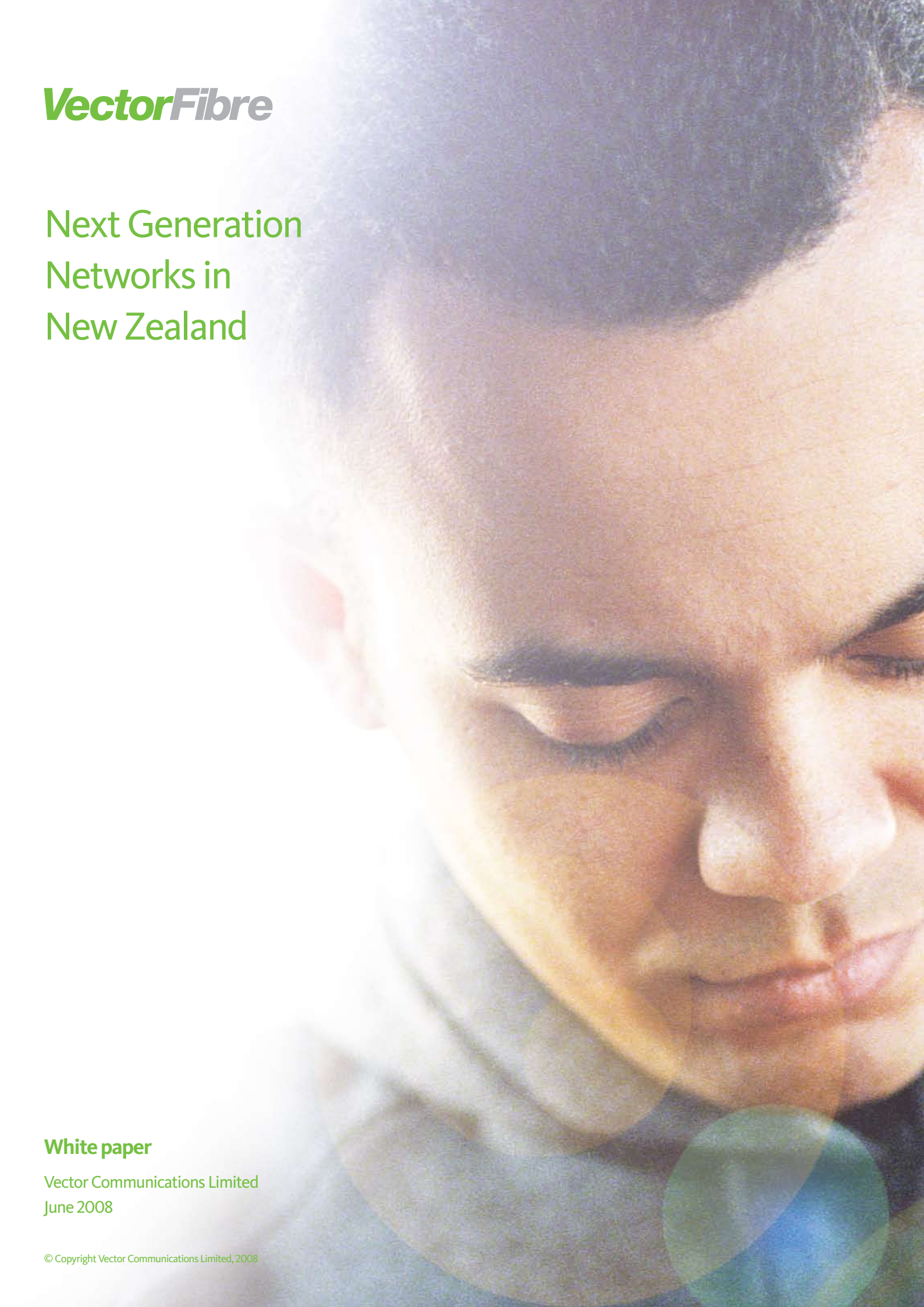
VectorFibre

Next Generation Networks in New Zealand



White paper

Vector Communications Limited
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Contents

Executive summary

Voice and data services are converging, and will eventually be delivered using a single protocol, regardless of its physical network. This will be Internet Protocol, or IP.

