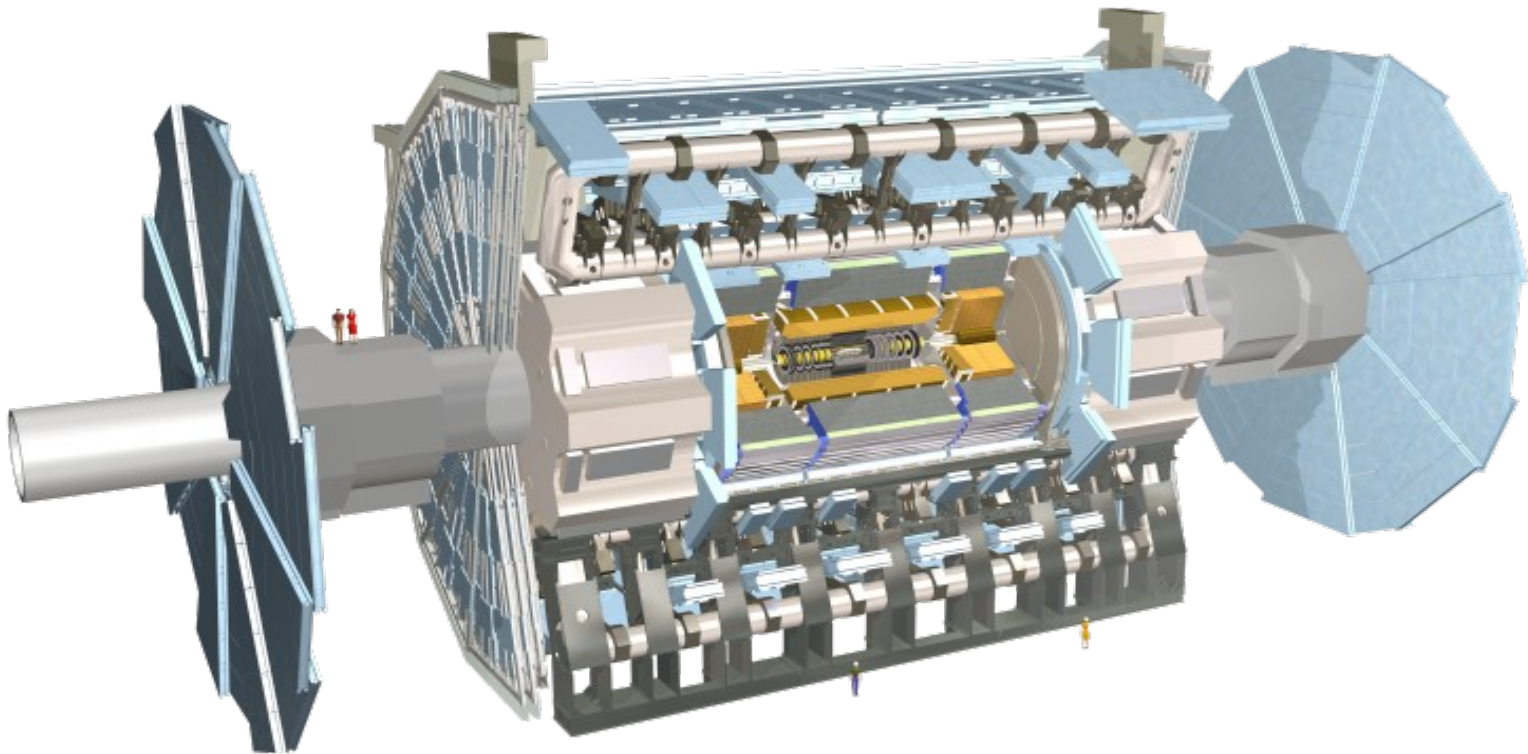


# High Energy Physics Collaboration across the Pacific



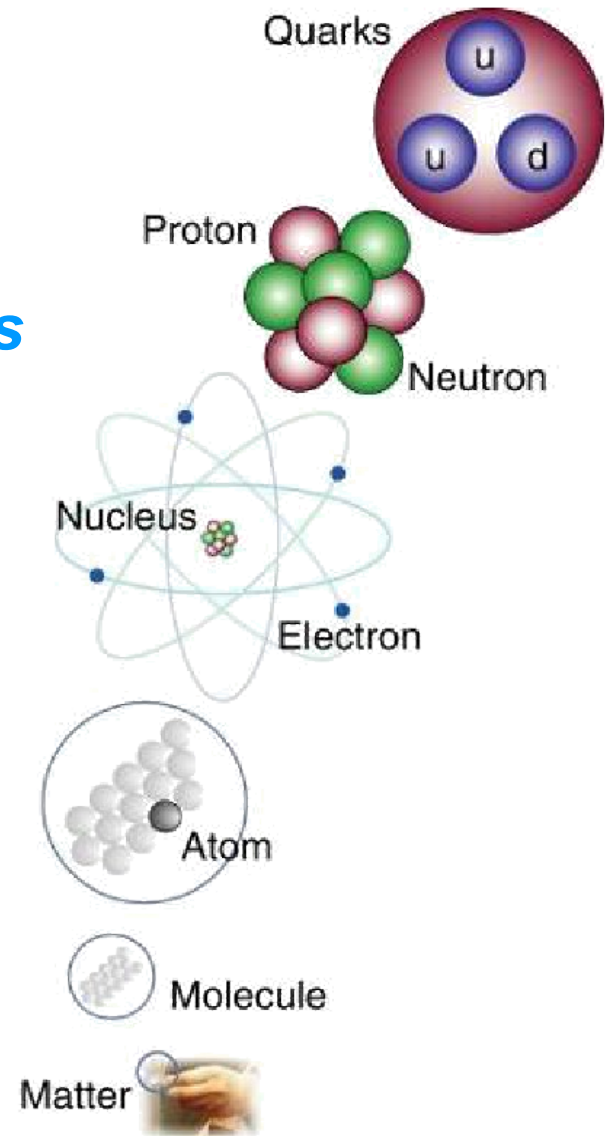
# Experimental High Energy Physics in Australia

- **Close collaboration between:**
  - University of Melbourne
  - University of Sydney
  - University of Wollongong
    - *Hold joint Research Grants*
      - *a single community of researchers*
- ***The Physicists:***
  - *Academic Staff, Research Fellows, Postgraduate Students, Engineers and Technicians*
- ***Members of major international HEP experiments...***
  - *ATLAS at the Large Hadron Collider, CERN, Geneva, Switzerland*
  - *Belle at the KEK laboratory, Tsukuba, Japan*

# High Energy Particle Physics

The aim of High Energy Physics is to:

“Understand the *fundamental laws of nature* by *studying elementary particles and fields* and their interactions”



