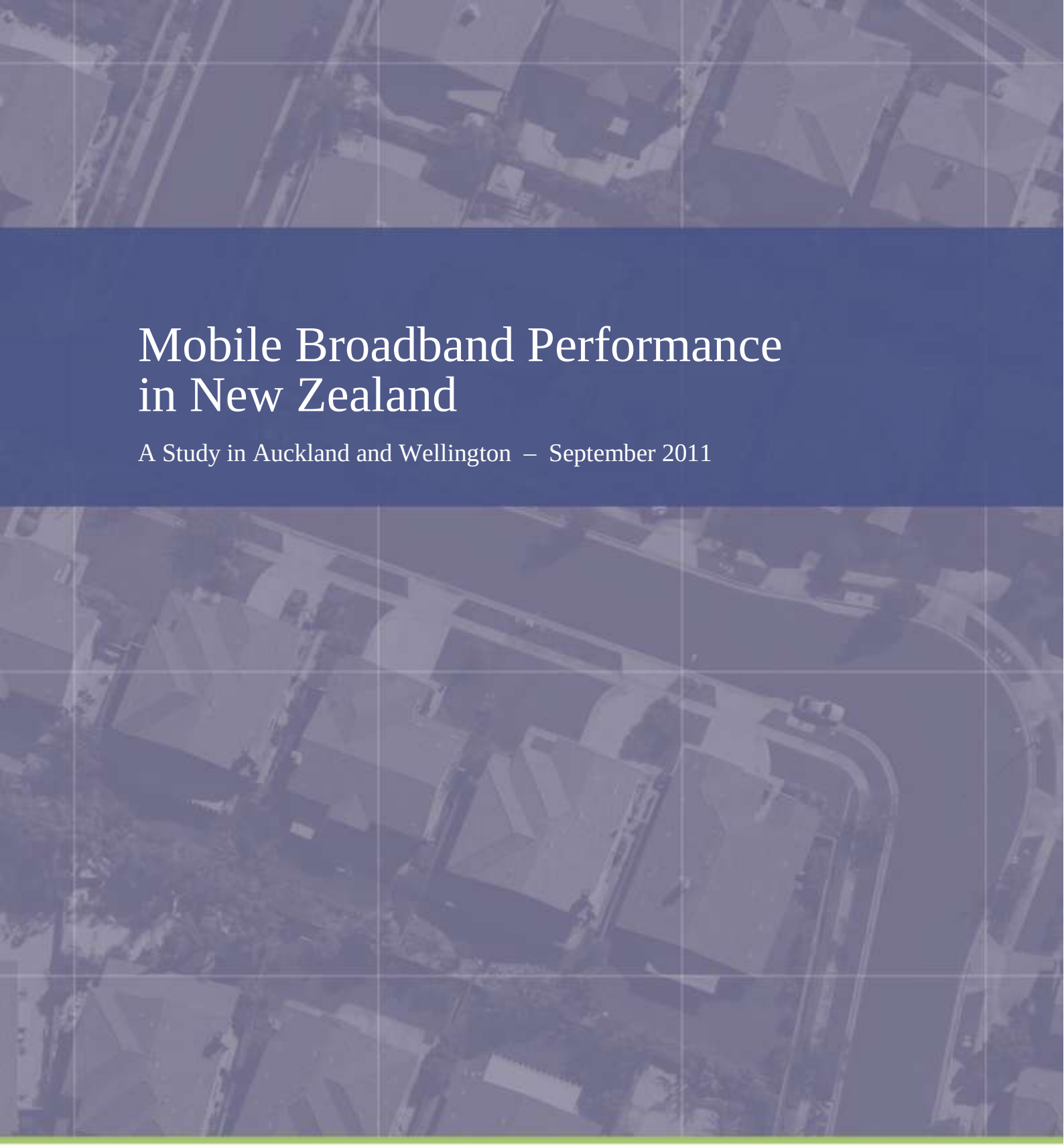

Mobile Broadband Performance in New Zealand

A Study in Auckland and Wellington – September 2011

epitiro

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EXECUTIVE SUMMARY

In September 2011 Epitiro carried out a study measuring the performance of mobile broadband in New Zealand with aim of understanding the quality of experience of the services accessed by users and to establish a baseline of performance to provide a context for future research.

This report describes the performance of mobile broadband networks in New Zealand based on data collected during drive testing in Auckland and Wellington between 2nd and 7th September 2011. The performance of mobile broadband services from Vodafone, Telecom and 2degrees were tested and analysed with over 133,000 measurements collected.

The following key points were determined;

- The average download speed recorded in Auckland and Wellington was 3.4 Mbps, and the fastest speed measured was 15.2 Mbps on Vodafone in Auckland.
- The majority (55%) of download speeds were measured as being over 3 Mbps, and 17% recorded at faster than 5 Mbps.
- Tests of access to popular websites in New Zealand measured the average network latency as 123ms, and the average time to download a webpage as 1 second.
- Mobile broadband performance varies significantly between operators and across the geography tested in Auckland and Wellington.

A summary of the average performance observed for each KPI by operator is presented in Table 1 below.

