

Broadband performance testing in New Zealand

Topic Paper

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Introduction

Broadband is a rapidly developing telecommunications service that is becoming increasingly important to New Zealand consumers – it has almost become a necessity. At least 82% of New Zealand households have a broadband connection and there are more options available to consumers than ever before.

Kiwis love being connected to the internet. The World Internet Project New Zealand 2017 found 94% of the population use the internet.¹ We spend more than \$1.2 billion a year on home broadband bundles to get this connectivity. However, many consumers find broadband baffling. Products and pricing can be complex and in-home performance can be hard for consumers to measure.

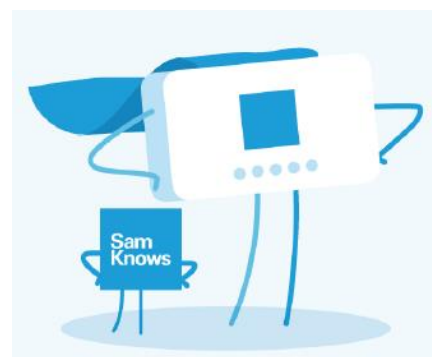
Traditional fixed-line broadband use for households has developed from web browsing and emailing to now commonly include activities such as streaming video, video calling and virtual reality gaming.

Consumers now have a lot more choice with broadband bundles, retail service providers and different service technologies. Crown Infrastructure Partners reports that there are 92 retail service providers selling fibre broadband around the country.²

Despite the availability and importance of broadband for consumers, the factors that determine good broadband performance are not well understood. Unlike buying a tangible product such as a fridge, it is often harder for consumers to know and compare options of what exactly they are purchasing when they purchase a broadband connection. Differences in broadband technology and terms such as throughput, latency, and even speed can often be overwhelming for consumers to engage with, as well as potentially misleading.

The aim of our broadband performance testing is to provide consumers with accurate, accessible and independent information on broadband performance across different providers, plans, and technologies, to help them choose the best broadband for their household. Shining a light on broadband performance also helps make broadband better across the board, by allowing comparisons between providers and encouraging providers to compete on performance and not just price.

On 30 May 2018 we announced a new provider for our independent broadband performance testing – SamKnows. SamKnows currently runs testing in over 40 countries on behalf of telecommunications regulators and retail service providers. Collectively their testing programmes cover almost half of the world’s internet population. SamKnows expect to start reporting on New Zealand broadband performance testing from October this year.



¹ Work Research “World Internet Project New Zealand Internet in New Zealand in 2017” (2017) available at https://workresearch.aut.ac.nz/_data/assets/pdf_file/0009/174915/Internet-in-NZWIP-2017.pdf

² Crown Infrastructure Partners, available at <https://www.crowninfrastructure.govt.nz/>

This topic paper describes the broadband network and explains basic broadband service metrics and performance measures. The paper also considers the underlying technology and how this has developed over time and improved broadband performance in New Zealand and internationally.

Our broadband performance testing

Section 9A of the Telecommunications Act 2001 enables us to monitor and report on telecommunications matters to help consumers understand the market and make informed choices. As part of this monitoring, we have funded independent broadband performance testing since 2007.

Our broadband performance testing has developed over time

The Commission started residential fixed-line broadband performance testing in 2007 when we selected EpiTiro to provide a broadband testing service. EpiTiro used a rack of PCs at each test site to run various tests on premium broadband plans. There were 11 test sites spread across five cities. The various test results were converted into an index score to compare retailers. The first broadband performance report was published in June 2008 and gave results for the first quarter of 2008.

In March 2012 the Commission selected TrueNet to test broadband performance in a way that was more oriented towards measuring the performance experienced in consumers' homes. TrueNet used around 400 test devices deployed in the homes of volunteers to measure broadband performance of the main retail service providers. Initially only ADSL broadband services were tested but as new technologies became available, TrueNet started testing VDSL, cable, fibre and fixed wireless broadband.

TrueNet produced independent monthly reports that showed a range of measures including how much broadband performance declined in the 'peak hour' time of day when the network was most congested, this was usually around 8 to 9pm.

Monthly reporting was chosen so that consumers would always have relatively up-to-date test results on retail service providers' performance available. Retail service providers would also be able to quickly see the effect of any changes they made to their networks to improve broadband performance. A result that reflected poorly on a retail service provider's offering could be remedied relatively quickly, and the improved performance could show up in a report within two months. This short feedback cycle provided an incentive for retail service providers to improve any poor performance promptly to avoid repeated publication of results below what was expected.

TrueNet's monthly reports continued until its contract with the Commission finished in January 2018. We provide more detail in this topic paper of some of the retail service providers' performance improvements over time.

New broadband testing provider

As telecommunications services change, and with more options available to consumers than ever before, we consider that broadband testing remains a crucial component of our market monitoring. Our monitoring and testing helps ensure that consumers have adequate information to make good choices in telecommunications markets.

We have commissioned an enhanced broadband testing programme to monitor the broadband performance of up to 3,000 households. The programme is being delivered by SamKnows, a world leader in internet performance measurement covering almost half of the world's internet population. SamKnows was founded in 2003 and is based in London. It works with regulators from the UK, US, Europe, Singapore, Brazil and Canada to measure internet performance across the whole of Europe, North and South America, parts of Asia, and Australia. More information about Sam Knows can be found at: www.samknows.com.

Monitoring results and reports from the programme will be available on a dedicated website from October 2018 at www.measuringbroadbandnewzealand.com. We are also exploring other options and communication channels to get broadband performance information to as many consumers as possible.

Volunteers wanted

The Commission and SamKnows are seeking 3,000 households to be part of our new nationwide programme.

Once selected, volunteers will be provided with a Whitebox (similar to a modem) to plug in at home. The Whitebox will perform automated tests on a home's internet performance at different times of the day. It will not record any personal information or browsing history, and checks are performed to ensure it does not interfere with volunteers' internet activities. Some broadband data will be used to conduct testing.

Volunteers will have access to their own personal broadband performance information collected by their Whitebox in real time through a personalised online performance dashboard. This information may help diagnose problems and improve their home broadband performance.

