



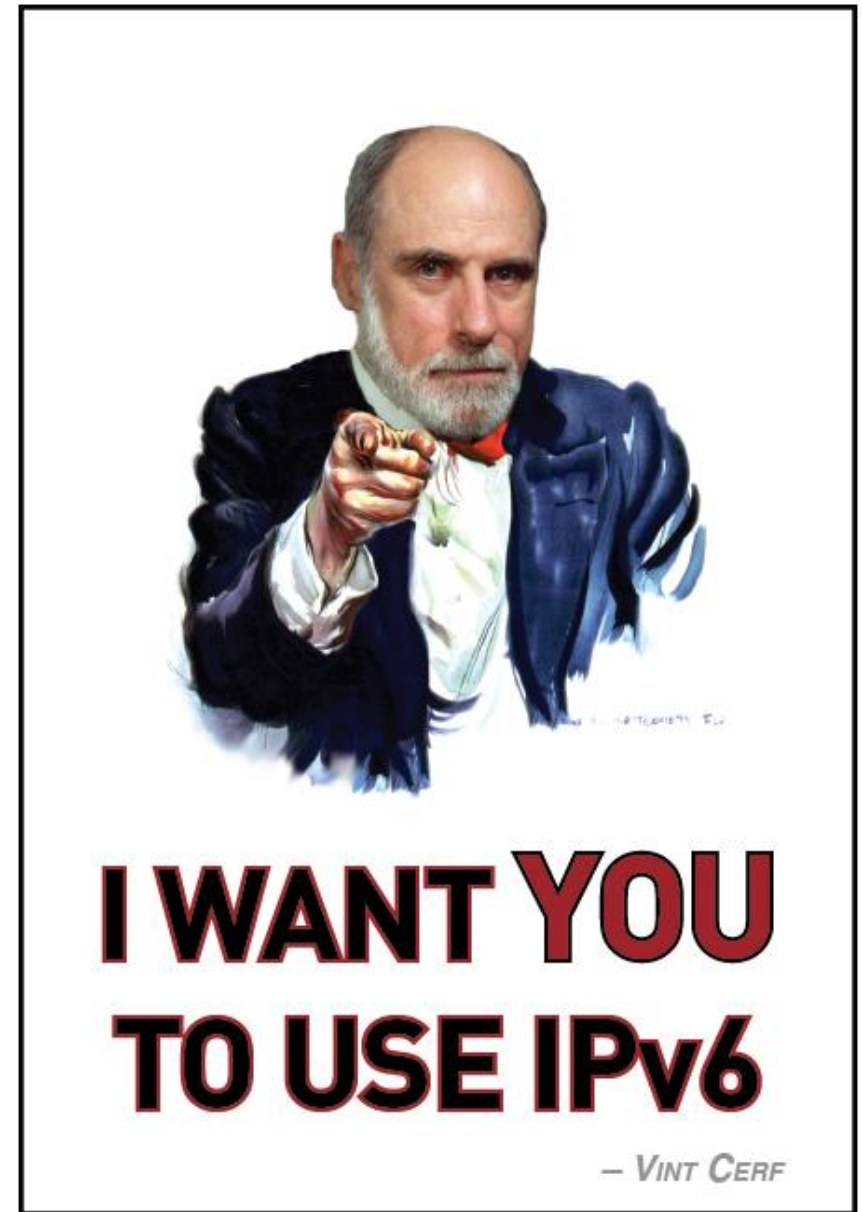
# Introduction to IPv6 Adoption within New Zealand Enterprise

Prepared by the NZ IPv6 Task Force in collaboration with  
InternetNZ & CIO Magazine

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# Outline

- Introduction
- The Problem
- The Solution
- When to Adopt Ipv6
- Pre-requisites
- Planning
- Execution
- Case Study
- Challenges
- Conclusion



# The New Zealand IPv6 Task Force: Who are We?

## **Working to promote the adoption of IPv6 in New Zealand**

"The New Zealand IPv6 Task Force is tasked with promoting the adoption of IPv6, assisting with training and education options and implementation planning. The Task Force is aligned with the Global IPv6 Forum, and its work is driven by the impending exhaustion of IPv4 addressing and the associated risk and additional cost that this is expected to impose on New Zealand organisations."