- The fastest download performance observed during this study was on Vodafone where an average download speed of 4.1 Mbps was measured.
- The fastest upload performance at an average of 1.5 Mbps was also measured on Vodafone.
- When KPIs other than speed are considered, 2degrees were measured with the best latency and web page download performance.

Epitiro will continue its research into mobile broadband performance and recommends that further study is required in New Zealand to measure emerging HSPA+ and LTE services, and to assess the user experience of these services across a wider geography.

Table 1 Summary of average performance by KPI and operator

	Download Speed	Upload Speed	Network Latency	Web Page Download Time
Vodafone	4.1 Mbps	1.5 Mbps	140 ms	1.2 seconds
Telecom	3.3 Mbps	0.9 Mbps	135 ms	1.0 seconds
2degrees	2.7 Mbps	0.8 Mbps	95 ms	0.9 seconds

INTRODUCTION

Since 2000 Epitiro has measured broadband performance and regularly published studies examining numerous key performance indicators (KPIs) that affect the quality of experience of those services. Epitiro provides services and broadband performance data to ISPs, industry bodies and telecommunication regulators for benchmarking, service assurance and customer experience management purposes.

Founded on Epitiro's ipQ™ technology that enables measurements of broadband services from the customer experience perspective, this report details the performance of mobile broadband services in the cities of Auckland and Wellington in New Zealand. Specifically, the performance of cellular 3G and HSPA services, based on data collected in September 2011. To enable this study Epitiro conducted a period of drive testing to measure the performance of leading mobile operators from locations across Auckland and Wellington. The analysis of that data forms the basis of this report.

RATIONALE FOR THE REPORT

Mobile broadband is an increasingly important element in the provision and delivery of consumer broadband services, with user adoption of smart phones and tablets being a key driver in the growing demand for mobile broadband services.

A recent study of Mobile Broadband in New Zealand by IDC[1] predicted an 18% growth in use of mobile broadband services from handsets, from 1.4 million connections in 2010 to 1.6 million in 2011. Access to mobile broadband using USB dongles also continues to grow, with a predicted increase of 32% from 252,000 dongle connections in 2010 to 333,000 in 2011. Spending on mobile broadband services in 2011 is expected to exceed $300m, growing from $236m in 2010.

[1] IDC New Zealand, January 2011

OBJECTIVES OF THE STUDY

Epitiro's objectives for this study of mobile broadband performance in New Zealand were as follows:

- Understand the consumer experience of mobile broadband services in New Zealand.
- Compare the performance of the services currently delivered by the three operators in New Zealand.
- Establish a baseline of performance to provide a context and direction for future research.

DEFINING MOBILE BROADBAND

Mobile broadband is an undefined term with respect to speed and technology used. GPRS, 3G, HSDPA, HSPA+, LTE and WiFi technologies may be considered by service providers as mobile broadband thus there is a variance in what is promoted to the public.

For the purposes of this research, Epitiro focused on cellular broadband services. GPRS (because of its low speed) and WiFi (as it connects via fixed line infrastructure) were excluded in favour of researching mobile broadband services delivered using available 3G, HSDPA and HSPA+ access technologies.

METHODOLOGY

SCOPE OF TESTING

This study of mobile broadband services in New Zealand focused on measuring the performance delivered by the three leading operators (Telecom, Vodafone and 2degrees) in the major cities of Auckland and Wellington.

A wide range of performance measurements were captured during the testing, including measures of download speed, upload speed, network latency, and web page download performance. Alongside the measures of broadband performance, the radio network state was recorded throughout the testing, and was characterised in terms of the serving bearer and signal strength. During the course of the testing, in excess of 133,000 measurements were recorded.

The focus of the analysis of the performance data in this report is on the broadband performance measures. Radio coverage data was collected during the period of drive testing, but is not considered for analysis in this report.

The performance data analysed in this report was collected from vehicle mounted smartphones. Mobile broadband performance delivered by dongle connected PCs is outside of the scope of this research.

APPROACH AND METHODOLOGY

The measurements that form the basis of this report were conducted by drive testing in Auckland and Wellington. Each city was tested over a period of five days between the 2nd and 7th September 2011 (no testing was carried out on Sunday 4th September).

The vehicles used were fitted Samsung Galaxy S II handsets running Epitiro's ipQ software. The Samsung Galaxy S II is capable of connecting to HSPA+ based mobile broadband services and supports download speeds of up to 21 Mbps and upload speeds of up to 5.6 Mbps. Three handsets were deployed in each vehicle to enable the concurrent testing of the three mobile services.

Testing was carried out between 9am and 8pm, covering the working hours and early evening of each day. The adopted drive test routes covered the central business district in Auckland, as well as areas as far as Ponsonby to the west, Parnell to the East and Eden Terrace to the South. In Wellington the testing covered the central business district, in addition to areas as far as Thorndon to the north and Newtown to the South.

All the measurements of broadband performance were conducted while the vehicle was stationary, with tests executed on all three operators for approximately 20 minutes at each location along the routes.