Watch our volunteer recruitment video [here](#). More information on the programme and details about how to become a volunteer can be found at www.measuringbroadbandnewzealand.com.

Retail telecommunications are a Commission priority

Retail telecommunications have been a priority focus area across both our consumer and our regulation work for 2017/18.³ Although telecommunications services are complex and fast changing, we would like to see a reduction in the number of problems consumers are reporting.

³ Commerce Commission "Priorities 2017/18", available at <http://www.comcom.govt.nz/the-commission/about-us/>

Our initial focus for 2017 was to provide consumers with information to help them make informed purchasing decisions as well as to know where to go when they have an issue. Our beginners' guides to broadband can be found on our [website](#).

New legislative obligations

Under the Telecommunications (New Regulatory Framework) Amendment Bill that is currently before Parliament; section 9A (1)(d) will require the Commission to “monitor retail service quality in relation to telecommunications services”.⁴ Amendments to Part 1 of the Act specify that retail service quality should be interpreted to include “service performance, speed and availability”. Section 9A(1)(e) will then require us to “make available ... information about retail service quality in a way that better informs consumer choice”.

There are a wide range of factors besides the tested broadband performance metrics that affect a consumer's broadband experience. These factors include installation, faults and customer service experiences (such as call centre wait times). We will also be monitoring these other factors and publishing information to inform consumers.

Broadband performance explained

Retail broadband services connect Kiwi consumers to the internet by allowing for a high speed exchange of data over the broadband network. A broadband connection enables consumers to use all of the services the internet makes available such as email, websites, streaming video and online gaming.

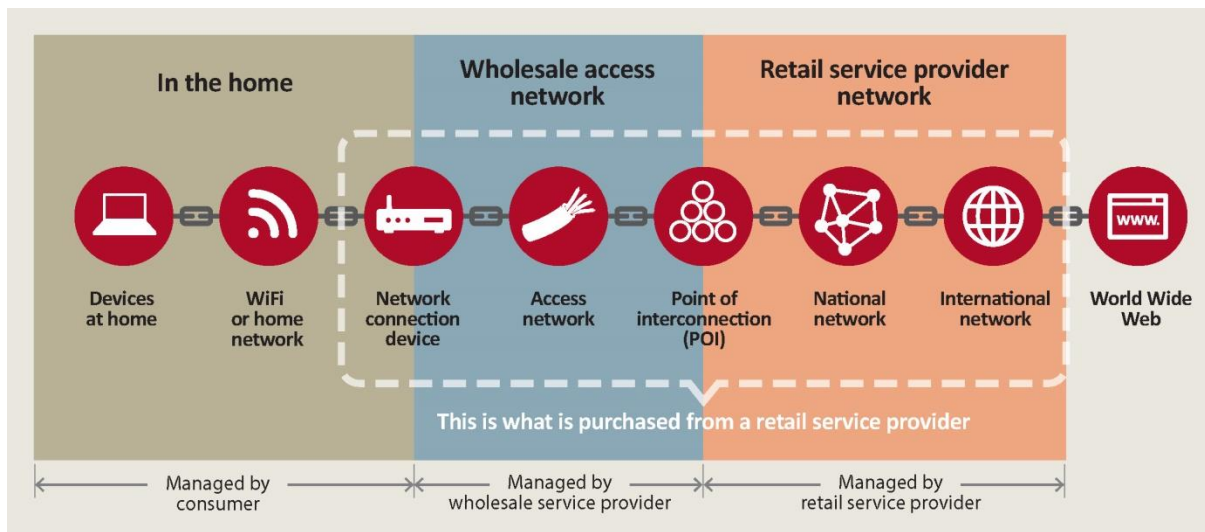
A broadband network that gives consumers access to the internet consists of several distinct parts that are controlled by different players, as illustrated in Figure 1. The World Wide Web is a way of sharing information over the medium of the internet.

All of the links in the residential broadband supply chain, including the consumer's link, contribute to the final service experienced by the consumer in their home.

It can be seen from Figure 1 that broadband retail service providers manage the service from the point of interconnection to the handover of content from the World Wide Web. The retail service provider also often supplies equipment to consumers that goes in the home, including Wi-Fi routers and modems. This retailer-supplied equipment gives the retail service provider some influence over the in-home part of consumer's broadband experience too.

⁴ Available at <http://www.legislation.govt.nz/bill/government/2017/0293/latest/DLM7393520.html>

Figure 1: The broadband network



The whole network, starting with the devices in the home and ending with the world wide web, is essentially what is referred to as the internet.

How does broadband performance affect consumer experience?

The main consumer activities on the internet are:

- looking at email, websites and using apps, where consumers want content to appear quickly;
- watching videos, where consumers want the picture to be good quality and for the video to stream seamlessly (and to not need to pause and wait while it is buffering); and
- downloading and uploading files, where consumers want this to happen as quickly as possible.

The broadband performance consumers experience is the end result of the different components in Figure 1. The performance experienced by the consumer will only ever be as good as the weakest link in the chain. In some situations performance may be limited by the distance data is travelling across the network. In other situations the performance may be limited by an older device in the consumer's home.

What affects broadband performance?

There are many different factors that can affect broadband performance when using the internet to perform a particular task but there are essentially three main factors that determine the consumer experience. To perform one of the activities above, a connection or number of connections have to be established.

The three factors that affect the performance delivered by the connection(s) are:

- how quickly the required connection(s) can be set up;
- the speed at which data can be sent over the connection(s); and
- how far the data has to travel.

Of the many factors that affect how broadband is performing, some are the broadband provider's responsibility, and some consumers may be able to improve themselves.

We have produced a series of fact sheets to help Kiwis spot potential issues, and when they should discuss them with their broadband provider. We also highlight some things consumers can do to improve their broadband performance including tips for getting the best out of their Wi-Fi. Our beginners' guides to broadband can be found [here](#).