Applications for IP data are steadily increasing, so networks need high capacity to deliver them. These high capacity IP networks are called Next Generation Networks, or NGNs. All New Zealand carriers have them.

NGNs will eventually rely on fibre-optic cabling to the premises. Fibre-optic is the "heavy lifter" of network media, carrying thousands of times more information than copper. Every New Zealand network, mobile or fixed line, relies on fibre to carry its traffic "within the network". Copper and mobile signals are only used to distribute network traffic to individual sites.

The high bandwidth of fibre eliminates distance as a factor in a network. All sites are connected with the same immediacy as if they were in the same building. This creates significant opportunities.

One way of carrying IP data is by using standard Ethernet protocol, as used by virtually all internal data networks in New Zealand. MetroEthernet uses the same protocol across an NGN network. This means a MetroEthernet NGN can connect two or more existing LANs – or even a single device to a distant LAN – without the need for investing in special equipment. (In effect, this simplicity of connection is the equivalent of plugging one PC into a phone socket in Penrose, and another into a phone socket in the Auckland CBD, and instantly being able to transfer data between the two.)

The speed of fibre and the simplicity of MetroEthernet combine to make a great deal of applications possible for businesses, including cross-country WANs, remote data warehouses, videoconferencing, IP telephony and more.

At present, VectorFibre has an Auckland-wide fibre-optic network operating the MetroEthernet protocol. This network is almost everywhere throughout the Auckland CBD, and extends to most business and industrial areas of Auckland as well.

Introduction

Internet Protocol (IP) networks are generally accepted as becoming the "unified" transport layer for almost all information services and applications.

This concept has been called the all-IP network, multiservice backbone and others, but is usually known as NGN, or the Next Generation Network.

Next Generation Networks will carry voice, data and other services over one physical network, with all network traffic converted to IP data packets. Most industry analysts expect these NGN networks to be anchored in fixed fibre networks, with copper and mobile networks acting as a complementary capillary system to extend the IP network to most premises, albeit at limited speeds.

Several network protocols carry IP data efficiently. One of the most widely used in LANs is the Ethernet protocol, which can be implemented across very widely dispersed networks as "MetroEthernet". This system has several advantages, not least of which is the ability to connect directly to existing LANs and Ethernet-capable devices without the need for network connection equipment.

Several New Zealand organisations are working toward NGN networks, using different technologies and approaches. But because of the global standards-based nature of the IP protocol, each network will, in theory at least, be able to pass data between each other, routing the traffic as required without loss or bottlenecks. As an analogy, networks are like railway operators who have now agreed to use the same gauge track. While trains – the voice and data of our analogy – have been limited to their own rail network in the past, now they will be able to travel on any network within New Zealand and overseas without stopping, albeit at different speeds.

This White Paper examines the business management implications of NGNs and MetroEthernet, the options available to New Zealand businesses now and in the near future, and the business case for adopting NGN technology sooner rather than later. This paper assumes a low general knowledge of the technical aspects of networks, and little desire to know more than is necessary to make sound management decisions. It is not a technical paper. For detailed technical information, please contact Vector Communications Limited or your own communications advisor.

Cables: the physical layer of Next Generation Networks

New Zealand has several network infrastructures, each with its own limitations and strengths.

All network operators have moved to one basic type of architecture: a central backbone of fibre-optic cabling, either their own or leased, with the final connection to the user's premises or device as either a copper or mobile connection. This allows the network to act like a cardiovascular system, with fibre acting as the high capacity arteries, and copper and mobile as the capillaries taking information to the edge of the network.