A detailed description of the testing methodology that resulted in the individual measurements is presented in the Technical Testing Methodology at the end of this report.

FINDINGS – MOBILE BROADBAND PERFORMANCE

This section examines the performance of the three mobile broadband services as observed during this study. In excess of 133,000 measurements were captured during the drive testing over five days in both Auckland and Wellington.

The performance analysis in this report focuses on performance delivered while connected to 3G, HSDPA or HSPA+ bearers. Measurements recorded from a GPRS bearer are excluded.

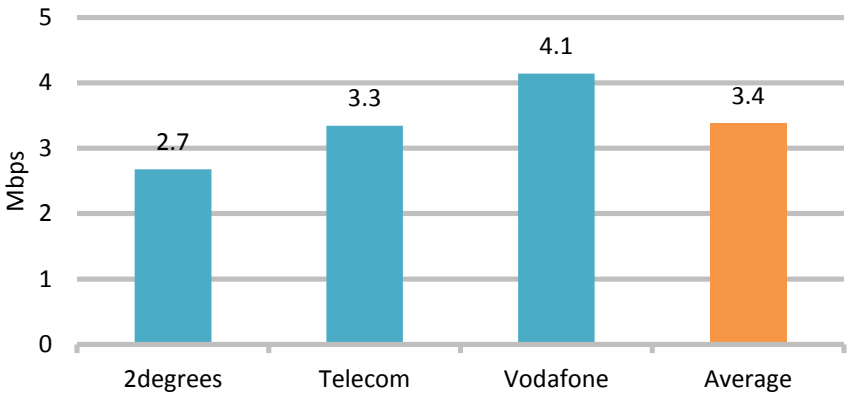
THROUGHPUT SPEED

Throughput speed is a measure of the rate at which data can be delivered by the mobile broadband service to the user's device. Higher bandwidth applications, such as video and audio applications, benefit significantly from faster throughput speeds.

During the testing conducted in this study, throughput speed was measured from the drive test probes to an Epitiro server hosted in the Auckland Peering Exchange. The server was managed and monitored by Epitiro throughout the testing and is attached to bandwidth dedicated to the purpose of throughput measurement.

The average download speeds recorded for each mobile operator are shown in Figure 1. The average download speed measured across all operators was 3.4 Mbps. Vodafone delivered the fastest download speeds with an average of 4.1 Mbps, which was 24% faster than the average measured for Telecom, and 52% faster than 2degrees.

Figure 1 Average download speed by operator



These throughput results compare favourably with those presented in a recent Ofcom study of mobile broadband performance in the UK[2]. The average download speed of 3.4 Mbps in this report is 62% faster than the 2.1 Mbps average in the UK study by Ofcom. It should be noted that the Ofcom study covered a broad range of UK geography and was not limited to measurement of dense urban centres as in this research. So this comparison cannot be validated until a more thorough study of mobile broadband in New Zealand is available.

Figure 2 Distribution of average download speeds by operator

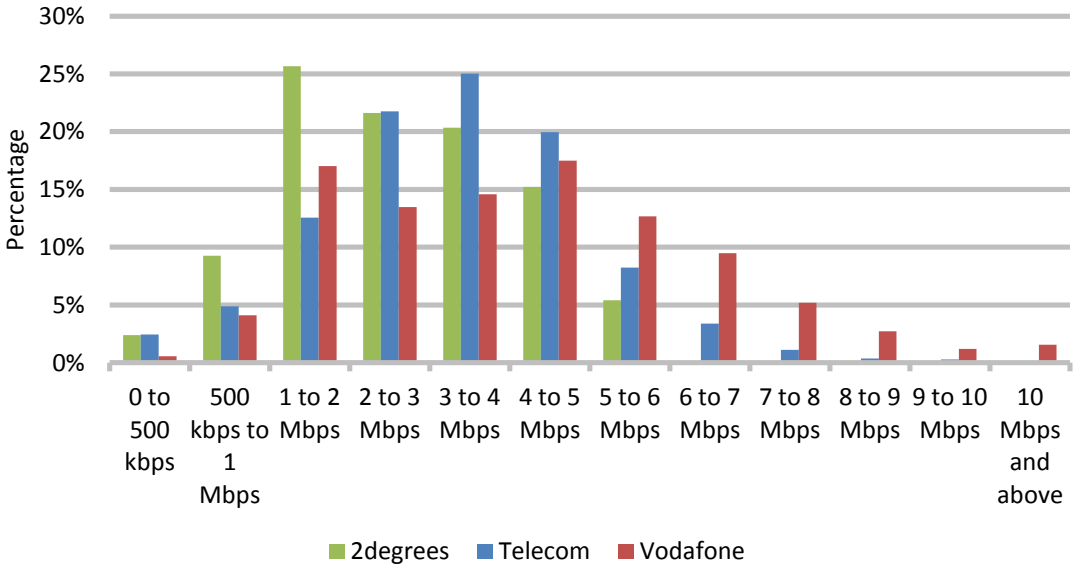
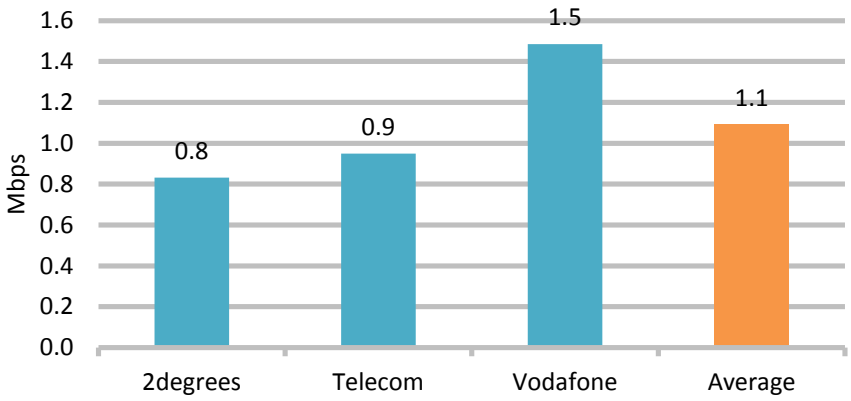