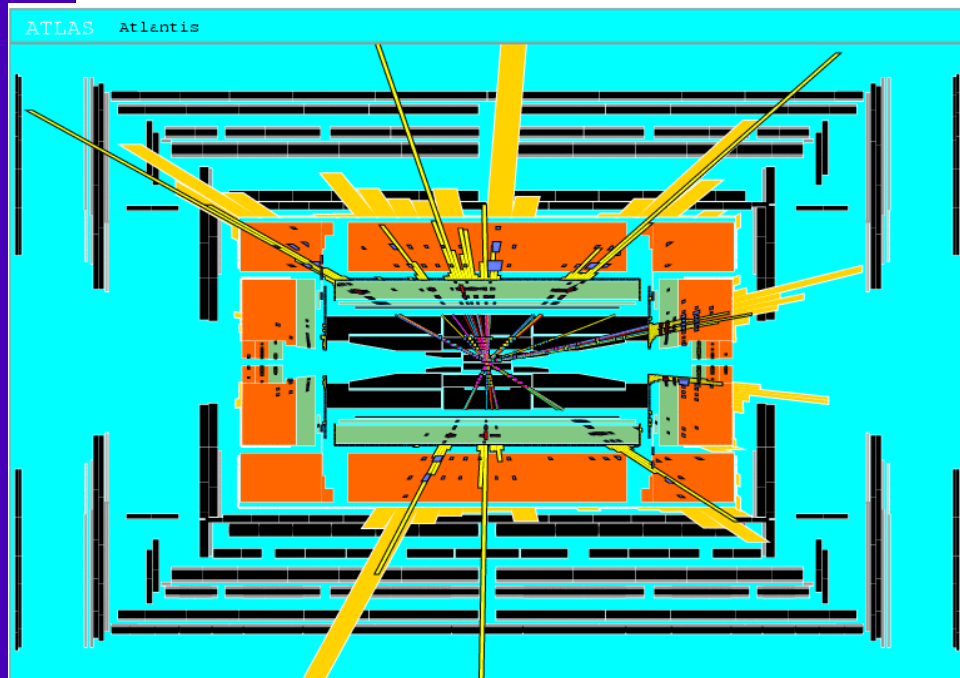


# Physics at the Tera-Scale

- The LHC is a *frontier machine* – operating in an unprecedented energy regime: *TeV collider*
  - Searching for New Physics – beyond the Standard Model
  - Enhancing our understanding of the fundamental structure of matter
    - ...and throwing a light on the the nature of the universe in the first moments after the Big Bang
- **ATLAS will look for:**
  - The elusive *Higgs Boson*: the “origin of mass”
  - Supersymmetry
  - Dark Matter, Dark Energy??
  - Large Extra Dimensions:
    - Microscopic Black Holes
  - Exotics: Magnetic monopoles,.....