<http://www.ipv6.org.nz/about/>



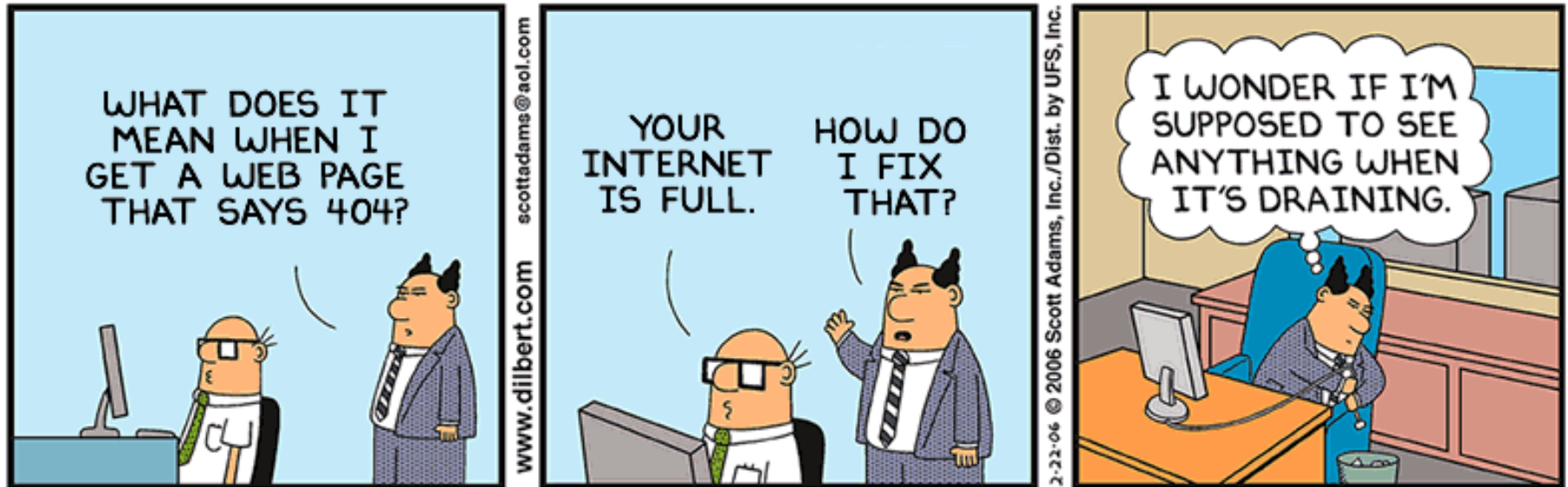
# The Problem:

## Is IPv4 really running out?

## Why should I be concerned?

# The Internet

## We take it for granted!



# IPv4 Exhaustion

- IPv4 addresses are at the core of IP networking and the Internet
- Address allocation mechanism
  - Addresses are allocated from the Internet Assigned Numbers Authority (IANA) to Regional Internet Registries (RIRs)
  - The RIR for our region is the Asia Pacific Network Information Centre (APNIC)
  - RIRs assign addresses to organizations, including Telcos, ISPs, enterprises and government
  - Organizations assign them to users
- **This resource is not endless**
  - It is almost exhausted today

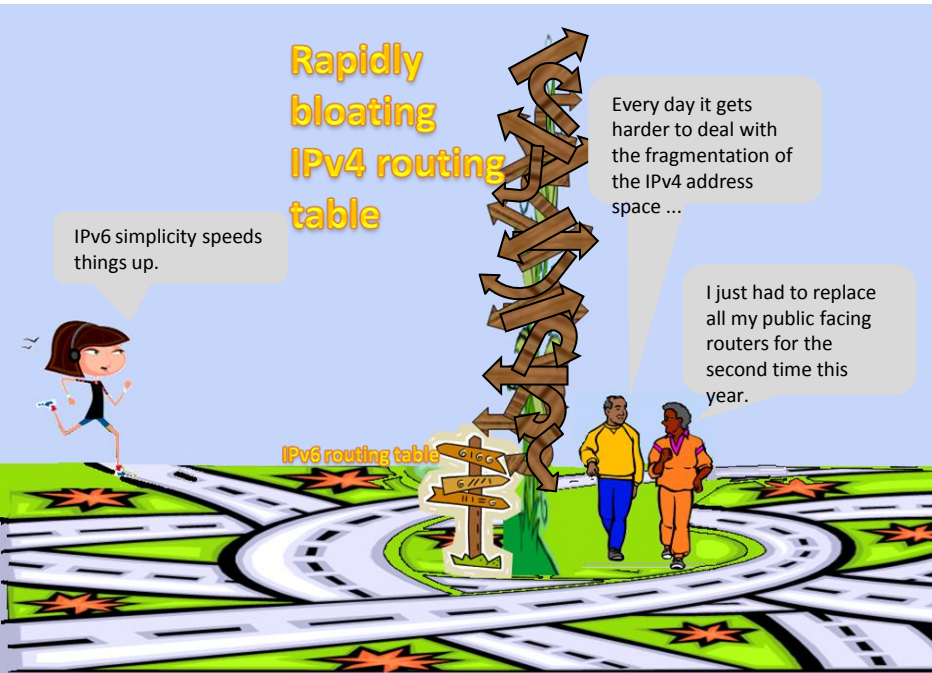


# IPv4 Exhaustion: Now!

- The supply of new IPv4 address allocations has essentially been exhausted
  - Still IPv4 addresses available for use by many entities around the world
  - Many ISPs, Telcos and other organisations continue to have some stock of IPv4 addresses
- Remaining stock distribution is not uniform across organisations
  - Neither within New Zealand and certainly not across the globe
  - Especially for high economic growth countries, such as in China and India
- Many organisations in high growth countries will need to find IP addressing alternatives soon
- The same situation will emerge in New Zealand over the next few years
  - Emerging technology will consume the remaining IPv4 addresses
  - Growth of more devices, machine to machine (m2m) interaction, etc