How to measure broadband performance

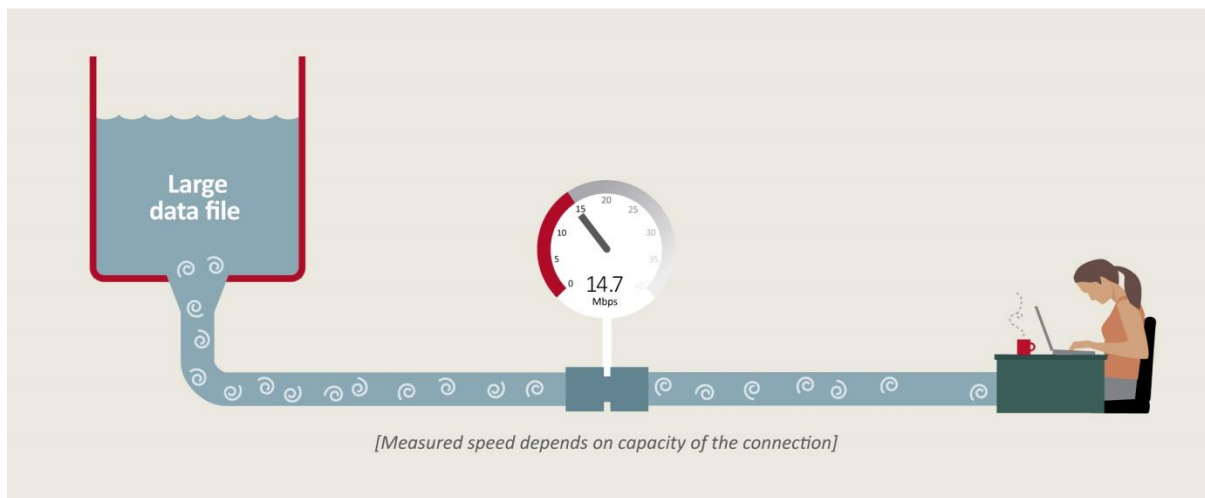
We explain below some of the common measures of broadband performance. Understanding these measures can help consumers understand the difference between generic download speed testing and independent testing results, and to identify what is important to them when deciding between broadband options for their household.

Download and upload speed

Consumers can test the notional download and upload speeds of their broadband service by going to a generic speed test site like www.speedtest.net. These tests work by dumping a relatively large amount of data down and then up the connection pipe. Retail service providers generally ensure that speed test connections traverse as little of the network as possible by minimising restrictions to give the best possible result.

A generic speed test is like connecting a hose pipe to a large tank close by and then measuring how fast water flows through the pipe, as shown in Figure 2. This usually gives an impressive headline speed but often bears little resemblance to the speed experienced in most real life uses of a broadband connection.

Figure 2: Download speed testing

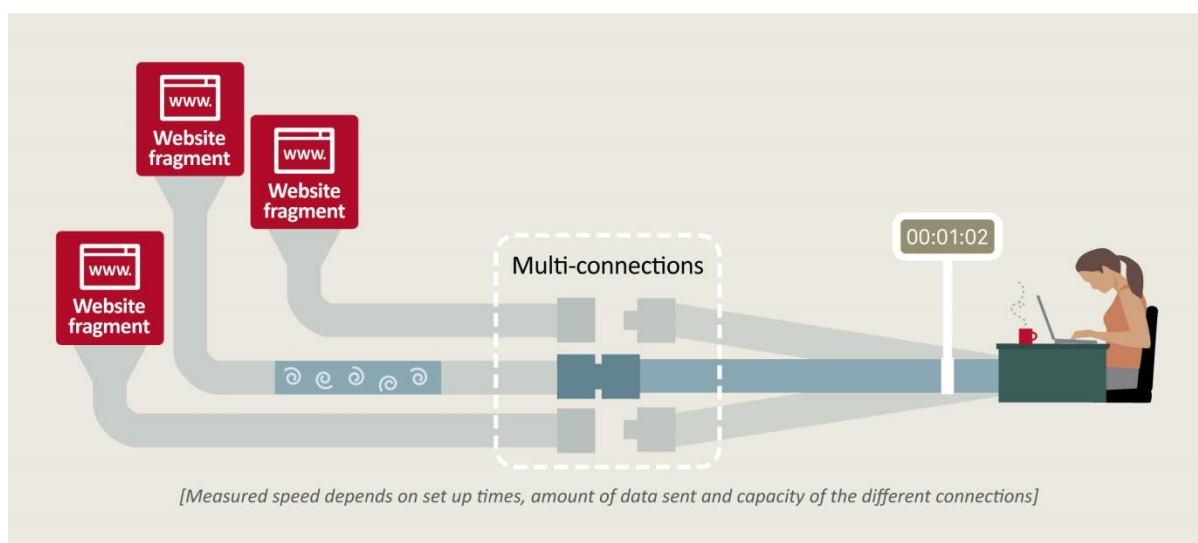


Web browsing

Web browsing is the real life practice of looking at websites or accessing content through an app. Web browsing performance can be expressed as a website load time, and is calculated by measuring how long a website takes to fully open (or load) and how much data was downloaded in the process. The result is sometimes converted into a download speed rather than being expressed as the time in seconds for the website to load because websites with more data will take longer to load than smaller websites.

Website load time depends on a large number of different factors such as the capacity of the website itself (ie, how many users the website can handle before performance becomes noticeably impaired) and where it is located. However, viewing a website generally requires downloading a large number of small data files, with multiple connections having to be established, possibly from different sources.

Testing website load time is like setting up a connection, emptying a small tank of water, shifting the hose to set up another connection, emptying another small tank of water and so on. This process takes a lot longer to shift the same amount of data compared to one, much larger, water tank (as is the case for a download speed test) because of the additional time taken to set up multiple connections. Figure 3 below shows the website load time testing process. In reality there are likely to be many more than 3 website fragments to be loaded.

Figure 3: Website load time testing

The website loading process described above explains why, despite a blistering fast download speed test result for their retail service provider, a consumer can still find they are left staring at an unchanging screen for seconds on end while a website loads. It also helps to illustrate why a generic download speed test is a poor indicator of the quality of a broadband service, and why independent testing using more ‘real life’ scenarios, such as our independent broadband testing programme with SamKnows, is so important.

Speed by time of day

At different times of day, because of changes in the volumes of traffic travelling across the network, the speed at which data travels over connections can be limited. Time-of-day congestion has been a problem exhibited by some broadband services in the past, and we discuss this below.

