TEIN2

International Research Networking

AARNet

Australia's National Research and Education Network

Mark Prior

J-Talk, Canberra, 6 July 2006

TEIN2

aarnet

Agenda

- A little history
- Technology
- Applications
  - Astronomy
  - High Energy Physics
  - Tele-medicine
- TEIN2
  - Regional Collaboration

A little history…

- 1989
  - ACSnet protocol of choice, Fidonet, SPEARNET, …
  - Discussions about “AARNet” at Australian Networkshop
  - Adelaide to Melbourne IP link
    - Combo of 9600 & 4800 baud!
  - Melbourne to US
    - TrailBlazer modems
- 1990 - AARNet
  - 48kbps interstate links
  - 56kbps link to Hawai`i (joint with NASA)

International Research Networking

A little more history …

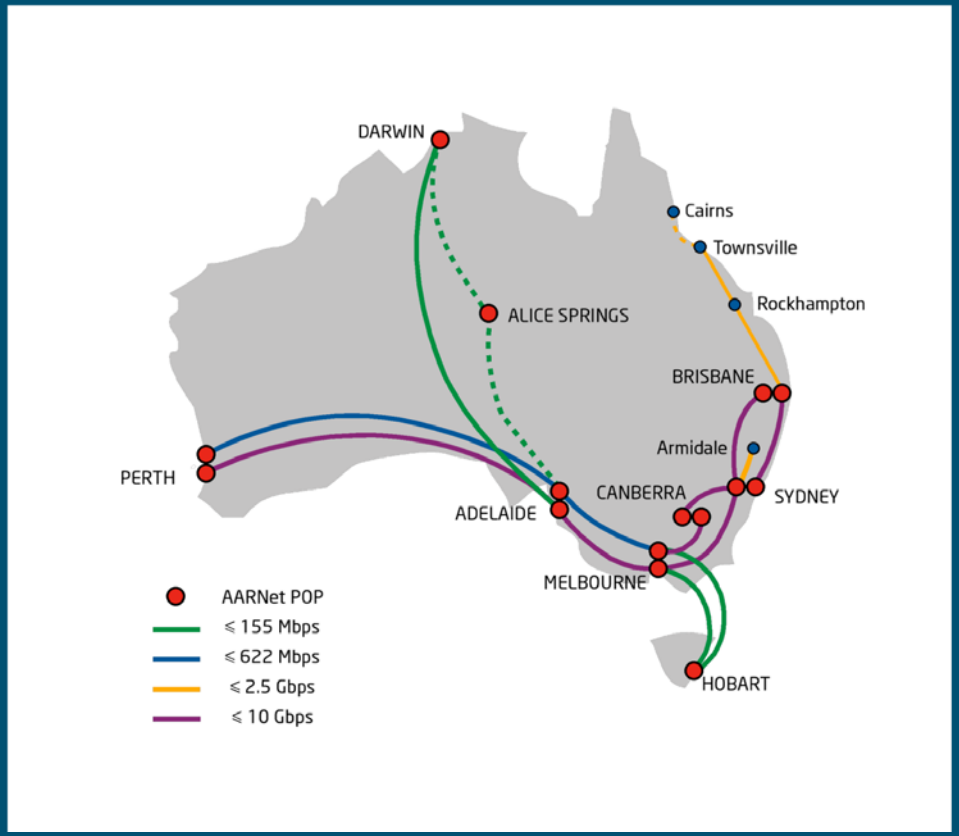
- 1992 - First commercial ISPs
- 1993 - Gopher, WAIS, and … World Wide Web
- 1995 - Commercial customer base sold to Telstra
- 1997 - AARNet2
  - ATM based network with Cable & Wireless Optus
- 2001 - Links on Southern Cross Cable Network (SCCN)
  - Direct connection to Internet2
- 2003 - AARNet3 RFP, Nextgen into receivership
- 2004 - 10Gbps SDH backbone, SXTransPORT
- 2006 - DWDM, Dark Fibre, Direct connection to Géant2