Figure 2 shows the distribution of average download speeds observed during the drive testing when connected on 3G or HSPA bearers. Overall, across all three mobile operators, over half (55%) of the recorded download speeds were faster than 3 Mbps, and fewer than 8% of the measurements were lower than 1 Mbps.

When considering the distribution of speeds for individual operators, all three operators were measured with the majority of their download speeds between 1 and 5 Mbps. 82% of speeds on 2degrees, 79% of speeds on Telecom, and 62% of speeds on Vodafone were within this range. Download speeds of more than 5 Mbps were measured on all three operators. 32% of speeds measured on Vodafone's mobile broadband service exceeded 5Mbps, with Telecom and 2degrees services delivering faster than 5Mbps, 13% and 5% of the time respectively. The fastest download speed recorded during the drive tests was 15.2 Mbps on the Vodafone service in Auckland.

[2] Ofcom: Measuring Mobile Broadband in the UK, May 2011

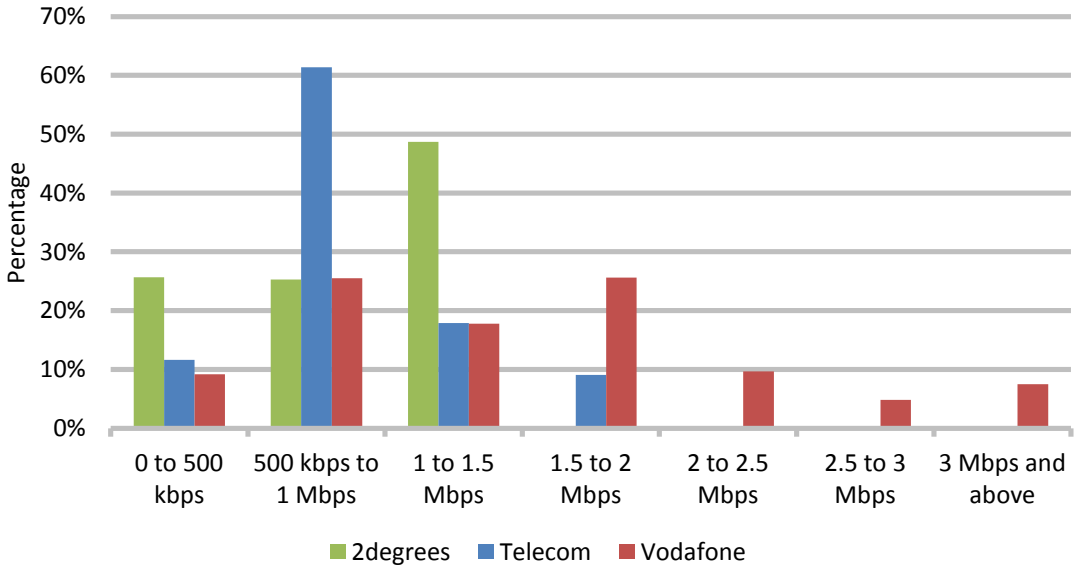
Figure 3 Average upload speed by operator



As shown in Figure 3, the average upload speed measured across all three operators was 1.1 Mbps. The average upstream performance on Vodafone's service was over 60% faster than the services from Telecom and 2degrees, with an average upload speed of 1.5 Mbps.

The upload performance recorded for this study shows 92% of upstream measurements were slower than 2 Mbps. In the areas of Auckland and Wellington covered during this study, neither 2degrees nor Telecom offered upload speeds faster than 2 Mbps. Vodafone did deliver upload speeds faster than 2 Mbps, with 21% of Vodafone's average upload speeds in this range. Speeds in this range indicate the availability of HSUPA bearers that offer enhanced upstream speeds. The fastest upload speed recorded during this research was 4.5 Mbps on Vodafone's mobile broadband service in Auckland.