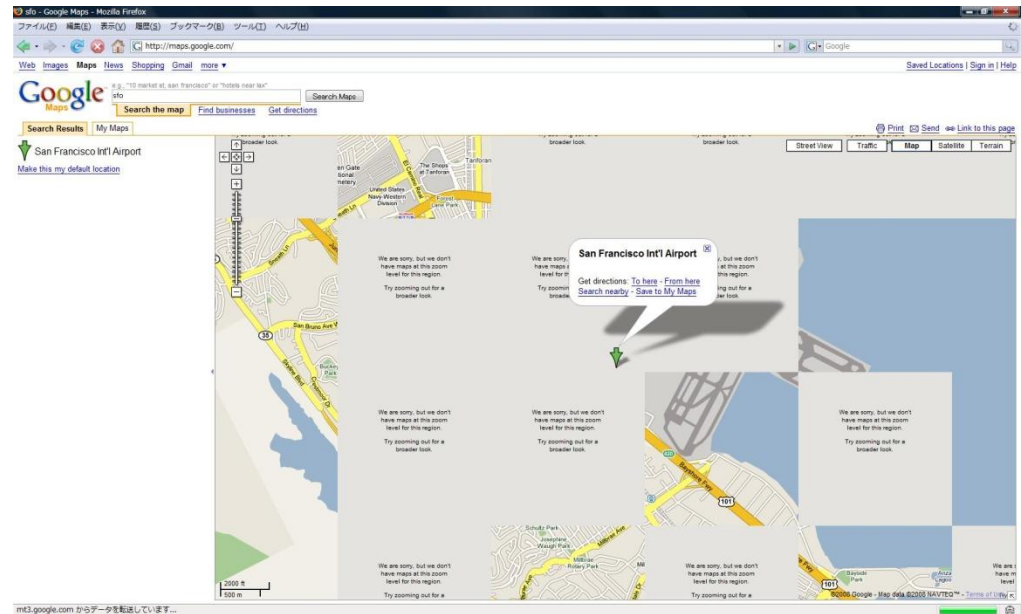
# Remaining IPv4 Distribution: One Alternative



**Problem:** Lack of feedback path allows the routing system to grow unconstrained as ever smaller blocks are traded in the open market leading to bloating IPv4 routing tables

# Another Alternative

- Carrier grade Network Address Translation (NAT)
- Is being used
- Problems
  - Port scalability
  - Increased delay
  - Session unreliability
- All resulting in
  - Poor end user experience
  - Accelerating cost over time with increasing volumes



# The Real Solution: IPv6

- Over a decade ago, IPv4 exhaustion was predicted
  - The IETF developed a new protocol: IPv6
  - To extend the life of the Internet for many more decades into the future
  - IPv6 is being adopted slowly around the globe today
- The IPv6 protocol increases the address range