TEIN2

aarnet

AARNet3 National Network

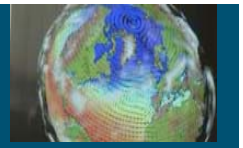
- 10Gbps SDH backbone
- DWDM
- Dual POPs
- Multi Vendor
  - Juniper core
  - Cisco edge & optical
  - Some Foundry
- R&E + Commodity
- Customers connected via Gigabit Ethernet



TEIN2

aarnet





DIY Network

- Carrier #61
- Using dark fibre to build a national optical network from Adelaide to Brisbane
- Lit with DWDM equipment
- Providing Gigabit Ethernet services to regional areas
- Carrying inter-capital 10Gbps

TEIN2

aarnet

Protocols

- IPv4 and IPv6
  - Waiting for IPv6 traffic to appear though
- Unicast and Multicast
  - SSM for both IPv4 & IPv6, ASM for IPv4
- Routing Protocols
  - BGP and OSPF(v3) [multi area]
- MPLS Traffic Engineering
  - Currently only for AUP enforcement
  - Will use for load balancing into Hobart

Billing

- Multi component model
- Relies on *flow
  - Measurement at edges facing customer
  - Issues with scaling past Gigabit Ethernet
- R&E traffic flat rate, “all you can eat”
  - Based on staff & student numbers + research income
- Commodity usage based
  - Need to pass on costs from transit providers
- End users may not see benefits of flat rate R&E
  - AARNet has no control over how they are billed by their organisation

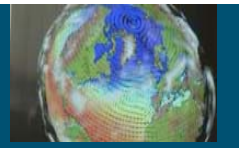
Why is a R&E network different?

- Peak demand can be driven by a single user driving a single application
- Interest in advanced services
  - IPv6
  - Voice, video, multicast
- Latency important to some but others more interested in bandwidth
- Need to build for peak demand
- So that means lots of “white space”
- But “Nature abhors a vacuum” …

Enough of the plumbing!

- The network is a fine thing but what you do with it is more important
- Commodity Internet (boring)
- Astronomy
- High Energy Physics
- Tele-medicine





Huygens Space Probe

- Cassini spacecraft left Earth in October 1997 to travel to Saturn
- On Christmas Day 2004, the Huygens probe separated from Cassini
- Started it's descent through the dense atmosphere of Titan on 14 January 2005

International Research Networking

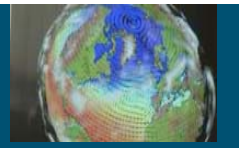
Tracking the Descent

- Very Long Baseline Interferometry (VLBI) is a technique where widely separated radio-telescopes observe the same region of the sky simultaneously to generate images of cosmic radio sources
- Using this technique 17 telescopes in Australia, China, Japan and the US were able to accurately position the probe to within a kilometre (Titan is ~1.5 billion kilometres from Earth)