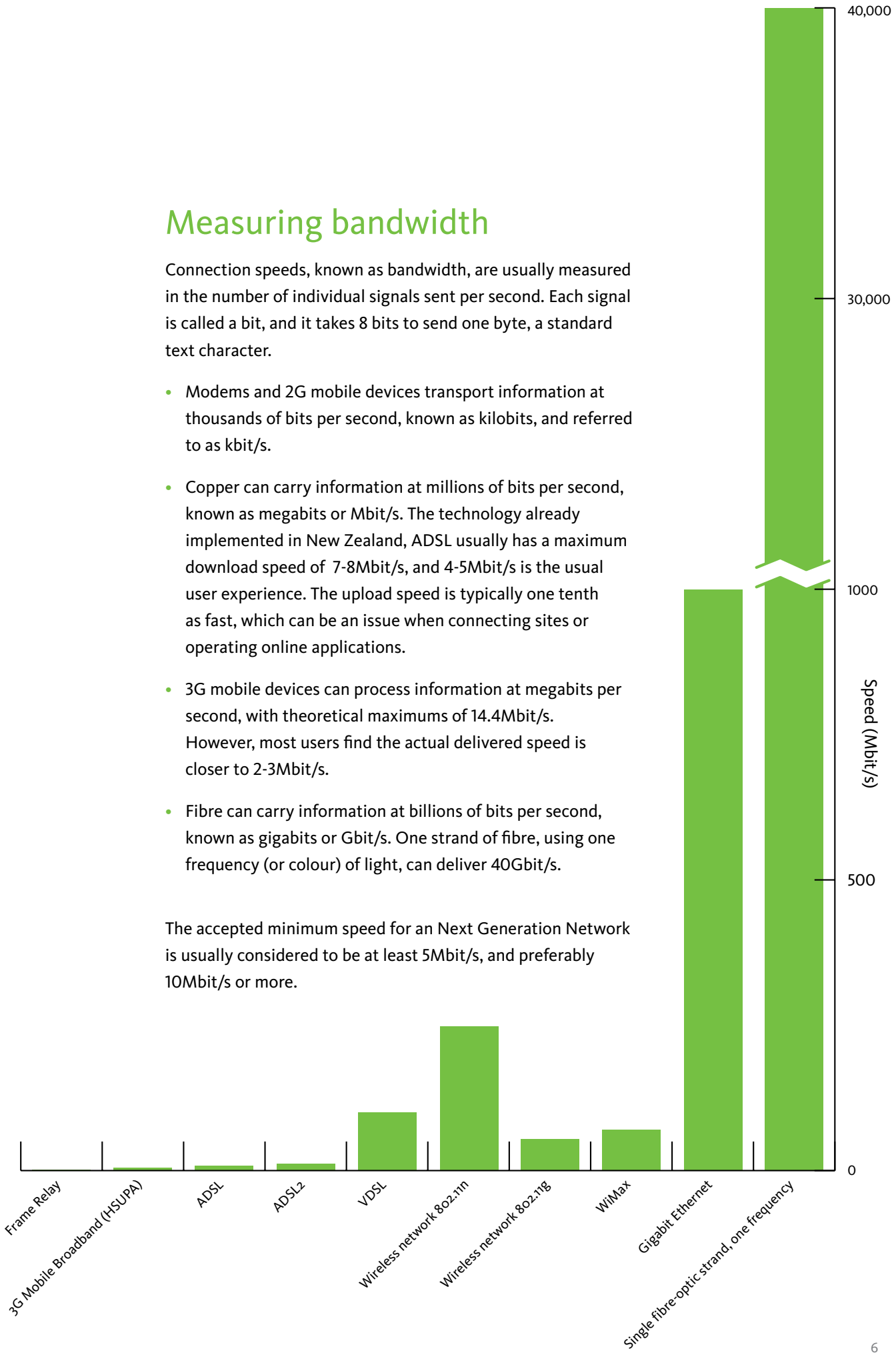
The core of the network is usually super fast. Information travels almost instantly, using the capacity of fibre-optic networks. The speed restrictions occur at the edge of the network, in the connection between the network core and the user's premises. The limited capacity of the copper and mobile capillaries creates a speed barrier through which information needs to pass. One goal of NGN operators is to extend more capacity to the end user – which usually means bringing fibre as close to the premises as possible.

