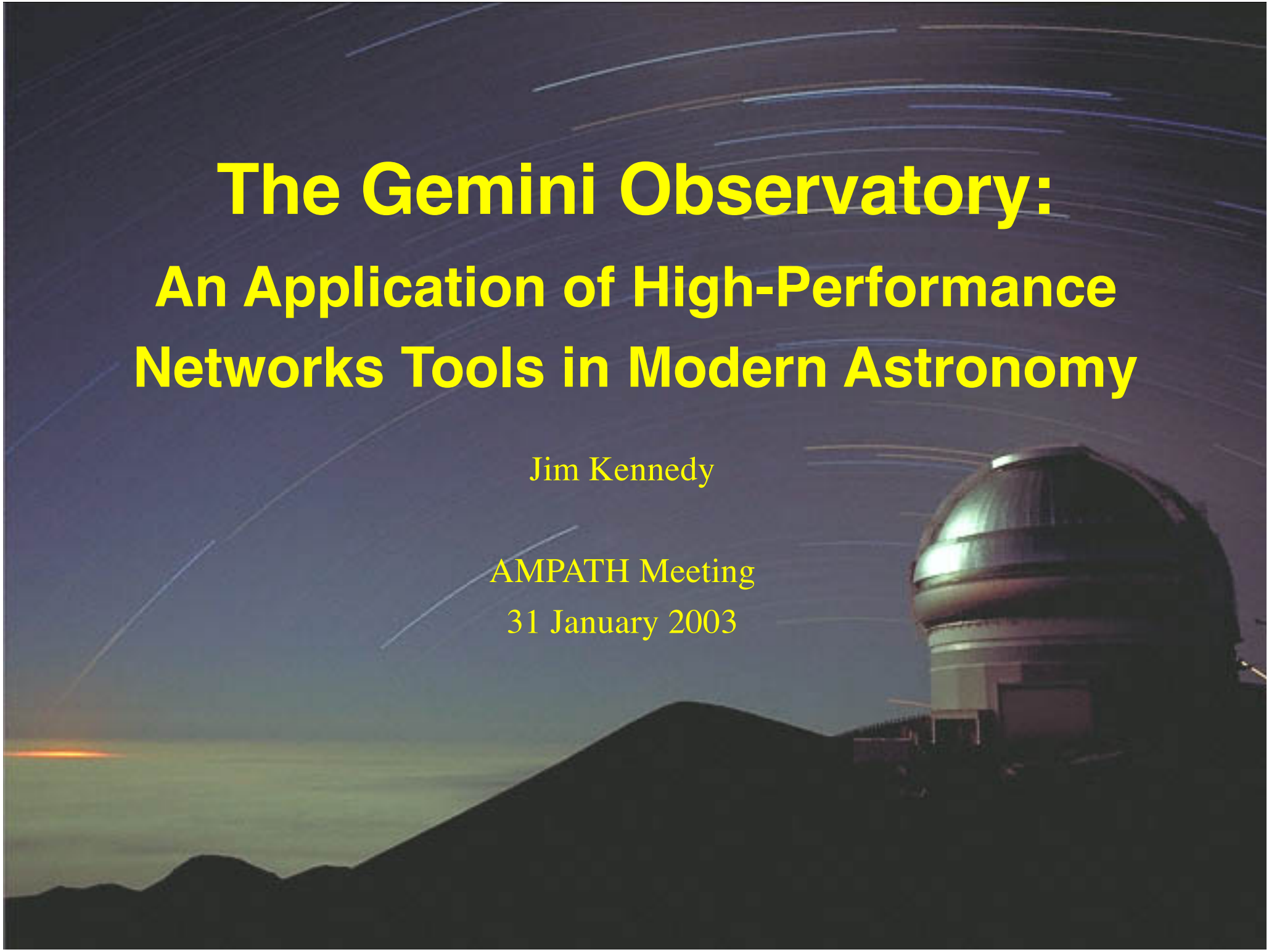


The Gemini Observatory:
An Application of High-Performance Networks Tools in Modern Astronomy