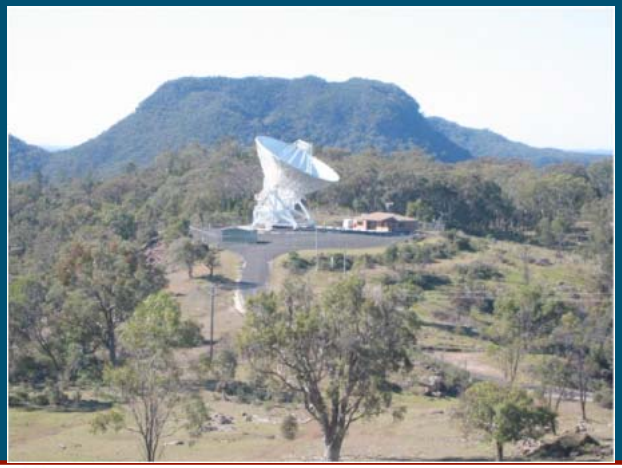
TEIN2

aarnet





Australian Contribution

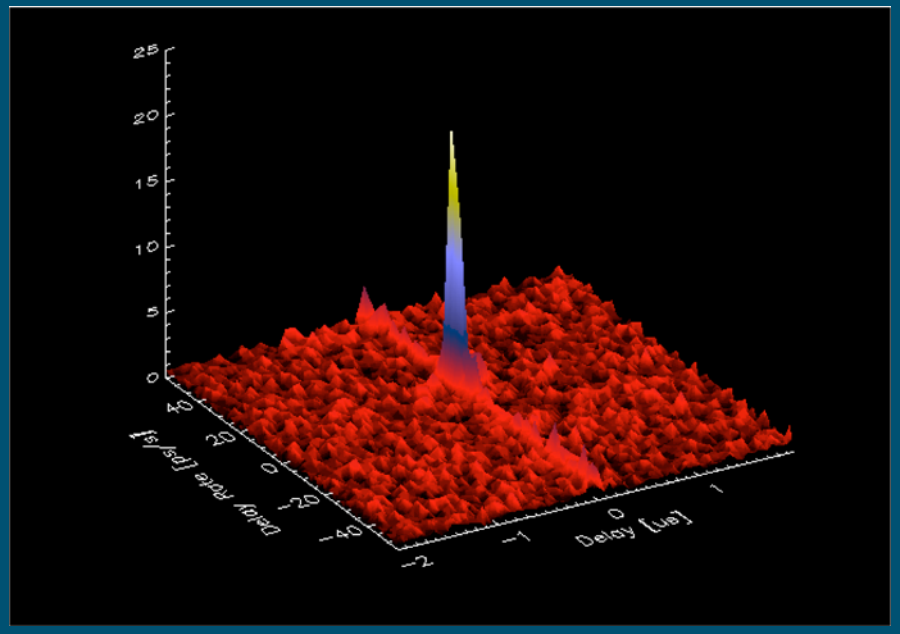


- Created “dedicated” circuit
- The data from two of the Australian telescopes (Parkes [The Dish] & Mopra) was transferred via light plane to CSIRO Marsfield (Sydney)
- CeNTIE based fibre from CSIRO Marsfield to AARNet3 GigaPOP
- SXTransPORT 10G to Seattle
- “Lightpath” to Joint Institute for VLBI in Europe (JIVE) across CA*net4 and SURFnet optical infrastructure

TEIN2

aarnet

Australian Contribution



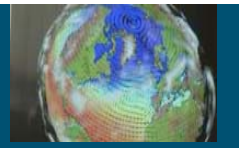
VLBI Fringes

- The data was transferred at a peak rate of 400Mbps
- 1Gbps path was available
- TCP/IP stack tuning important
- The data from these two telescopes were reformatted and correlated within hours of the end of the landing
- This early correlation allowed calibration of the data processor at JIVE, ready for the data from other telescopes to be added

TEIN2

aarnet





Mauna Kea

- the world's largest astronomical observatory on a dormant volcano on Big Island of Hawai`i
- altitude of 4,205 m (13,796 ft)
- mountain sickness is common
- Australia partner in “Gemini”
  - NB Gemini South in Chile
- Soon to be connected to SXTransPORT South
  - Sydney to Los Angeles
  - Multiple Gigabit Ethernet
  - Improved remote observing

SX TRANSPORT

TEIN2

aarnet

Large Hadron Collider (LHC)

