Chorus Network Update

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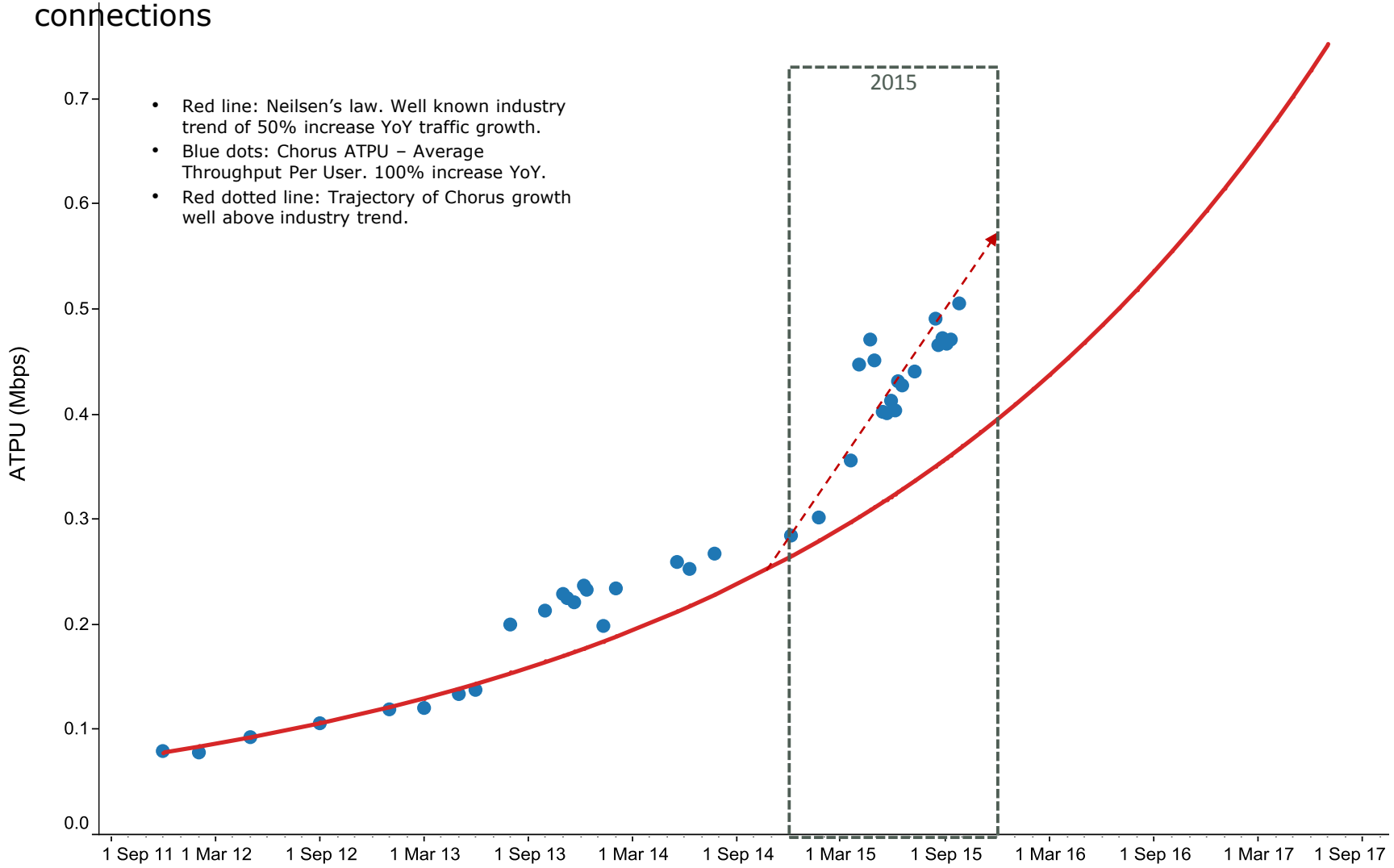
Chorus

Video – the impact on Chorus

- Bandwidth use in New Zealand is growing at an enormous rate; well above the most optimistic industry trends
- The main driver is video on demand in line with the availability of faster fibre and VDSL connections



- Red line: Neilsen's law. Well known industry trend of 50% increase YoY traffic growth.
- Blue dots: Chorus ATPU – Average Throughput Per User. 100% increase YoY.
- Red dotted line: Trajectory of Chorus growth well above industry trend.

Global Macro Technology Themes

Market Trends

Smart Devices

> Broadband devices requiring data at home and on the move.
> Proliferation of these now cheap devices is driving up network bandwidth.

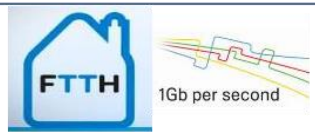
Online Video

> Video is the largest consumer of internet traffic.
> Content providers know that a good network is essential for their customer experience to be acceptable

Cloud Services

> High bandwidth and low latency means it is possible to store & run applications remotely.
> Compute and storage will be moved to the Cloud. Devices will get cheaper and simpler

Network Trends



Fibre

> Fibre is the solution when economic
> Fibre can carry terabytes of data.
> Fibre is being built deeper into networks.

Copper

> Copper innovation continues internationally.
> 100Mbps possible. Short loops & technology needed.
> Fibre must be nearby for copper to perform well.

Wireless

> WiFi widely used. Suffers from interference & distance.
> New WiFi technologies will extend it's usefulness.
> Fibre must be nearby for WiFi to perform well.

Mobile

> Essential for voice and data on the move.
> Data offloads to wireless at home & now in the street.
> Fibre must be nearby for mobile to perform well.

Challenges

Coverage

> Providing ubiquitous coverage to all is extremely difficult.
> Mobile and wireless need fibre to expand coverage.

Capacity

> Fibre network capacity is determined by investment in network electronics.
> Mobile & wireless capacity is also determined by backhaul fibre and by air interface technology.