  - From 4 billion to **around 340 trillion, trillion, trillion**
  - An enormous number
- Should enable the Internet to deliver current and new services well into the future



# IPv6: What has Changed?

**EVERYTHING...**

# New Packet Structure

IPv4 Header

0	4	8	12	16	20	24	28	31
Version	IHL	Type of Service	Total Length					
Identification				Flags	Fragment Offset			
Time to Live		Protocol		Header Checksum				
Source Address								
Destination Address								

IPv6 Header

0	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	63
Version	Traffic Class		Flow Label						Payload Length				Next Header		Hop Limit	
Source Address																
Destination Address																

# New IP Addresses

IPv4

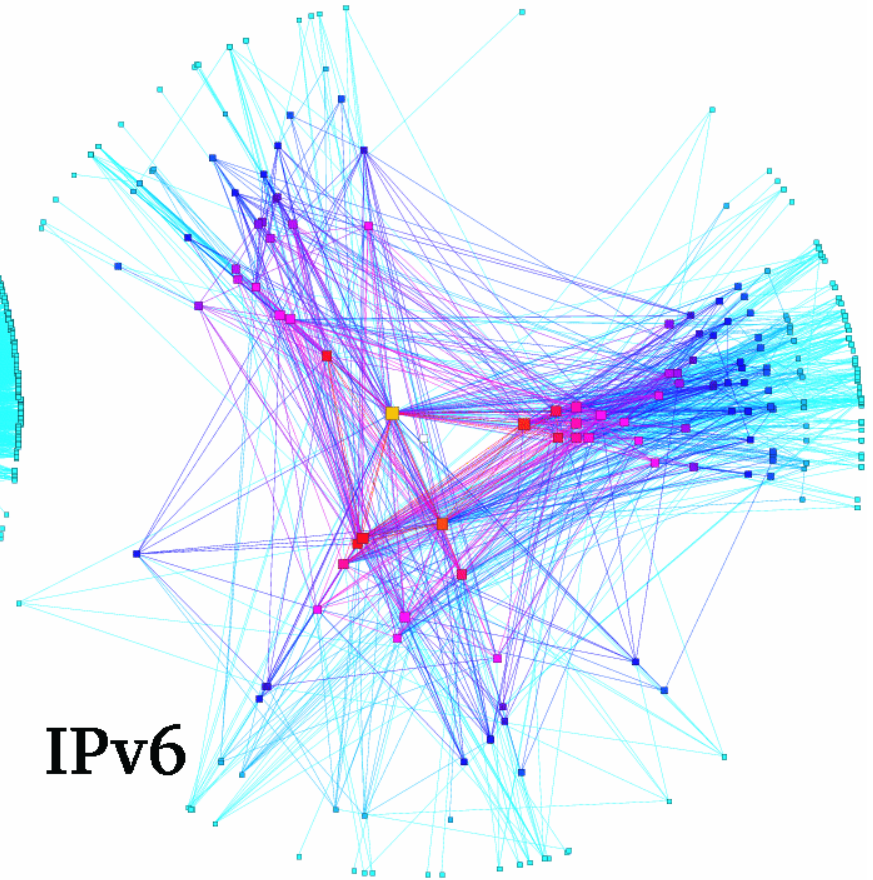
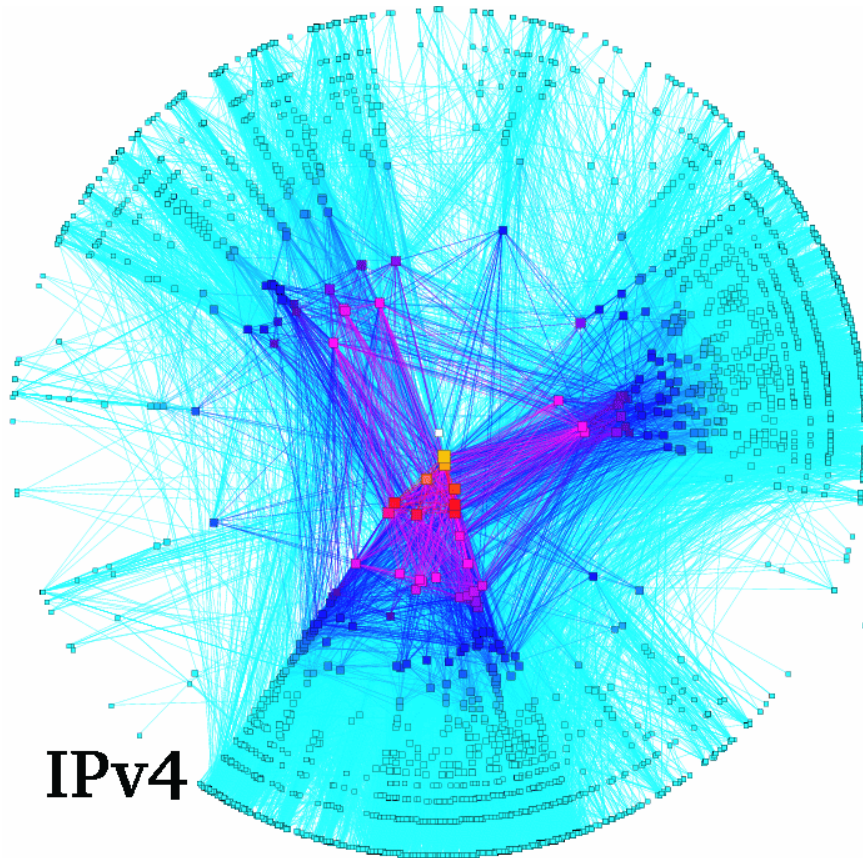
192.0.2.234