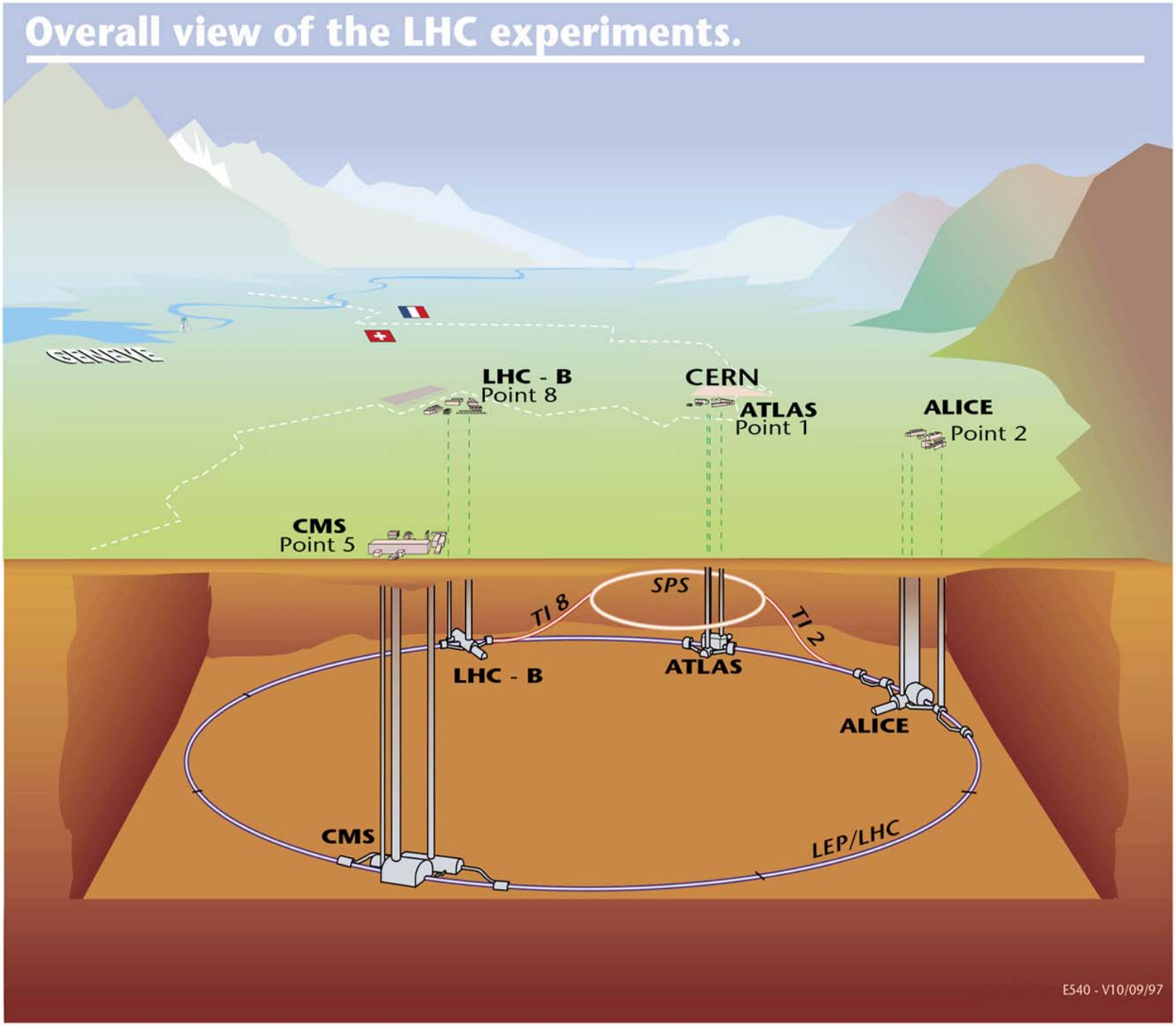
International Research Networking

- The Large Hadron Collider is currently being installed in a 27-kilometer ring buried deep below the countryside on the outskirts of Geneva, Switzerland.
- When its operation begins in 2007, the LHC will be the world's most powerful particle accelerator. High-energy protons in two counter-rotating beams will be smashed together in a search for signatures of supersymmetry, dark matter and the origins of mass.
- For most of the ring, the beams travel in two separate vacuum pipes, but at four points they collide in the hearts of the main experiments, known by their acronyms: ALICE, ATLAS, CMS, and LHCb.

TEIN2

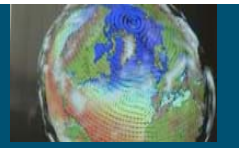
aarnet

Overall view of the LHC experiments.



