



# IPv6 In Business Development



# IPv6Now

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# Workshop Objective

To provide delegates and others interested in IPv6 the opportunity for an introductory exposure to the IPv6 protocol platform and practical business issues.



# Some of the Business Topics

Cost implications	Innovation from attributes of IPv6
IPv6: why, when, how?	Business Continuity
Competitive advantage	Market growth from IPv6
Uptake gotchas	Audit and assessment
Transition issues	Product lifecycle replacement
Security issues	Transition technologies
Mobile IPv6	Customer support for IPv6 systems
Using IPv6 for innovation	IPv6 training



# Why are we here?

- What approach should your organisation take in dealing with IPv6?
  - Does IPv6 mean more than internal operations?
  - What external issues do you need to consider?
- How will IPv6 affect my business or organisation?
  - How will I know what questions to ask?



# Who are we?

- Founders have decades of experience with Internet-based networks
  - high profile in the international discussion
- **Services** – hosting , transit, IPv6 tunnels
- **Training** – built on our own experience
- **Consulting** – IPv6 strategic planning & advice
- **Market focus:**  
*"delivering business benefits based on IPv6"*



# Freenet6



The Freenet6 Federation consists of POPs in leading IPv6 networks. Based on gogoSERVER tunnel brokers which power each POP.

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# Agenda

- Strategic Overview (summary)
  - Why should your organisation take an interest in IPv6?
- Scenarios for Business & IPv6
  - Where is my organisation likely to be positioned?
- Business issues to consider
- Technical issues to consider





# Summarising Strategic Overview

- Strategic Overview Course content:
  - IP dominates almost every aspect of ...
  - The Internet as we know it is limited
  - Business tsunami coming – bigger than the Web, wiping all that's gone before
  - Rewards and Threats
  - What do you need to do about it?
- With IPv6 – the Internet becomes far larger and more capable



# What is IPv6 about?

IPv4 = only 4.3 billion unique addresses

IPv4 Internet growth has continued due to re-use of addresses under network address translation (NAT)

IPv6 =  $3.4 * 10^{38}$   
unique addresses

*GENERALLY IPv6 ADDRESSES ARE GLOBALLY ROUTABLE  
(specific exceptions)*



# What is IPv6 about?

- Domain name: `www.ipv6now.com.au`
- IPv4: `116.197.146.20`
- IPv6: `2406:a000::29`

“The Internet is like a 15 storey building, and the domain name system the columns holding it up...”

Paul Twomey, ex CEO, ICANN

... and the Internet Protocol is the foundation on which the whole building stands!







# Agenda

- Strategic Overview (summary)
  - Why should your organisation take an interest in IPv6?
- **Scenarios for Business & IPv6**
  - Where is my organisation likely to be positioned?
- Business issues to consider
- Technical issues to consider



# 4 Scenarios for Business & IPv6

	DEFENSIVE	AGGRESSIVE
EXTERNAL	<b>SUSTAINING PRODUCT LINE</b> 	<b>MARKET GROWTH INNOVATION</b> 
INTERNAL	<b>TRANSITION</b> 	<b>BUSINESS PROCESS EFFICIENCY</b> <b>PRODUCT &amp; SERVICE DEVELOPMENT</b> 



# IPv6 Technical Opportunities

- **Larger address space: Increased address size from 32 bits to 128 bits**, plus
  - Streamlined Protocol Header: Improves packet-forwarding efficiency
  - Extended Attribute Headers: Multiple integrated service profiles
  - Stateless autoconfiguration: The ability for nodes to determine their own address
  - Multicast: Increased use of efficient one-to-many communications
  - Jumbograms: The ability to have very large packet payloads for greater efficiency
  - Network Layer Security: Encryption and authentication of communications
  - Quality of service (QoS) capabilities: QoS markings of packets and flow labels that help identify priority traffic
  - Anycast: Redundant services using non-unique addresses
  - Mobility: Simpler handling of mobile or roaming nodes
- (Note: some aspects re-engineered into IPv4)



# IPv6 Business Imperatives

Cost

Market Share

Profit

Skills

Business Processes

Policy & Governance

Image, Branding, Reputation



# Case Study Methodology

- *Who*: Background of Corporate Entity
- *What*: Corporate circumstance requiring IPv6
- *How*: IPv6 was implemented

Leading up to:

- ***Benefits*** of IPv6 implementation





# 4 Scenarios for Business & IPv6

EXTERNAL	SUSTAINING PRODUCT LINE	MARKET GROWTH INNOVATION
INTERNAL	TRANSITION	BUSINESS PROCESS EFFICIENCY PRODUCT & SERVICE DEVELOPMENT
	DEFENSIVE	AGGRESSIVE



# Transition

- How does my organisation survive IPv6?