Capability

> Copper, mobile, wireless technologies are requiring extremely creative capability solutions to carry more data.
> Fibre is highly capable of more with little innovation required.

Fibre is at the heart of everything

Mobile

- originally a technology for voice
- a bridging technology between fibre and end user for data/broadband
- performance is highly variable
- additional cell sites the easiest way to add capacity
- more fibre backhaul needed as bandwidth demand grows
- technology advances (E.g. LTE) require stable connections over short distances to perform

Fibre

- initially a transport technology for long distance and large data capacity
- becoming the end to end connectivity technology where economic
  - very high performance and capacity, enormous room for growth

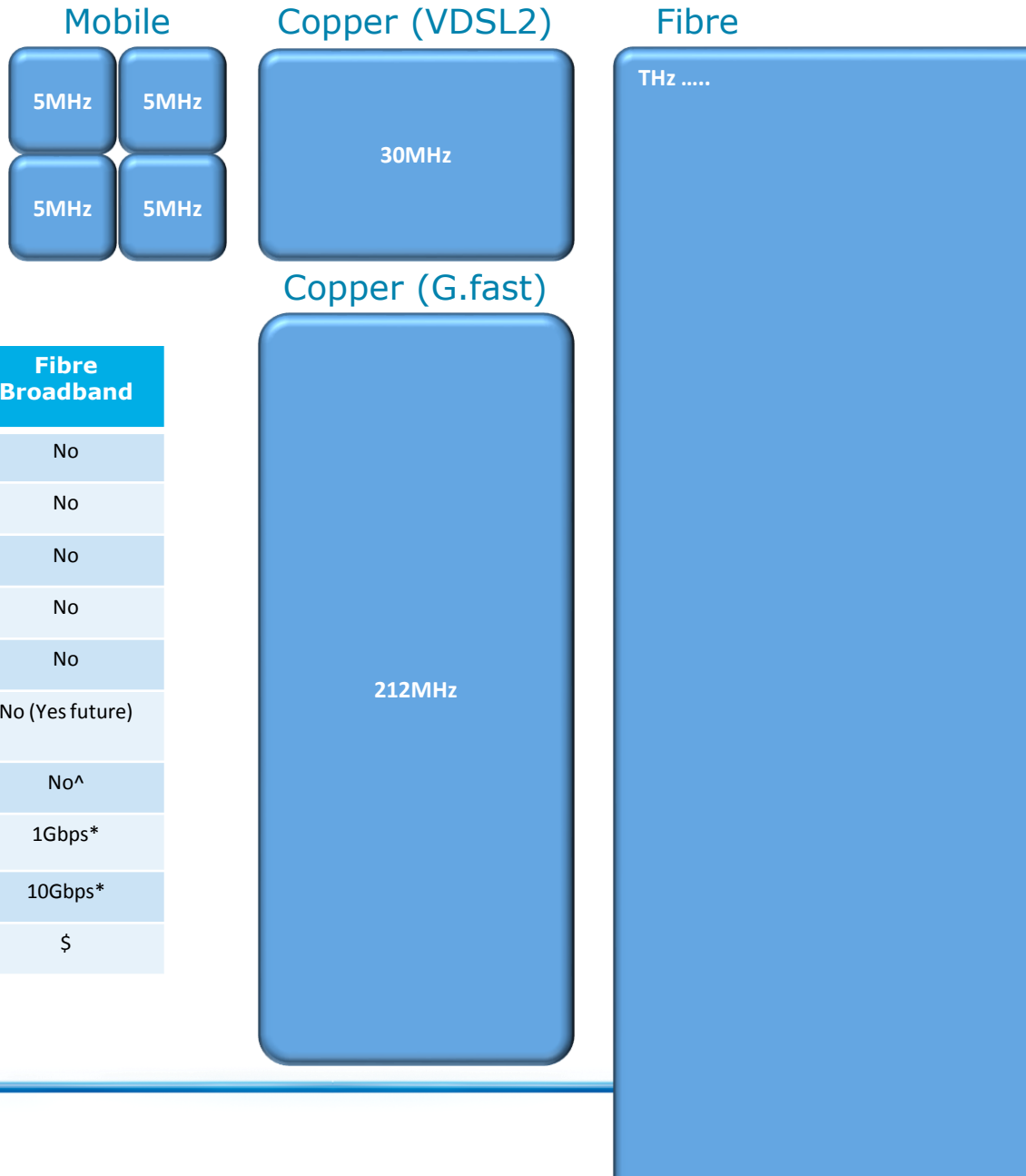
Wireless

- designed to bridge the very short distance between fixed broadband networks and wireless broadband devices
- coverage is very specific but high capacity
- performance constrained by availability of good backhaul (fibre), spectral congestion and distance limitations
- data from mobile "macro" cells offloaded onto wifi wireless networks

Copper

- originally a technology for voice
- a good quality copper connection over short distance provides a bridge between fibre and end users for data/broadband
- line speed varies subject to distance, line quality and technology.
- Chorus fibre to cabinet (FTTN) rollout shortened copper loops, enabling VDSL to ~60% of end users
- G.fast technology suggests >100Mbps at distances <300 metres

Why is fibre the future?