Measuring bandwidth

Connection speeds, known as bandwidth, are usually measured in the number of individual signals sent per second. Each signal is called a bit, and it takes 8 bits to send one byte, a standard text character.

- Modems and 2G mobile devices transport information at thousands of bits per second, known as kilobits, and referred to as kbit/s.
- Copper can carry information at millions of bits per second, known as megabits or Mbit/s. The technology already implemented in New Zealand, ADSL usually has a maximum download speed of 7-8Mbit/s, and 4-5Mbit/s is the usual user experience. The upload speed is typically one tenth as fast, which can be an issue when connecting sites or operating online applications.
- 3G mobile devices can process information at megabits per second, with theoretical maximums of 14.4Mbit/s. However, most users find the actual delivered speed is closer to 2-3Mbit/s.
- Fibre can carry information at billions of bits per second, known as gigabits or Gbit/s. One strand of fibre, using one frequency (or colour) of light, can deliver 40Gbit/s.

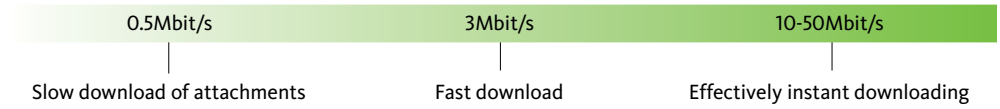
The accepted minimum speed for an Next Generation Network is usually considered to be at least 5Mbit/s, and preferably 10Mbit/s or more.



Application bandwidth

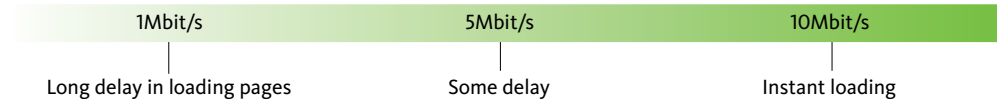
Email access

(Requires good download speed.)



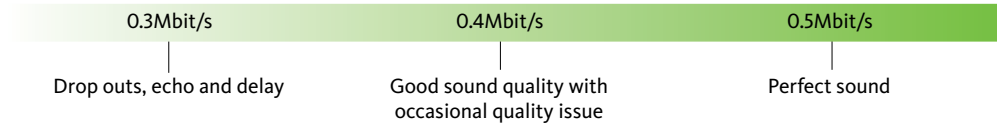
Web access

(Requires good download speed.)



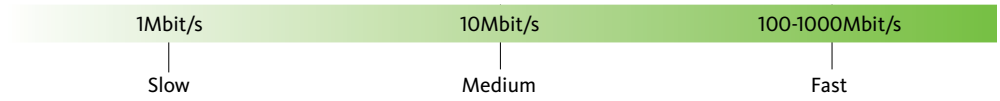
VoIP

(Requires good two-way speed, low jitter and low latency.)



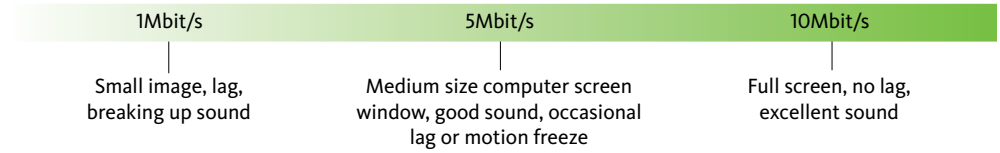
File transfers

(Requires very high two-way speed.)



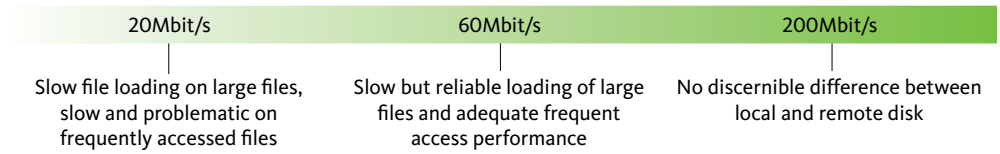
Video conferencing

(Requires high two-way speed, low jitter and low latency.)