Cost	☹️	Moderate increase initially
Market Share	😐	No immediate impact
Revenue	😐	Static
Skills	☹️	Potentially severe
Business Processes	😊	Opportunity to fine tune
Policy & Governance	😐	Static
Image, Branding & Reputation	😊	Access to developing countries China, India, Asia, Africa

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# Transition Case Study: *US Government Agencies*

- **Who**

- Largest enterprise in the world
- 1175 agencies, 5 million employees
- \$60 billion IT budget
- Individual agencies are the size of large corporations
- R&D responsibility to evolve and adapt



# Transition Case Study: *US Government Agencies*

- **What**

- ICT networks are increasingly IP based
- IT networks managed internally
- Thousands of workstations, PC's and VoIP phones
- Mixture of packaged applications and in-house developed applications
- Security ensured through network engineering groups



# Transition Case Study: *US Government Agencies*

- **What** (Problems in order of identified importance):
  - Privacy & security of communications
  - Quality of Service (QoS)
  - Network performance
  - Network management
  - Cost of operation
  - Interoperability



# Transition Case Study: *US Government Agencies*

- **What** (Network Characteristics):
  - Address lifetime: temporary DHCP addresses
  - Address types: Global IPv4 & private IPv4
  - Address shortage issue
  - Large scale networks required but constrained
  - Future service infrastructures are limited



# Transition Case Study: *US Government Agencies*

- **How** (strategic principles)
  - Forward & backward compatibility
  - Transit existing applications
  - Provide for IP mobility: greater security, interactivity and connectivity
  - Equipment procurement: insist on native IPv6 support
  - Train technical staff
  - Application vendors



# Transition Case Study: *US Government Agencies*

- **How** (identified challenges)
  - Security
  - Application dependency on IPv4
  - Equipment support for IPv4
  - Non-IETF standards may not support IPv6
  - Detailed analysis of compatibility with corporate information systems





# Transition Case Study: ***US Government Agencies***

- **Benefits & Lessons**

- Update the IPv4 environment: clean-up the existing network first
- Dual stack
- Leverage the technology refresh cycle
- Hasten slowly
- Security is both improved and a concern



# 4 Scenarios for Business & IPv6

EXTERNAL	<b>SUSTAINING PRODUCT LINE</b>	MARKET GROWTH INNOVATION
INTERNAL	TRANSITION	BUSINESS PROCESS EFFICIENCY PRODUCT & SERVICE DEVELOPMENT
	DEFENSIVE	AGGRESSIVE



# Sustaining Products

- How do my products survive in an IPv6 enabled market

Cost	☹️	Moderate increase initially
Market Share	😊	Exposed to IPv6 world
Revenue	😐	Maintained, Defensive
Skills	😐	About the same
Business Processes	😐	About the same
Policy & Governance	😐	Unchanged
Image, Branding & Reputation	😊	Current, innovative, flexible

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# Sustaining Case Study: *Cisco*

- **Who**

- World leader in networking for the Internet
- Cisco IP based network solutions are the foundation of and essential to many corporate, government and residential communications
- Cisco name is synonymous with the Internet

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# Sustaining Case Study: *Cisco*

- **Who**

- Global operations
- 63,000 employees
- \$34.9Billion revenue
- Market share:
  - Routers: 73%
  - Ethernet switches: 73%
  - WLAN: 65%
  - Home: 51%
  - VoIP: 23%

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# Sustaining Case Study: *Cisco*

- **Who**

- Managed workstations: 60,000
- Servers: 8,000
- IP phones: 60,000
- Routers & Switches: 5,500
- Unmanaged devices: 15-20,000



# Sustaining Case Study: *Cisco*

- **What**

- To stay competitive, network equipment manufacturers cannot wait for market adoption acceleration or mass adoption.



# Sustaining Case Study: *Cisco*

- **What (market considerations)**

- Infrastructure for IPv6 developers & testers
- Acquire own expertise to support customers
- Keep up with customers: as customers utilise IPv6 need to keep pace
- Marketing: Eat own dog food





# Sustaining Case Study: *Cisco*

- **How – 3 Phases**

- Phase 1: 1998 - Present
- Phase 2: 2005 - 2007
- Phase 3: 2008 onwards



# Sustaining Case Study: *Cisco*

- **How – Phase 1 (1998-present)**
  - Initial connectivity
  - Acquired v6 address space
  - Renumber internal users
  - Provide v6 connectivity via ISATAP tunnels



# Sustaining Case Study: *Cisco*

- **How – Phase 2 (2005-2007)**

- Upgrade layer 2 & layer 3 infrastructure
- Milestone reached: network ready for v6 deployment
- Trial Windows Vista
- RFI to ISP's and upstreams for IPv6 transit



# Sustaining Case Study: *Cisco*

- **How – Phase 3 (2008-onwards)**
  - Deploy Windows Vista
  - Provide IPv6 internal access network
  - Interim external services
  - Dual stack external services (DMZ)
  - Deploy IPv6 on a service-by-service basis



# Sustaining Case Study: *Cisco*

- **Benefits**

- Early planning generated benefit even prior to deployment, by improving existing IPv4 network
- Phased approach ensured existing services were not jeopardised
- Internal evaluations ensured that benefits were quantified and realised