  - ..... the *Unexpected*

# Black Holes at ATLAS

*ATLAS was honoured by a visit from Stephen Hawking*



Simulation of a mini black hole event with  $M_{\text{BH}} \sim 8 \text{ TeV}$  in ATLAS

# Data Mining

Particle physicists wade through vast collections of events, searching for increasingly rare processes

- *In principle, each physicist, or each team, is looking for something different.*

So, we have thousands of scientists searching through vast collections of data:

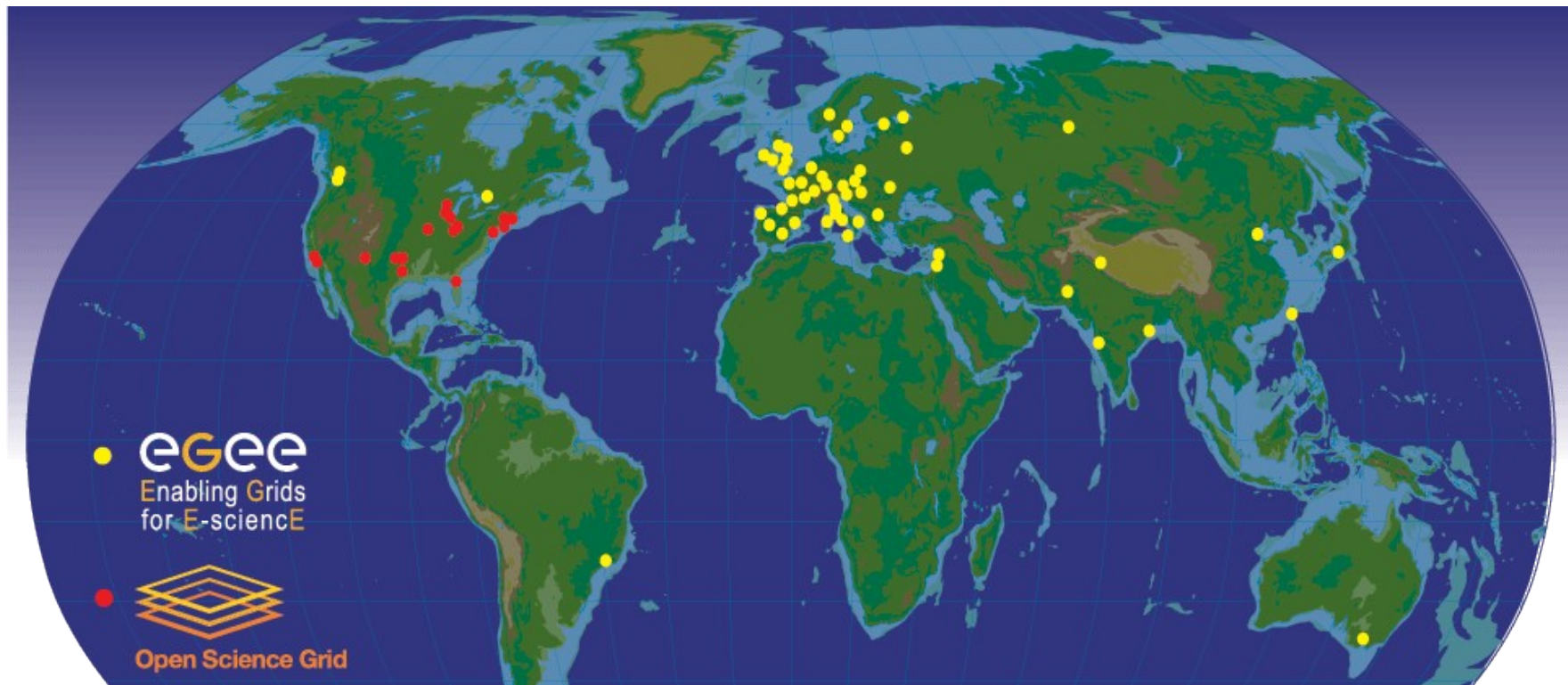
- Widely distributed across the Earth
- Each looking for a different type of needle in the haystack

