



→ The AARNet story

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3. Keith Burston – The regional network
4. George McLaughlin
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 - Charging
5. Steve Maddocks - Operating the network
6. Mark Prior - Peering

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The big picture

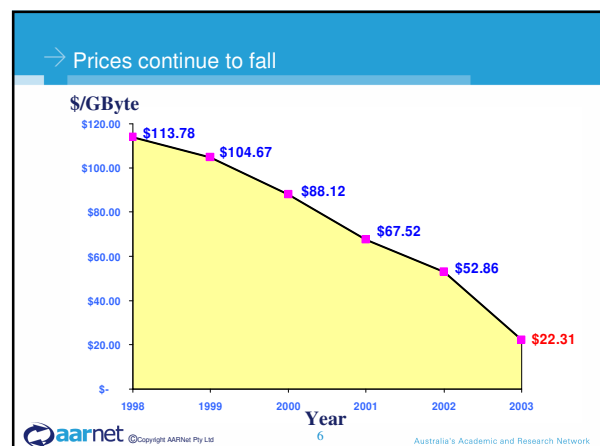
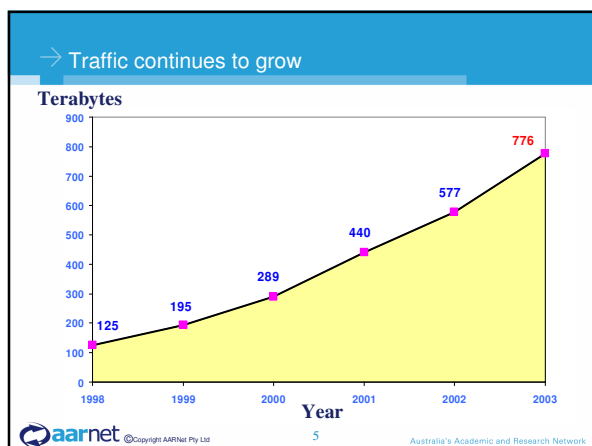
Chris Hancock

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→ Setting the foundations

- Traffic growth continues to escalate
- Prices continue to fall
- Our success is our strategic alliances
- Nextgen provides new opportunities
- Charging moves away from usage

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→ Gigabit capacity within Australia – challenges and solutions

- Poor response to request to carriers to make dark fibre available
 - Solution: use AARNet's carrier licence to carry out civil works to lay our own fibre
 - Only needed to do once in any area after this some enough players willing to sell/lease dark fibre
- Poor response from traditional carriers for high capacity connectivity to regional areas
 - Solution: form strategic alliances with power utilities for mutual benefit
 - Now have affordable gigabit capacity in North Queensland and inland NSW
- Tasmania: monopoly carrier, no affordable high capacity option
 - Solution: form strategic alliance with State govt, Basslink, gas pipeline groups to deploy alternative undersea cable capacity

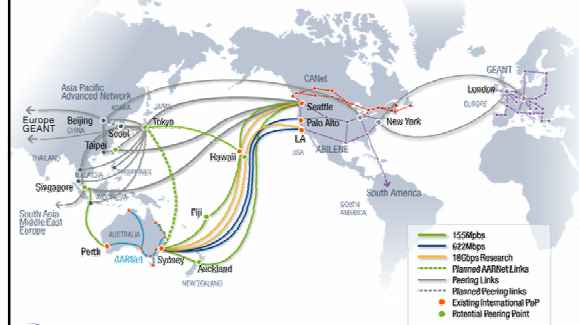
→ Key strategic alliances

- with Australian Government and the Australian Research and Education Network Initiative (AREN) – provided funding to catalyze key regional initiatives
- with Leightons (construction company – dark fibre across Australia as basis for AARNet3 and regional gigabit connectivity (eg to remote telescopes)
- with Powerlink (North Queensland) and TransGrid (NSW) – power utility companies that provided fibre to regional areas – resulted in gigabit capacity where not previously economically feasible
- with Southern Cross on SXTransPORT
- with AUSAID (Australian Aid Agency) to provide a connection from the Fiji Campus of the University of the South Pacific to AARNet and global R&E networks

→ AARNet's Australian network - 'world class'



→ AARNet a 'world player'



→ Charging

- Moving away from a volume based charging model to a charging regime that is largely subscription based
- To encourage innovative and unconstrained use of the network for research and education
- More on charging later ...

→ Catalysts for change

- Moved from a reseller of capacity to owning and managing significant infrastructure
- Now managing and operating the AREN

→ Where to from here?

- Building Australia's next generation of advanced networks
- Developing a future network road map for network connectivity
- Developing new services for our members
- Reaching more of the research and education sector
- Partnering to secure new initiatives

The AARNET 3 rollout

Don Robertson

→ The Story So Far ...

- Current network (AARNET2) built on Optus ATM has been in operation since 1997
- Operates a STM-1 ring to Hawai'i and Seattle on Southern Cross, primarily for research but some commodity via Pacific Wave
- Buys commodity access from Optus or Telstra
- AARNET Pty Ltd (APL) went to market in February 2003 for a new network
- Multiple announcements in December 2003 creating basis for AARNET3

→ Design Issues for AARNET3

- Redundancy & Resilience
- Support for IPv4 and IPv6
 - unicast and multicast
 - line rate performance
- Traffic Accounting and Monitoring
- End to end performance measures
- Support QoS (diffserv)
- Support for large traffic flows, jumbo frames

→ Redundancy & Resilience

- Dual points of presence (POP) in major capital cities
- Diverse, dual unprotected national links
 - Will use MPLS Fast Reroute for protection
 - Provides ability to burst above capacity
- Use single metro dark fibre pair to connect intra city POP sites
- Creates rings between cities
- Provides opportunity for clients to build diverse, redundant connections to AARNET

→ Traffic Accounting and Monitoring

- Flow based traffic accounting
- Scaling issues require function to be moved to the edge of the network
- Use anycast addressing so data supplied to a central collector in an emergency
- Centralise reporting to a POP based server
- Provides AARNET with a window on the network allowing it to identify anomalous traffic, e.g. DDOS

→ Other Issues

- End to end performance measures
 - Desire to measure performance from member site
 - Provide connectivity reports on core services
- Support QoS (diffserv)
 - Need to support VoIP and VideoIP traffic
 - Possibly introduce scavenger service
- Support for large traffic flows, jumbo frames