Remote disk access

(Requires very high two-way speed, with low latency.)



Copper – the original network medium

Copper cabling has been the preferred medium for information networks since the advent of the telegraph over 120 years ago. It has the advantage of being totally ubiquitous in New Zealand, reaching almost all businesses and private residences.

Copper delivers modern high-speed information in three main formats. Each one suffers from relatively high degradation of performance as the distance from the network core increases.

- ADSL (Asymmetric Digital Subscriber Line) is robust but relatively slow, delivering download speeds of up to 10Mbit/s, although most users experience performance of 3-5Mbit/s. Upload speeds are much lower (which is the "asymmetric" part of the name), making it generally unsuitable for true NGN services.
- ADSL 2 is a more robust version of ADSL, offering better performance over similar distances.
- VDSL (Very high speed Digital Subscriber Line) is much faster over short distances, delivering up to 50Mbit/s up to 400m.

Copper systems have the huge advantage of being available to most New Zealand businesses and homes with very little investment in equipment, using cabling that is already in place.

Fibre-optic

Fibre-optic cables are thin, flexible glass strands. Low power lasers pulse light into the cable, and the flashes pass through the fibre, reflecting off the interior walls of the glass and thus losing almost no signal along the way. One laser can transmit 40 gigabits (Gb) down one fibre strand each second – 40 billion individual signals, or about 5 gigabytes (at 8 bits per byte) of information. In addition, up to 40 different colours of light can be shone through the fibre at once, each refracted at the other end into their specific frequency, each colour carrying 40Gb for a total of 1.6 terabits (1,600Gb). By comparison that's more than Auckland's entire residential broadband capacity in one strand – and in one fibre conduit there are typically over 750 strands.

Fibre has other advantages:

- High bandwidth speed eliminates distance as a factor in a network. Sites are connected with the same immediacy as if they were in the same building, allowing LANs to either extend to additional sites over any distance without investing in new servers and equipment, or to connect existing LANs.

- Its capacity and the ability to carry any type of data signal means it can become a "single socket solution" for voice, data and future applications. All the organisation's communications can be channelled through a single connection (with copper as a back-up) allowing efficiencies and opportunities (see below).
- Virtually no loss of signal across distance no matter how far from the local exchange.
- Its capacity eliminates performance loss due to congestion, so the rated performance will always equal actual performance.
- Once the connection is secured, upgrading bandwidth is usually just a matter of placing a call to the network operator.

There are increasing numbers of businesses connecting their premises directly to fibre networks to ensure the performance of their critical data links, and to create opportunities for "single plug" convergence opportunities (see below).

There are four types of fibre connection:

- Fibre to the Neighbourhood (FTTN) – fibre runs to a local cabinet (a "mini-exchange") and then relatively low-performance copper cabling takes the data the last 500m or so to individual premises. This is much better than standard ADSL from a distant exchange, but performance is significantly lowered. This is the "cabinetisation" option being pursued by Telecom's network subsidiary Chorus, and roll out is currently promised to be complete in the Auckland CBD by 2010.
- Fibre to the Curb (FTTC) – fibre runs past a premises, and customers arrange to connect from there themselves – this is not an option being offered in New Zealand.
- Fibre to the Building (FTTB) – fibre is terminated within the actual building, allowing all tenants to access its data connection via their own high performance network cabling. This supports data speeds of up to 1Gb per second over standard Cat 6 cabling. This option is available from VectorFibre, either directly or via ISP partners, and, for large customers, from Chorus.
- Fibre to the Premise (FTTP) – fibre running directly to an organisation's server room, so that there is effectively no copper whatsoever between the system and the connection. This option is offered by VectorFibre for large connections.

The disadvantages of fibre mostly revolve around its availability. Copper connects virtually every business premise in New Zealand, and is the easiest option by far. With imminent cabinetisation, copper will remain the most viable option for most New Zealand businesses for some years to come.