Figure 4 Distribution of average upload speeds by operator

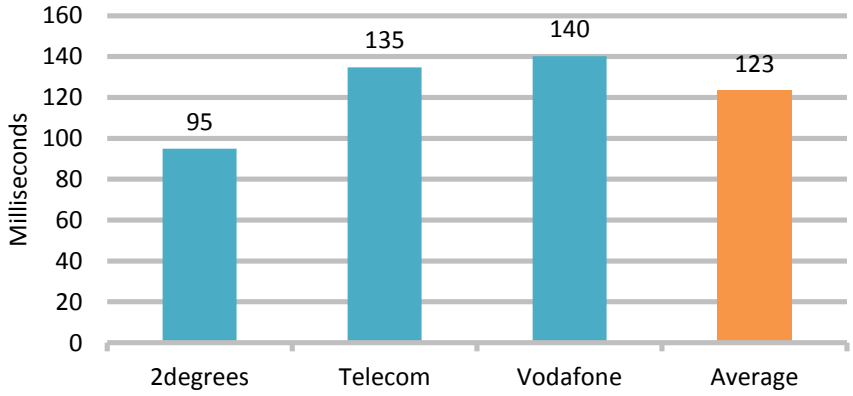


NETWORK LATENCY

The latency or delay in the network is measured as the time taken to deliver a single packet of data across that network. The latency measures in this analysis are network round-trip times, and indicate the time for data to be transmitted from the probe, to the targeted server and back again. Low latency is critical for an acceptable user experience of real-time applications such as voice and gaming. It is also a key factor in the experience for web browsing where the delivery of a complete web page involves multiple requests from the user's browser.

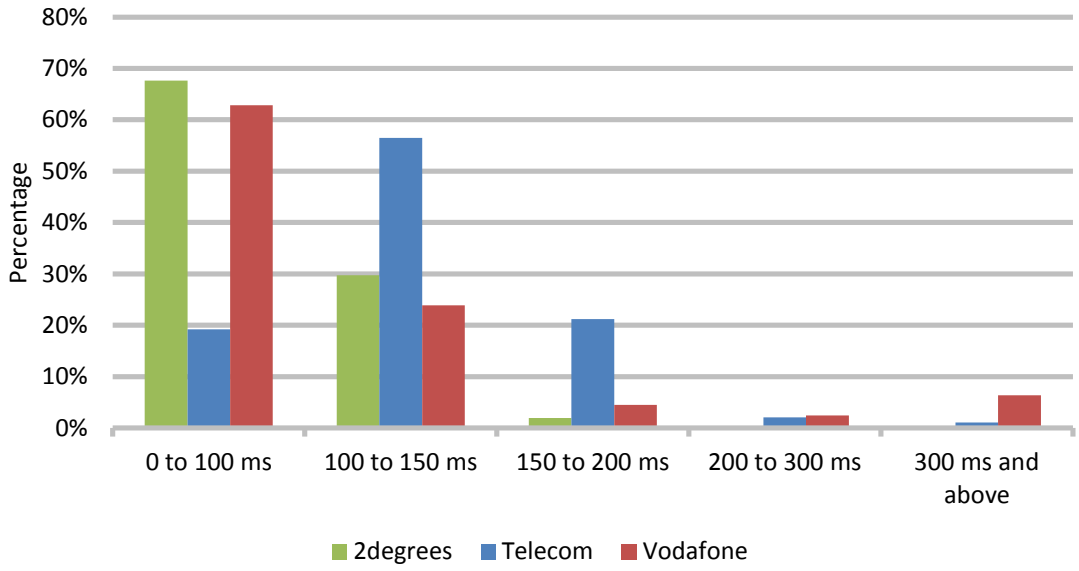
The average network latency measured across the three operators was 123 ms (Figure 5). There was variation in latency between mobile operators. The lowest network latency was observed on the 2degrees mobile broadband service, with an average of 95ms.

Figure 5 Average latency by operator



The distribution of average latency in Figure 6 also shows that the latency in the service from 2degrees is consistently low, with 67% or measurements below 100ms, and nearly all (97%) lower than 150ms. The latency in the mobile broadband services from Telecom and Vodafone was recorded as being more variable. Latency measurements exceeding 150ms were recorded in 24% of tests on Telecom's service and 13% of tests conducted when connected to Vodafone.

Figure 6 Distribution of average latency by operator



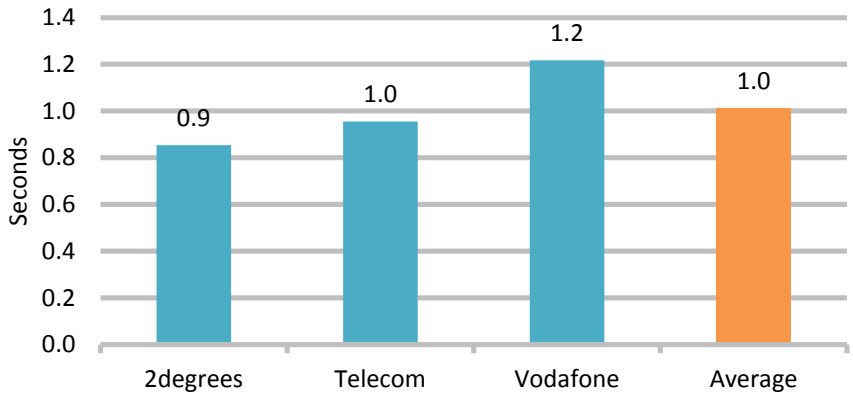
WEB PAGE DOWNLOAD TIME

Access to the web continues to be a growing application of mobile broadband. It is estimated that 85% of mobile handsets shipping globally now have the capability to access the web via a browser[3]. There are currently over 500 million users globally using their handsets to access the web[4]. This is forecast to reach 1 billion users and overtake desktop access to the web by 2015[5].