The internet has been compared to the public road network that gets congested at peak times as more and more traffic is moving across the network. However, unlike the road network, the internet can have extra capacity and new routes added quickly and for relatively little cost – so internet congestion can generally be dealt with much more easily than road congestion.

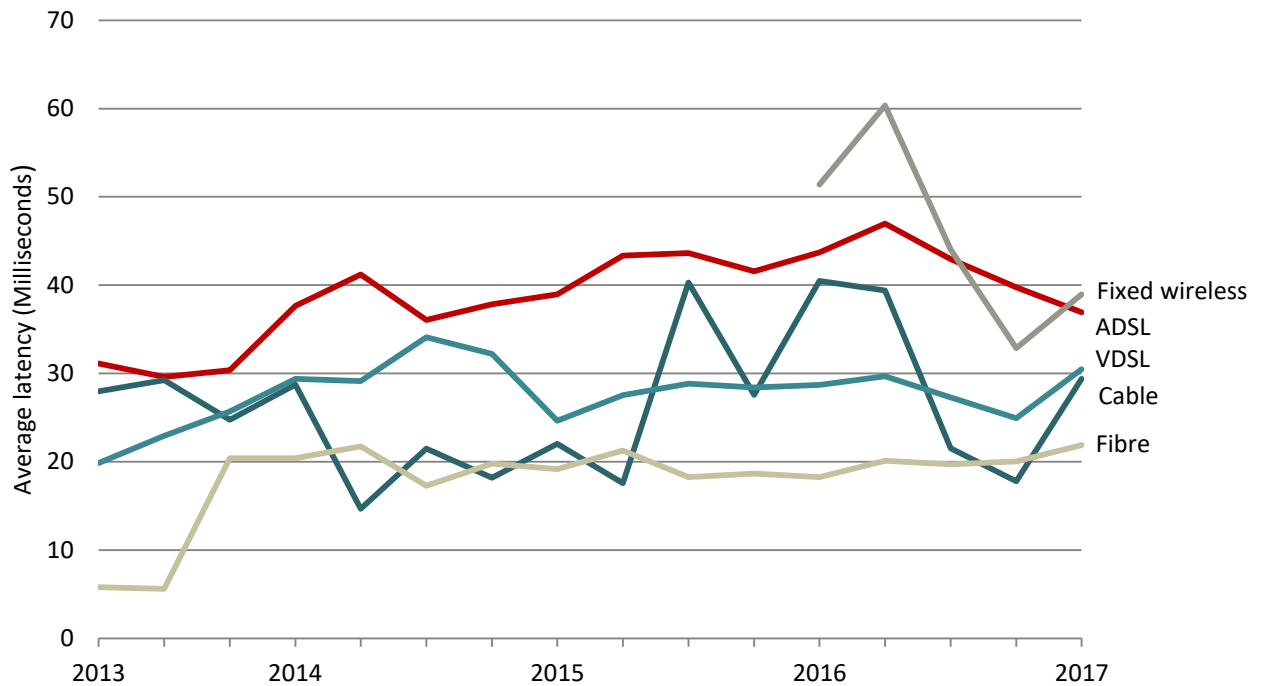
Our roading analogy can hold true for internet congestion where an international data cable is at absolute full capacity and the only solution is to build a new undersea cable. This solution does take a long time to organise and is expensive. However, there are options than can lessen traffic on international cables like storing widely used content domestically to avoid bringing it over the cable each time it is requested. This is known as caching.

Latency

Another performance measurement that can be affected by the technology used is latency. Latency is the round trip time in milliseconds (Ms) for a small amount (packet) of data to travel to its destination, like a website, and back again (in a process known as pinging). In general, the lower the latency, the better.

Latency is an important measure for online gamers because they need to respond to new events and their online opponents as quickly as possible. The amount of data used in a ping is small so latency is mostly affected by the distance of the connection route set up. Figure 4 below shows the average latency by technology as measured by TrueNet between 2013 and 2017.

Figure 4: Average latency by technology



Source: TrueNet testing results

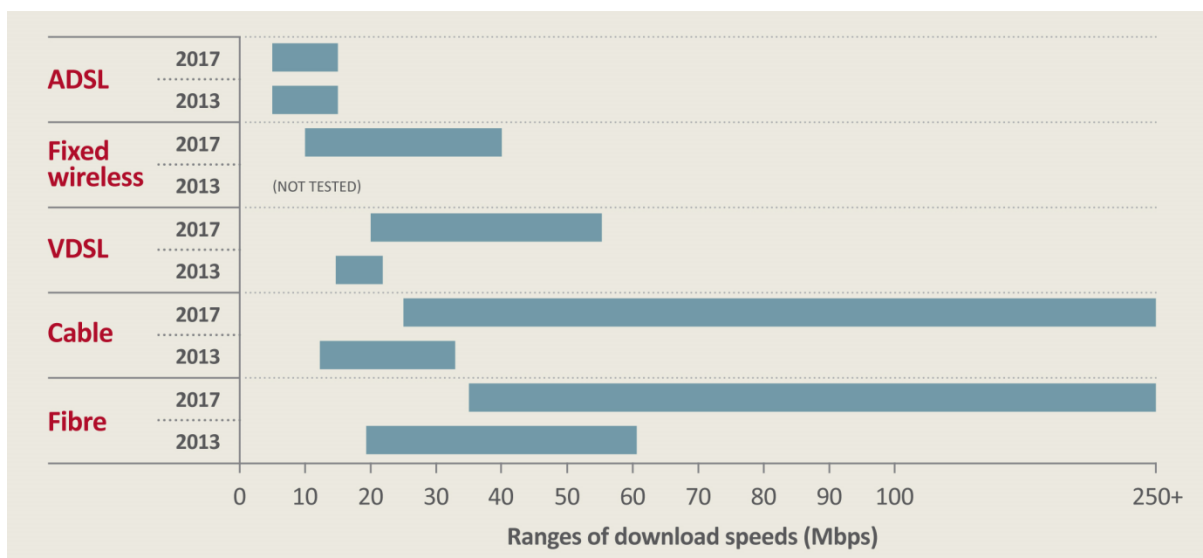
Fibre connections tend to have the lowest latency while the current generation of fixed wireless connections tend to have considerably higher latency because the connections take longer to set up.