Mobile

As well as voice services, mobile technology is now capable of supporting data services. In these high bandwidth mobile networks, individual cell sites are connected to the main network by fibre, and data transmitted onwards by high-performance mobile signals. This effectively replaces copper with mobile, creating several advantages:

- "No socket" connectivity – users can operate independently of fixed access points, making working environments more fluid and providing access for remote workers without investing in connection points.
- Organisations can divest themselves of their internal networks.
- The end user's network has unlimited numbers of end points.
- Reduced requirement for network infrastructure equipment, as the mobile operator effectively takes over the termination of each connection to the user.

Disadvantages:

- Atmospheric conditions and the distance to the transmission point compromises mobile performance, resulting in network-wide slowdowns.
- The organisation risks being charged for all network traffic, including its own internal traffic (although unlimited use deals are becoming more frequent).
- Cost per user is generally higher than a simple fixed connection (although it does offer the advantages listed above).
- The flexibility of internal mobility can often be replicated at far less initial and ongoing cost with internally operated Wi-Fi solutions.

For these reasons, mobile broadband is usually used as a supplementary system rather than a single data connectivity solution.

Mobile broadband technology has a clear roadmap of increased performance, with two-way speeds of 100Mbit/s predicted by 2015. However, this has to be put in the context of current performance versus user experience: one provider claims its network currently offers speeds of 10Mbit/s, while most users find it only performs at 1-2Mbit/s. This is similar to the theoretical maximum speed of copper: the exchange sends the data at 10Mbit/s, but it tends to arrive at the user's premises at 3-6 Mbit/s or less.

New Zealand situation

The nature of New Zealand's communications structure has changed with the government mandated functional separation of the largest operator, Telecom.

Telecom now has an infrastructure operator, Chorus, responsible for its underlying network. A wholesale division buys network capacity from Chorus and on-sells it to retailers, including Telecom's own retail operation.

As a result, all operators now have access to Telecom's copper network assets and exchanges. This reduces the need for network investment, and encourages network operators and retailers to work as each other's suppliers and customers as well as competitors. As a result New Zealand has seen a change in the approach of almost all network providers. Instead of a "our network built our way" philosophy, most providers are completing their networks using a combination of their own and third party infrastructure suppliers. This also extends the potential offerings of many smaller companies. So we have ISPs offering integrated voice services, and Vodafone connecting cell sites to the VectorFibre network and then back to their exchanges.

While this network agnostic model reduces costs to end users and increase competition, it may also depress the level of investment in new network services as operators stand back and wait for Telecom to do the "heavy lifting". This has been stymied to an extent by Telecom's announcement of its own NGN plans which involve cabinetisation ("Fibre to the neighbourhood"), which is not included in local loop unbundling (LLU).

MetroEthernet

Ethernet is the standard protocol used in most Local Area Networks (LANs). It's simple, it offers speeds of 1Gbit/s as a standard in new installations (with 10Gbit/s as the new high end speed), and it's capable of carrying most types of traffic, including Internet Protocol (IP) data.

It thus makes sense for most end users that their WAN connections – the external networks that connect their premises and LANs – also use Ethernet. It creates a "single language LAN", with no need for translation boxes in server rooms. In effect, one Ethernet plug in the server room wall can connect one LAN to another, or even one device to a distant LAN. With a high-performance NGN carrying the Ethernet traffic, there need not be much difference in performance between sites across the country and terminals down the hall.

Ethernet is also a preferred network protocol because of the increasing use of IP communications. Ethernet was originally designed to allow data transmissions between different computer stations. It was designed to be flexible and adaptable, which makes it useful as the "heavy mover" of an NGN.

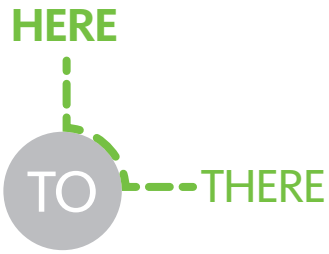
MetroEthernet can be delivered at almost any speed. Speeds of 1Mbit/s to 1Gbit/s are standard within LANs, with 10Gbit/s possible with higher end equipment and cabling. This means Ethernet transmissions can arrive "right out of the NGN socket" at up to 1Gbit/s without the need for additional equipment.