→ AARNet3 and SX TransPORT



→ AARNet3 National Backbone

- Dark fibre pair on each path of Nextgen Network's national SDH backbone.
- Initially using STM-64 (10Gbps) service.
- Diverse path between Melbourne, Adelaide and Perth from another carrier. Capacity likely to be STM-4 (622Mbps).
- Solution for Hobart and Darwin still "work in progress"

→ Trans Pacific Transmission

- "SX TransPORT" - Dual STM-64 (10Gbps)
 - Hawai'i - Manoa and Seattle (Abilene, CA*net 4)
 - Los Angeles (Abilene, CENIC, CUDI)
 - Look to add Mauna Kea to Los Angeles path later
- Dual STM-4 (622Mbps) for commodity Internet
 - PAIX Palo Alto (Silicon Valley)
 - Los Angeles
- Add drop offs to existing STM-1's (155Mbps)
 - University of South Pacific, Fiji
 - Possibly Auckland, New Zealand
 - Connects to 155Mbps path to Tokyo from Hawai'i

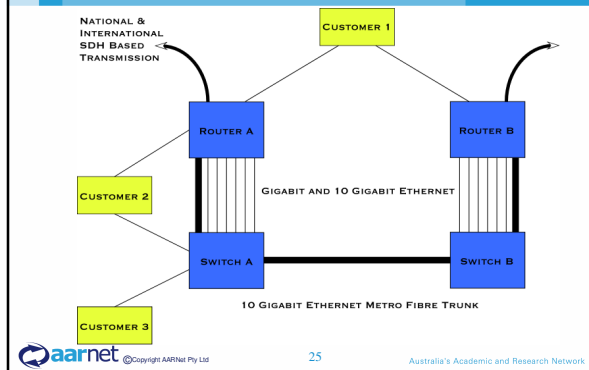
→ Services

- DNS Cache and Secondary Servers
- Usenet News
- Hexago IPv6 Migration Broker
- DDoS Detection and Mitigation
 - Investigate appliances
 - Interest in automatic detection and filtering
 - Locate next to transit (and peering) links
- AARNet Mirror
- VoIP Gateways
- Traffic Performance Measurement and Availability

→ Client Connections

- Client provides connection to AARNet3
- Can choose the level of diversity and redundancy
- Diverse connection to each POP
 - Two diverse, independent links, one to each POP
- Dual connection connecting each POP
 - Two links over same infrastructure to single POP
 - AARNet trunks one link to the second POP though switches
- AARNet provided diversity
 - Single link to one POP, AARNet provides LAN linking both AARNet POP sites and the member

→ Connections through the GigaPOPs



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→ High Bandwidth Client Connections

- AARNet supplied and managed edge router
- No firewall functionality
 - clients are responsible for their own security
- Interacts with client border router via BGP/MSDP
- Edge server used to collect flow information
- Modem provides out of band access to APL staff

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→ Equipment

- Core Router
 - 40Gbps capable
 - Redundant power but not CPU
 - Packet over SDH to STM-64 (roadmap to STM-256)
 - Gigabit and 10 Gigabit Ethernet
- Core Switch
 - Pure L2 switching
 - Fast, Gigabit and 10 Gigabit Ethernet only
- Edge and POP based "Legacy" routers
 - 3 x Gigabit Ethernet (LAN, POP "A", POP "B")
 - 1 x Fast Ethernet dedicated to flow accounting
 - Capability to handle legacy (slow) interfaces

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→ Current State of Play - National

- Brisbane
 - Racks in place, switch and router installed, awaiting backhaul
- Sydney
 - UTS site operational
 - Rosebery site, racks in place, switch and router installed
- Canberra
 - Racks in place, switch and router installed, awaiting cross-connect

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→ Current State of Play - National

- Melbourne
 - Racks in place, awaiting switch and router installation and backhaul
- Adelaide
 - Racks in place, switch and router in place and operational, awaiting backhaul
- Perth
 - Racks in place, switch and router in place and operational, backhaul being tested

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→ Current State of Play - International

- Palo Alto (PAIX)
 - Fully operational (Since March)
- Los Angeles
 - POP site chosen (Telehouse, Wilshire)
 - Tier 1 transit providers chosen
 - Equipment to be ordered
 - Backhaul from SCCN cable station - to be ordered

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The regional network

Keith Burstn

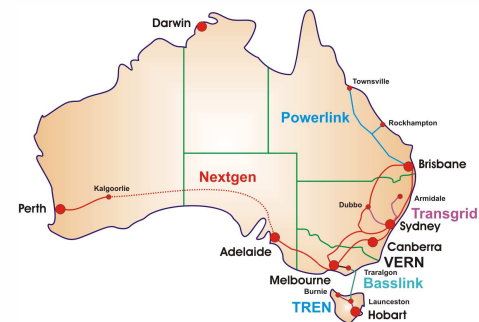
→ The academic and research *Regional* network

- Network capabilities to regional research and education equal to those in metropolitan areas
- Providing at least 1Gbps capacity from AARNet to regional University sites and Research institutions
- Providing dedicated 1Gbps and 10Gbps network connections for advanced research projects

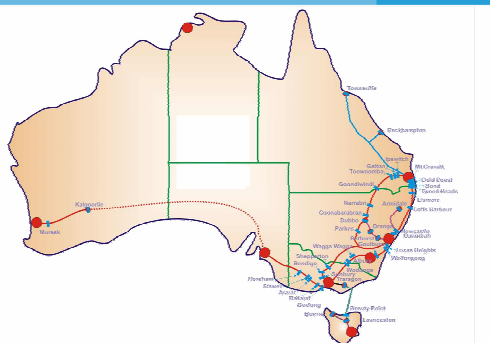
→ Building the network - the AARNet model

- Combination of different infrastructures
 - The backbone is a dark fibre pair on the Nextgen national network
 - Other capacity obtained from working with:
 - Electricity companies with fibre on power poles
 - Local AARNet members
 - State governments
- Funding from
 - DEST as part of national AREN project
 - CCIF Funding
 - AARNet members
 - State governments