Large Hadron Collider (LHC)





International Research Networking

CMS

ATLAS

Per experiment

40 million collisions per second

- After filtering, 100 collisions of interest per second
- A Megabyte of digitised information for each collision = recording rate of 100 Megabytes/sec
- 1 billion collisions recorded = 1 Petabyte/year

1 Megabyte (1MB)
A digital photo

1 Gigabyte (1GB)
= 1000MB
A DVD movie

1 Terabyte (1TB)
= 1000GB
World annual book production

1 Petabyte (1PB)
= 1000TB
10% of the annual production by LHC experiments

1 Exabyte (1EB)
= 1000 PB
World annual information production

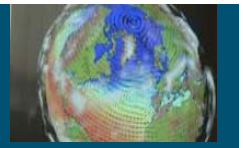
TEIN2

aarnet

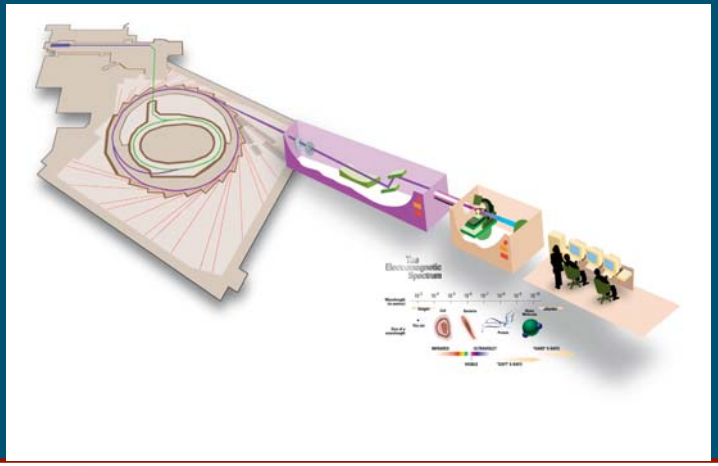
Tiered data distribution model

- Tier0 center at CERN processes raw data into event data
- Tier1 centers receive event data from CERN
  - No Tier1 center in Australia
  - Regional Tier1 center in Taiwan
  - In practice Australian scientists might use North American centers
    - FNAL is CMS Tier1 center for USA
    - BNL is Atlas Tier1 center for USA
    - CERN to USA Tier1 data rates: 10Gbps by 2007, 30-40Gbps by 2010/11
- Tier2 and Tier3 sites receive data from Tier1 centers
  - Tier2 & 3 sites are end user analysis facilities
  - Analysis results are sent back to Tier1 and Tier0 centers





Canadian Light Source

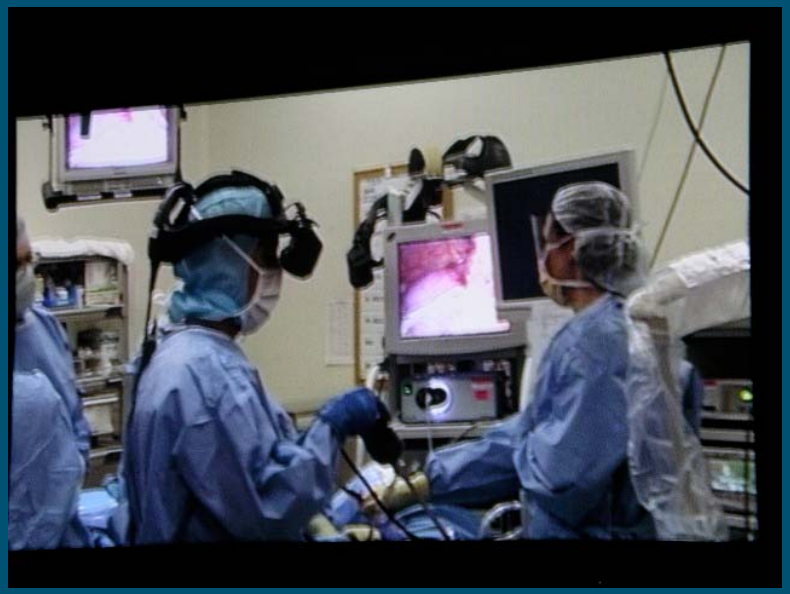


- Canada's national facility for synchrotron light research
- Early access to beamlines by Australian Researchers before the Australian Synchrotron is available
- Opportunity to test out the issues associated with global access to synchrotron facilities
- Discussions initiated with Bill St Arnaud (CANARIE) and with Stewart McIntyre and Elder Matias (Lightsource)

