



Connecting the Australian Education & Research Communities: The AARNet Optical Network

by

Infrastructure Development Team



Overview

1. Implementation
 - Doug Farmer (Project Manager)
2. Technical Architecture
 - Ivan Philips (Infrastructure Specialist)
3. Connecting Communities
 - Dr Greg Wickham (Infrastructure Development)
4. Questions?
 - And please chat with us throughout the conference



The AARNet Optical Network: Implementation

Doug Farmer
Project Manager



Project Objectives

1. Build an Optical Network to provide our customers regional and inter-capital services, on all legs of the Nextgen fibre from Brisbane to Adelaide.
2. Migrate the AARNet3 IP 10Gbps backbone from managed services to the new Optical Network.

Underlying Business Objective:

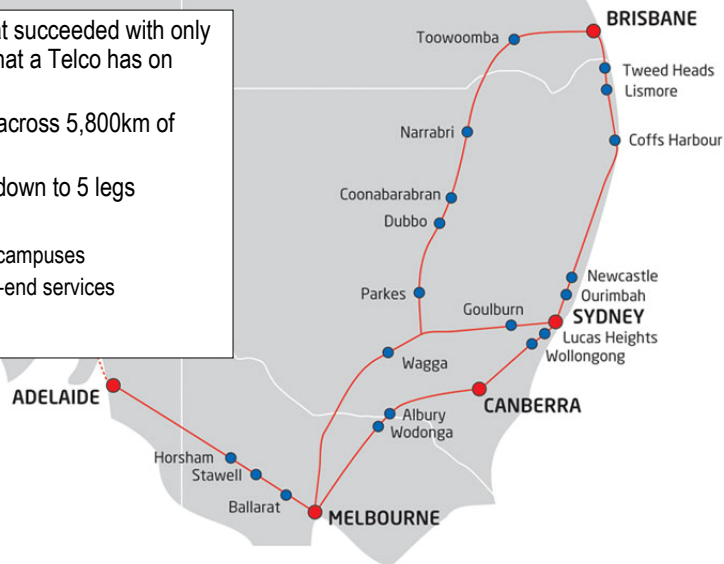
Transition from a buyer/reseller of network capacity
To a strategic owner of network assets.



Long term viable access to bandwidth for research and education.

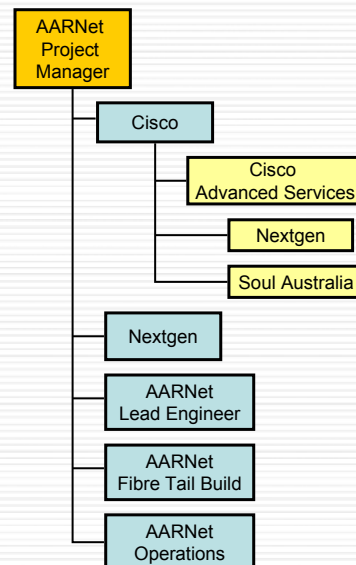
Project Scale

- Major “Telco” project that succeeded with only a fraction of resources that a Telco has on hand.
- 63 equipment locations across 5,800km of Nextgen fibre cable.
- Implementation broken-down to 5 legs
- Customer integration
 - Fibre tails to regional campuses
 - Connect & test end-to-end services



Why the Project was a Success

- **Project Management**
 - Project Team established
 - Weekly formal meetings - communication, issue & risk management
 - Design walk-through (while there was still time to fix issues)
- **Executive Focus** and escalation path
 - Weekly update for AARNet execs.
 - CEO involvement
- **Supplier Management**
 - Trust, patience, look for a “win-win” as issues arise
 - But.... have a big stick in the contract ... just in case!