Performance Impacts	Mobile Broadband	Copper Broadband	Fibre Broadband
Shared connection	Yes	No	No
Backhaul constraint	Yes	Yes	No
Spectrum constraint	Yes	Yes	No
Spectrum $	Yes	No	No
Interference	Yes	Yes	No
Modem/Handset compatibility issues	Yes	Yes	No (Yes future)
Distance Degradation	Yes	Yes	No^
Per user Current Technology	~20Mbps*	30-70Mbps*	1Gbps*
Per user Next Technology	~50Mbps*	~300Mbps*	10Gbps*
Cost per MB	$$$$	$$	$

* Expected user rate in good conditions
^ Optical signals do degrade due to scatter or absorption. Neither are a factor in the performance of the Chorus UFB network

Connection Speed vs. Bandwidth

Sustained Throughput is key to a quality broadband experience …
… not momentary Headline Speed

Your connection speed will always be consistent

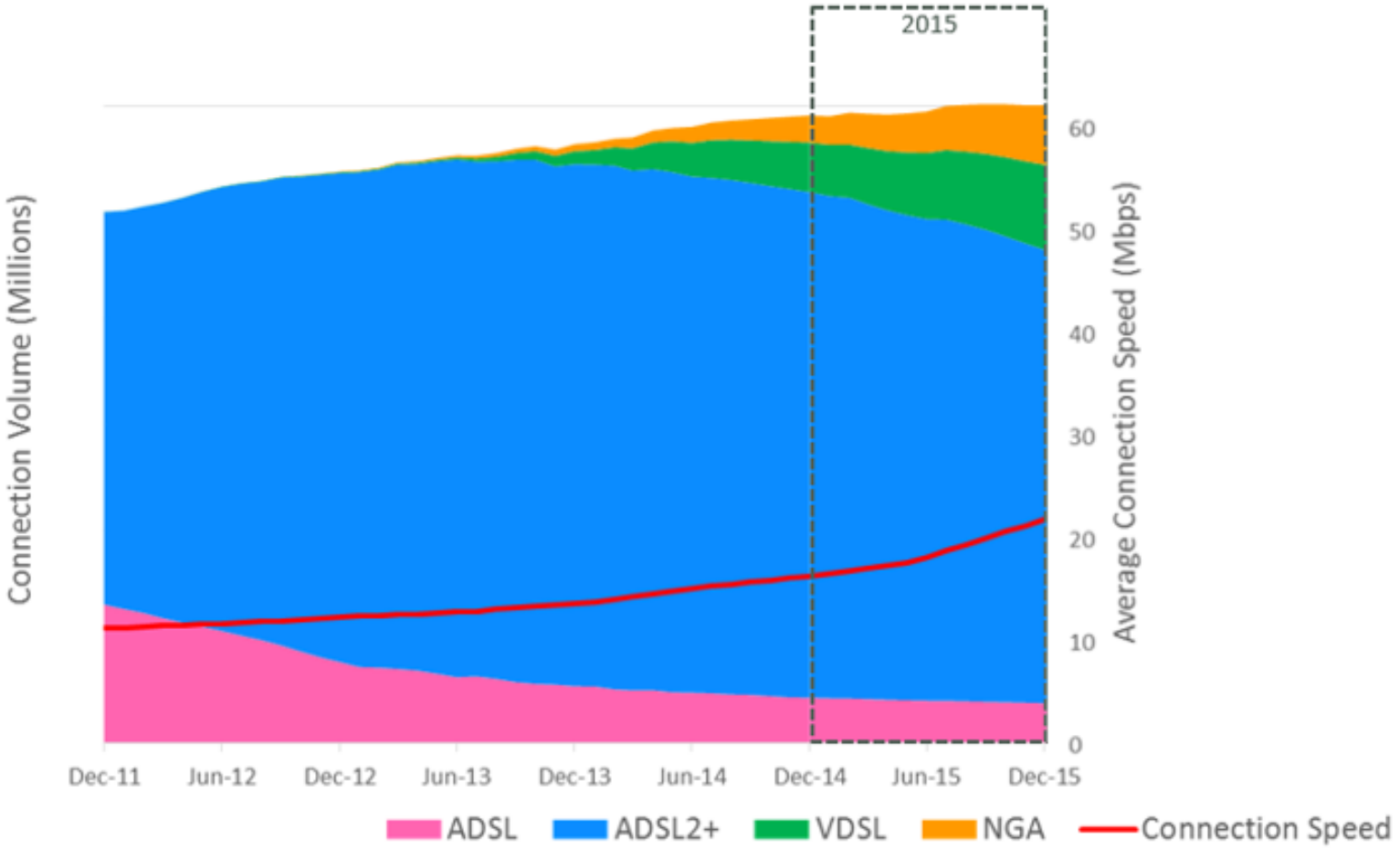
Your throughput will not be constrained below this speed