Telepresence on advanced networks

International Research Networking

- “As good as being there”
- Relies on good
  - Bandwidth
  - Quality of service
  - Latency (delay)
- Supported by Human Factors and Computer Human Interaction research



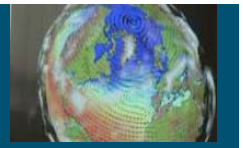
TEIN2

aarnet

Telepresence in medicine

- Complex information spaces, such as multidimensional medical images
- Supports delivery of complex procedures over a distance
  - Surgery
  - Emergency medicine
- Synchronous interaction rather than “store & forward”





Telepresence in medicine

- Support of multisensoral working
  - High resolution video
  - Stereoscopic video
  - Stereophonic sound
  - Immersive vision for high situation awareness
  - Haptic (force) feedback for interaction with tissue
- CSIRO Virtual Critical Care Unit
  - Nepean and Katoomba

AARNet & TEIN2

- AARNet is a non beneficiary partner of TEIN2 project
  - an Asia Europe Meeting (ASEM) initiative
  - Australia has no official government representation
- Project facilitated better pricing for westward circuits
- The Australian R&E community gains a direct link into Asia and access to Europe via western path
- Potential to improve real time collaboration and position focus of joint activity towards Asia
- Our time zone is finally an advantage

TEIN2

aarnet

TEIN2 – In a Nutshell

International Research Networking

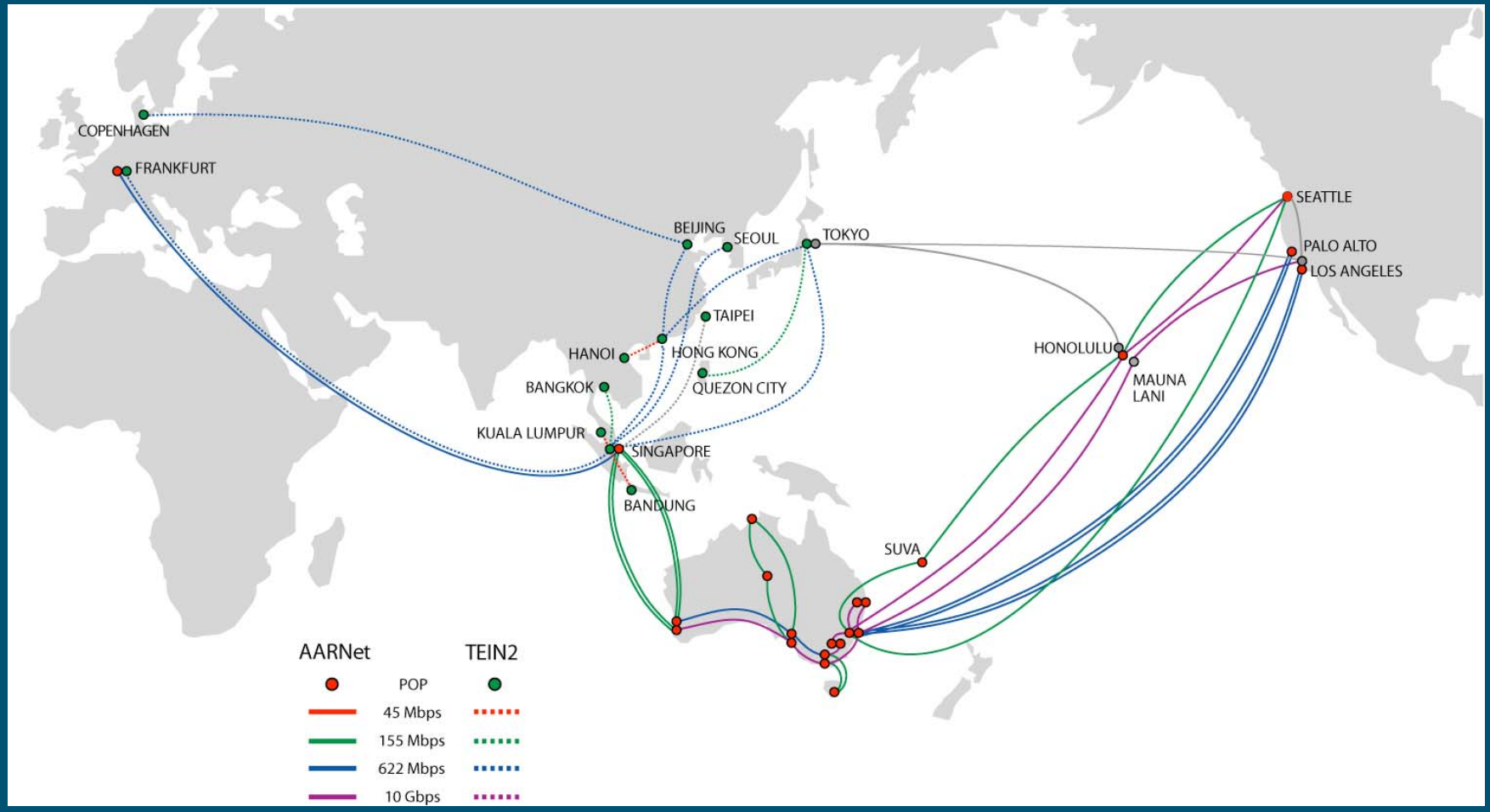
- TEIN2 is an ASEM success story
- Continuity: extends success of TEIN1 to regional level
- Establishes first intra-regional R&E network in Asia-Pacific
- Via GÉANT2, it enables EU-Asian R&E collaboration
- Asia-Europe traffic no longer via North America
- Strengthens links between Asia and Europe
- Contributes to bridging the digital divide in the region
- Drives innovative applications with high societal impact (e.g. telemedicine, e-learning etc)
- Fosters regional development and cohesion in Asia
- Validates EC's strategy of extending global research networking
- Prepares the ground for long term sustainable research networking
- Future funding, beyond 2007, crucial to guarantee consistency and further geographical extension of network