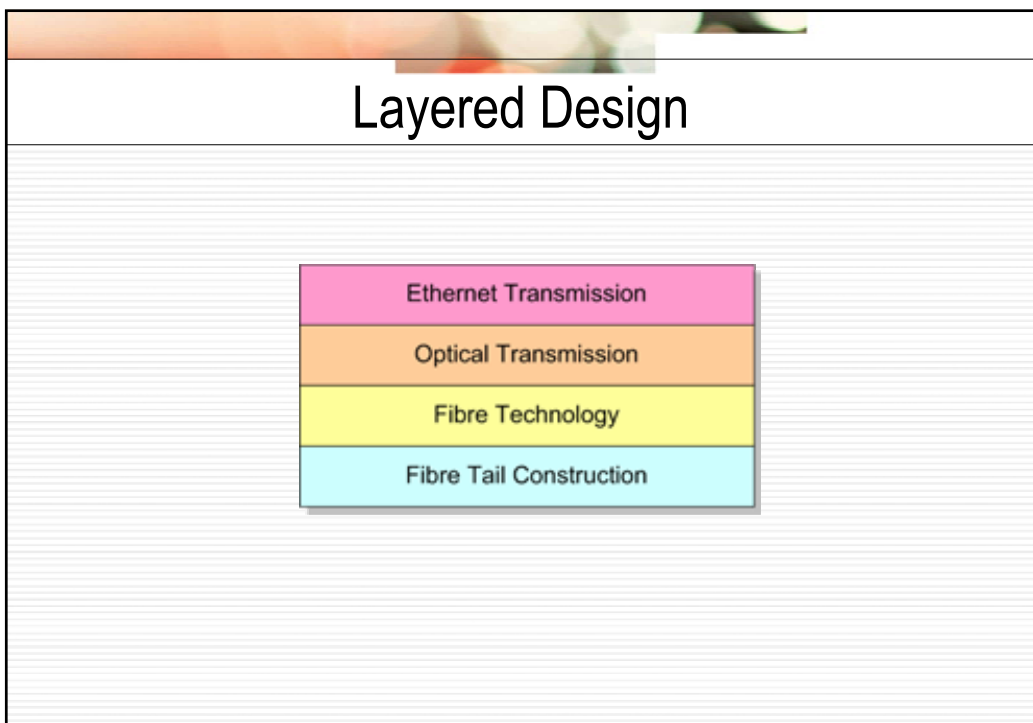
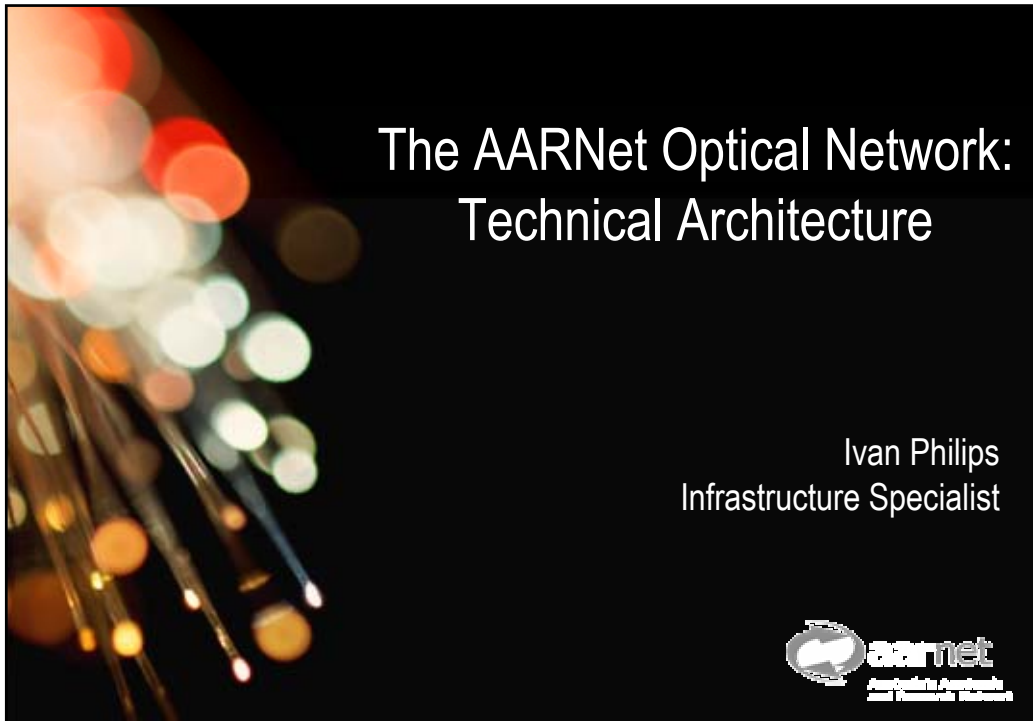
Project Outcome