# 4 Scenarios for Business & IPv6

EXTERNAL	<b>SUSTAINING PRODUCT LINE</b>	<b>MARKET GROWTH INNOVATION</b>
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	DEFENSIVE	AGGRESSIVE



# Business Process Efficiency

- Taking advantage of technical and business dimensions of IPv6

Cost	😊😊	Significant Improvements
Market Share	😐	No special impact
Revenue	😐	Essentially flat
Skills	😐	Some increase
Business Processes	😐	Needs updating
Policy & Governance	😊😊	Improved Security, Auditability
Image, Branding & Reputation	😐	No significant impact



# Efficiency Case Study: *Bechtel*

- **Who**

- Founded in 1898
- One of the world's premier engineering, construction & project management firms
- Project based organisation
- 22,000 projects completed in 140 countries on all 7 continents





# Efficiency Case Study: *Bechtel*

- **Who**

- Employees: 42,500
- Geography: Global
- Revenue (2007): \$US27 billion
- New work booked: \$34.1 billion



# Efficiency Case Study: *Bechtel*

- **Who**

– Managed workstations:	20,000
– Servers:	2,000
– IP Phones:	12,000
– Routers & Switches:	5,500
– Wireless Access Points:	400
– Other managed devices:	3,000
– Applications:	1,000



# Efficiency Case Study: *Bechtel*

- **What**

- Extreme project-based organisational structure prompts management to view IP addressing in same manner as an ISP
- Projects have a distinct life-cycle varying from weeks to years
- Hundreds of concurrent projects
- IP addresses need to be assigned, managed, and reclaimed at end



# Efficiency Case Study: *Bechtel*

- **How (Strategy)**
  - Foundation first – building blocks
  - Keep IPv4, add IPv6
  - Minimize use of transition technology
  - Broad deployment
  - Ensure nothing breaks in production
  - Maintain/improve security
  - Watch costs, use refresh cycles



# Efficiency Case Study: *Bechtel*

- **How (Strategy)**
  - Actively engage key technology partners
  - Use existing change management processes
  - Address all IPv6 touch points...

**It is much more than a network upgrade!**



# Efficiency Case Study: *Bechtel*

- **How (Timeline)**

- 2005-2H: Acquire address allocation
- 2006-1H: Detailed implement'n plan
- 2006-2H: IPv6 enabled in lab
- 2007-1H: Testing in Office 2007
- 2007-2H: 90% PCs dual stacked
- 2008-1H: Enabled all WAPs
- 2008-2H: Enabled servers
- 2008: Deployment substantially complete

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# Efficiency Case Study: *Bechtel*

- **How**

- Applied to ARIN for provider-independent IPv6 address allocation, received a /32
- Allocates a /48 to each individual site for as long as it needs it
- /48 is adequate for ANY foreseeable future site requirements



# Efficiency Case Study: *Bechtel*

- **How**

- Bechtel's address allocation guidelines are aligned with:
  - IETF standards
  - RIR policies
  - industry best practices
  - the company's business needs





# Efficiency Case Study: *Bechtel*

- **How**

- Separate high level blocks for each permanent office
- A site is a physical location/delivery address
- Each site related directly to a site in Microsoft Active Directory Sites and Services



# Efficiency Case Study: *Bechtel*

- **How**

- Enterprise-wide aggregation-level pattern of a /56 for common functions
- No subnet uses a prefix longer than /64
- Each VLAN assigned one /64



# Efficiency Case Study: *Bechtel*

- **How**

- Targetted end of 2008 as the best time to complete the implementation of an enterprise IPv4/IPv6 dual-stack environment