TEIN2

aarnet

AARNet & TEIN2 Footprint

International Research Networking



TEIN2

aarnet

Royal Children's Hospital Melbourne
National Hospital of Paediatrics, Hanoi

International Research Networking

- 8-10 exchange visits per year
- Collaboration on NHP Hospital redevelopment
- Staff training master plan
- Other specialised paediatric training
- Reducing newborn mortality

TEIN2

aarnet

Royal Children's Hospital Melbourne
National Hospital of Paediatrics, Hanoi

International Research Networking

- Improving outcomes congenital adrenal hyperplasia
- Prevention of blindness due to retinopathy of prematurity
- Early detection, prevention of eye disease
- Cause & incidence of Intussusception

TEIN2

aarnet

Flinders Medical Centre, Kyushu University Hospital & National University of Singapore

International Research Networking

- Endo-laparoscopic (keyhole) surgery at FMC
- Doctors & Students view surgery at KUH and NUS
- Interaction with surgeon conducting operation
- Video conferencing via Digital Video Transfer System (DVTS)

TEIN2

aarnet

Potential applications of TEIN2

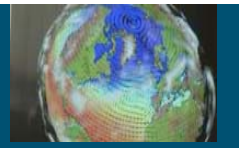
International Research Networking

- Training through lecture or example
- Mentoring & planning complex procedures, e.g. complex surgery
- Followup examinations of patients
- Multidisciplinary case discussions
- Specialist intervention available at call
- More interaction, less travel

TEIN2

aarnet





The way forward

- Unlock specialist expertise to create medical teams who can ignore borders and distance.
- Success depends on supporting research into applications.
- A focus on training and children’s health will build for the future.




TEIN2

aarnet

Acknowledgements

- Laurie Wilson, CSIRO
- Shuji Shimizu, Kyushu University
- Canadian Light Source Inc., University of Saskatchewan
- Fermi National Accelerator Laboratory and Stanford Linear Accelerator Center

TEIN2

aarnet

International Research Networking

Thank You

- Mark Prior
  Chief Technology Officer
  AARNet
  Adelaide Office
  Level 7, 10 Pulteney Street
  The University of Adelaide, 5005

  mark.prior@aarnet.edu.au

http://www.aarnet.edu.au
http://www.tein2.net

TEIN2

aarnet