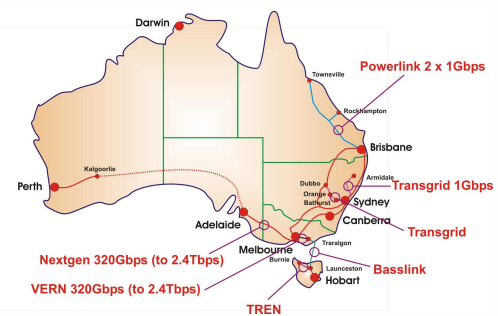
→ The regional network



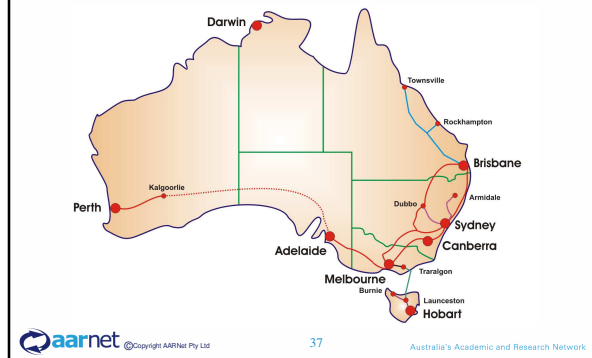
→ Sites of interest



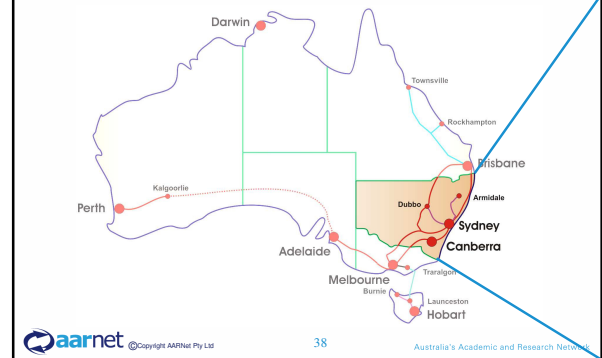
→ Regional network capacity



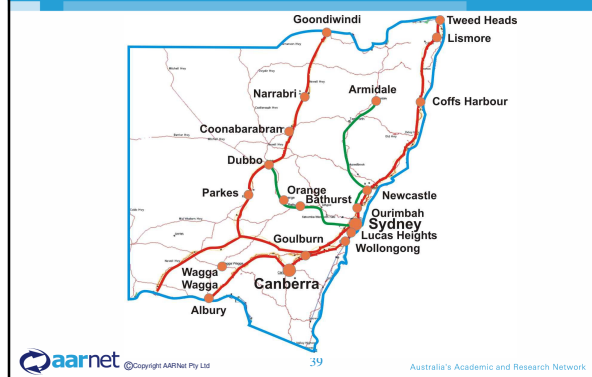
→ Regional network details



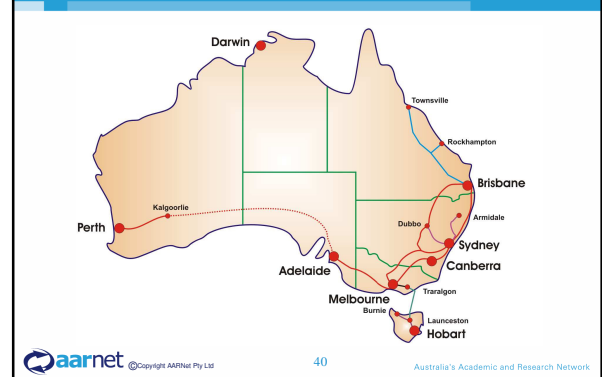
→ NSW



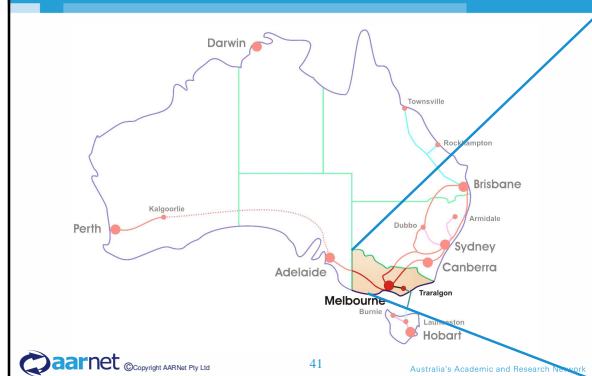
→ NSW



→ Regional network details



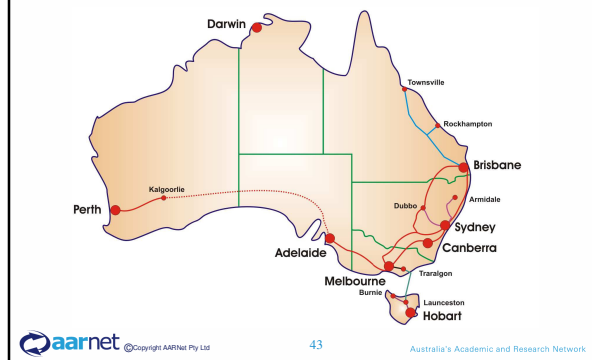
→ Victoria



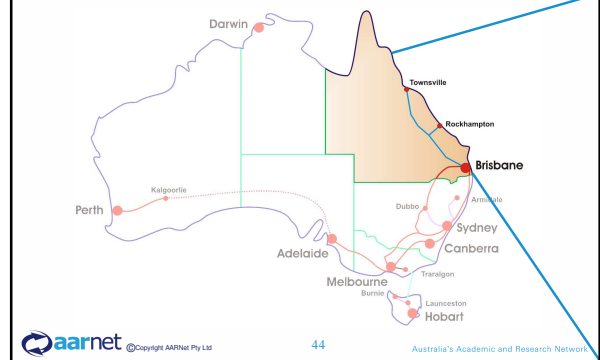
→ Victoria



→ Regional network details



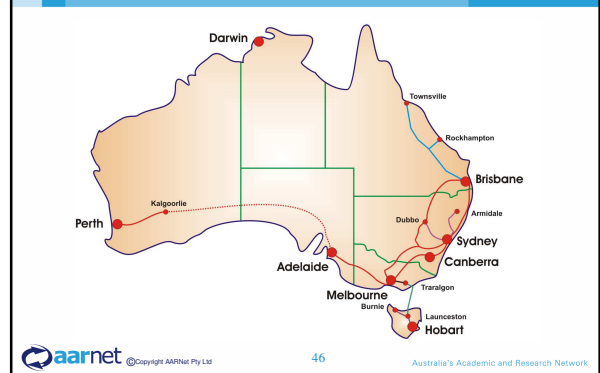
→ Queensland



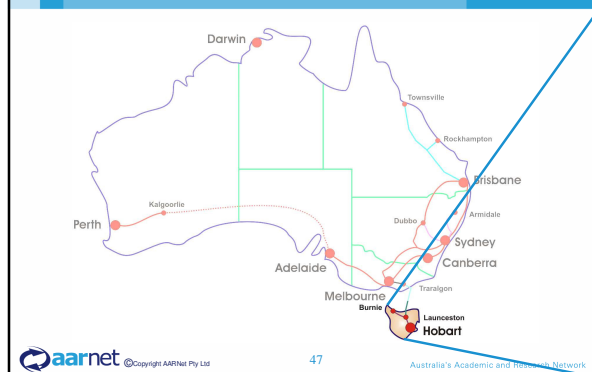
→ Queensland



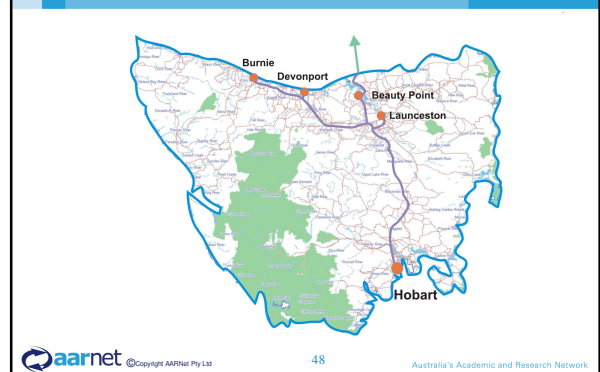
→ Regional network details



→ Tasmania



→ Tasmania



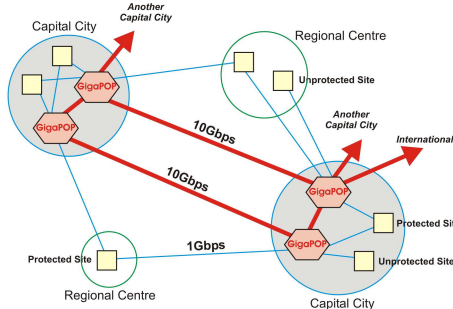
→ Regional report card

Network	Status	Target
Nextgen	Choosing equipment	4 th Qtr 2004
Powerlink	Newly constructed	3 rd Qtr 2004
Transgrid – Armidale	Operational	3 rd Qtr 2003
Transgrid – Dubbo	In development	4 th Qtr 2005
VERN	In development	4 th Qtr 2005
Basslink	In development	4 th Qtr 2005
TREN	In development	1 st Qtr 2005

→ Nextgen regional network architecture

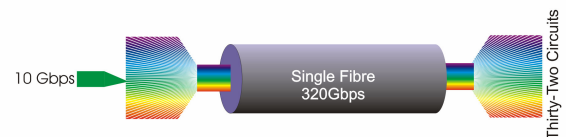
- The core AARNet service is provided by a two "GigaPOPs" in each capital city (at different locations)
- Capital city sites can connect to one or both GigaPOPs (for protection)
- Regional network will provide a 1Gbps to two capital city GigaPOPs for protection, (where the network topology allows)

→ Connectivity

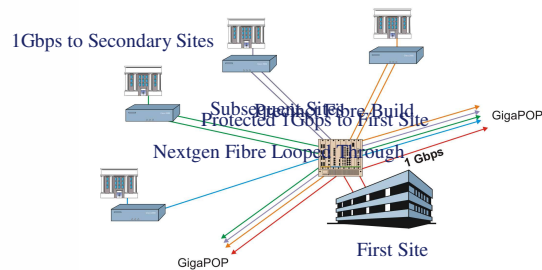


→ Lighting the Nextgen network