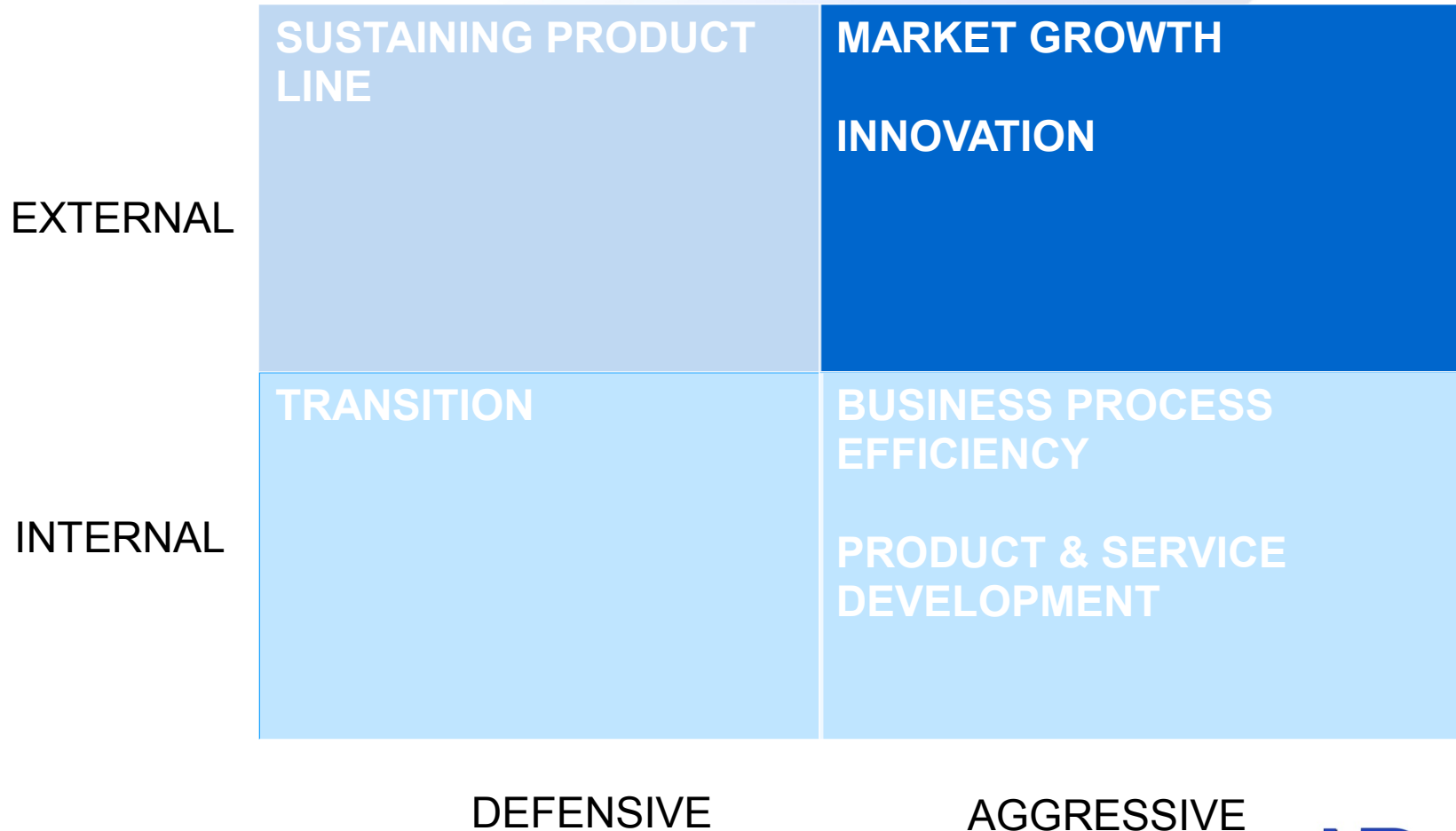
# Efficiency Case Study: *Bechtel*

- **Benefits**

- Customer requirements eg DoD
- Partner adoption eg Cisco
- Supplier induced IPv6 insertion eg Windows7 and Windows Server 2008
- Natural technology evolution
- New capabilities for projects
- Industrial automation convergence to IPv6

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# 4 Scenarios for Business & IPv6



# Product Innovation and Market Growth

- Growth Opportunities through world wide IPv6 adoption

Cost	☹	Moderate increase initially
Market Share	☺	Increase
Revenue	☺	Improve
Skills	☹	Some increase
Business Processes	☹	Needs updating
Policy & Governance	☹ ☺	Security, Auditability
Image, Branding & Reputation	☺	Current, innovative, flexible



# Innovation Case Study: *Arch Rock*

- **Who**

- Systems & software developer for innovative wireless sensor networks (smart networks).
- Partner in multiple projects that extend capabilities of services by providing immediate access to vast sensor networks generating critical data.



# Innovation Case Study: *Arch Rock*

- **Who** (Mission Statement)

*"...bridge the physical and digital worlds by bringing data gathered by wireless sensor networks into the enterprise IT infrastructure, where it can be easily viewed, analyzed and managed."*





# Innovation Case Study: *Arch Rock*

- **Who (Industries & Environments)**

- Environmental monitoring: energy utilities, data center monitoring etc
- Industrial Automation: process control, machine monitor, data center monitoring
- Location & proximity detection: Asset tracking, OH&S, QoS, compliance
- Action & control: Lighting control, machine automation

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# Innovation Case Study: *Arch Rock*

- **What**

- Little existing legacy in IP-based sensor networks or applications
- Opportunity to choose the most efficient & future proof IP technology for their emerging field



# Innovation Case Study: *Arch Rock*

- **What (Motivators)**
  - End-to end communications
  - Large address space
  - Plug and play
  - Energy efficiency and simplified protocol processing
  - Future growth



# Innovation Case Study: *Arch Rock*

- **How**

- Built IPv6 natively into their product line
- IETF 6LoWPAN Working Group: extensive work to map and optimise IPv6 for use over IEEE 802.15.4 (a low power wireless technology) – RFC 4944
- Arch Rock offers low-power wireless sensor nodes based on IETF 6LoWPAN Working Group for IEEE 802.15.4



# Innovation Case Study: *Arch Rock*

- **Benefits**

- Clean slate foundation for building the next generation of network devices
- Open IP model
- Low risk compared to using IPv4
- Standards innovation and feedback