During the drive testing for this study, access to the web was tested from all three operators, by measuring the speed of access and time to download seven popular websites within New Zealand. In order to enable a direct comparison to previous studies of mobile broadband performance, such as that recently published by Ofcom in the UK[6], the analysis in this report looks at the average time taken to download the HTML content of the websites tested.

[3] Gartner: Ten Mobile Technologies to Watch in 2010 and 2011
[4] Strategy Analytics, March 2010: Global Mobile Media Forecast 2001-2015
[5] ITU, February 2010: http://www.itu.int/newsroom/press_releases/2010/06.html
[6] Ofcom: Measuring Mobile Broadband in the UK, May 2011

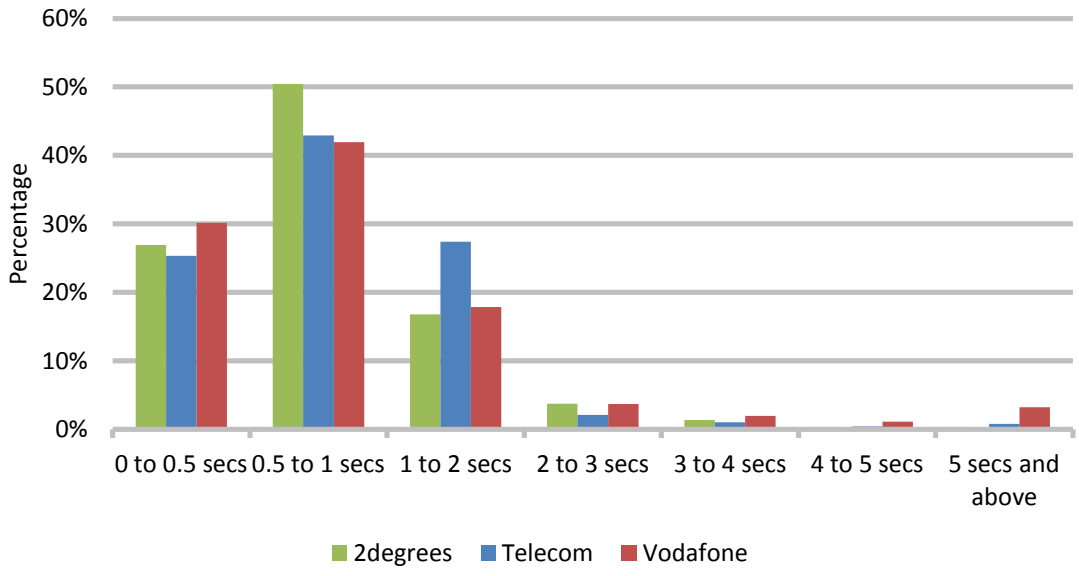
Figure 7 Average web page download time by operator



The results in Figure 7 show that the average time to download a web page was 1 second. The average varied between operators, with Vodafone services taking an average 1.2 seconds to download a page, and 2degrees offering the fastest access to web pages with an average download time of 0.8 seconds. The recent study of UK mobile broadband by Ofcom recorded and average web page download time of 2.5 seconds. The performance observed in Auckland and Wellington suggests significantly better web browsing performance than in the UK study, but a more substantial study is required in New Zealand, before this comparison can be qualified.

The distribution of web page download times is shown in Figure 8. Across all three mobile operators, 93% of web pages accessed took less than 2 seconds to download.

Figure 8 Distribution of average web page download times by operator

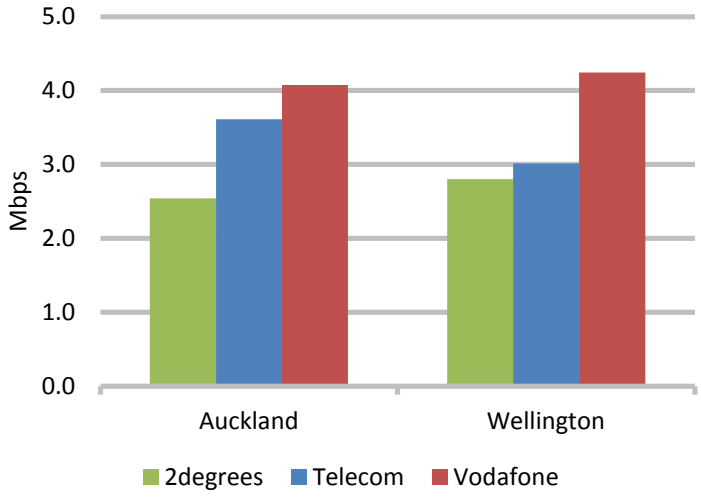


VARIATION BY GEOGRAPHY

Location is a major factor in users gaining access to the radio network and to the types of bearers necessary to deliver a desirable mobile broadband experience. The level of service available in a given area is determined by the local provision of network infrastructure by the mobile operators and also by the behaviour of the user population in accessing the mobile broadband services. This behaviour can be the cause of contention for services and bandwidth in densely populated areas at peak times.