- After a long incubation period....
 - We were too optimistic about time it takes to architect and conclude commercial arrangements
 - Moving the backbone from a managed service to the AARNet operated optical network required extreme caution
- But once the contract was signed with Cisco...
 - First customers cut-over after 4 months, before Semester-1. (USQ, SCU)
 - Implementation completed in 6 months, within 6 days of our baseline schedule.



“The greatly improved connectivity means we now see distant campuses as if they were next door”

***Maria Gilliam
Southern Cross University***



Fibre Tail Construction

- Communications Huts
- Communications Pits
- Construction Methods
- Fibre Kilometres

Communications Huts



Communications Pits



Fibre Construction Methods

D6R Plough In Operation at Parkes



Fibre Construction Methods

Directional Drilling



Fibre Construction Methods

Trenching



Installed Fibre Kilometres

- Optical Backbone: 5,800km
- Access Network: 188km



Fibre Technology – What Makes it Hard?

- Fibre attenuation over long distances
 - Huts at least 80Kms apart
 - Overcome by high powered lasers and EDFAs
- Chromatic Dispersion
 - Optical waveform distorted over long fibre spans
 - Install dispersion compensation devices that “remove” the distortion
 - Install fibre with a lower dispersion specifications (G.655 NDS)
- Bit Error Rates still occur at high speeds (10Gbit/s)
 - Circuits should run error free
 - ITU-T G.709 Forward Error Correction
 - Adds redundancy to transmitted data
- Optical – Electrical – Optical (OEO) Regeneration
 - The “hammer”

Optical Transmission

- Wave Division Multiplexing (WDM)
 - Multiplex multiple channels/frequencies of light onto a single fibre
 - Course Wave
 - Dense Wave
- Transponders
 - Convert from client interface (GigE, 10GigE, SDH, FC) to DWDM coloured trunk interface and adds FEC.
- Solution based on Cisco ONS 15454 MSTP
- AARNet3 IP Backbone directly attached to STM-64 (10G) transponders

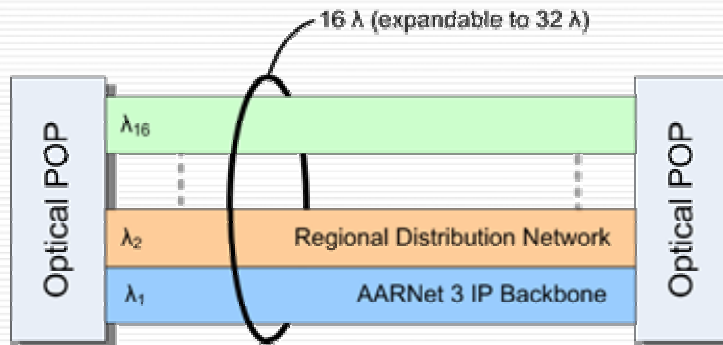
Ethernet Transmission

- Synchronous Digital Hierarchy (SDH)
 - TDM Network – Guaranteed bandwidth, no statistical multiplexing like in an IP network
- Utilises STM-64 Transponders on DWDM Optical Backbone
- Ethernet Frames encapsulated on the SDH network
- Provisioned circuit has guaranteed bandwidth
- Totally transparent to client systems
 - “Long Patch Cord” – No routers, no switches, no confusion
- Solution based on Cisco ONS 15454 MSPP