Improvements in performance over time

There have been noticeable improvements in the performance of broadband services since 2007 when we first started testing broadband performance. Download speeds have been the most consistently measured metric over the decade we have been testing broadband performance, and the most easily understood. Consistently higher download speeds allows for more people in each household to stream video at a higher quality.

We explain below how download speeds have improved over time and compare them regionally and internationally. Between 2013 and 2017 there have been speed improvements across technologies as shown by Figure 5.

Figure 5: Ranges of average speeds by technology (2013 & 2017)



Source: TrueNet testing results

TrueNet's testing showed that the range of average in-home speeds experienced by Kiwis on fibre, cable and VDSL technologies have all seen marked improvements in ranges of speeds between 2013 and 2017. While ADSL speeds only improved marginally, many consumers who were on ADSL have been upgraded to VDSL (which is capable of much higher speeds) over this period.

There are a number of reasons for the improvements in broadband performance over time including improvements at all points in the broadband network shown in Figure 1. Some improvements have been driven by retail service providers and some by wholesale network providers.

Retail service providers can influence broadband performance

Retail service providers can influence performance in a number of ways. On the customer end of the network, improvements in broadband performance can come from upgrades to the customer premise equipment, such as modems and routers, provided to consumers.

Improvements in performance have also come from upgrades in the part of the network that retail service provider's control. This can be seen from decreased peak hour congestion, which notably improved over the time that TrueNet was reporting on this.

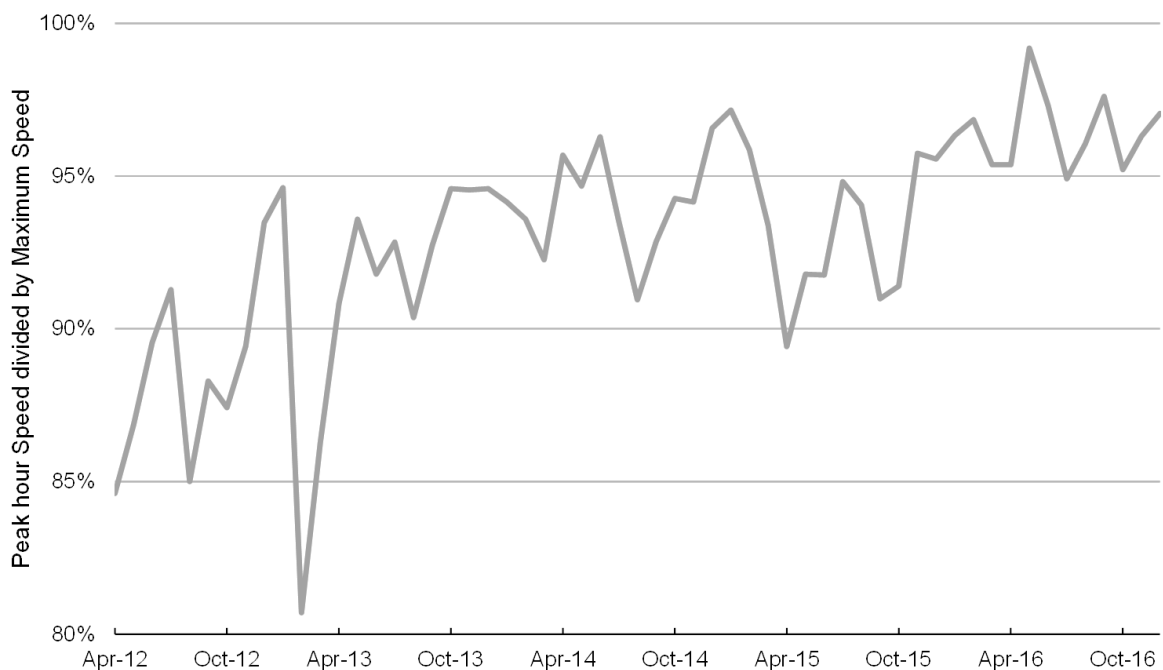
Retail service providers can manage the broadband traffic over their part of the broadband network to improve broadband performance. When retail service providers effectively manage traffic congestion on the network, consumers experience better broadband performance.

Differentiating traffic can allow retail service providers to make plans available for different price points to customers.

Figure 6 illustrates how better management of the retail service provider's network has allowed the variability of speed to reduce over time. In early 2012, ADSL speeds were as low as 85% of the maximum speeds possible on the connections. By the end of 2016, this was consistently exceeding 95%.

Figure 6 was previously shown in our 2016 Annual Telecommunications Monitoring Report. It shows how average copper ADSL broadband performance in peak hour, as measured by TrueNet, tracked over the period April 2012 to December 2016.

Figure 6: ADSL peak hour speed variability

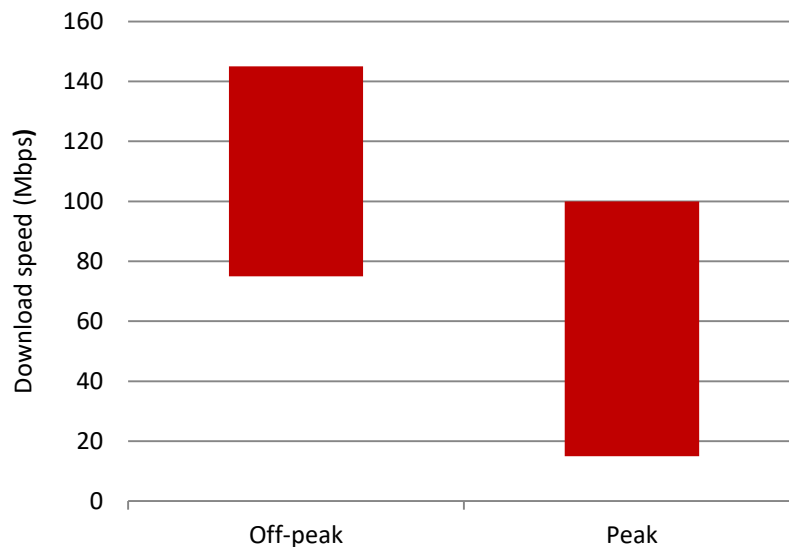


Source: Annual telecommunications market monitoring report 2016

Case study of broadband monitoring: the 'Netflix effect'

The 'Netflix effect' was the large increase in video traffic over broadband networks after the arrival of Netflix in New Zealand in March 2015. The large increase in traffic caused congestion that was more noticeable in some retail broadband services than others. Particularly hard hit was Vodafone's cable broadband as can be seen from Figure 7. Figure 7 shows the range of speeds during peak and off-peak hours for a 100 Mbps cable test device deployed by TrueNet.