IPv6

2001:0DB8:DEAD:BEEF:CAFE:0000:E1E1:0000



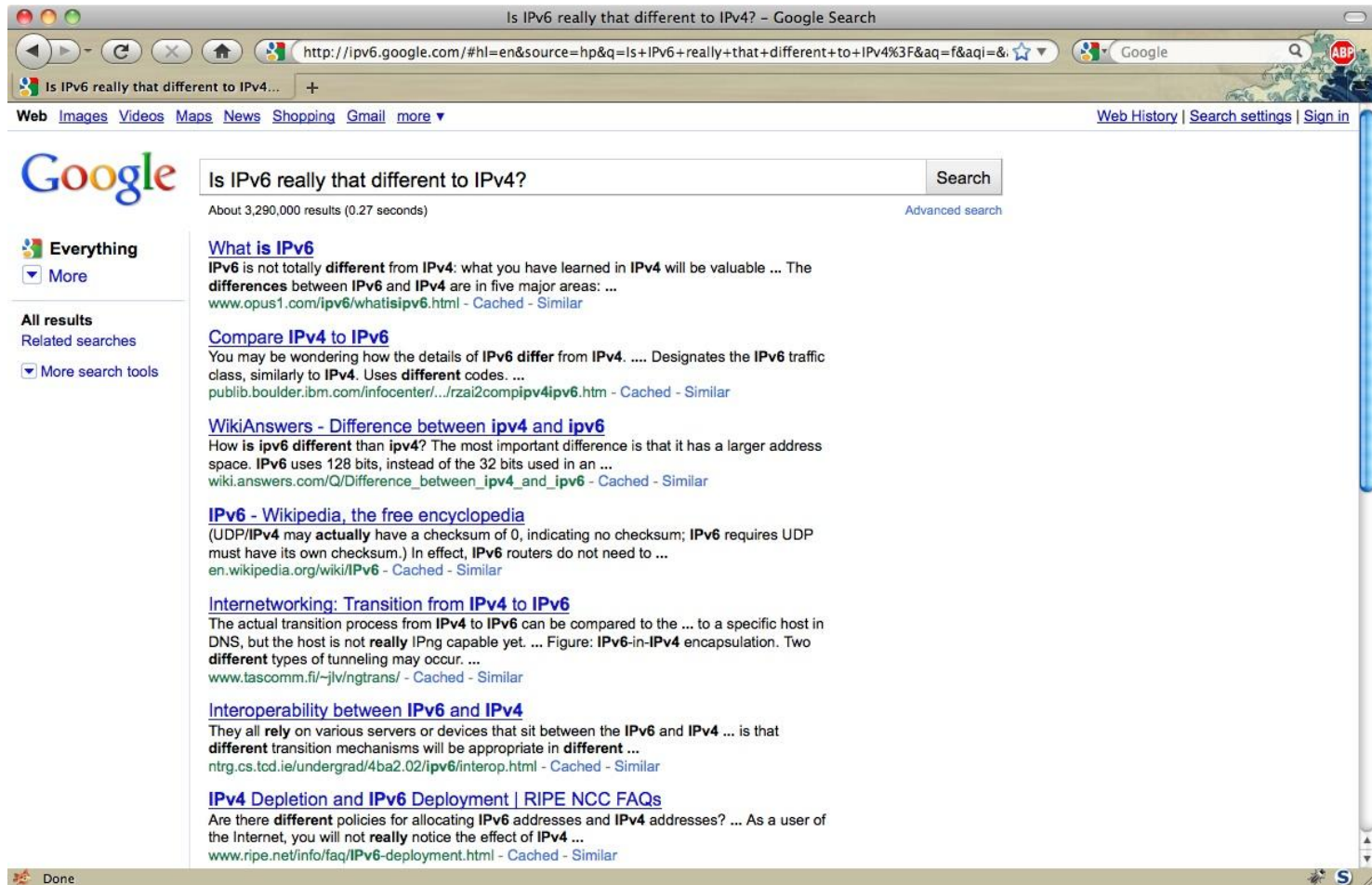
# New Internet



# What has changed?

# ... And Nothing

# Everything looks the same to users



http://ipv6.google.com



# We Need to Adopt Now!

- Adoption of this new protocol is not seamless
  - **It is not backward compatible with IPv4**
- It essentially creates a new Internet, which sits alongside the existing Internet
  - Most functions and features of this new Internet look and feel to end users much the same as those of the old Internet
  - However, the users on the existing IPv4-based Internet cannot communicate directly with users on the new IPv6-based Internet
- Critical that all New Zealand organisations and network providers adopt IPv6 for use in conjunction with IPv4
  - This will ensure end users will continue to be able to connect with any other user on the Internet
  - Continued ubiquity is essential
- IPv4 exhaustion not an immediate problem for your organisation?
  - Every organisation and user of the Internet needs to consider the potential impact of the loss of ubiquity which staying with IPv4-only will cause



# Loss of Ubiquity and Innovation

- Commencing in 2011, there are organisations around the globe that only have access to IPv6 address allocations
  - Services and applications are being developed based on IPv6 only
  - Those organisations that remain without IPv6 visibility are not able to see and take advantage of these new services and applications
  - **What market opportunities are you missing out on today?**
- New IPv6-based services and applications will rapidly grow
  - Those specifically developed for the IPv4-based Internet will slowly diminish
  - The greatest innovation will occur on the IPv6-based Internet
  - **Innovation on the IPv4-based Internet will slowly stagnate and eventually die**
  - This transition may take more than a decade



# Emerging Trend

- This trend is here today, with many of the most recent innovative applications being delivered using IPv6 only
  - This includes applications such as Microsoft’s “Direct Access” which comes bundled with all the latest versions of the Microsoft operating system
  - Through to the next generation of mobile telephony and data technology
    - Most global operators are implementing LTE technology using “native” IPv6
  - Many of the next generation of Internet applications will require IPv6 in order to function properly
- The emerging “Internet of Things” must be based on IPv6
  - **7 Billion people using 7 Trillion devices by 2020**



# Emerging Business Risk

- It is essential for all organisations to understand the impact of this loss of ubiquity and innovation
- It represents an emerging business risk
  - Must plan their adoption of the IPv6-based Internet
  - **It is not a matter of if, but only when?**
- In a 2011 survey of enterprises in the United States, 92% of the 210 respondents agreed with the following statement:
  - "IPv6 is fundamentally important to the future of the Internet" (Network World survey, July 2011).