- Using "Dense Wave-Division Multiplexing" (DWDM) providing:
 - 32 wavelengths of 10Gbps capacity initially
 - Growth to 64 or more wavelengths of 40Gbps over life of the network



→ Protected precinct architecture

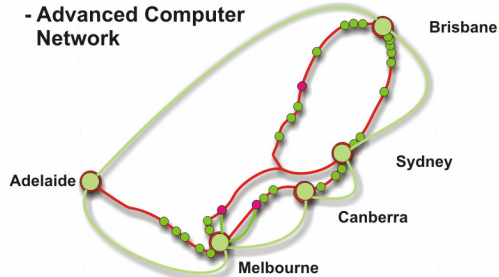


→ Additional capabilities

- High capacity network offering multiple optical wavelengths
- Can offer "overlay" networks with dedicated capacity
 - Between campuses of a University
 - To specialised instruments, radio telescopes etc.
 - To interconnect specialist resources such as the supercomputers in various states

→ Overlay networks

National GRID Services - Advanced Computer Network



→ The future

- Establish regional POP sites
 - Provision of low bandwidth, routed services over shared capacity
 - Service small research organisations, Schools, TAFE sector etc.
- Commercial partnerships sharing capacity to provide alternate commercial broadband services to regional areas
- Evolve to high speed provisioning of research capacity by adding an optical switching layer to the network
- Expand coverage via future partnerships

The international network

George McLaughlin

→ Strategic Alliance: AARNET and Southern Cross Cable Networks (SCCN)

- AARNET has worked with SCCN since 2000, initially deploying dual 155Mbps circuits between Sydney, Hawaii and the Pacific Wave GigaPoP in the Seattle
- In December 2003 AARNET and SCCN announced a major new strategic initiative – the Southern Cross Trans Pacific Optical Research Testbed
- The “bundle” of services that AARNET acquired from SCCN involves 3 sets of circuits