*Chaotic data usage patterns!*

*Equity of Access:* It is essential to deliver high bandwidth data streams to researchers at their home or regional data analysis facilities - a very competitive business

# The Worldwide LHC Computing Grid

- The **EGEE** and **OSG** projects are the basis of the Worldwide LHC Computing Grid Project: **WLCG**



**Inter-operation between Grids is working!**

# WLCG: A Truly Global Grid



Scheduled = 25002  
Running = 12614



15:38:56 UTC



# Australian ATLAS Computing Service

- Target Resources for Australian facility:

	2007	2008	2009	2010
Disk (TB)	30	250	400	700
CPU (kSI2K)	80	550	850	1500

- An average Tier 2/3 – to serve Australian ATLAS members
  - *Essential to ensure Australian researchers are competitive at the LHC*
- Australia has deployed a production Tier 2 centre at the University of Melbourne
  - Will become an Australian Tier 2 Federation with partner resources at VPAC, AC3, SAPAC, University of Sydney...
  - Supported by APAC National Grid program since 2004
  - University of Melbourne provides hosting and network support

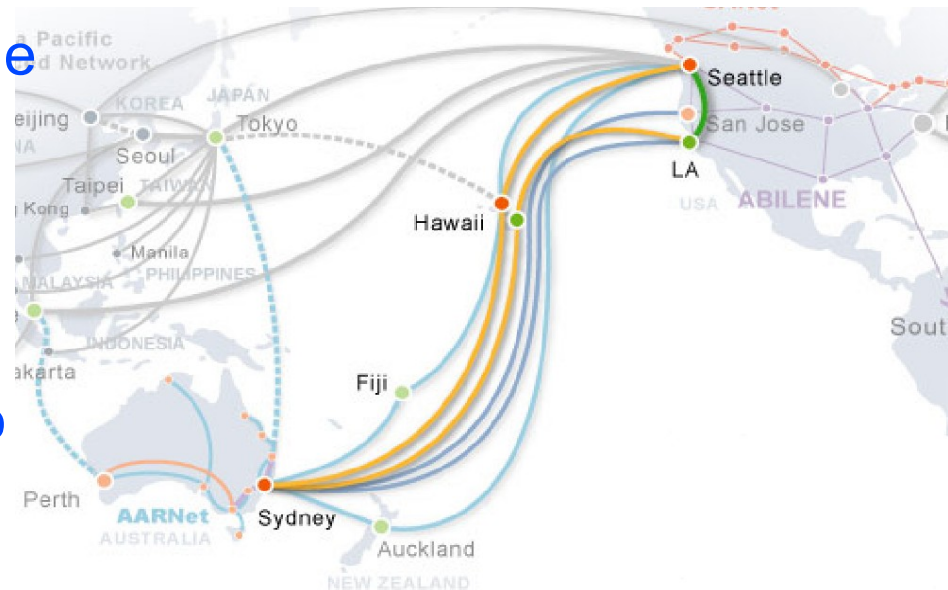
# Australia's ATLAS Computing Service

We are now operating a reliable *production* facility in the *world's largest eResearch infrastructure*  
(cyber-infrastructure, research e-infrastructure)

- Now hosting 12 Terabytes of simulated ATLAS data
  - replicated from ATLAS collaborators across the globe
  - 35 Terabytes capacity since September 2007
  - Supporting simulated data production, data analysis and detector calibration
- Building expertise and capacity:
  - Major capacity upgrade for 2008
  - We will be ready for first data from the LHC in 2008.