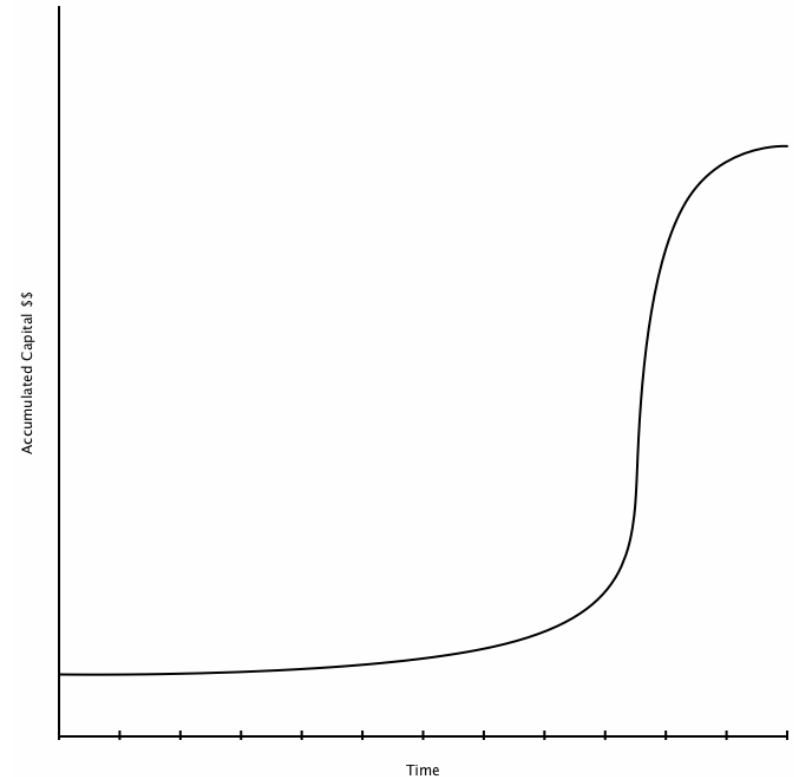
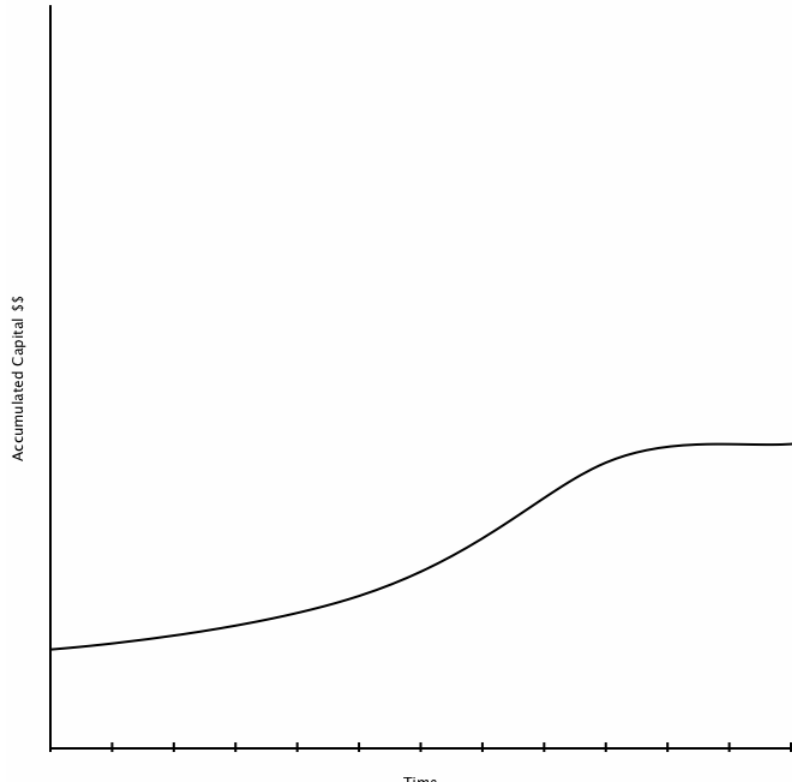
# The IPv6 Adoption Journey

Future proofing your Internet



**Delaying adoption will almost certainly increase the risk that a business will be constrained in some way in the future and the cost for implementation will increase over time**

# Your Choice: The Journey



- Essentially a choice between an orderly progression or chaotic change

Source: Jamie Baddeley, FX Networks

# Pre-requisites to Adoption

- The adoption of the IPv6 protocol within any business is best undertaken using a well-proven approach
  - Every organisation will be different in terms of detail, but a single high-level approach can be adopted universally
- Pre-requisite steps:
  - **Gain** senior management commitment
  - **Allocate** specific resource to achieve the agreed outcome
  - **Ensure** allocated resource is adequately trained in IPv6 technology
  - **Undertake** an audit of the use of IPv4 addresses across the business
  - **Ensure** that IPv6 adoption is included as part of any procurement, refresh, upgrade or rehabilitation of any ICT infrastructure or application
  - **Commit** to a planned approach to the adoption of IPv6 in association with any ICT procurement and refresh cycles



# The Business Proposition for IPv6

- IPv4 and NAT is NOT a sustainable option – many problems
- IPv6 is less complex and easier to manage for implementation and operations
- **Adoption of IPv6 can be very low cost!**
- Retaining external visibility through websites and connectivity is business critical
  - Enables greater ROI from emerging and new business applications – Innovation on the IPv6 Internet
  - Natural evolution to improve operations, productivity, and service flexibility

Where does your network need to be in 3-5 years?

What applications and services will be expected?

**IPv4 will NOT get you there!**



# Training: Mental & Emotional Preparation

IPv4 to IPv6 adoption and the stages of grief



For many, ***IPv4 knowledge is their justification of value in the market.*** As demand for that knowledge withers, and demand for the unfamiliar grows, people progress through the stages of grief in a futile attempt to avoid the inevitable [Tony Hain]

**Training in IPv6 is a critical enabler**



# Audit

- There are a number of well defined procedures available
  - For undertaking a thorough audit of all infrastructure and applications
  - To identify the precise impact of IPv6 adoption within a particular organisation
- Critical issues:
  - Identify where and how IP addresses are used within the ICT capability used by the business
  - Identify which business functions/operations will be affected
- **Provides visibility of risk exposure**

# Procurement Guidelines

- Procurement procedures within any organisation must ensure that all technology purchased is IPv6 compatible
  - The sooner this procedure is put into place, the sooner all technology across the business will be replaced with IPv6 compatible technology
  - Refresh cycles take some years to complete within most organisations
  - The right procurement procedures ensure a better the outcome
  - Ensure every dollar spent is spent with the right outcome in mind
- There are several guidelines available to assist making procurement procedures IPv6 compatible
  - Strongly recommended that these be reviewed and adapted to a given organisation's procurement procedures at the earliest possible opportunity



# Some Key Insights for Adoption

1. Keep reminding your organisation about IPv6
  - Without a **dedicated champion** we know you will find this be very difficult
2. Remember to include IPv6 in the 5 P's
  - Policies
  - Procedures
  - Procurement
  - Planning
  - Projects
3. **Think big but START SMALL**
  - External facing web sites are the best place to start
  - Do not overwhelm your investment manager with the need for a BIG \$ investment, you may never get started
  - Incremental costs associated with refresh are low