Figure 7: Vodafone cable 100 Mbps range of results for July 2015



Source: TrueNet testing results

Vodafone responded to what was going on with its broadband performance and in July 2015 told its Wellington customers the huge success of Netflix and NEON had led to a 'massive spike' in demand for data, slowing the network, noting a 30% increase in data usage a month since video-streaming services started.

At this time Vodafone New Zealand technology director Tony Baird said video streaming accounted for about 60% of Vodafone's home broadband traffic. He also stated that during the school holidays they had seen Netflix traffic on their network grow by 83%.⁵

Vodafone admitted some Wellington and Christchurch customers on its cable broadband network had been experiencing slower broadband speeds as the network tried to cope with demand. The sudden surge in demand meant Vodafone moved planned network upgrades forward to resolve the issue.⁶

⁵ Stuff "Netflix demand slows broadband data speeds" (15 July, 2015)

<https://www.stuff.co.nz/business/industries/70268550/Netflix-demand-slows-broadband-data-speeds>

⁶ Ibid.

By October 2015 TrueNet was reporting Vodafone cable as the standout performer. TrueNet reported that its October 2015 testing showed Vodafone cable had made a major improvement in time-of-day performance in peak hour from about half of the advertised speed to now often exceeding advertised speeds.

Disruptions to the market such as the arrival of Netflix in New Zealand impact on performance, but retail service providers recovered from this disruption by improving the operation of their networks. Broadband monitoring helps to raise the visibility and understanding of such events and makes the information accessible to consumers to make informed choices.

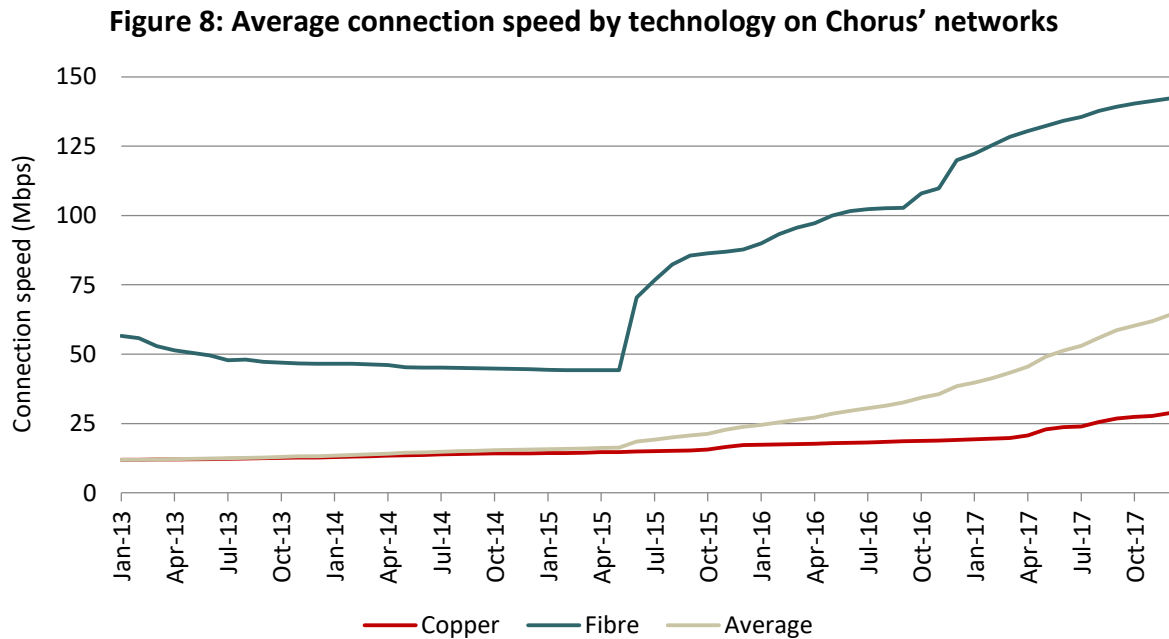
Wholesale service providers also influence broadband performance

Much like retail service providers, wholesale service providers also influence broadband performance experienced by Kiwis in their homes through the part of the broadband network supply chain which they control. Wholesale service providers can influence broadband performance through infrastructure and technology improvements to offer wholesale products to retailers to on sell to consumers.

The data from Chorus shown in Figure 8 below does not include connection speed on Ultra-Fast Broadband (UFB) networks where Chorus is not the wholesale service provider, for example Christchurch and Hamilton.

The connection speed measured by Chorus is the data transfer rate at which the customer premise equipment connects to Chorus' access network equipment. In technical terms, the speeds for copper (ADSL and VDSL) and fibre broadband are measured slightly differently due to the configuration of the technologies. For copper broadband it is the sync rate between the customer's modem and Chorus' equipment (called a DSLAM). For fibre it is the configured speed of the virtual circuit between the customer's premise and Chorus' cabinet.

Figure 8 shows the New Zealand average connection speed for Chorus' copper and fibre networks.



Source: Chorus

In December 2017 the average connection speed for fibre was 142Mbps, almost five times higher than the average connection speed for copper at 29Mbps. Between January 2013 and December 2017 the average connection speed more than doubled both for copper and for fibre. The figure for copper includes both ADSL and VDSL connections. Over time, as Chorus has migrated more customers from ADSL to VDSL, which is capable of much faster speed (see Figure 5 above), the average copper connection speed has increased.