# Australia's ATLAS Computing Service

- Australia's Tier 2 is a node of the EGEE/LCG Grid:
  - Academia Sinica, Taipei, hosts the Asia-Pacific Tier 1 centre and ROC: Strong collaboration and mutual support
- Intensive collaboration in Asia-Pacific:
  - Working closely with EGEE, OSG, APAC, AARNet, CERN, Taipei, China, Japan - *a truly global collaboration*
- Network Connectivity
  - Our primary data source is the Tier 1 (Taipei)
  - Our data crosses the pacific twice:
    - Melbourne-US-Taipei
  - AARNet have worked hard to support our program

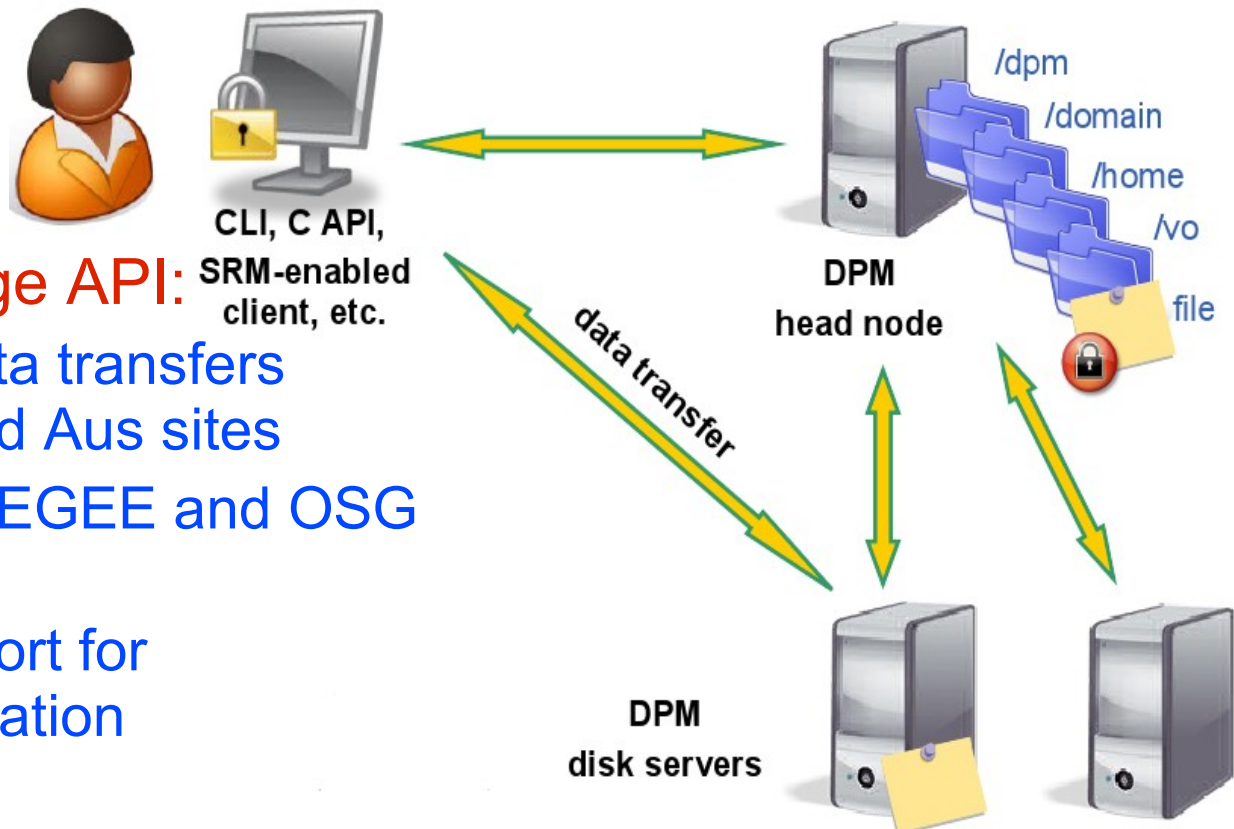


# So, how do researchers use these facilities?

- EGEE/OSG middleware provides:
  - Storage Resource Management (SRM)
  - File Transfer Service (FTS) for managed file transfer queues
  - File Catalogues (LFC,LRC) with file replica management
- ATLAS deploys a Distributed Data Model (DDM) on top of these services
  - Data files are organised into *data sets*
  - We request *subscriptions* of data sets to our sites.
  - DDM system manages subscriptions and files are transferred through a managed data transfer service: *FTS*
- Analysis of data “goes to the data set”
  - Place the data – then send jobs to it