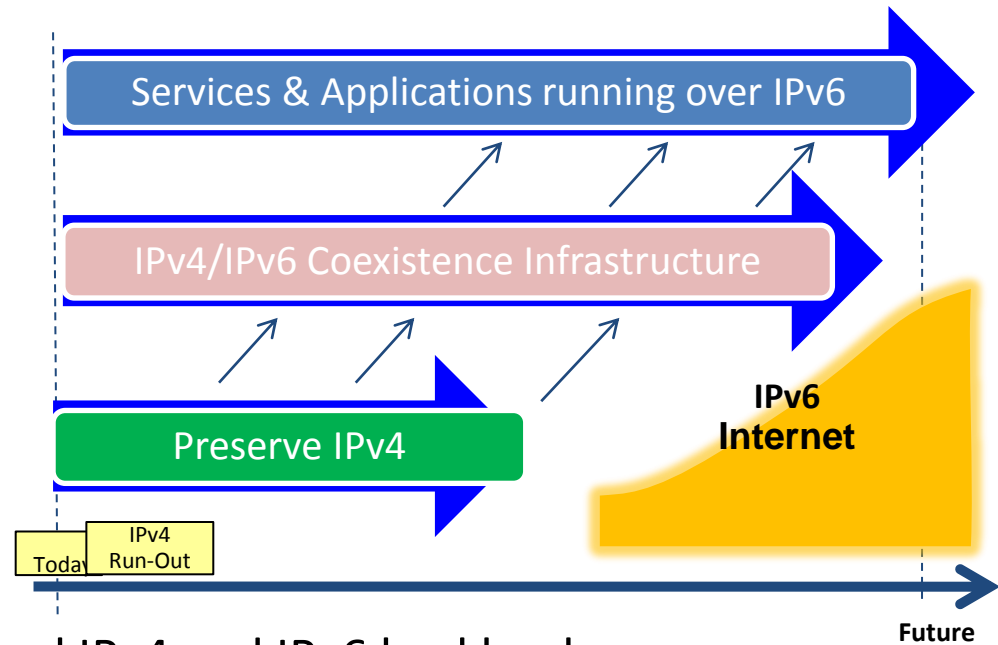
# Planning Process

- The components of any plan will include the following:

- External website upgrade
- Service provider provision of dual IPv4 and IPv6 backhaul
- Internal website upgrade
- Wide Area Network dual stack upgrade
- Local Area Network dual stack upgrade
- Internet Gateway dual stack upgrade
- Business application suite upgrade