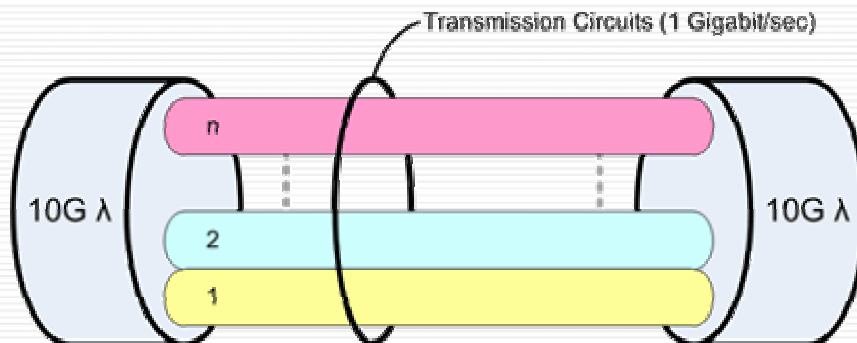
	
Connecting Communities	
• Understanding the infrastructure • Case study: Southern Cross University • Case study: Partnership for Advanced Computing	

The AARNet DWDM Backbone



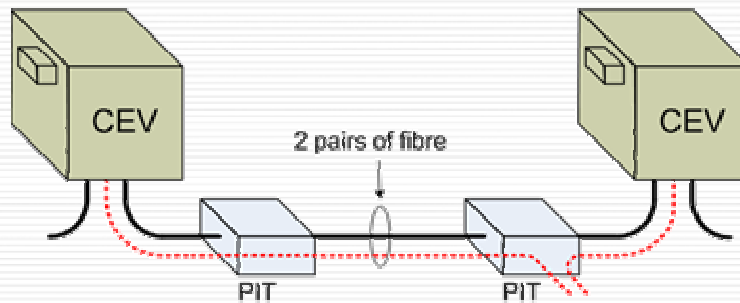
- Provisioned for 16 wavelengths today
- Expandable to 32 wavelengths
- 40G (STM256) compatible

Regional Distribution Network



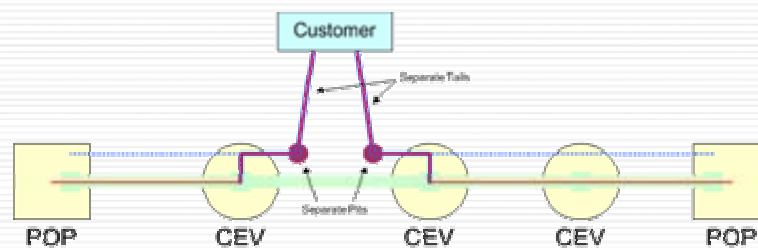
- One 10G (STM64) bearer can carry:
 - 8 x 1 Gigabit/sec transmission circuits using LEX (VC4-8c)
 - 9 x 1 Gigabit/sec transmission circuits using GFP-F (VC4-7v)
- Only accessible at CEVs

Regional Breakout



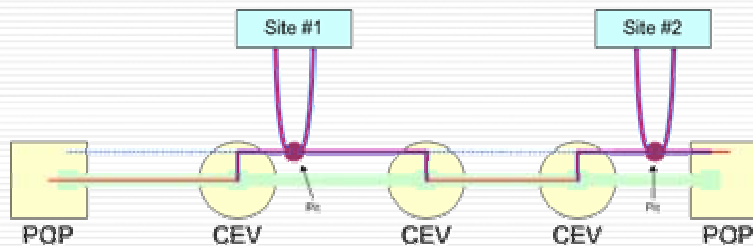
- AARNet uses two pairs of fibres NextGen Inter-capital fibres
 - Pair 1: APL National Optical Backbone
 - Pair 2: Regional Access Fibre

Member Connection: Protected



- Full path redundancy
 - Two fibre tails
 - Two Pits
 - Circuits to different capital cities

Member Connection: Multiple Sites



- One member has two sites
 - Each site has an AARNet 3 IP connection
 - Sites are directly connected
 - A firewall isn't necessary between Site #1 and Site #2

Accessing the Optical Network

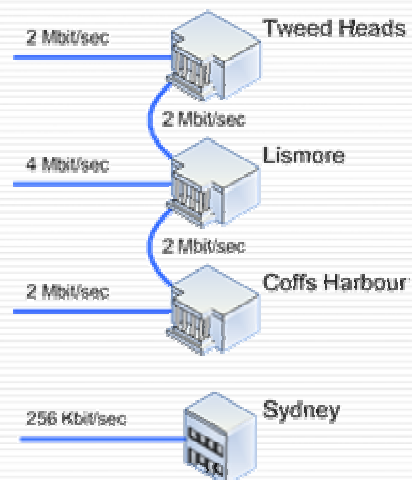
- Fibre required back to an Optical POP or Pit
 - New build to Optical POP from customer
 - New build to Regional Access Fibre (Pit) from customer
- Provisioned services:
 - 1 Gigabit/second Ethernet
 - Point to point (Campus to Campus; or Campus to AARNet3 IP Network)
- Charge schedule
 - Available on application