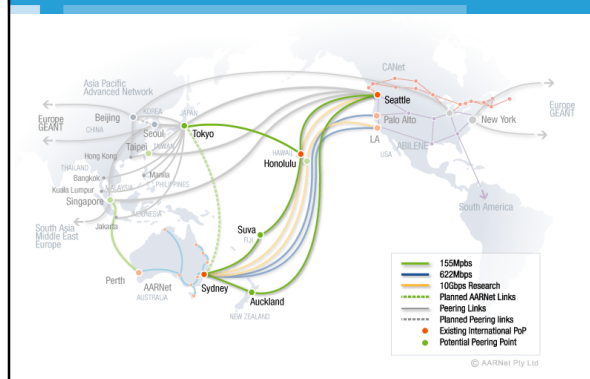
→ Overview - International Links

- Add drop offs to existing dual STM-1/OC3 (155Mbps)
 - Mixed traffic - R&E and Commodity
 - University of South Pacific, Fiji
 - Possibly New Zealand
 - Connects to 155Mbps path to Tokyo from Hawai'i
- Dual STM-4 (622Mbps)
 - Commodity Internet transit - NTT/Verio and Sprint
 - PAIX Palo Alto
 - Los Angeles
- “SX TransPORT” - Dual STM-64 (10Gbps)
 - Research and Education (R&E) traffic only - AUP
 - Hawai'i - Manoa and Seattle (Abilene, CA*net 4, NLR)
 - Los Angeles (Abilene, TransPac, CENIC, CUDI)
 - Look to add Mauna Kea to Los Angeles path later

→ Dual 155Mbps circuits – regional and Pacific Island connectivity

- 4-drop ring (4 unprotected circuits, MPLS, fast failover)
 - Sydney-Suva (new)
 - Suva-Oahu (Hawaii) – and then to U Hawaii, Manoa
 - Oahu-Hillsboro – and then to Pacific Wave, Seattle
 - Hillsboro-Sydney
- AUSAID to provide funding for the University of the South Pacific to contract AARNET to provide connections to AARNET and the global R&E Networks (monopoly carrier issues)
- Interconnect at Hawaii with new Hawaii –Tokyo link
- USPNet to other Pacific Islands to be upgraded later
- Possible connection of NZ later

→ AARNET's Pacific Rim STM1's



→ Dual 622Mbps circuits – commodity traffic

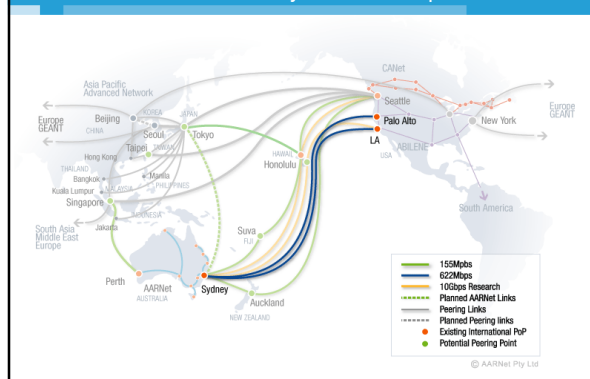
Access Commodity Internet in Palo Alto

- Backhaul in place from Market Post Tower, San Jose
- Connected to the PAIX peering fabric
- Transit in place with NTT/Verio, Sprint is second transit provider
- Peer with other organisations at PAIX

Second commodity POP in Los Angeles

- Build PoP at Telehouse America and peer in LA complex
- Backhaul from Morro Bay (San Luis Obispo) being finalised
- Transit providers, Sprint plus one of NTT/Verio or MCI

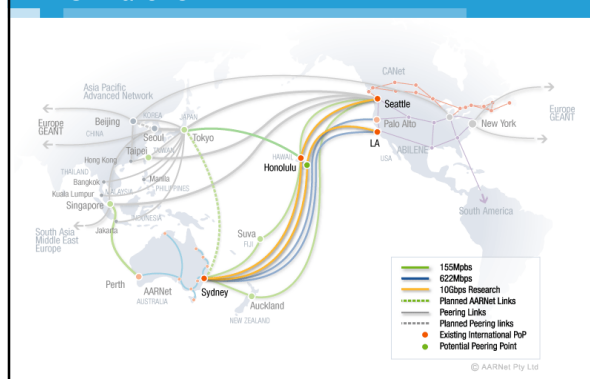
→ AARNET's Commodity dual 622Mbps circuits



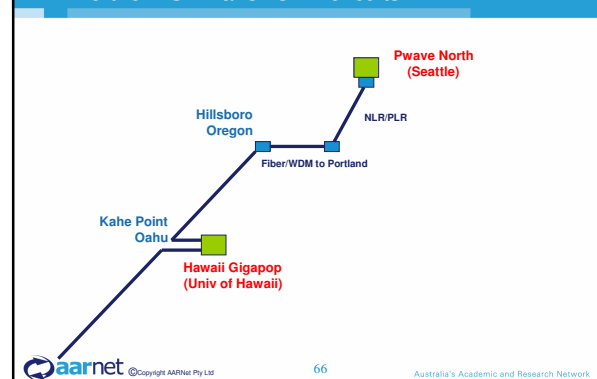
→ Dual 10Gbps circuits – SXTransPORT Trans Pacific Optical Research Testbed

- Major new partnership announced between AARNet and Southern Cross Cable Network (SX) on 11 December 2003
- Support from Australian Government
- Dual 10Gbps circuits between Australia and US West Coast
- Activation Q3/2004, Initial term 5 years, option for 5-year term
- AUP applies similar to Abilene
- Advisory Board to be set up with reps expected from SX, AARNet, global research interests
- Will provide affordable high throughput access allowing Australia to effectively participate in global e-science initiatives
- Will strengthen case for locating unique research facilities in Australia, eg Square Kilometre Array