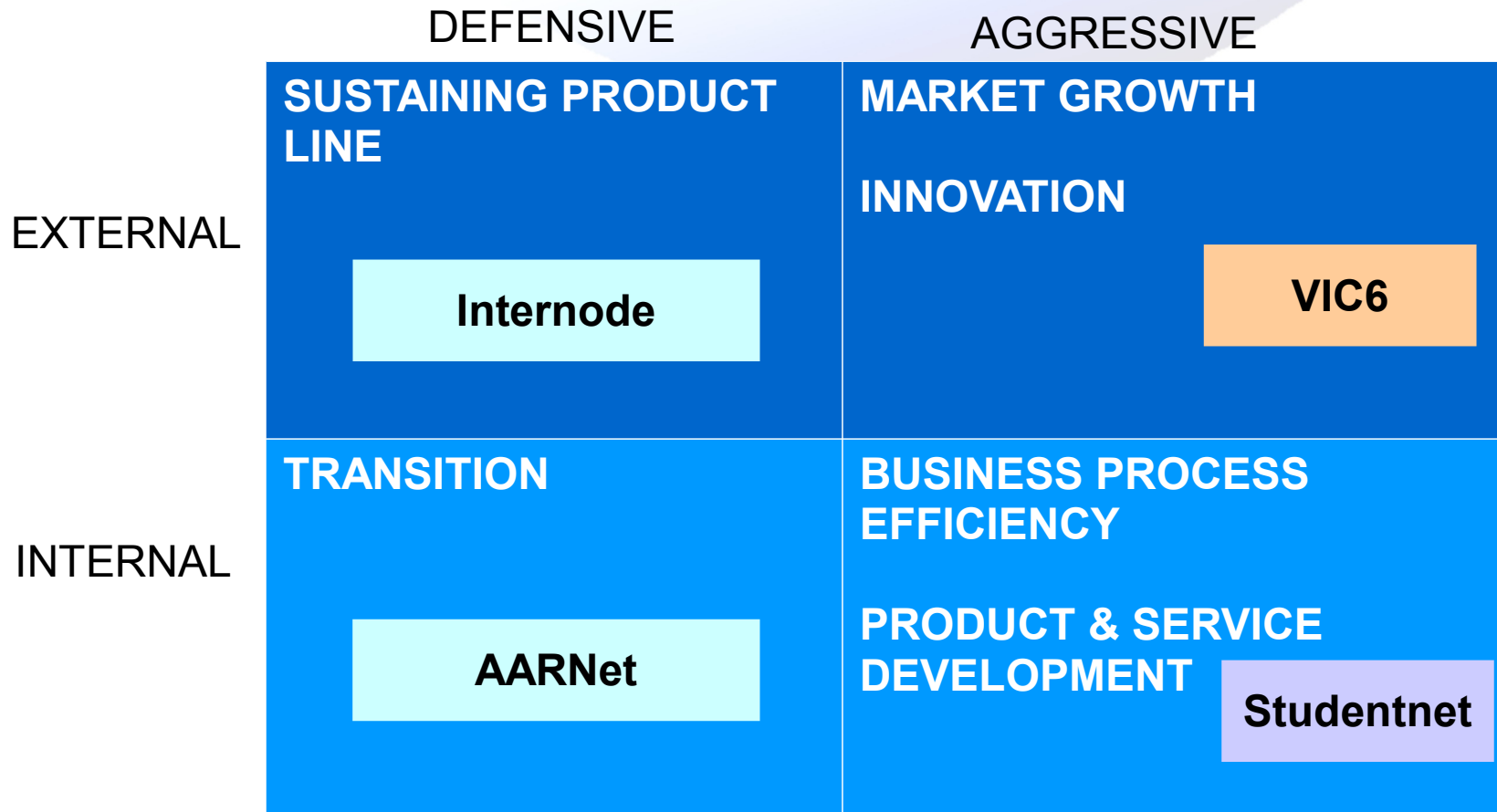


# Australian Case Studies

- **AARNet**: Academic networks, dual stack core, free 6in4 transit provider
- **Internode**: IPv6 core, 6in4 transit
- **VIC6**: IPv6 testing services
- **Studentnet**<sup>®</sup>: IPv6 for schools



# 4 Scenarios for Business & IPv6



# Agenda

- Strategic Overview (summary)
  - Why should your organisation take an interest in IPv6?
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  - Where is my organisation likely to be positioned?
- Business issues to consider
- Technical issues to consider





# Product lifecycle replacement

- Focus on IPv6 migration cost reduction
- IPv6 product procurement plans in existing information technology budgets.
  - Budget cycles
  - Network refresh
  - RFI/RFP/RFT
  - Group buying, inventory planning
  - Provision for interoperability testing



# Audit and Assessment

Examine existing infrastructure, both hardware and software inventories, for compliance with and sensitivity to upgrades or interworking in an IPv6 environment

The “Network Discovery” process...



# Network Discovery (1)

- what operating systems are in use?
  - For servers, for desktops, for mobile devices, network fabric
- what applications are in use? A general idea of each application's importance would be useful.
  - utilities, management, administration, network management,
  - network administration, billing, etc.
- what applications are planned?