# Storage Resource Manager

- **SRM defines an API to Storage**
  - Multiple implementations: dCache, DPM, Castor, StoRM
  - Australia has deployed DPM
  - US ATLAS has deployed dCache

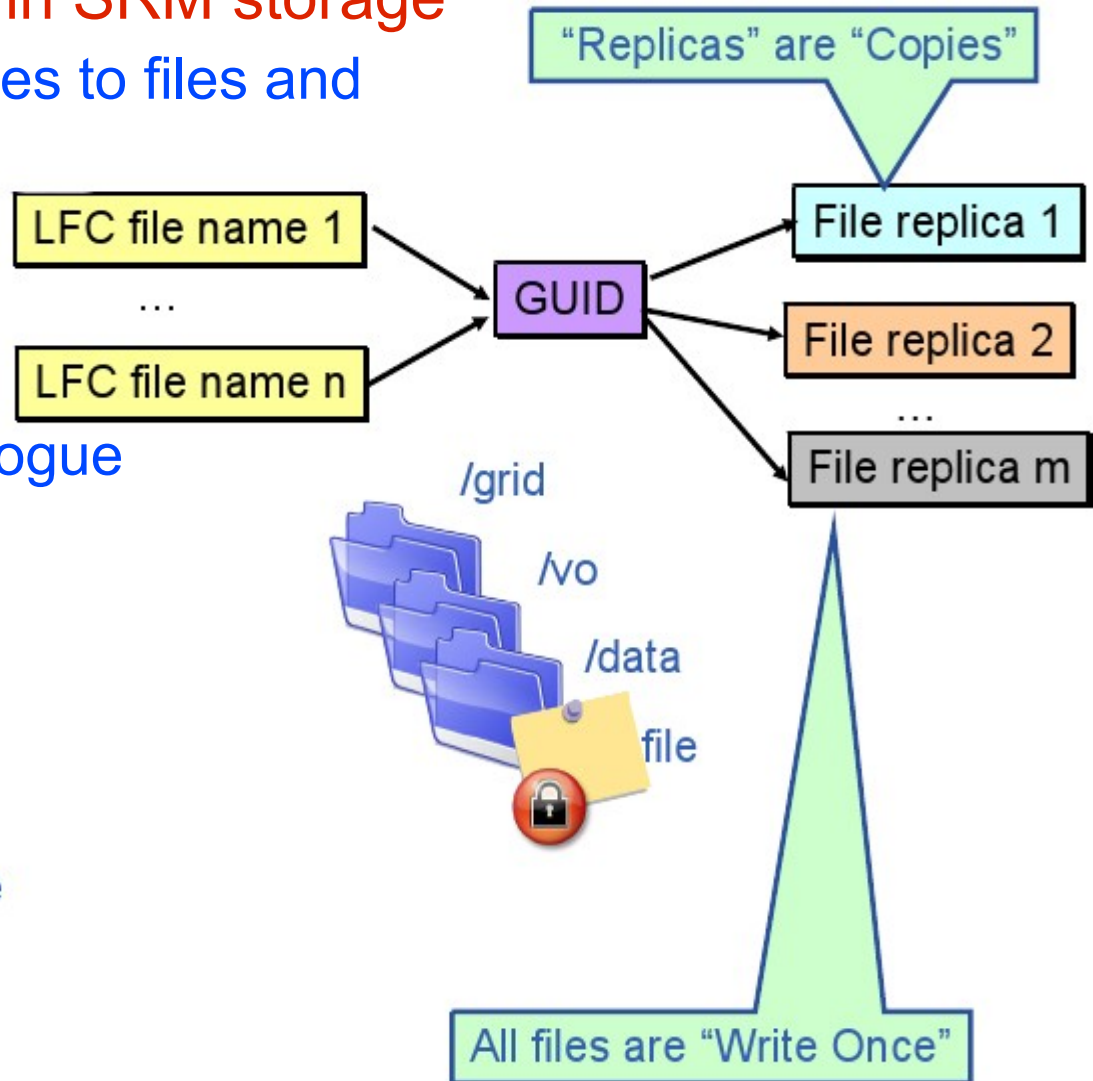


- **A common storage API:**
  - Transparent data transfers between US and Aus sites
  - Integrated with EGEE and OSG grids:
    - VOMS support for access/allocation