This study is limited in its coverage of geography, but does enable a comparison of the performance observed in the cities of Auckland and Wellington covered by the drive testing. Future research should acknowledge this limitation and aim to measure performance across a wider geography in New Zealand.

Figure 9 Average download speed by city and operator



The average download speed measured for each operator in Auckland and Wellington is shown in Figure 9. There was no significant difference in the average speed observed in each city. Both Auckland and Wellington services delivered an average download speed of 3.4 Mbps.

There is variation in performance when individual operators are considered in each city. Vodafone and 2degrees were both measured as marginally faster in Wellington than Auckland. Vodafone was 5% faster in Wellington with an average speed of 4.2 Mbps. 2degrees was measured with an average speed in Wellington of 2.8 Mbps, 10% faster than the average download speed observed in Auckland on the same service. Telecom's service was measured in Auckland with an average download speed of 3.6 Mbps, 20% faster than the Telecom service in Wellington.

The heat maps in the analysis below provide a view of the download speeds measured for each operator in the different areas of Auckland and Wellington covered by the drive tests. The areas where throughput speed tests were conducted are represented on the maps by a coloured tile. The colour of the tile indicates the average performance experienced in that area while connected to the operator's mobile broadband service. The legend above the heat maps in Figure 12 and 13 shows the range of speeds represented by each colour. Where there is no coloured tile, it simply indicates that no measurements were made in that area, and does not represent lack of service or coverage.

Figure 12 Average download speed across Auckland by operator

0 to 1 Mbps
1 to 2 Mbps
2 to 3 Mbps
3 to 4 Mbps
4 to 5 Mbps
5 Mbps and above
Tiles with no colour indicate areas where no measurement was carried out

Figure 12.1 Vodafone

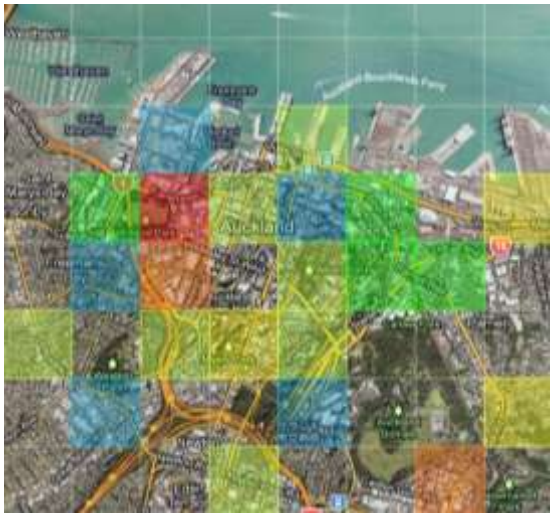


Figure 12.2 Telecom

Figure 12.3 2degrees

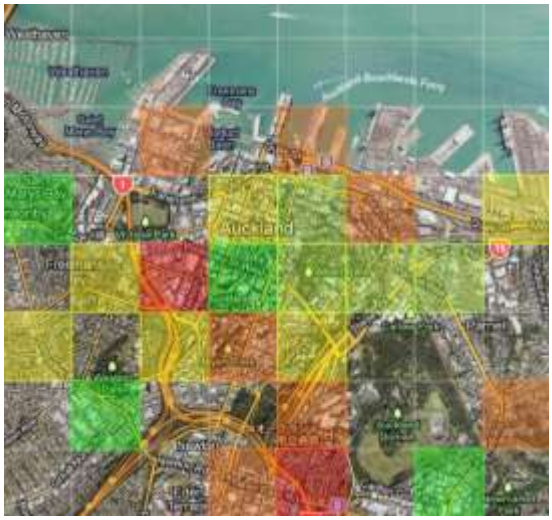


Figure 12 provides heat maps showing the average download speeds measured for Vodafone, Telecom and 2degrees throughout the drive tests in Auckland. Slower speeds of up to 2 Mbps are represented by red and orange tiles. Green tiles indicated faster speeds in the range of 3 to 5 Mbps, and blue tiles are shown where the average download speed in the area exceeded 5 Mbps.

The performance of all three operators is variable across the areas of Auckland tested. The heat maps for Vodafone and Telecom both indicate that in some areas of the city, those services are measured as delivering mobile broadband with average speeds exceeding 5 Mbps. The performance of the 2degrees service in Figure 12.3 generally shows slower average performance than Vodafone and Telecom, but average download speeds between 4 and 5 Mbps were measured in a number of areas.