Connection Speed

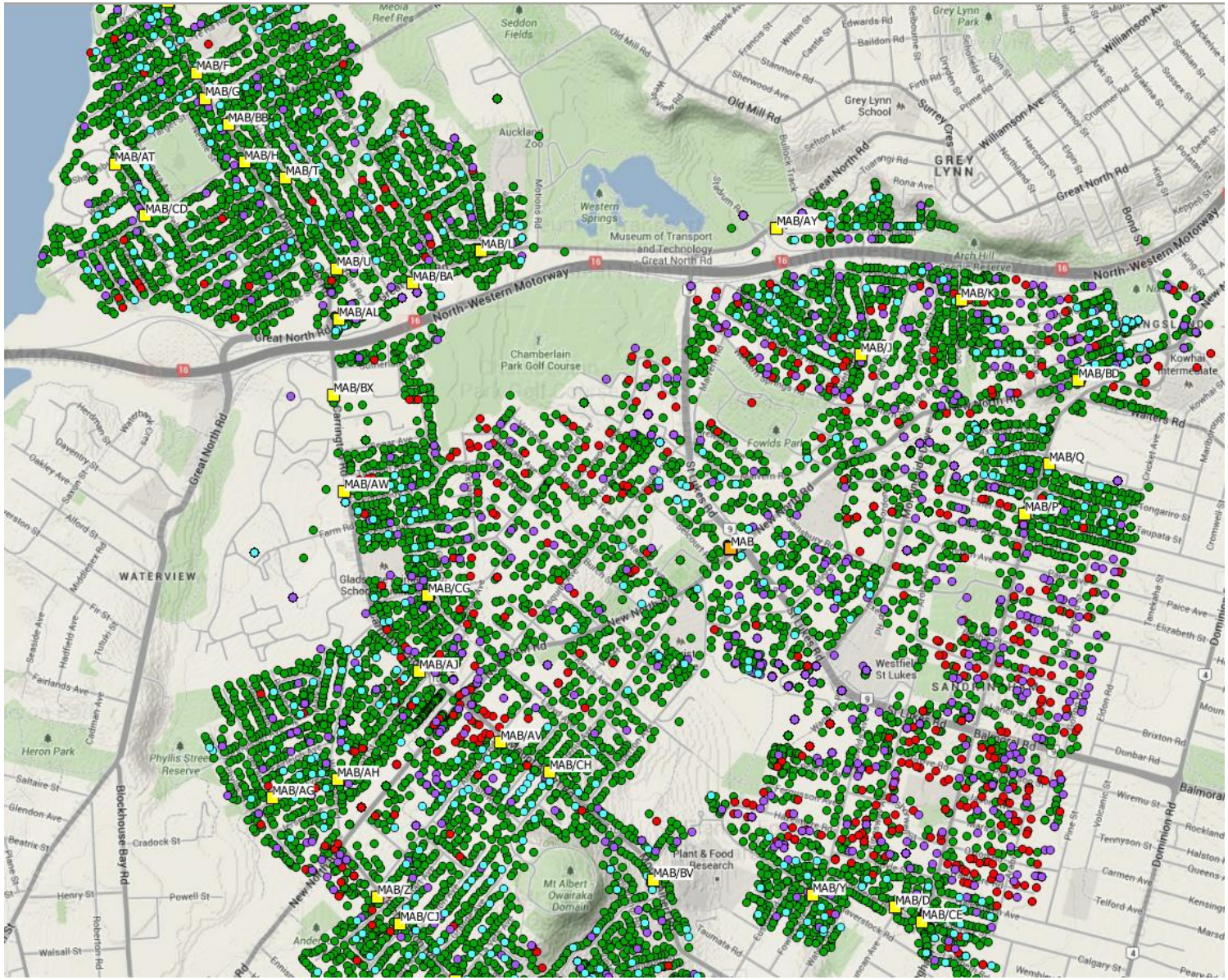
The Fastest Connection you can get

Connection Speed

- The chart shows connection volume, type and speed.
- You can clearly see a growing trend toward faster fibre and VDSL connections.
- The result is a growing average connection speed; we have now exceeded 20Mbps average for the first time and the trend is upwards – fast. That's great for New Zealand.