The simplicity of MetroEthernet and the simplicity of connection also acts to decrease the total cost of ownership for WANs and connected premises.

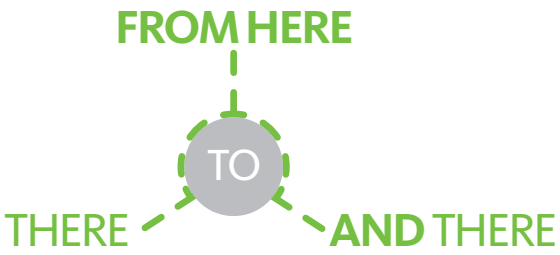
MetroEthernet WAN architecture

MetroEthernet links between sites can be done to three international standards.

- A simple straight line connection, known as an MetroEthernet Private Line (EPL), is single connection dedicated to joining two premises.



- Two or more of those connections in a star configuration, known as a MetroEthernet Virtual PrivateLine (EVPL), connects each premise to a central location, but does not connect the peripheral premises to each other.



- A full all-points to all-points WAN, known as a MetroEthernet LAN (ELAN), where all premises can connect to each other's LANs.

Delivering MetroEthernet

MetroEthernet as a connectivity service is simple and robust, but needs a high performance NGN network, preferably with fibre either to the server room, the building or at least to a local and nearby cabinet. The preferred connection is definitely fibre to the building.

The characteristics of a MetroEthernet service need to be specified on three levels.

1. The bandwidth at each premises' connection point. This is the data capacity at each site, based on average usage and allowing for any critical peaks.
2. The bandwidth that should be reserved within the network itself to service traffic between all sites. For example, an organisation with five sites, each of which has a 20Mbit/s connection, probably needs 40-70Mbit/s total capacity "inside" its network, to allow for the traffic from all sites.
3. The network performance that is required of a particular MetroEthernet service depends on the types of applications that will be used. For example, VoIP needs a service that ignores missing data rather than delivering it late, while data intensive services need all data delivered reliably, even if there is a slight delay in particular packets. Some applications such as transport of live video require bandwidth to be available exclusively. While for other applications, such as web browsing, bandwidth can be shared.

MetroEthernet applications and opportunities

Very high two-way bandwidth is more and more important to New Zealand businesses. From a user perspective, MetroEthernet offers the significant benefit of the same protocol for the WAN as is already used in the LAN.

Moving to MetroEthernet from a legacy service (such as ATM, Frame Relay, or a leased line) delivers more bandwidth – and it does so at a lower cost per megabit, with easy, fast and flexible bandwidth changes and robust SLAs.

Virtual Private Networks

Virtual Private Networks (VPNs) link an organisation's sites across a shared NGN infrastructure without compromising security. Typical applications include:

- Linking a data warehouse to the core corporate LAN.
- Extending a high-bandwidth corporate LAN across New Zealand.
- Connecting several branch offices in a metro area.

These links are far more cost-effective than the old-style solution of "leasing a private line" – in effect, taking over part of the public telephone network.

MetroEthernet networks can deliver these VPN services, together with the performance and service benefits of guaranteed bandwidth and encryption. But compared to a leased line, the shared infrastructure costs far less.

With MetroEthernet carrying the VPN traffic, bandwidth can be changed as required by 1Mbit/s increments. These changes are effected by "the press of a button" by the network operator. As a result, costs for change are minimal, usually with no need to change any of the organisation's on-site equipment.

Distributed data centres

The high bandwidth and quality of service of fibre-optic data, and the simple connection of MetroEthernet, lets organisations store their data in remote and secure data centres. It also creates the opportunities to outsource data storage, by using third party “server farms”. Separating the data form workplace sites also provides additional operational security and more robust disaster recovery capability.