→ SXTransPORT



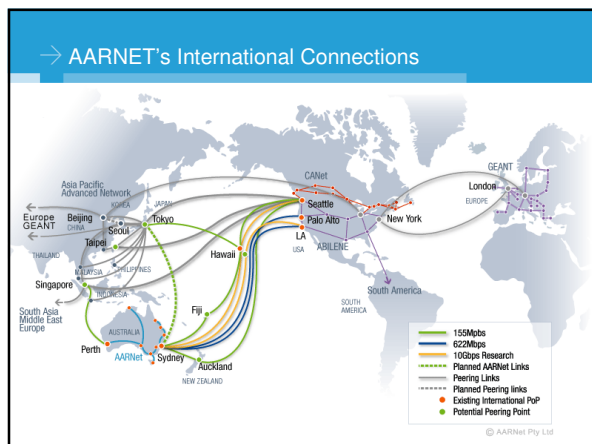
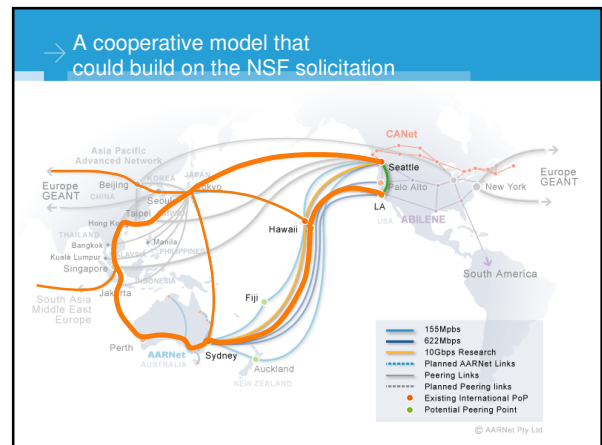
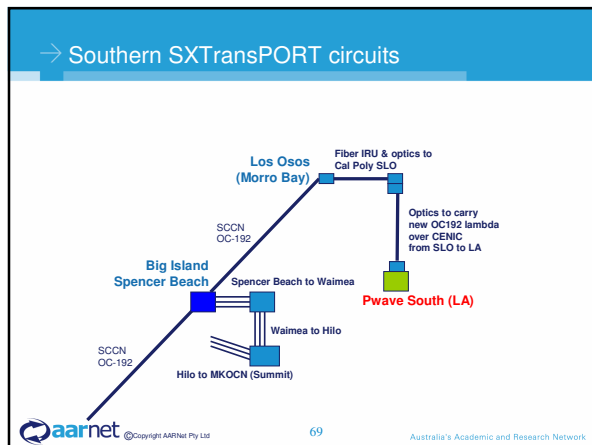
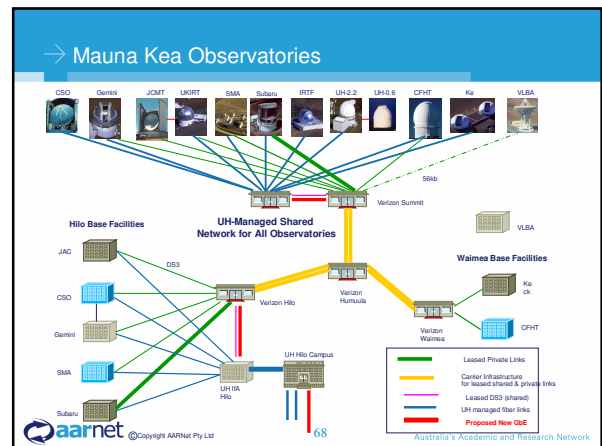
→ Northern SXTransPORT circuits



→ Mauna Kea Observatories

UH 0.6	UH 0.6-m telescope	0.6m University of Hawaii
UH 2.2m	UH 2.2-m telescope	2.2m University of Hawaii
IRTF	NASA Infrared Telescope Facility	3.0m NASA
CFHT	Canada-France-Hawaii Telescope	3.6m Canada/France/UH
UKIRT	United Kingdom Infrared Telescope	3.8m United Kingdom
Keck I	W. M. Keck Observatory	10m Caltech/University of California
Keck II	W. M. Keck Observatory	10m Caltech/University of California
Subaru	Subaru Telescope	8.3m Japan
Gemini	Gemini Northern Telescope	8.1m USA/UK/ Canada/Argentina/ Australia/Brazil/Chile
Submillimeter		
CSO	Caltech Submillimeter Observatory	10.4m Caltech/NSF
JCMT	James Clerk Maxwell Telescope	15m UK/Canada/Netherlands
SMA	Submillimeter Array	8x6m Smithsonian Astrophysical Observatory/Taiwan
Radio		
VLBA	Very Long Optical/Infrared	0.6m University of Hawaii
UH 0.6m UH 0.6-m telescope		25m NRAO/AUI/NSF
UH Baseline Array		

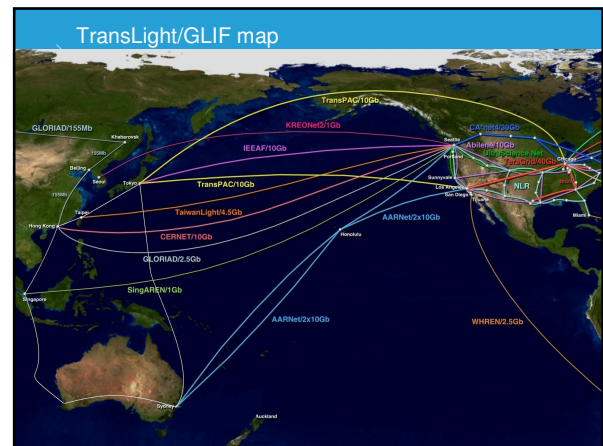
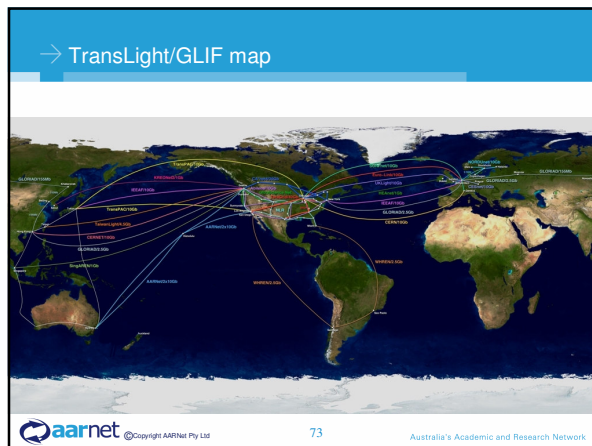
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→ Developments with Asian Countries

- SEAMEWE3 link between Perth and Singapore being used – improved effectiveness for interactions with South East and South Asia – managed service
- Dedicated R&E link being considered subject to funding
- Direct link to Japan also being considered – discussions with Japan
- South Asia taking an increasing focus in APAN
- TEIN2 – a 10million EC funded initiative to improve connectivity between the developing ASEM member countries – may lead to improved connectivity to Europe and additional options out of Western Australia – discussions being held with DANTE at the APAN meetings in the Hilton