Example Copper Connection Speed Map

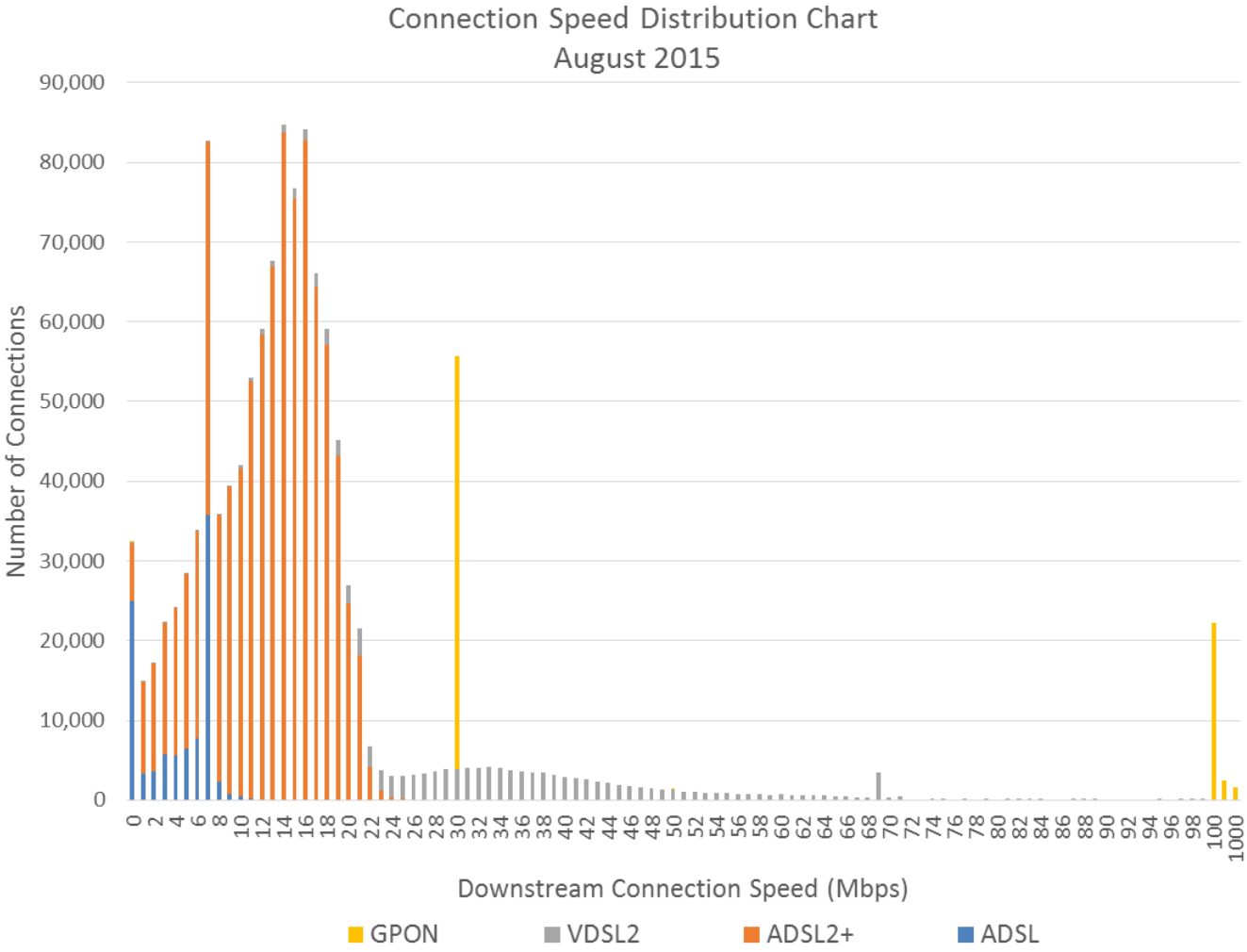


Connection Type

- ADSL
- ADSL2+ <5Mbps
- ADSL2+ >5Mbps
- VDSL

Connection Speed

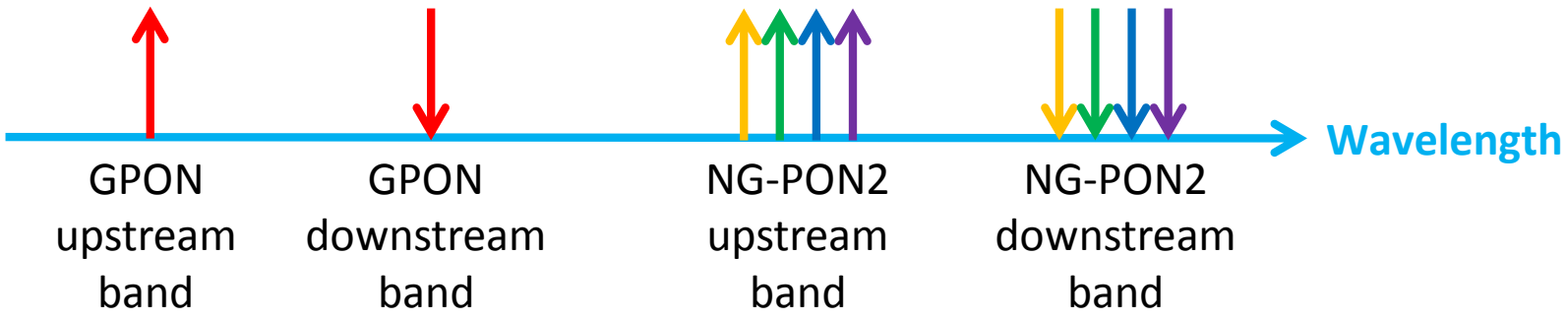
- Fibre (GPON) connection speeds are consistent; set by the plan purchased
- Copper (xDSL) connection speeds are variable and dependent upon many factors

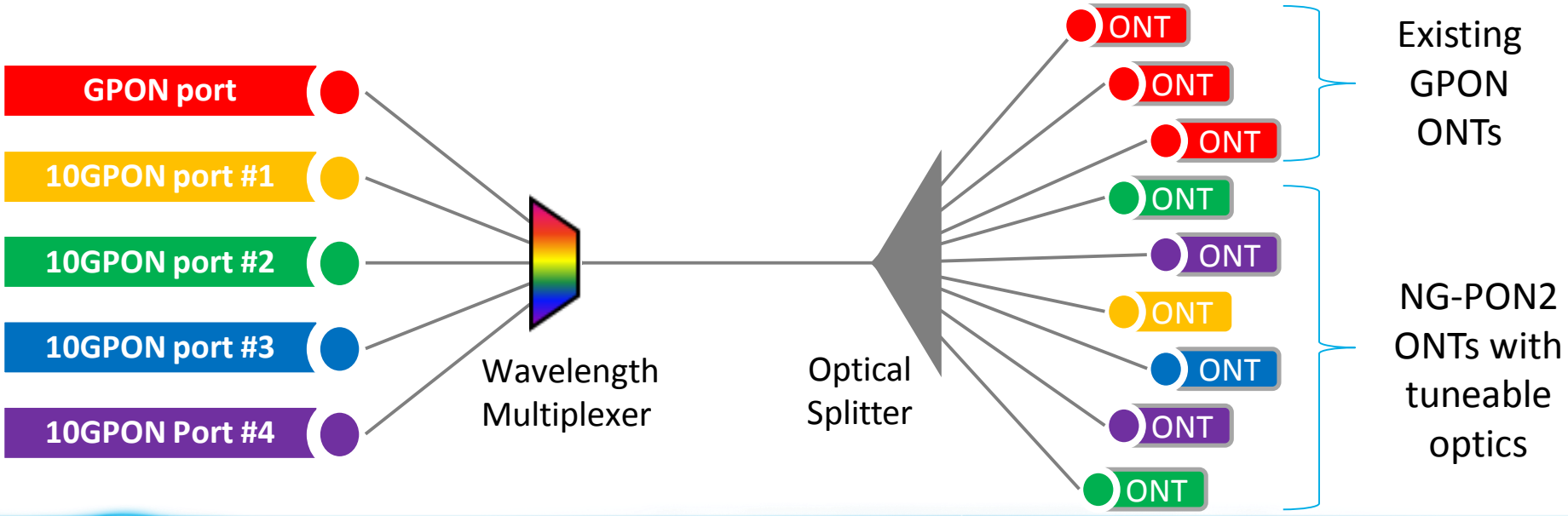


- Connection speed is independent of any network congestion
- NGA connection speeds are consistent and ubiquitous
- DSL connection speeds vary depending on line length and quality
- ~500K ADSL2+ connections could get VDSL2
- ~40K ADSL1 connections could get ADSL2+
- ~20K ADSL1 connections could get VDSL2
- Some customers are constrained by their modems
- Some customers have degraded performance due to home wiring
- Some customers have degraded performance due to Wi-Fi networks
- 998 bandplan change will improve VDSL2 line speeds and service coverage

Fibre: We are only just beginning …

> 100Mbps, 200Mbps and even 1Gbps services are all real and available today.
> What's next? 10Gbps connections …





Summary – The Fastest Connection you can get

- Connections speeds are growing strongly (>30% year on year)
- Fast UFB and VDSL2 connections and RBI program are driving this growth
- Fibre is ubiquitous, consistent, reliable, touch free

But…

- Copper is more varied and held back by issues like legacy equipment, home wiring and old modems
- Not Everyone "takes" the fastest connection available
- Rural legacy DSLAMs are a challenge
- Connection speed does not equal throughput, unless Chorus and Retail Service Providers can keep traffic moving

Which brings us to "Bandwidth"….