# Network Discovery (2)

- Switches, routers, IDS, firewalls, load balancers, servers, Web, UPS, VoIP phones...model, capacity, firmware/software revisions
- what services does the networking equipment have to provide?
- Management tools - Netflow, SNMP...?
- Network devices for xDSL, Frame Relay, MPLS, ATM, LANs,...?



# Network Discovery (3)

- Unified communications, Videoconferencing
- Internal and external high level servers-services, e.g., DNS, DHCP, VLANs, VPNs, Cloud and hosted applications..?
- Security and architectural issues
  - Topologies and demarcations
  - Business, budget, billing administration
  - External supplier and social networks
- Growth projections



# Specifying IPv6 compliance in RFPs

Adding IPv6 support to new procurement is critical to all the IT requests for proposals, tenders and ongoing purchases. Integrating IPv6 procurement planning into existing IT processes helps avoid unexpected or unnecessary costs

What is IPv6 compliance?



# IPv6 'Standards'

- IETF RFC's are not legal 'Standards'
- Many ISO accredited organisations are involved, e.g:
  - ISO, IEEE, NIST, ETSI, ITU, OECD, APEC
  - Standards Australia
  - Research and Education Network Profiles
- IPv6Ready Logo program



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# Transition technologies

Enterprises are incorporating techniques, such as temporary network tunneling, until the end of the device lifecycles to meet IPv6 compliance deadlines.

Let's explore dual stack and other migration techniques for adoption by your organisation





# Transition techniques

- Pure IPv6 with gateway to IPv4
- Pure IPv4 with gateway to IPv6
- Translation (addresses and/or protocols)
- Dual stack (including tunnels)



# Transition techniques

- ◆ Pre-configured tunnels (VLAN, VPN)
  - ◆ Automatic tunnels
    - Tunnel Brokers (RFC 3053)
    - 6to4 (RFC 3056)
    - ISATAP (Intra-Site Automatic Tunnel Addressing Protocol)
    - 6over4 (RFC 2529)
    - Teredo
- ...plus many others