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Charging

George McLaughlin

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→ A new charging environment

- The acquisition of NextGen capacity and SXTransPORT results in a higher proportion of fixed costs to APL than was previously the case
- AARNet's members are asking for a charging regime that is largely subscription based
- In making funds available toward the cost of NextGen capacity and SXTransPORT, DEST want to see a charging regime that will encourage innovative and unconstrained use of the network for research and education

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→ Components of the Charging Model

- Irrespective of model, need to recover sufficient funds to sustain and enhance ongoing provision of services
- Should not lead to any short-term major distortions in relative charges to members
- Three charging components
 - On-net (includes national and international traffic between universities, research organisations and other organisations connected to the global research and education networks)
 - An access charge for each connection to AARNet
 - Commodity (off-net) traffic between AARNet clients and anyone that is not "on-net" either nationally or internationally

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→ What we mean by "on-net" traffic

- On-net traffic includes:
 - Any data that flows between AARNet Members and Affiliates across the AARNet backbone
 - Any data that flows between interstate locations of the same AARNet Member or Affiliate across the AARNet backbone
 - Any data that flows between AARNet Members and Affiliates and equivalent organisations that are connected to overseas Research and Education Networks
 - Any data drawn from the AARNet mirror
 - Multicast traffic received from on-net sources
- All of the above will be provided on an unlimited basis (subject to available capacity in the cases of Darwin and Hobart) under the new subscription based charge for on-net

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→ (i) On-net

- Criteria – certainty of cost, reasonably equitable, independence of formula sources, number of backbone connected locations
- Graduated subscription based on independent measures
 - research grant funding (from AVCC/DEST Research Data)
 - EFTSU and EFT (from DEST Student and Staff surveys)
 - Multi-state factor (for traffic between interstate locations of the same organisation)
- Implementation – 1 July 2004 (no more volume based charging for on-net)
- For 2004, no one to pay more than the projected spend under the current charging model (~130% max of 2003 spend)

→ (ii) On-net – components

- Research use proxy:
 - ~75% of on-net subscription is related to “Total Research Income”, as per AVCC website
 - This research subscription component equates to ~0.2% of “Total Research Income”
- Teaching/Admin/Outreach proxy
 - ~25% is related to EFTSU, FTE and number of AARNet backbone-connected locations
 - This Teaching/Admin/Outreach use equates to \$1/pa/per EFTSU and \$3/pa/per FTE, times the number of backbone connected locations

→ (iii) Access Fee

- Set to cover APL edge equipment costs to connect and monitor
- \$1,000 for each connection per month to any AARNet PoP (\$12,000pa) – equipment cost amortised over three years
- Currently most single-state members have only one connection, expectation that many will opt for two to increase resilience when second PoPs are available

→ (iv) Off-net or commodity

- Criteria – simplicity, equity, excess demand component
- Largely subscription based with a low marginal cost for traffic above the amount covered by the subscription
- Total commodity cost in 2005 less than projected total 2004 commodity cost, but for 20% increase in volume
- Implementation – 1 Jan 2005

→ (v) Basis of commodity charge

- A subscription for 2005 is set as the actual cost incurred between 1 June 2003 and 31 May 2004
- The 2005 subscription will cover the same volume as that received during the period 1 June 2003 and 31 May 2004
- Any excess above this (estimated on average at 40%) will be charged at \$7/GB

→ (vi) Non-Member charges - Affiliates

Monthly Base fee (includes first connection charge)	Included volume/month (any traffic type)	Excess rate above included volume
\$1000	10GB	\$33/GB
\$2000	40GB	\$25/GB
\$4000	120GB	\$20/GB
\$6000	220GB	\$18/GB

Affiliates have no automatic access to SXTransPORT or subscription-based R&E traffic

→ (vii) Non-Member charges - Associates

- Small group almost like members, but are not shareholders (eg DSTO) ie don't have a vote at AGM
- On-net subscription fee can be determined from historical records and similar measures to members, but will not be less than \$1000 per month
- Access fee of \$1000 per month per connection will apply, as for members
- A commodity fee will be determined but will not be less than an amount per month to be determined
- Associates may opt to be charged as affiliates if that suits them better

→ (viii) What's not included

- Tail costs (capital and recurrent) to an AARNet PoP
- Costs associated with QoS, MCU's, etc associated with multimedia over IT – this will be the topic of a follow-up study

→ (ix) GrangeNet

- If any GrangeNet Client has a need to use AARNet national infrastructure as an alternate path in the event of a GrangeNet failure or for access to international networks, they must be or become AARNet clients and pay the AARNet Member or Affiliate charges (as the case may be)

Operating the network

Steve Maddocks

→ AARNet network management

- AARNet Network Operations Centre (NOC)
- NetFlow
- MRTG
- Nagios
- Performance Measurements

→ AARNet's NOC

- 24 x 7 Call Centre (02) 9963 3538
 - or noc@aar.net.edu.au
- Call Centre operator will ask
 - Who's calling?
 - Where from?
 - Brief description of fault
- SMS sent to 'best fit' AARNet engineer
 - based on geography and time of day

→ AARNet's NOC

- Escalation process
 - If 1st engineer does not respond...
 - ... sent to next best engineer
 - If 2nd engineer does not respond...
 - ... sent to Director of Operations
- 1st engineer may 'handball' to another
- Response time usually immediate but can vary due to escalation process

→ NetFlow – AARNet's 'Eyes and Ears'

- Backbone routers, Cisco 7500 and 7300 generate NetFlow records
- A 'flow' is a unique 'conversation' between hosts on the network
- A flow record contains information about:
 - Timestamp
 - Source and destination IP numbers
 - Protocols and Port numbers
 - Number of packets and bytes in the flow
 - Interfaces used
 - Autonomous system information
- Most of which is not available from interface statistics alone

→ NetFlow – AARNet's 'Eyes and Ears'

- NetFlow records are 'exported' by the router and 'collected' by the server
- Records are then processed by Bruce Morgan's nfd software
- All manner of usage based statistics presented on-line using open, web access.
- Processed records made available to each Member organisation for their internal use