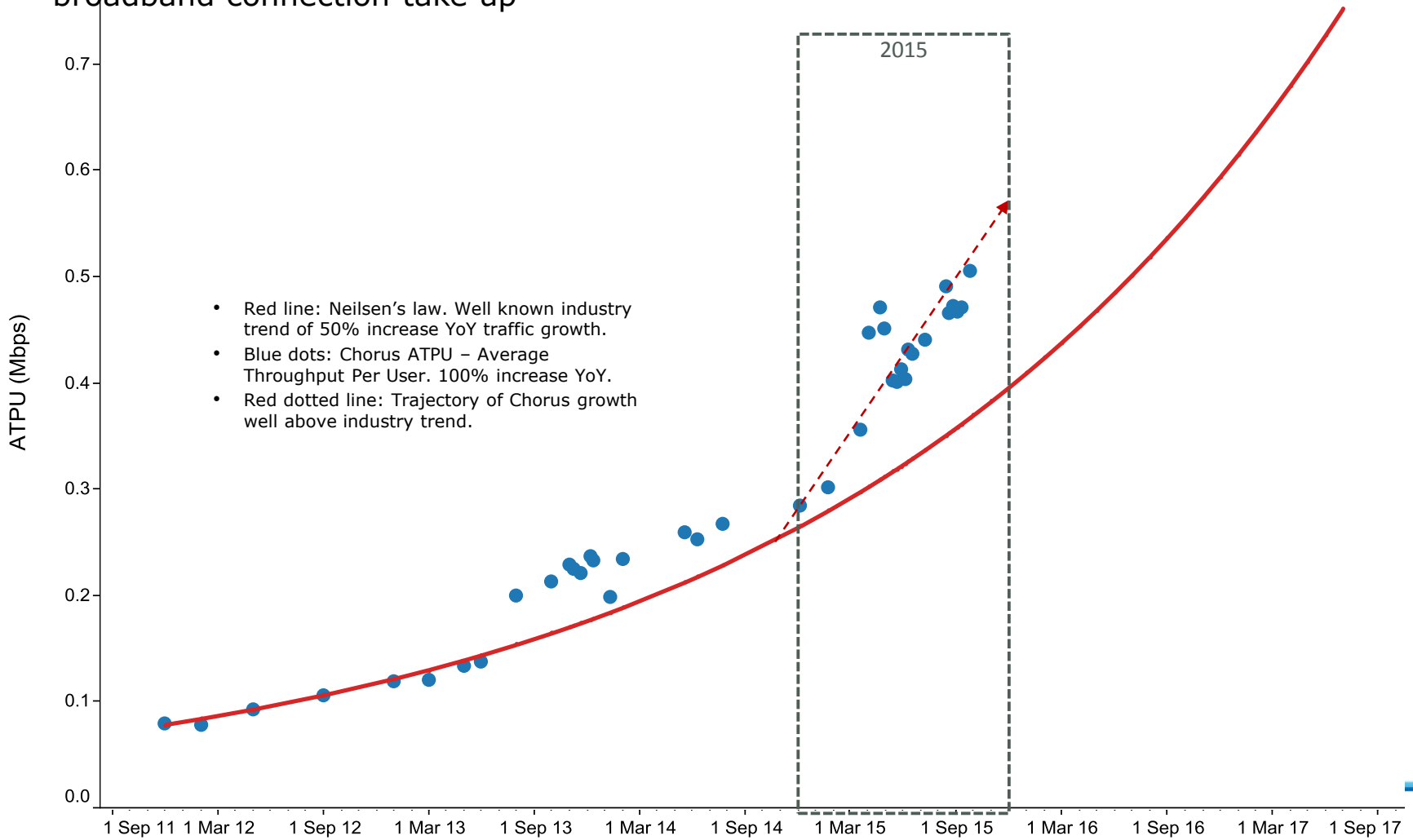
Bandwidth

A Congestion Free Network

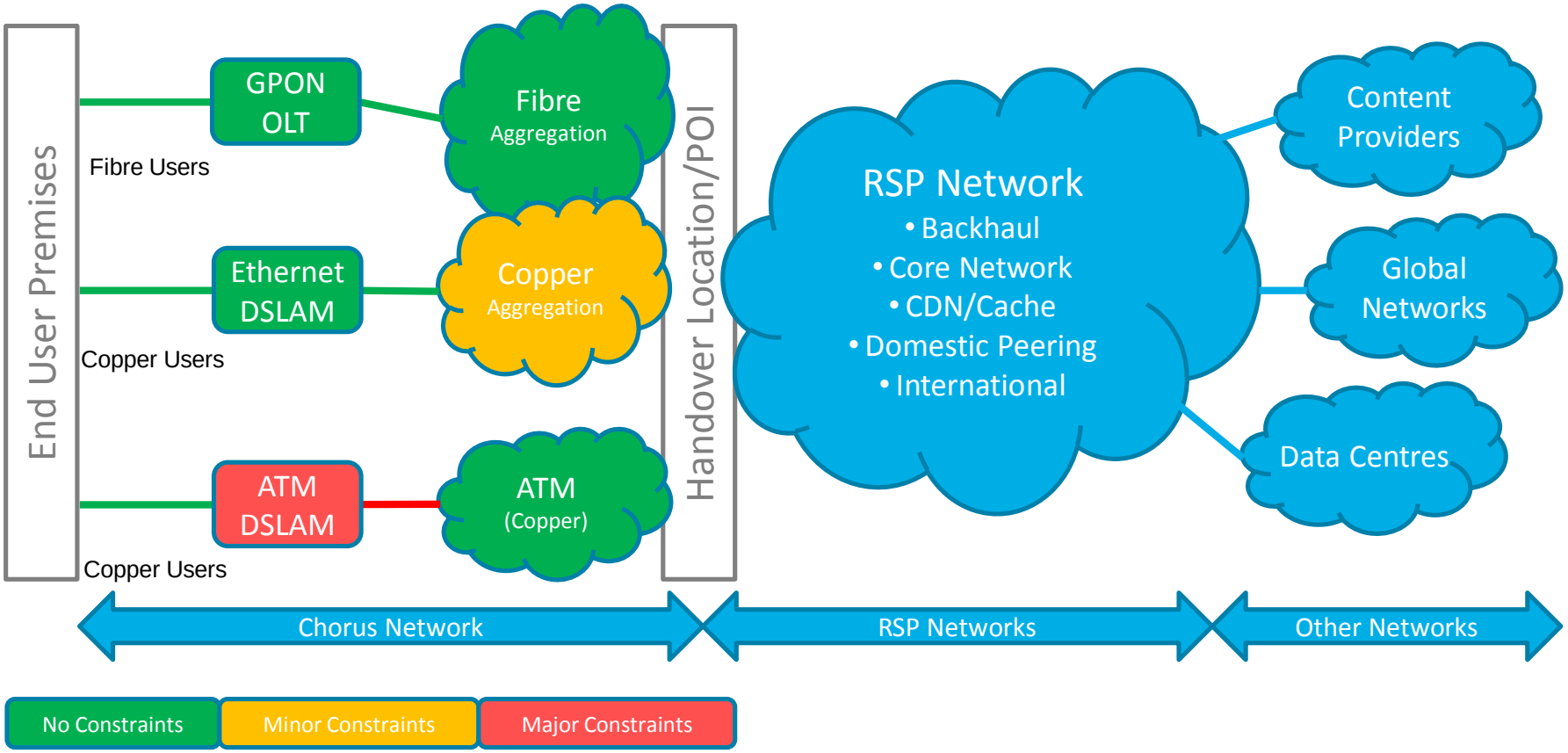
Chorus

Throughput

- The chart below shows the ATPU (Average Throughout Per User) on the Chorus network.
- The red curve tracks Neilsen's law of internet bandwidth growth; an often disbelieved trend of 50% year on year growth that has been proved true over time.
- The blue dots are tracking the data passing through our network. As you can see 2015 is turning into a year of unbelievable growth, a perfect storm of online TV and fast broadband connection take up