IP telephony

With an NGN in place, Voice over IP (VoIP) becomes an attractive option to reduce cost. All voice calls are delivered over the same data link as the data services, eliminating several cost areas. Users can choose to integrate a VoIP solution with an existing or new IP-capable PBX, or outsource the “brains” of their voice system to a network-based service. VoIP services only need relatively low bandwidth, but work far more reliably, and with a better quality of service, across a fibre-optic network with its low latency and smooth flow of data (known as low “jitter”). The higher latency and jitter levels of other network media can result in echo and a choppy, watery quality to the call.

Converged telephony

When voice services move to IP, there is the opportunity to converge voice telephony with data services and applications. Most New Zealand telecommunication carriers offer converged telephony products that use IP networks as their central unifying platform. These systems integrate mobile, fixed line and data systems to create “one user, one number” systems in which each employee has a single “geographic number”, can answer any call on their mobile phone, fixed line phone or VoIP-enabled PC, and integrate their calling systems with their PC-based calendar and address book. These systems need relatively low levels of bandwidth for each user, but as the number of users increase the higher bandwidth and reliable quality of service of a fibre-optic network becomes the only viable choice.

Videoconferencing

Videoconferencing lets distant employees, customers and suppliers meet at short notice. Short meetings can take the place of long and expensive travel times. Together with VoIP, desktop videoconferencing allows low-cost face-to-face business meetings without leaving the desk, which is ideal for businesses with wide-spread offices. High data rate NGN connections allow large desktop images of the other party, and don't suffer from the jumpy picture and high drop-outs of sound that have held back video-conferencing in the past.

In contrast, the bandwidth and quality of service of true NGNs – especially fibre-optic networks – allow videoconferencing with large screens and good picture quality. This is known as "telepresence" videoconferencing, where participants are able to see each other in reasonable life-like sizes and with little delay in video transmissions. This high quality of service makes videoconferencing a realistic alternative to travelling to meet in person in more cases.

Fibre-optic networks in New Zealand

Several carriers operate fibre-optic networks in New Zealand. Telecom New Zealand uses a great deal of fibre-optic, but tends to reserve this for its own network use. Some large customers are granted access.

TelstraClear has a relatively widespread fibre network in Christchurch and Wellington, as well as a limited fibre presence in Auckland, Tauranga and other smaller centres.

In Wellington, CityLink operates a CBD fibre-optic ring, available for general connection.

In Auckland, VectorFibre, the infrastructure arm of Vector Communications Ltd, has a fibre-optic MetroEthernet network which is ubiquitous through the CBD, and extends to Manukau City, Penrose, Newmarket, Parnell, Ponsonby, Dominion Road and the North Shore as far as Albany in the north and Takapuna in the east. Recent joint partnership agreements with Vodafone will increase the fibre network by 30% again.

Conclusion

Next Generation Networks will become the new standard for all networks within New Zealand and the rest of the developed world within the medium term.

Ultimately, these networks will involve fibre to some degree, and the most reliable and future-proofed will have fibre direct to the premises.

All New Zealand network providers are implementing NGNs over their preferred network medium: copper, mobile, or copper/fibre hybrids.

With these NGNs in place, New Zealand businesses will be able to access new applications which will create new opportunities and unlock more potential, including:

- Virtual private networks to link sites with the same performance as local LANs
- Distributed data centres for disaster recovery, security and cost control
- IP telephony for reduced total cost of communications
- Converged telephony to integrate computers, deskphones and even mobiles onto one platform
- Videoconferencing to connect distant offices for instant meetings, and reduce the time and cost spent travelling. These videoconferences

All NGNs will eventually deliver these services using Internet Protocol (IP). One of the simplest transport layers for IP services is Ethernet, the same system used within most organisations' LANs. With Ethernet connecting sites, there is no need to invest in additional "translation" boxes, making it simple to implement.

VectorFibre currently runs the largest fibre-optic network in Auckland, using Ethernet as a transport layer. This network has a very wide coverage.

For more information on VectorFibre

To find out more about VectorFibre, including maps of coverage within Auckland, visit www.vectorfibre.co.nz.

You can also email sales@vectorfibre.co.nz, or call on 0508 244 758.