# File Catalogues: the LFC and LRC

## File Catalogues for files in SRM storage

- Maps Logical File Names to files and replicas on the grid
- EGEE uses the LFC:
  - LCG File Catalogue
- OSG uses LRC:
  - Local Replica Catalogue



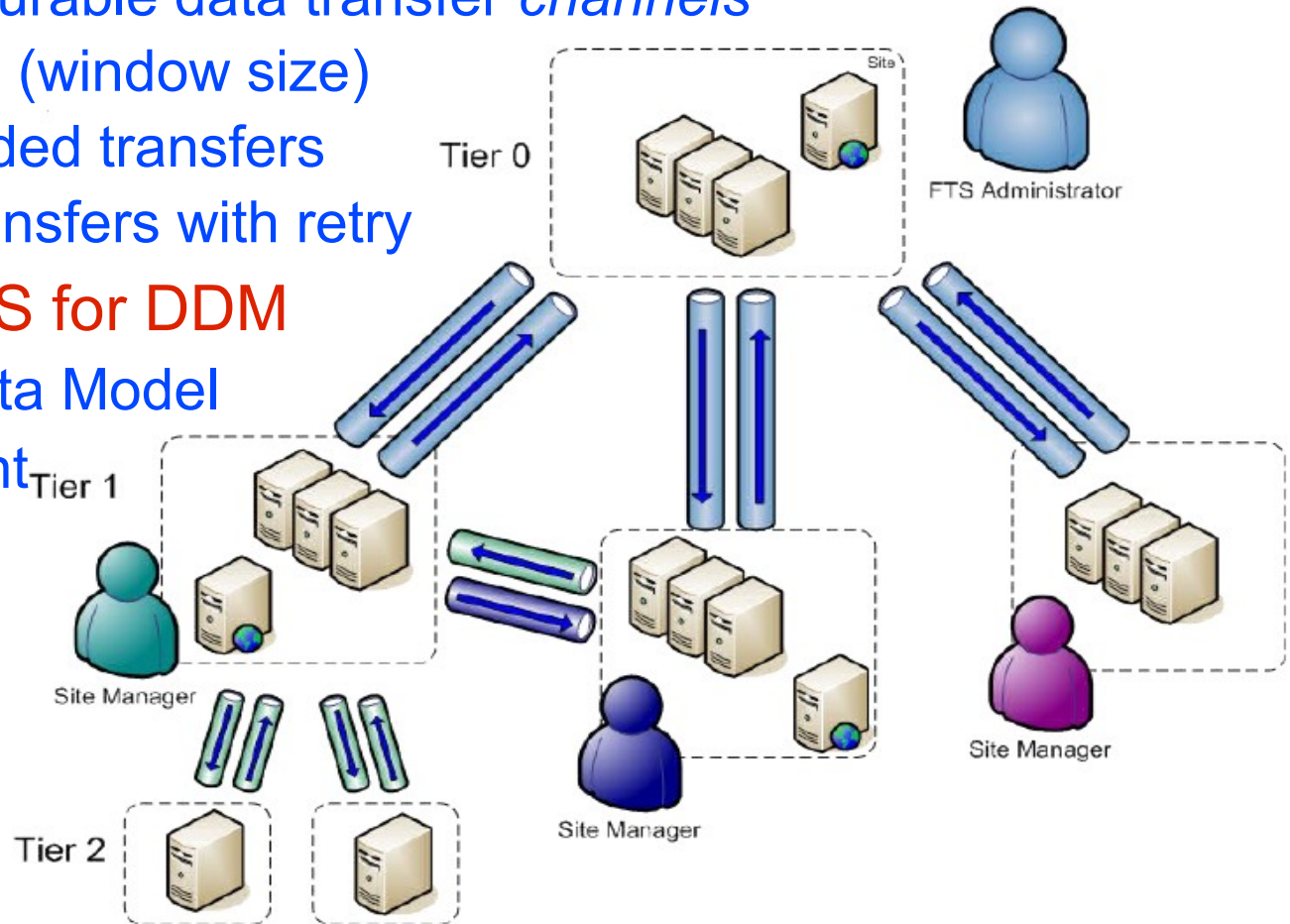
# The File Transfer Service

FTS is a reliable VO-aware data transfer service

- Manages data transfers between SRM endpoints
- Defines configurable data transfer *channels*
  - TCP tuning (window size)
  - Multi-threaded transfers
  - Queued transfers with retry