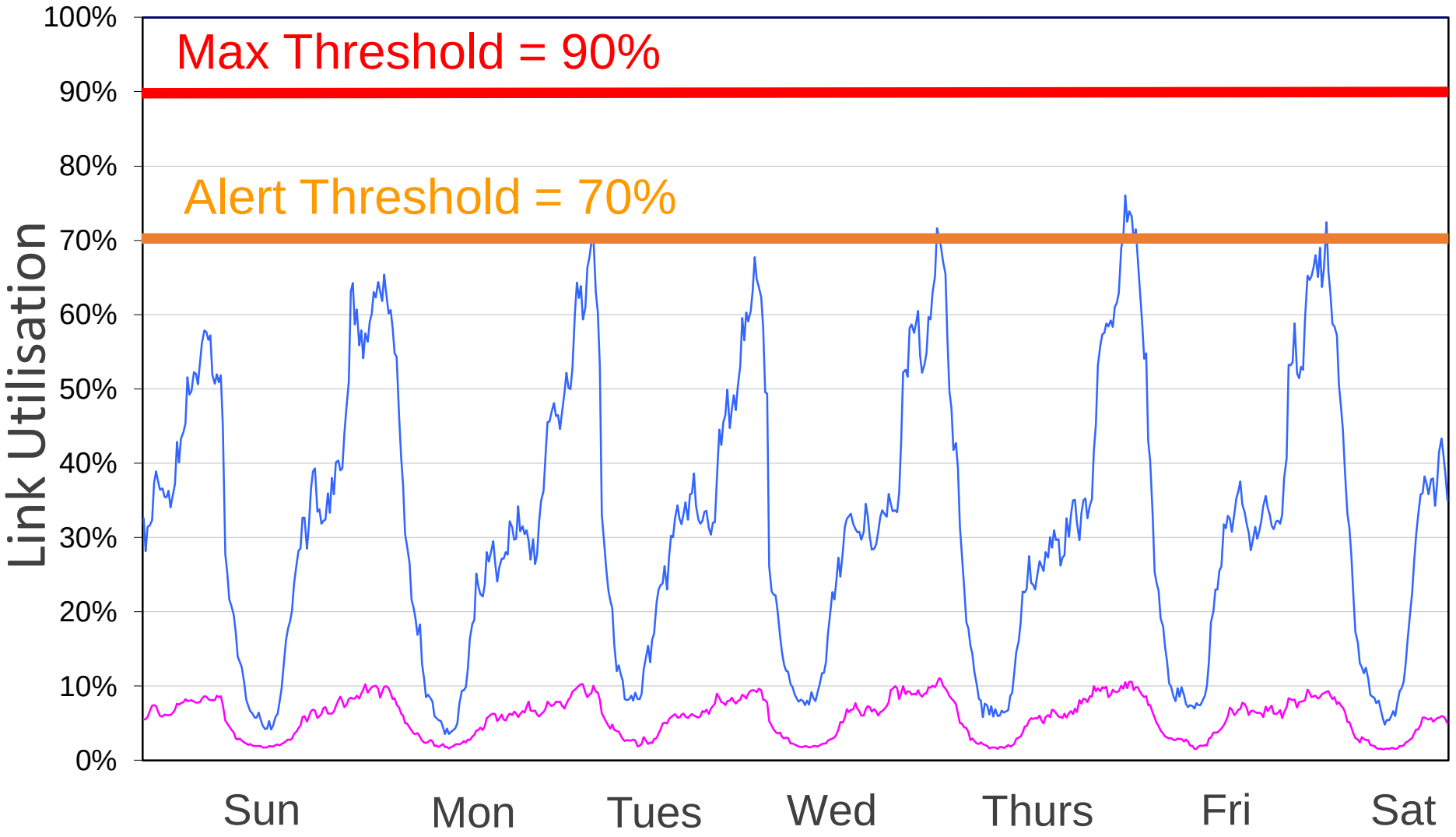


Network Bandwidth Growth

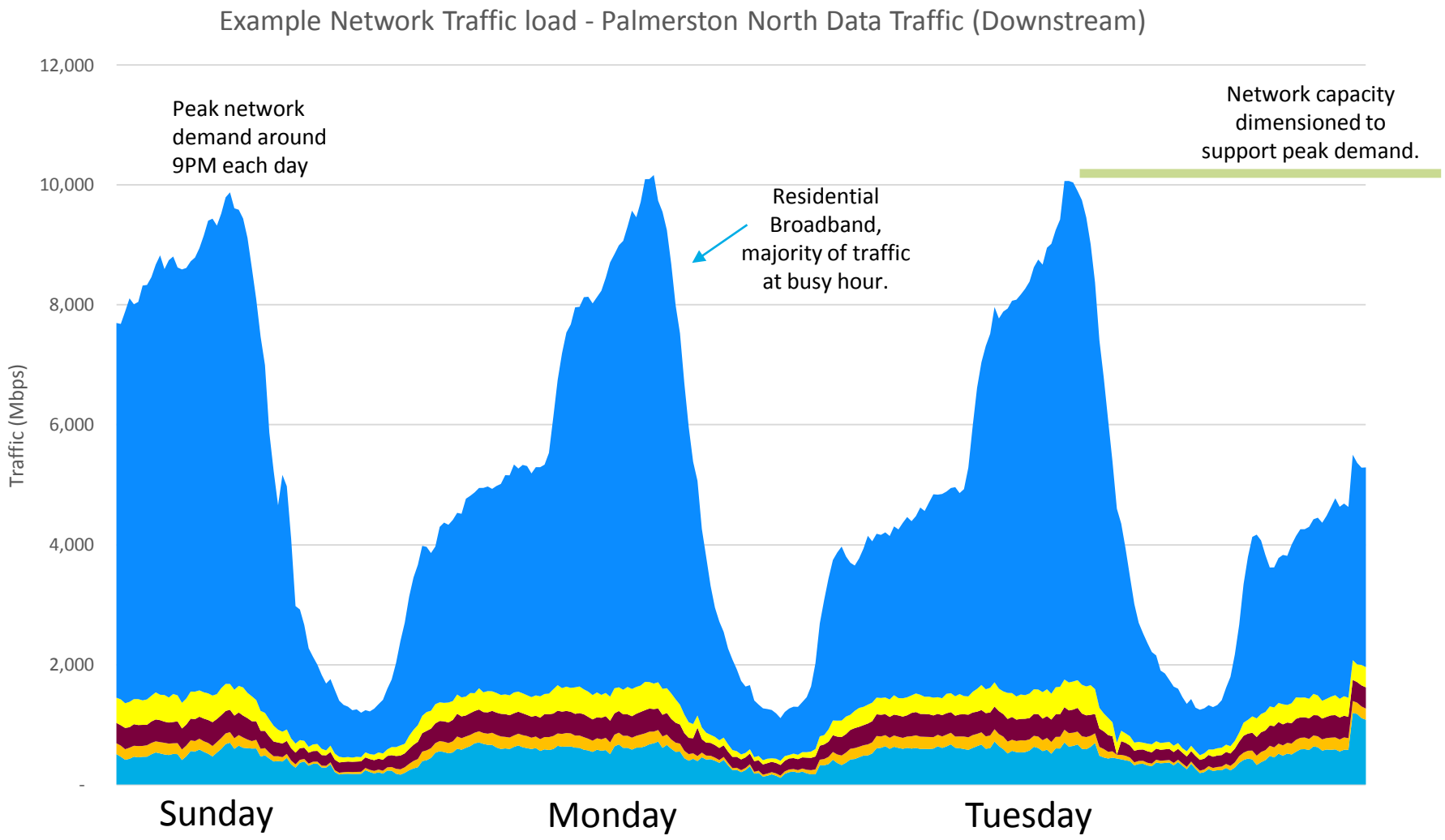


Managing Network Links

Telecommunications operators must plan for busy hour(s), the busiest time of the day



Residential Traffic drives capacity



The 100:1 Rule

The connection speed for any given user should on average be 100 times faster than the average network throughput

Let's test it:

- In 2012, 10Mbps was a good ADSL2 connection. Average throughput per user was 100kbps
- On Chorus copper network today, 40-50Mbps VDSL is a fast connection. Average throughput per user is 450kbps
- On UFB today, 100Mbps is the mass market fast connection. Average throughput per user is 1Mbps.

- In the future, when Average throughput per user is 10Mbps we will need 1Gbps connection speeds
- In the future, when Average throughput per user is 100Mbps we will need 10Gbps connection speeds

Summary – A congestion free network

- Bandwidth requirement is growing at an enormous rate
- Chorus and RSPs must plan for busy hour, not average bandwidth
- Chorus' network is largely congestion free – but to keep it that way is a constant challenge (especially legacy rural cabinets)
- Sustained throughput is key, not headline speed
- Our goal is to keep the Chorus network congestion free, but once traffic leaves our network it is out of our control