- **Always start from the outside and move inside**

- External facing websites through to internal applications



# A Lifecycle Approach to IPv6 Adoption

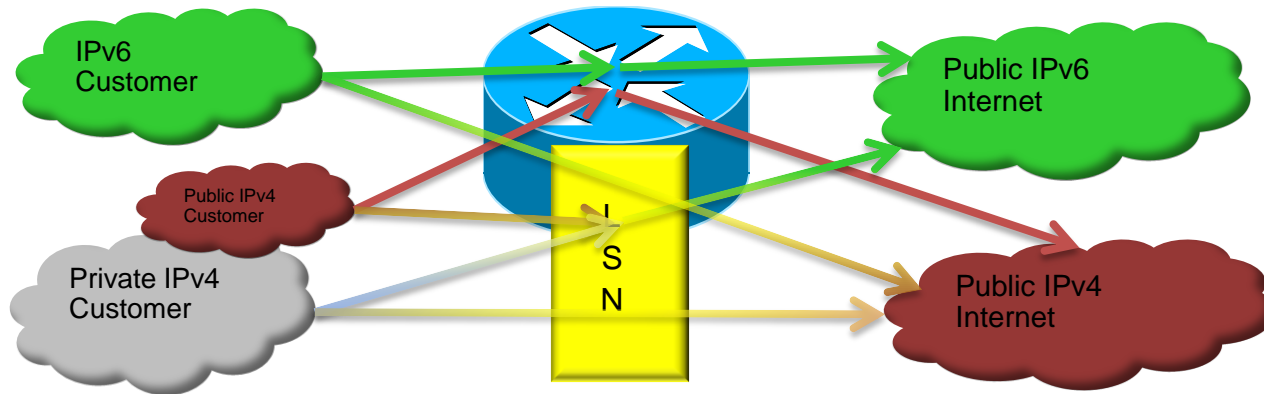


Source: Tony Hain

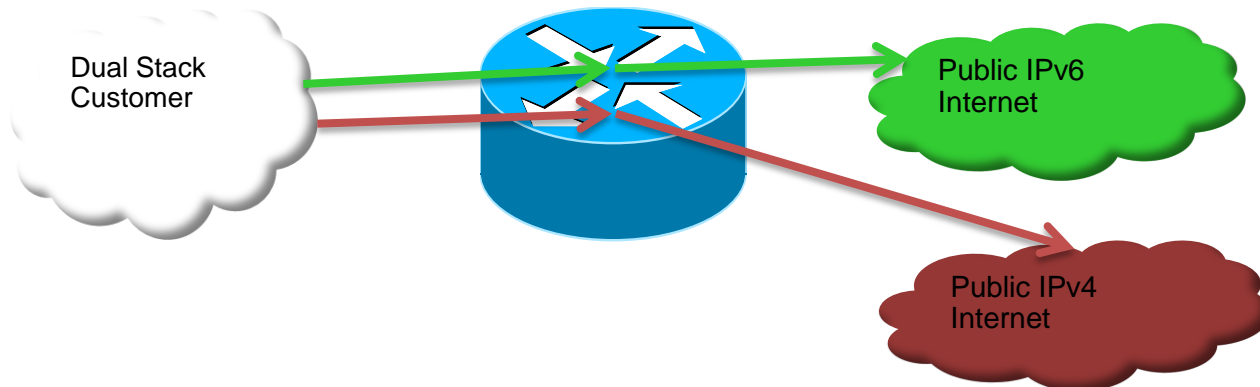


# Dual Stack Reduces Complexity

## Single Stack Customer



## Dual Stack Customer



Source: Tony Hain

# Executing the Plan

- The typical refresh and upgrade activities which provide an opportunity for the adoption of IPv6 compliant technology include:
  - Periodic refresh of websites, both internal and external
  - Any purchase of network technology
  - Any upgrade of business applications
- **NO opportunity should be missed – Incremental Approach**
  - Whenever technology change is involved to ensure that the resulting outcome is IPv6 compatible
  - The incremental cost of executing the IPv6 compatibility over that required to undertake the normal refresh or upgrade will be minimal
  - Providing it is properly planned into the refresh or upgrade process



# Case Study: Tauranga City Council Network



**Web Sites** – there are about 25 different domains that have their web services hosted at TCC.

**Major network elements** – around 40 internal switches with 24 to 96 ports each; about 650 users across approx 10 sites; there is an extensive virtual desktop infrastructure and around 110 servers (mostly virtualized).

**Internet service provider** – FX networks provide the Internet feed to TCC and some other councils that are part of the BOPLASS group. They supply native IPV6 connectivity.

**Council Fibre Network** – TCC has put a reasonable amount of single mode fibre around the city along with roadside cabinets. This fibre infrastructure is used by both TCC and some is also used by parties external to council.



# Learning Summary



*TaurangaCity*

- **The move to IPV6 has not been painful!**
  - Eased by doing adoption at network infrastructure equipment refresh time
  - The use of Windows 7 for the desktop is advisable to get the best experience and make life easy at the desktop
  - Windows Server 2008 is advisable at the server end
    - Windows Server 2003 requires a level of manual configuration
- There is a need for some training of all IT staff in general principles of IPV6 operation
  - Staff managing the Layer 3 routing and network infrastructure setup should be sent to advanced training
  - Other staff doing more desktop support will need to be aware of some of the options on ping, Traceroute and other diagnostic tools to enable selection of IPV4 or IPV6 and correctly interpret the results



# Learning Summary (Cont.)



*TaurangaCity*

- Setup of a site-specific Teredo relay and 6to4 relay router is not essential
  - Depends on what level of service is provided by your ISP and the reliability of the service
- For an organization of our size (650 staff, 40 network switches, 30 L3 VLANs and approx 110 servers) **~1 year is required to complete the adoption**
  - Assumes that 1 person is making all the necessary changes to servers and network infrastructure
  - Depending on IT staffing this can be made to happen more quickly
- Dual stack used on the client operating system means that much of the change can be performed during business hours thereby minimizing out of hours work required



# Challenges To IPv6 Adoption

- The IPv4 protocol has been in use worldwide within millions of organizations for over 30 years now
  - Hence it is a very mature and stable protocol, with very few “bugs” that haven’t already been found
- In comparison, **the IPv6 protocol is at the start of its maturity journey**
  - In recent years, it has been deployed much more widely in equipment across a wide variety of organization
  - However, this does not mean that all the bugs have been eliminated to date
  - The protocol is stable, but some of the implementations within different types of equipment are less than perfect
  - Problems are still being identified, even when working with equipment from highly reputable suppliers



# IPv6: Some Common Issues

- Uncertainty around the delivery of native IPv6 connectivity
  - Particularly the complexity of routing for IPv6 connectivity globally
  - Can introduce high latency relative to equivalent IPv4 connectivity affecting application performance
- Difficulties with implementation of IPv6 capability on some devices
  - Even where the capability is claimed to be present
  - Most prevalent in security devices and with certain types of web hosting software
- Protocol analysis and testing tools are at an early stage of evolution in their support of IPv6
  - Can be very frustrating and misleading for technical and administration staff
- **All resulting in Uncertainty = Risk**



# Risk Mitigation



- Training, training , training
- **Take an incremental approach to the adoption – not a “Big Bang”**
- Implement a dual stack approach to adoption of IPv6
  - IPv4 and IPv6 protocols are certain to operate alongside each other for many years to come
  - When a problem occurs with IPv6 adoption, the IPv4 capability should still continue to operate, ensuring that business continuity is assured
  - The “dual stack” approach is widely considered to be best global practice
- Use tunnelling to supplement “dual stack” where necessary
- Ensure that equipment is certified as IPv6 compatible
  - A useful start, but does not always guarantee the desired outcome – TEST!
- Collaborate and learn from others

# Conclusions

- Adoption of IPv6 is an essential business risk management issue
  - For all organisations in New Zealand that use the Internet
- Essential that businesses remains connected with their customers and suppliers
- An approach to address this impending change has been outlined
- The associated Whitepaper:
  - Highlights many of the issues which need to be managed in undertaking the adoption of IPv6
  - Presents some best practices to reduce implementation risk
- Critical to commence the planning early, before any specific pressure for change hits the business
  - Then execute an incremental adoption approach





Thanks for Your Attention

Questions?