ATLAS uses FTS for DDM

- Distributed Data Model
- data movement



# Deeper Collaboration across the Pacific

- Australian and US communities do collaborate:

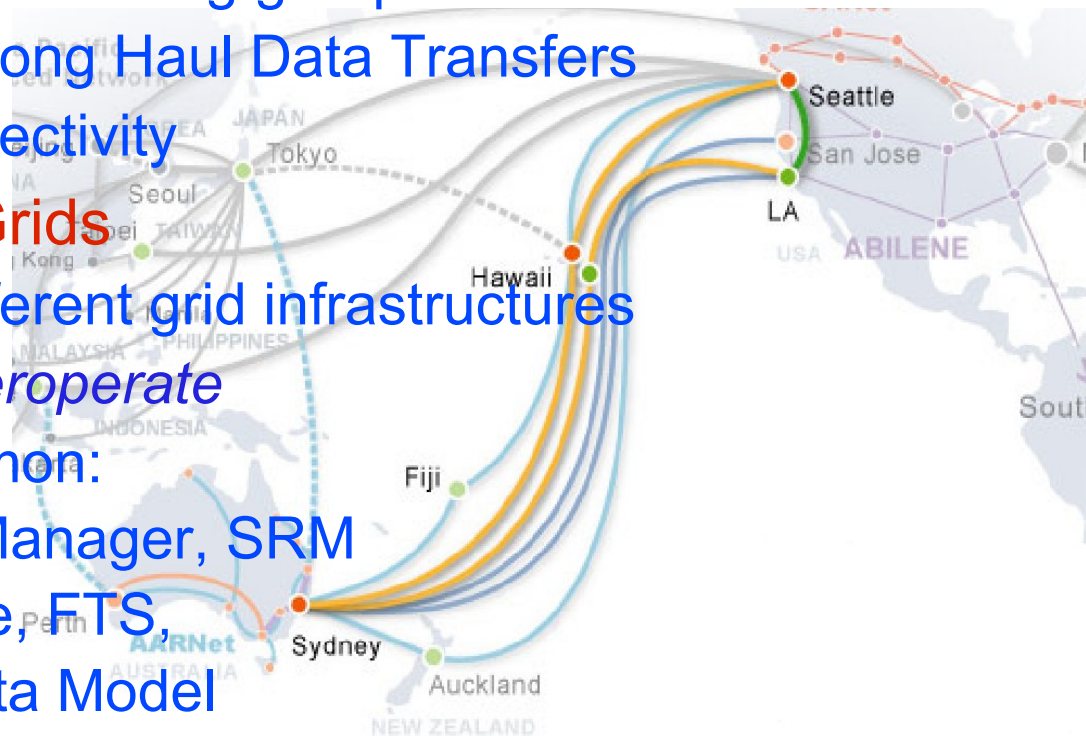
- We are members of the same collaborations: *ATLAS, Belle*

- We can deepen that collaboration around ATLAS data:

- Sharing Derived Physics Datasets (DPDs)
  - Produced by Physics working groups
- Common activities on Long Haul Data Transfers
- Improved network connectivity

- Collaboration between Grids

- We are members of different grid infrastructures
- *EGEE and OSG do interoperate*
- Data services are common:
  - Storage Resource Manager, SRM
  - File Transfer Service, FTS,
  - Atlas Distributed Data Model



# Data driven Collaboration across the Pacific

- **Sharing Physics across the Pacific:**
  - The default data path to our sites is via Taipei Tier 1
    - The ATLAS Distributed Data Model (DDM)
    - Data crosses the pacific three times!
  - But... We can share data directly between Australian and US physics groups
    - Opportunity to deepen US-Aus cooperation
    - Our best data path is to/from US ATLAS sites
- **Collaborating on Networks**
  - Optimising data transfer protocols and throughput:
    - AARNet, UltraLight, PacificWave
  - This workshop has already fostered this activity

# Sustaining Collaboration...

- **Sustaining increased collaboration across the pacific**
  - Requires engagement by ATLAS physicists
  - Come together around shared data
  - Sharing data across the pacific is a natural fit for Australian HEP researchers
- **Need to maintain high performance data transfers**
  - Cooperation on network and application tuning and monitoring
    - Can we sustain the efforts initiated by this workshop?