Between May 2015 and July 2015 there was a sharp increase in fibre connection speeds from 44Mbps to 77Mbps. This increase can largely be attributed to two things. First and most importantly – during the 2015/16 financial year Chorus introduced new 100Mbps plans for retail service providers at a \$40 wholesale price to help establish this speed as the entry level fibre product. This new wholesale fibre product meant that retail service providers could start offering a 100Mbps fibre plan to many consumers, which was higher than previous 30Mbps entry level fibre plans.

Secondly, average Chorus fibre speeds also increased as a result of the Dunedin Gigatown initiative - where Chorus made available a fibre service with a speed approaching one Gigabit per second at the same price as the entry level plan. The very first services were activated in February 2015 however the uptake of these services is dependent on the UFB build. Dunedin's UFB build has only recently been completed.

Regional differences in speed

Regional differences in connection speeds are a function of the types of broadband technology available in each area. Chorus' average connection speeds are typically much higher where there are more connections on Chorus' UFB network as fibre connections are capable of much higher connection speeds than copper connections.

Figure 9 below shows the geographic distribution of average connection speeds of Chorus' network by territorial authority area. Figure 9 shows higher speeds in urban areas where there is typically a higher proportion of fibre connections.

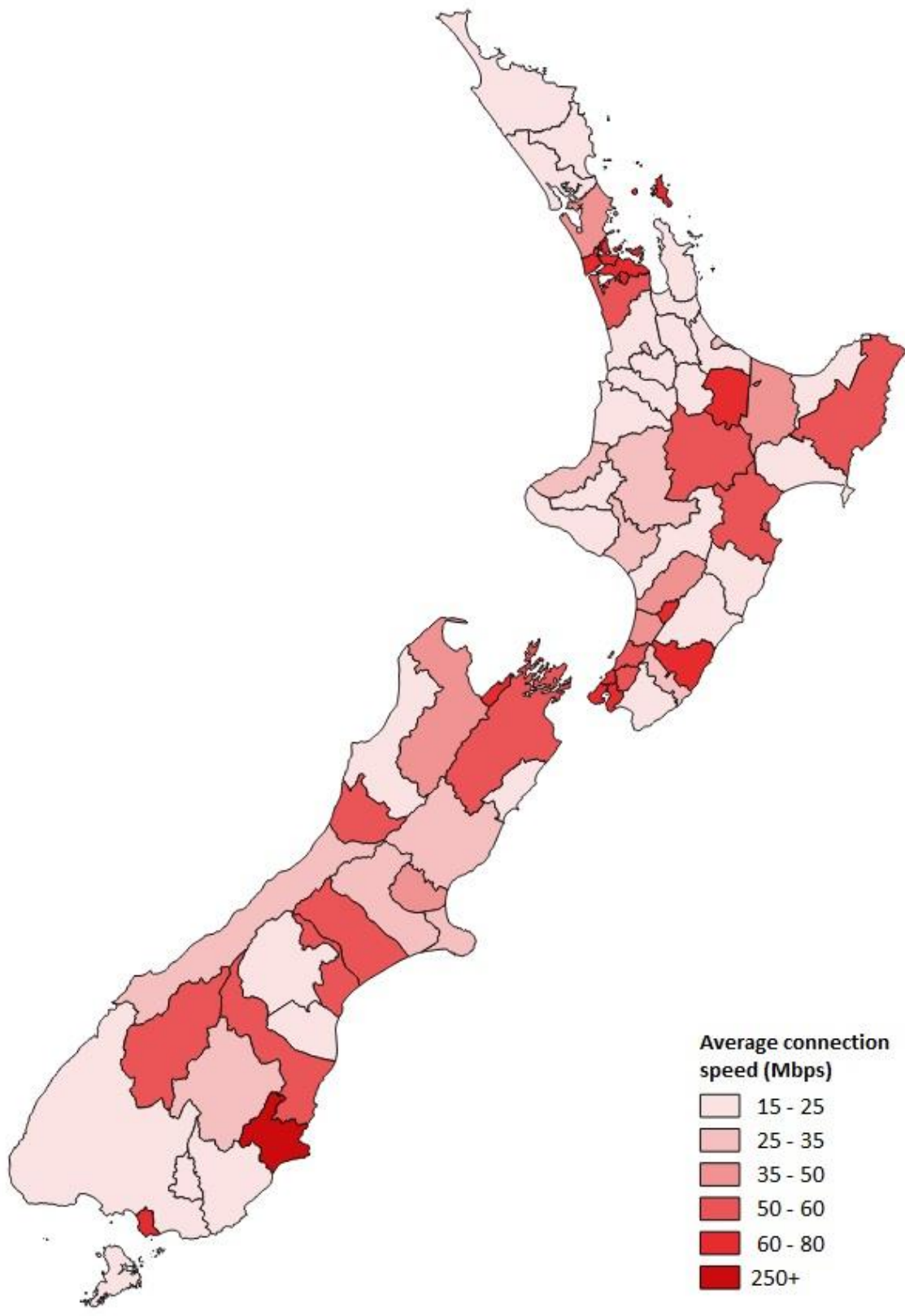
In August 2017 the Ministry of Business, Innovation and Employment (MBIE) announced that by 2022, at the completion of the UFB build, 87% of New Zealanders will have access to fibre.

In more rural areas the average speeds are lower as consumers are further away from exchanges and there is a limited range of technologies available to these homes.

Because it is not cost-effective for the Government to provide UFB in every rural community, it has set up the Rural Broadband Initiative (RBI) to provide faster broadband services to hundreds of thousands of rural homes and businesses outside UFB areas.⁷

⁷ See <http://www.mbie.govt.nz/info-services/sectors-industries/technology-communications/fast-broadband/broadband-and-mobile-programmes#rural>

Figure 9: Average connections speeds on Chorus' network – December 2017



Source: Chorus

The Chorus data used above shows that Dunedin City had an average connection speed of 265Mbps. This is significantly higher than other areas and is a result of the Dunedin Gigatown initiative. The next highest average connection speed was in North Shore City at 81Mbps. The lowest average connection speed was 19Mbps in the Waimate, Central Hawke's Bay and Otorohanga Districts with other more rural areas at around 21-25Mbps.

Note that these average connection speeds on Chorus' network only. In areas where Chorus is not the wholesale fibre provider, such as in Christchurch where Enable is the fibre provider, average connection speeds may be higher than is shown, as Enable's fibre connections are not included in Chorus' average.