Connecting Communities: A Case Study with Southern Cross University

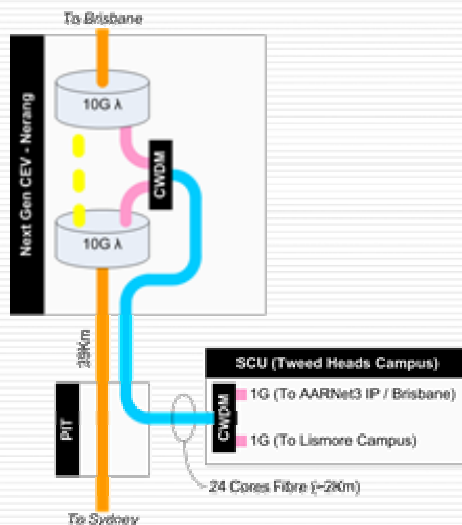


Southern Cross University

- Used ATM circuits:
 - Internet connectivity
 - Inter-campus connectivity

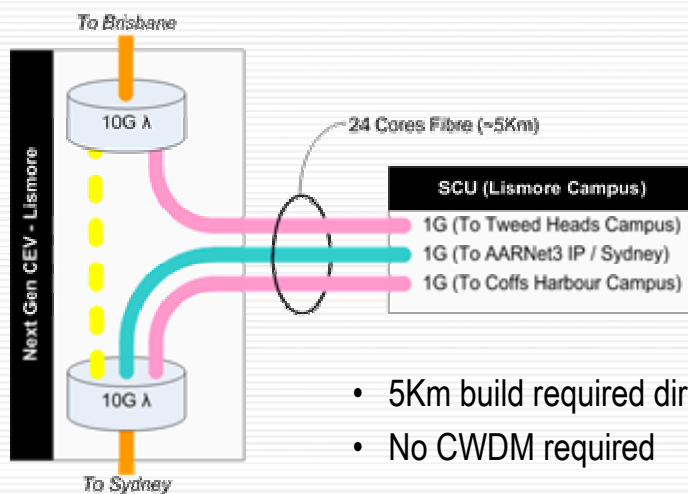


Regional: SCU Tweed Heads



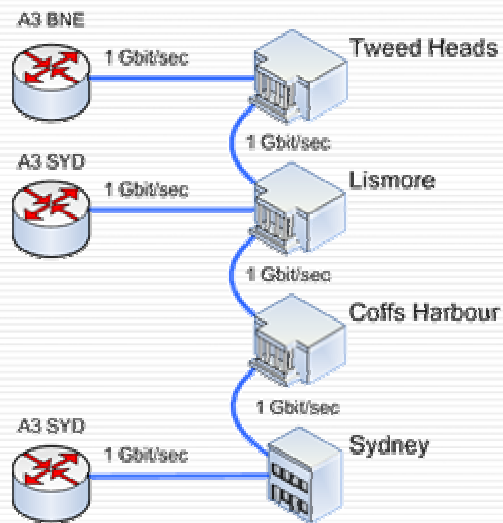
- 2Km build required to the closest NextGen Pit
- Two circuits required so CWDM deployed from CEV direct to customer

Regional: SCU Lismore



- 5Km build required direct to CEV
- No CWDM required

Southern Cross University



- All connections Gigabit Ethernet
- Benefits:
 - Consolidation of services
 - Improved video conferencing