→ NetFlow – More than just billing

- Common misunderstanding that NetFlow is only used for 'billing'
- NetFlow is invaluable as a technology to detect and mitigate against network security incidents
- AARNet has a history of 'early warning' virus, worm, denial-of-service and scanning activity
- AARNet proactively warns Members of network security incidents involving their organisation
- NetFlow extremely useful when troubleshooting network performance issues, e.g. excessive peer-to-peer
- AARNet uses NetFlow information to evaluate peering relationships

→ Multi Router Traffic Grapher (MRTG)

- Tobias Oetiker <oetiker@ee.ethz.ch>, Dave Rand <dlr@bungi.com> <http://www.mrtg.org/>
- No network management system complete without MRTG
- AARNet plots all the usual statistics
 - ... and some unusual ones, e.g.
 - Flows per second
 - NetFlow processing delay
- <http://noc.aarnet.net.au/>

→ NAGIOS – a 'Sainly' network monitor

- "Nagios Ain't Gonna Insist On Sainthood"
- "Notices Any Glitch In Our System"
- Ethan Galstad - <http://www.nagios.org/>
 - GNU General Public License, Free Software Foundation
- Extremely extensible network monitoring system
- Emphasis on reachability and availability of Hosts AND Services
- AARNet monitors more than 700 targets
- SMS alarms for the more critical
- Secured, on-line access from anywhere
- Extensive historical reporting

→ NAGIOS

- AARNet for a long time has become less and less interested in 'ping' tests (ICMP)
- Much more interested in system and service monitoring
- AARNet Monitors BGP peering status
- AARNet Monitors Web, Mail and DNS service for each Member's network
- Currently based in Canberra
- Additional International measurement point soon

→ Performance measurements

- Current system (perf) has served us well for more than 7 years
- Developed by Bruce Morgan
- Designed to 'confirm' the Optus SLA
- Mostly measures inter-capital and international links
- System is ICMP (ping) based
 - Measures, records and plots round-trip times and packet-loss
 - Various, selectable targets
 - Minimum, average and maximum RTT
 - Small and medium sized packets
 - Plots congested vs total packet-loss
 - ... all with historical lookup

→ Performance measurements – new systems

- Measurement to Member sites, rather than just National and International links
- Performance of 'flows' rather than packets
 - Automatic, periodic 'iperf' measurements?
 - Automatic, periodic 'wget' from popular sites?
- Packet-loss and Latency are bad, but so is Jitter for real-time applications
 - Jitter – or variance in Latency
 - Most A/V codecs don't handle Jitter well
 - How to detect, measure and visualise Jitter?
 - SmokePing (Tobi Oetiker)?
 - Develop our own new system?

→ Performance measurements – Quality of Service (QoS)

- Popular belief that QoS not required if enough Bandwidth
 - Except during global virus/worm meltdowns
 - Except during distributed denial-of-service attacks
 - Is 10 Gigabits/sec enough for 11 x 1 Gigabit connections?
 - Is 1 Gigabit/sec enough for 6,000 x 100 Megabit connections?
 - Do all switches, routers, firewalls, etc perform well at line rate on all interfaces concurrently (and with all features enabled)?

→ Performance measurements - QoS

- In implementing differentiated services or QoS, AARNet needs to measure differentiated performance
- Develop our own system?
 - Automated 'echoping' with and without prioritised packets
 - Automated flows with and without prioritised packets
 - Simulate audio, video and haptic streams
- QoSmetrics <http://www.qosmetrics.net/>
 - Dedicated hardware (probes) with CDMA clock source
 - One-way Latency and Jitter measurements
 - Affordable software solution for 'the edge'

Peering

Mark Prior

→ Types of ISP Relationship

- Transit
 - Supplier/Customer relationship
 - Service is access to "The Internet"
 - Customer buying this service
- Peering
 - Relationship between equals
 - Only providing access to each others network and customers

→ International Policy

- "Have a pulse" peering
- Peer with any provider that has a presence at an international location containing an AARNet Point of Presence (POP)
- Peer must be based outside of Australia

→ National Policy

- Geographic Scope
 - Must operate a national network, with points of presence in at least 3 states
 - Able to peer all routes in Sydney, Melbourne and either Adelaide or Perth
- Traffic Exchange Ratio
 - Within 2:1
- Traffic Exchange Volume
 - Average at least 1 Mbps in each direction

→ Regional Policies

- Specific to each state or territory
- No access to national or international trunks and resources, e.g. AARNet Mirror
- Need more advice from regional (AARNet) bodies
- To be formulated and interconnections pursued only after major national interconnections in place

→ Issues

- Major players have minimum traffic level that AARNet must meet to gain peering status
- Need to avoid nickel and dime deals that will divert traffic that could contribute to AARNet gaining the minimum level required by the major players
- Must avoid any impression that we are providing transit service to commercial ISPs

→ Strategic Relationships

- Useful to know from AARNet clients if there would be strategic advantage to peering with other organisations whose traffic wouldn't necessarily show in the traffic statistics, e.g.
 - Major DSL providers to staff and students
 - Content providers providing specialist content to clients
 - Joint Venture/Research relationships

→ Existing Peers

- Abilene
- Academic Services Network
- BBC
- CA*net4
- Dacom
- DREN
- ESnet
- Flag Telecom
- Internode (SA only)
- ISC
- HopOne
- Japan Telecom
- Jupiter Hosting
- KDDI
- KT Corporation
- Microsoft
- Mzima Networks
- PoweredCom America
- ServePath
- SingAREN
- SpeakEasy
- TAnet2
- TWGATE
- University of Hawaii
- WAIX participants (WA only)

→ Currently in Discussions/Progress

- In discussions with a number of ISPs, some under non disclosure, including
 - Internode [nationally]
 - NTT Australia
 - Pacific Internet (Australia)
 - Primus (Australia)
 - Sprint Australia
 - Telstra
- Need to complete GigaPOP builds, acquisition of peering routers and links to progress those "in the queue"

→ Summary

- Should improve performance or facilitate interconnection of advanced services
- Should be cost neutral to APL
- Could be via direct links or Internet Exchanges
- Requirement for bilateral peering agreements
 - Direct relationship with peer
 - No new multi-lateral agreements
- Use dedicated routers, where practical, to avoid ability of peers to steal transit
- International and National policies available at <http://www.aarnet.edu.au/about/publications.html>