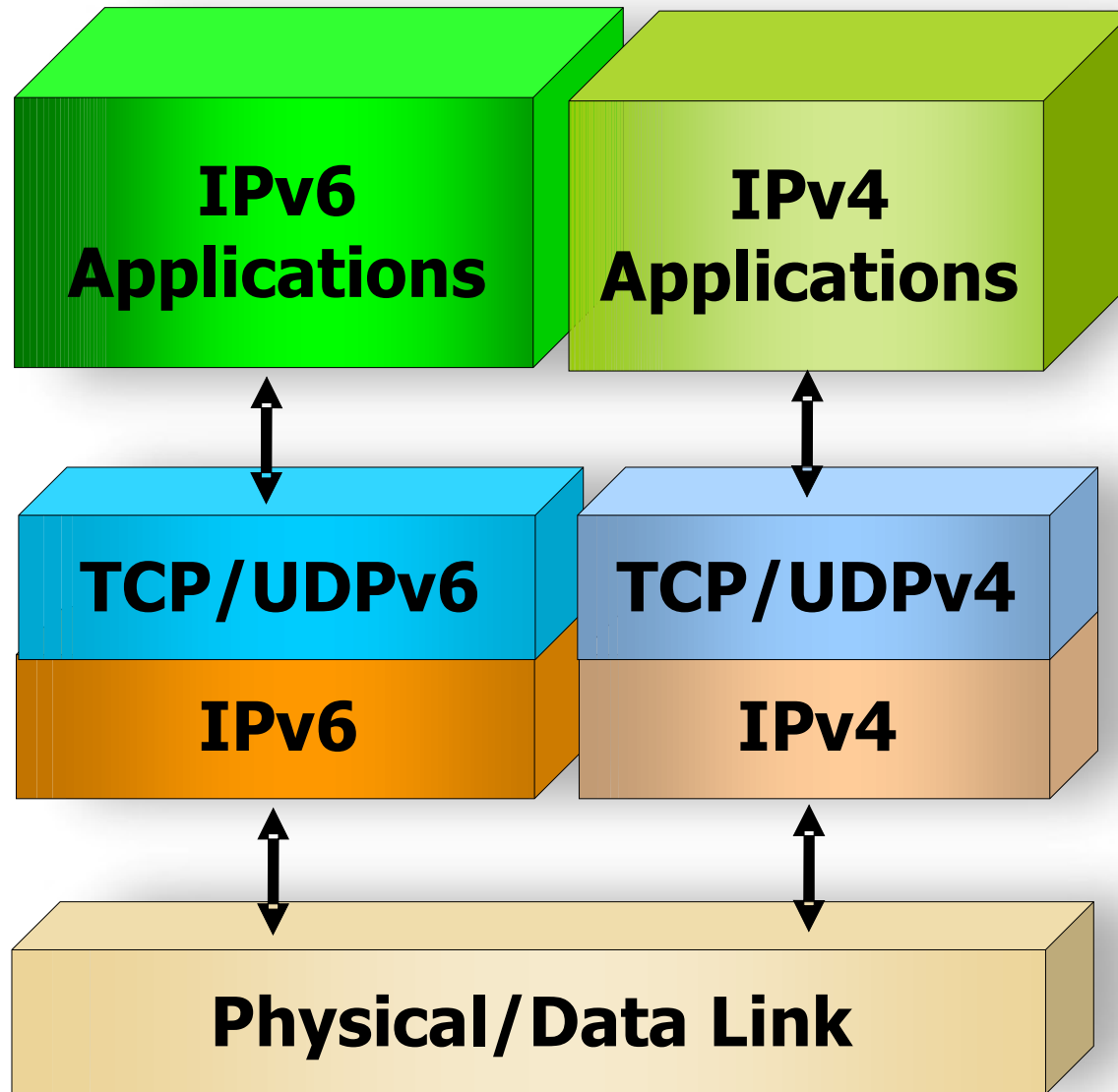


# Transition Issues

- ◆ No “Flag Day”, (like 1983 when NCP→TCP). Will be incremental, probably over several years
- ◆ Transition from IPv4 to dual stack must not break anything, IPv6 designed with transition in mind,
- ◆ Many different transition technologies are A Good Thing™, a “transition toolbox” applies to myriad unique situations



# Dual Stack



# Transition Security

- Many transition technologies open security risks such as DoS attacks, e.g.,
- Attacks by combining different address formats
- Abuse of IPv4 mapped addresses
- Abuse of 6to4 addresses
- Attacks that deplete NAT-PT address pools



# IPv6 Training

Integration of training costs into the IT training budget is fundamental to achieving a smooth IPv6 upgrade.

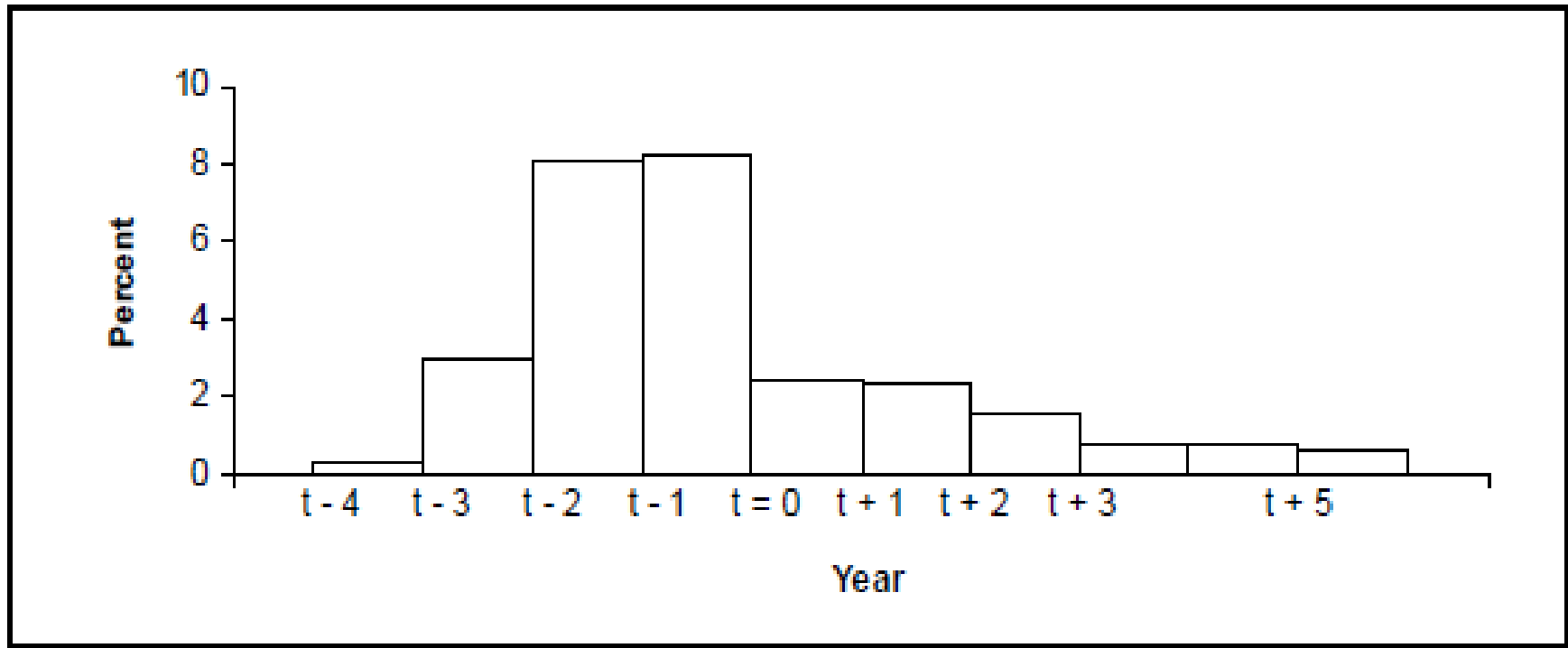
All aspects of the ICT activities are going to be impacted by this transition.