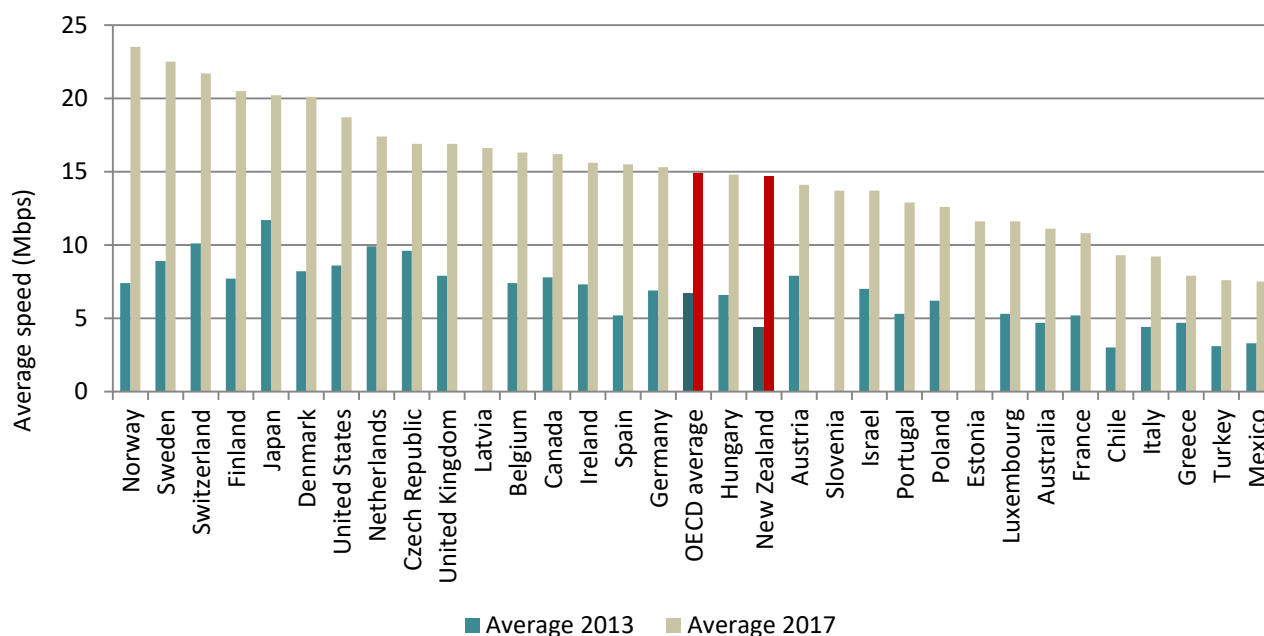
On average, connection speeds more than doubled between 2015 and 2017, with some areas (such as Wellington City) tripling the average connection speed in two years.

Our enhanced broadband performance testing programme provided by SamKnows will test up to 3000 test probes around the country. This testing should allow for a more detailed picture of broadband performance in New Zealand than previous testing regimes.

International comparison

Akamai measures broadband speeds internationally and produces regular State of the Internet connectivity reports.⁸ Figure 10 shows the average broadband speeds reported by Akamai in 2013 and 2017. While New Zealand is below the OECD average, our average speed has been increasing fast.

Figure 10: Akamai international average broadband speeds (2013 and 2017)



Source: Akamai

Between 2013 and 2017, New Zealand's average broadband speed increased threefold from 4.4Mbps to 14.7Mbps. This was the fastest rate of increase of all OECD countries tracked by Akamai. The increase is largely attributed to the rollout of UFB networks in New Zealand which are capable of delivering high speeds.

⁸ Akamai "Quarterly Connectivity Reports – Most Recent Connectivity Report" Available at <https://www.akamai.com/us/en/about/our-thinking/state-of-the-internet-report/global-state-of-the-internet-connectivity-reports.jsp>

About topic papers

This topic paper is published under section 9A(1)(a) and (c) of the Telecommunications Act 2001, which requires us to monitor competition in, and the performance and development of, telecommunications markets and to make information about these matters available. Topic papers are one of the ways that we report and summarise information relevant to that function.

In prior years we have reported on market developments as part of our Annual Telecommunications Monitoring Report. When we published our 2017 Annual Telecommunications Monitoring Report in December 2017, we signalled that we had decided to condense that report to focus on key trends and provide an additional series of topic papers on specific areas of interest, market developments, and trends.

Our topic papers are additional to our monitoring associated with specific section 9A studies, determinations and information disclosure.

List of defined terms

ADSL	Asymmetric Digital Subscriber Line – a type of DSL with download speeds up to 24Mbps
App	Application – an app is a standardised piece of software that runs on a computing platform. The term 'app' originally referred only to applications for mobile devices and tablets, but is now also used when referring to a wide range of devices including desktop computers
DSL	Digital Subscriber Line – method of transmitting high-speed data and, if necessary, voice simultaneously over a copper phone line
GB	Gigabyte – 1 gigabyte = 1024 megabytes. Roughly 5 hours of streaming video
LFC	Local Fibre Company – these are the four companies contracted with government agency Crown Infrastructure Partners to deploy Ultra-Fast Broadband to 75% of the population by rolling out fibre optic access networks
MB	Megabyte – a multiple of the unit byte for measuring the quantity of digital information
Mbps	Megabits per second – used to measure data transfer speeds of high bandwidth connections, such as fibre, Ethernet and cable modems
RBI	Rural Broadband Initiative – an initiative where the government partners with private sector telecommunications operators to upgrade or extend telecommunications networks in rural areas
UFB	Ultra-Fast Broadband – the name given to the Government's initiative to roll out a fibre-to-the-premise access network to give households and businesses access to very high-speed broadband
VDSL	Very High Bitrate (high-speed) DSL with speeds up to 70Mbps
Wi-Fi	Wireless Fidelity Standard – a series of standards for a popular technology that allows electronic devices to exchange data wirelessly (using radio waves), including allowing mobile devices to connect to high-speed internet connections. The distance over which a Wi-Fi connection will operate can vary from 20 metres indoors to potentially tens of kilometres outdoors