Figure 13 Average download speed across Wellington by operator

0 to 1 Mbps
1 to 2 Mbps
2 to 3 Mbps
3 to 4 Mbps
4 to 5 Mbps
5 Mbps and above
Tiles with no colour indicate areas where no measurement was carried out

Figure 13.1 Vodafone

Figure 13.2 Telecom

Figure 13.3 2degrees

The heat maps in Figure 13 represent the measured performance of each operator during the drive tests in Wellington, between Thorndon to the North and the area of Newtown to the south of central Wellington.

As observed in Auckland, the download speeds measured across Wellington vary significantly by geography. Vodafone delivered the fastest download speeds during the tests conducted in Wellington, and is the only operator of the three where a number of the areas tested were measured with an average download speed of 5 Mbps or above.

CONCLUSIONS AND FUTURE WORK

This study of mobile broadband performance in New Zealand provides a view of the user's experience of the services of the three main operators in the inner city areas of Auckland and Wellington.

The results show that the availability of 3G and emerging HSPA based mobile broadband services offer speeds comparable to, and some instances exceeding those typically delivered by fixed line broadband services. The performance of services offered does vary between mobile operators, and reflects the differing levels of investment into the infrastructure required to support and evolve mobile broadband.

Throughput speed is a significant factor in the quality of experience offered by mobile broadband services to users. However, speed is not the sole indicator of user experience, with some applications being influenced to a greater degree by factors such as network latency. A fast broadband service is no guarantee of a desirable quality of experience, with other measures of performance varying between operators, independent of the throughput speed of the service.

The experience of mobile broadband can vary dramatically based on geography. This study limited its focus to measuring the services in the densely populated city areas of Auckland and Wellington. Further research is required to understand the performance across the wider regions of New Zealand.

Mobile broadband access technologies are rapidly evolving. The continued rollout of HSPA+ services and the predicted emergence of LTE services in New Zealand during 2012 will continue to improve the speeds and quality of experience of mobile broadband. Epitiro recommends that future research measures these next generation access technologies to assess how they are delivering in relation to expectations.

GLOSSARY

2G: 2nd generation radio and network technology.

3G: 3rd generation radio and network technology.

Contention: A slowdown in performance caused when multiple users share the same limited bandwidth.

Download speed: The rate of data transmission from a network operator's access node to a customer, typically measured in Megabits per second (Mbps).

EDGE: Enhanced Data rates for GSM Evolution – an improved data solution for GSM GPRS.

GPRS: General Packet Radio Service.

GPS: Global Positioning System.

Headline speed: The speed at which a broadband service is marketed.

HSDPA/HSUPA: High Speed Downlink/Uplink Packet Access for 3G networks.

HSPA: High Speed Packet Access for 3G networks.

kbps: Kilobits per second. 1,000kbps is the same as 1Mbps.

Latency: The time it takes a single packet of data to travel from a user's device to a third-party server and back again. Most commonly measured in milliseconds.

LTE: Long Term Evolution. A 4G access technology characterised by high throughput speeds (downlink peak rates of at least 100Mbps) and low latency.

Mbps: Megabits per second. 1Mbps is the equivalent of 1,000kbps.

MNO: Mobile Network Operator.

RSSI: Receive Signal Strength Indicator.

SIM: Subscriber Identity Module.

UMTS: Universal Mobile Telecommunications System, the 3GPP 3G system.

Upload speed: The rate of data transmission from a customer's connection to a network operator's access node, typically measured in kilobits per second (kbps).

TECHNICAL TESTING METHODOLOGY

THROUGHPUT MEASUREMENTS

Measurements of download and upload speed were conducted from the probes to a dedicated Epitiro endpoint server. The endpoint server was hosted in the Auckland Peering Exchange on bandwidth dedicated to the purpose of throughput testing for this study.

All throughput tests were conducted over TCP and were single threaded with a single TCP connection. In order to ensure accurate results regardless of the speed being delivered by the mobile broadband service, all tests were configured as time bounded with both downstream and upstream speeds being measured for a period of 10 seconds each.

A lead-in period of 2 seconds (that did not contribute to the measured speed) was employed, to minimise the impact of TCP slow-start and any change in radio conditions or bearer that, depending on network management policies implemented by the operator, could be triggered by the flow of data.

NETWORK LATENCY MEASUREMENTS

The test of network latency employed a TCP 3-way handshake to measure the round trip time in milliseconds from the connected probe to the servers hosting seven popular New Zealand websites.

MEASURING WEB PAGE DOWNLOAD TIME

Web page download time was measured as the time taken to request and download the HTML body of a website. The test records the time taken to download the webpage, and also the HTTP status code returned by the hosting web server, so that failures can be excluded from analysis.

For the purposes of this research, web page download time was measured using seven popular websites in New Zealand.

MEASURING RADIO CONDITIONS

The radio network conditions were recorded throughout the drive testing and also at the start of each individual test. Radio network conditions were characterised in the following terms: Bearer (GPRS, EDGE, 3G, HSDPA or HSUPA); Cell ID; LAC; MNC; MCC; signal strength (RSSI).

CAPTURING LOCATION

The location of each test was recorded by employing the GPS capabilities of the Samsung Galaxy S II handsets. If a GPS signal was not available, then the location was recorded using triangulation.

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