Connecting Communities: The Partnership for Advanced Computing

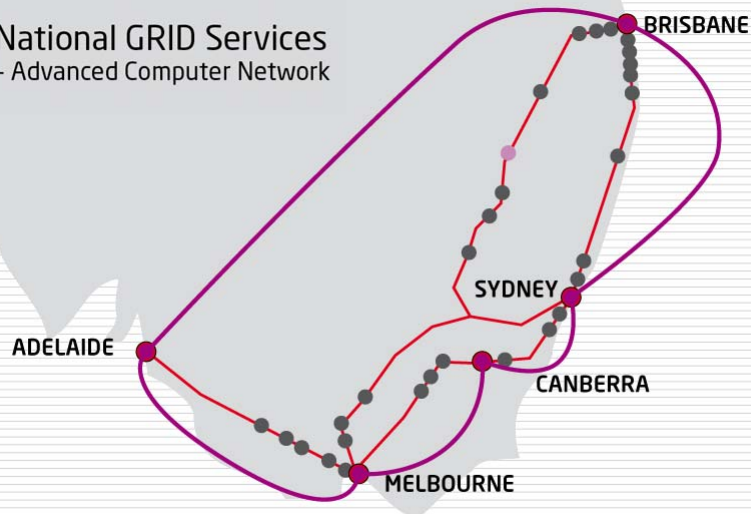


PAC Requirements

- PACs that can connect to Optical Network:
 - APAC (Canberra)
 - AC3 (Sydney)
 - QPSF (Brisbane)
 - SAPAC (Adelaide)
 - VPAC (Melbourne)
- Connect partners using dedicated gigabit ethernet
 - The challenge isn't technical

Connecting a Community

National GRID Services
– Advanced Computer Network





Summary
• The AARNet community has access to an asset: – The AARNet Optical Backbone – A full service solution (design, project management, contract management, operational management) • Demonstrated ability to deliver: – 188 Km of fibre builds – Committed to serving our community – Adelaide to Brisbane – Ready for inter-capital and regional connections

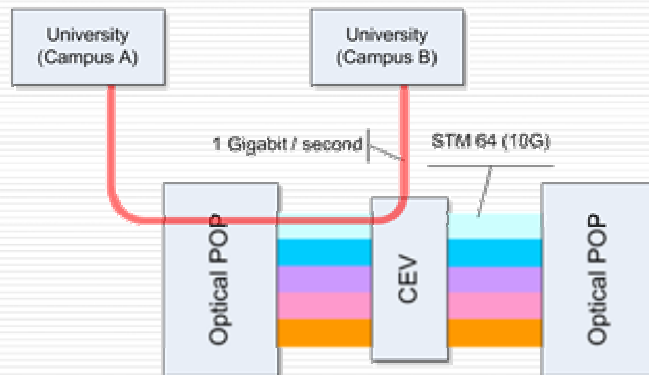
Summary

- Provisioning rates:
 - Current:
 - Gigabit Ethernet
 - Capability:
 - 10G Ethernet
 - Fibre Channel
 - SDH (STM1 up to STM256)