Familiarisation at all levels and practice with tools and support is essential



# Training Effort Required

**Figure 4-10. Percentage of IT Staff Dedicated to IPv6 Transition for Internet Users**



Source: IPv6 Economic Impact Assessment, Final Report, NIST 2005, Michael P. Gallaher, Ph.D. And Brent Rowe



# IPv6 Training Needs Analysis

- IPv6, while built on many of the fundamental principles of IPv4, is different enough that most IT personnel will require formalized training.
- The level of training required will vary
- Four main categories of education are specified





# IPv6 Training Categories

- Awareness
- Architectural
- Operational
- Specialised



# IPv6 Training AWARENESS

- Generalized information about IPv6 and IPv6-related issues.
- Workshops, seminars, summits provide:
  - an overview of IPv6 technologies
  - identify vendors that support IPv6
  - rudimentary understanding of technology
    - New services/products enabled by IPv6
  - business drivers
  - deployment issues





# Learning From Experience

In 2011,  
You're using IPv6 - congratulations!



Melbourne 17-19 October 2011  
[www.ipv6.org.au/summit/](http://www.ipv6.org.au/summit/)



# IPv6 Training ARCHITECTURAL

- Very detailed for individuals with primary responsibilities in architecting and deploying IPv6. Includes:
  - attention to the fundamentals of IPv6
  - IPv6 address allocation
  - routing, multicasting, and principles for connecting to the IPv6 Internet
  - security principles for IPv6 environments
  - Auto-configuration
  - DNS and DHCPv6
  - mobility
  - transition mechanism



# IPv6 Training OPERATIONAL

Job-specific education targeted to a participant's work responsibilities. Focus on supporting applications or protocols over IPv6. e.g:

- system administrators focusing on supporting IPv6-enabled e-mail, web, content and security servers.
- May be hardware or software specific, and could be produced for a particular vendor product.



# IPv6 Training SPECIALISED

As IPv6 deployment advances, the need for specialized training emerges:

- focus is less on IPv6 specifically
- more where IPv6 plays an important role, e.g. Mobility. Expanded to cover not only Mobile IPv6, but also topics such as:
  - mobility-specific security issues
  - low bandwidth compression algorithms
  - access media
  - protocols: MANET, NEMO



# IPv6 Cost Implications

- What are the real costs in transitioning?
- What business case exists for making this move?
- Consider the edge case through to whole core migration
- Identify tangible benefits



# Transition Cost Breakdown

**Table 4-7. Distribution of IPv6-Related Transition Costs for Users<sup>a</sup>**

Category	Distribution of Total Transition Costs
	Internal Network Costs
Network management software (upgrade)	18%
Network testing	17.6%
Installation effort	24%
Maintaining network performance	16%
Training (sales, marketing, and tech staff)	24.4%

<sup>a</sup> The percentages in this table sum to 100 percent, comprising the distribution of all costs necessary for users to move to IPv6.

Source: IPv6 Economic Impact Assessment, Final Report, NIST 2005,  
Michael P. Gallaher, Ph.D. And Brent Rowe





# IPv6 Benefits

- Cost reductions resulting from improved security
- Cost reductions resulting from increased efficiency
- NAT removal leading to increased efficiency
- Mobility, UC and VoIP - potential savings
- Remote access to existing products/services
- Innovations leading to new products and services



# World IPv6 Day

- Global experiment – in real time!
- Follows: IETF IPv6-only hour - 10 Jul 2008
- First international collaboration to test IPv6
- Major content providers involved
  - Dual stack home pages
- Local experience
  - IPv6Now network worked!
  - User experiences largely worked, but experience varied
- Analysis by Brian Carpenter (see over)



# World IPv6 Day Analysis

- 51 FAIL FAIL FAIL (12%) - part of the IPv4-only Internet.
- 6 FAIL FAIL SUCCESS (1%) - better late than never.
- 61 FAIL SUCCESS FAIL (15%) - OK on June 6th, but then they reverted.
- 32 FAIL SUCCESS SUCCESS (8%) - came up on June 6th and stayed up. Kudos!
- 2 SUCCESS FAIL FAIL (0.5%) - went down on June 6th and stayed down. Oops!
- 4 SUCCESS FAIL SUCCESS (1%) - went down for IPv6 day ;-)
- 64 SUCCESS SUCCESS FAIL (16%) - went down after IPv6 day :-)
- 191 SUCCESS SUCCESS SUCCESS (46%) - IPv6 addicts.

n=411

Brian Carpenter  
2011



# Key Points - Summary

- Four organisational case studies all take a 'dual stack' transition approach
- All organisations devoted resources specifically to IPv6 adoption – budget allocation unknown
- IPv6Now recommends a strategic approach
  - Gain maximum business benefit from IPv6
  - Minimise budget and cost impacts



# *Discussion*

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