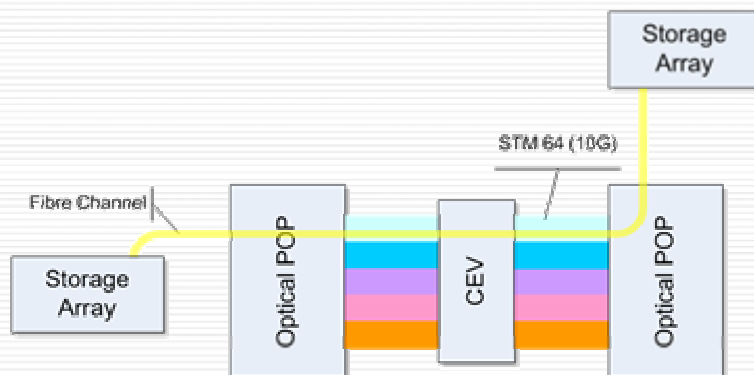
Summary



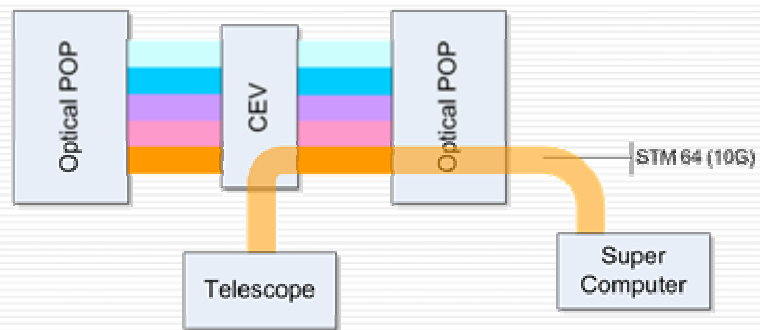
Summary



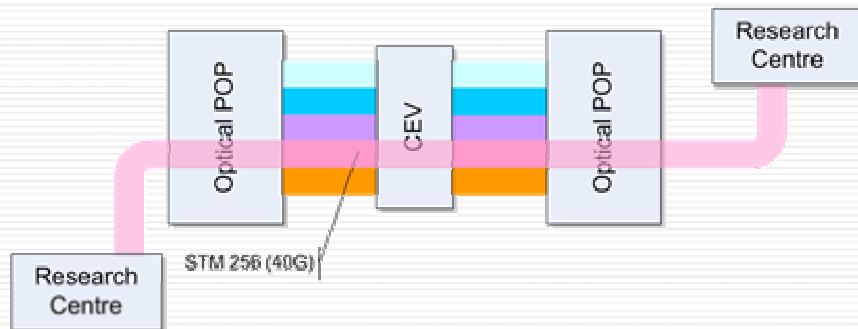
Summary



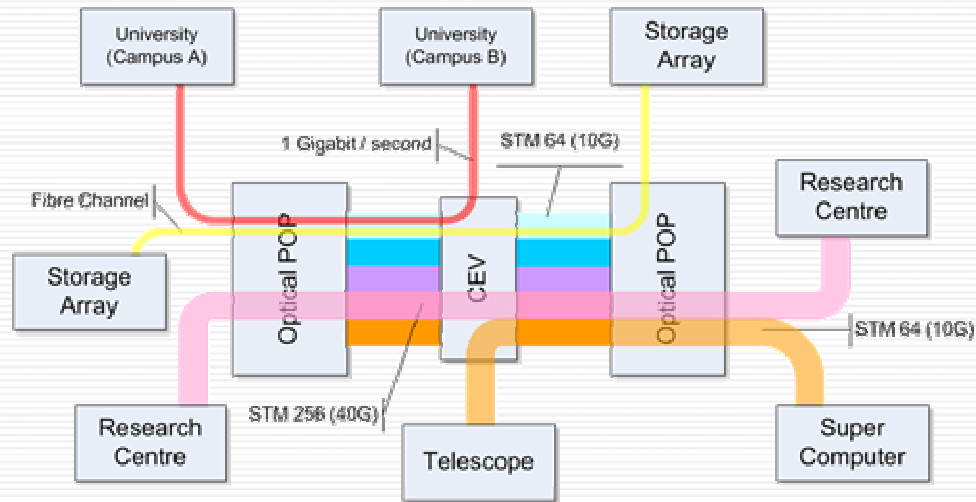
Summary



Summary



Summary



Summary

- Focus on the Community
 - High speed transparent networking has the potential to unite geographically challenged collaboration groups
 - A catalyst for new teaching paradigms
 - A facilitator and test bed for applications and services
 - Dedicated / reserved bandwidth
 - Private networks

AARNet – Building YOUR network



Questions?

Remarkable Achievement

- Carrier:
 - ‘Scale’ Network
 - ‘Quality’ network
 - fraction of the resources (and budget)
- Project:
 - Once started – completed on time & on budget
 - Demonstrated value of quality project management
 - Team: John Nicholls, Ivan Philips, Doug Farmer & Mary Fleming

AARNet: Supporting Australian Research

- Based on access to dark fibre
- Control of layers 1 to 3
- Effectively 'unlimited' capacity (Terabit capable)
- High speed IP (layer 3) backbone for 'production' traffic
- Dedicated point to point transmission for inter-campus links & specialised research & education needs
- UCLP or similar technology for access to scarce resources such as SXTransPORT
- Expansion of Optical Infrastructure – WA, Tas, Mitchell, Wagga, NT.....

AARNet – Building YOUR network



Questions?