Jim Kennedy

AMPATH Meeting

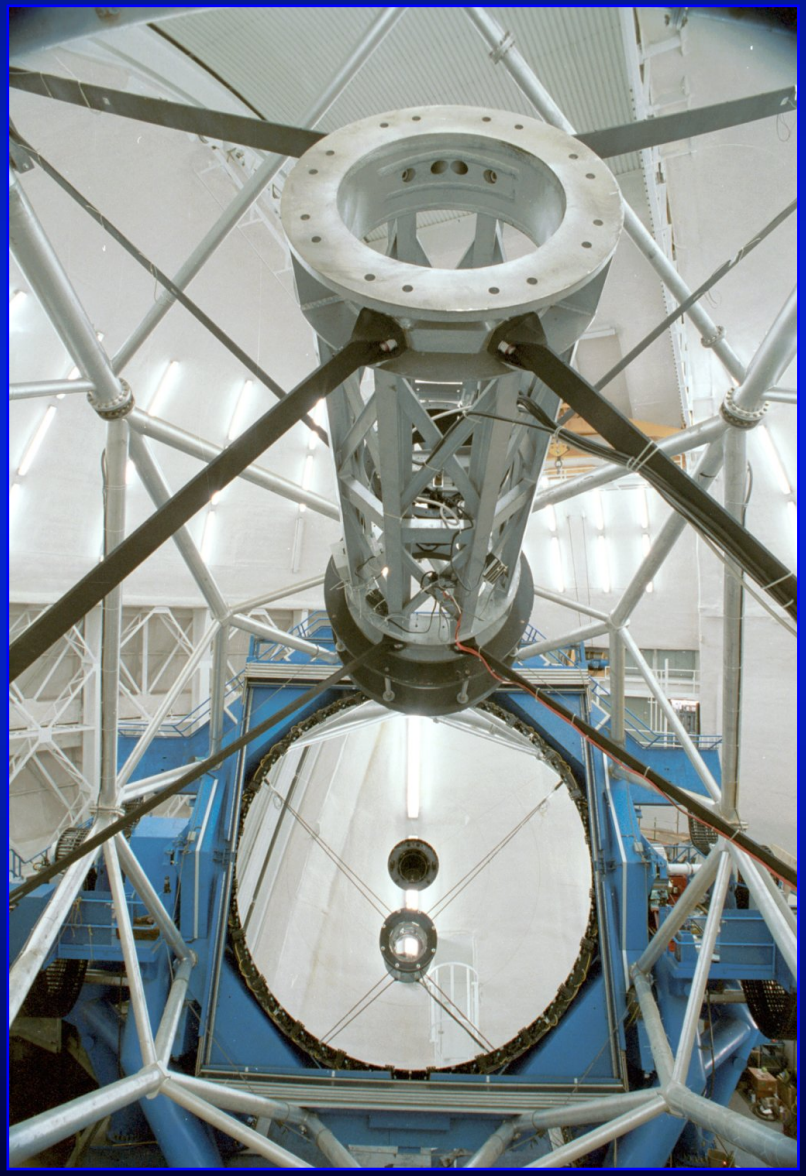
31 January 2003

Why Do Astronomy?
Research Objectives

- Understand the Universe
  - Its Origins
  - Current State
  - Its "Destination"
- Origins of Life in the Universe
- Connecting Relativity and QCD, (GUTs/TOEs)
- And Other Modest Goals

Some of Our Tools

Gemini North, Mauna Kea Hawaii



Typical Gemini Science Missions

Primarily Infrared Astronomy

- Evolution and Formation of Elements
- Formation and Evolution of Galaxies
- Black Holes in Galactic Cores
- Stellar Nurseries
- Visualizing Planets Around Other Stars
- Evolution of Planetary Systems

Observing Site Requirements

- Short air column to space
- High percentage of clear skies
- Very dry air – from telescope to space
- Low atmospheric turbulence – laminar flow
- Low EM “pollution” – light or radio
- Usually moderate wind speeds
- Accessibility to scientists

Where Are These Conditions Found?

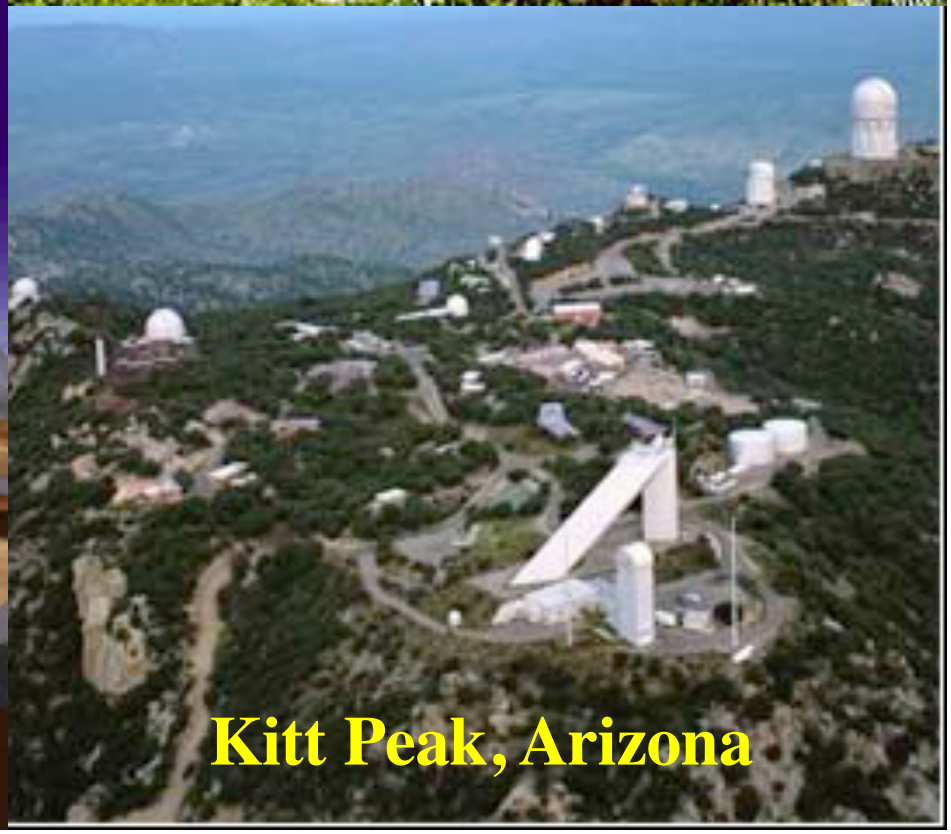
- High mountains
  - On some volcanic tropical islands
  - On some high, arid deserts
- Away from traditional storm tracks
- Smooth up-slope approaching terrain
- Far from major cities

=> Generally places were people don't live


Subaru, Mauna Kea Hawaii


Arecibo, Central Puerto Rico


ALMA, Atacama Desert Chile


Kitt Peak, Arizona

One Observatory
Two Telescopes
The Whole Sky

Mauna Kea Hawai'i
13,700 ft

Cerro Pachón Chile
9,000 ft

Where Do the Astronomers Live?

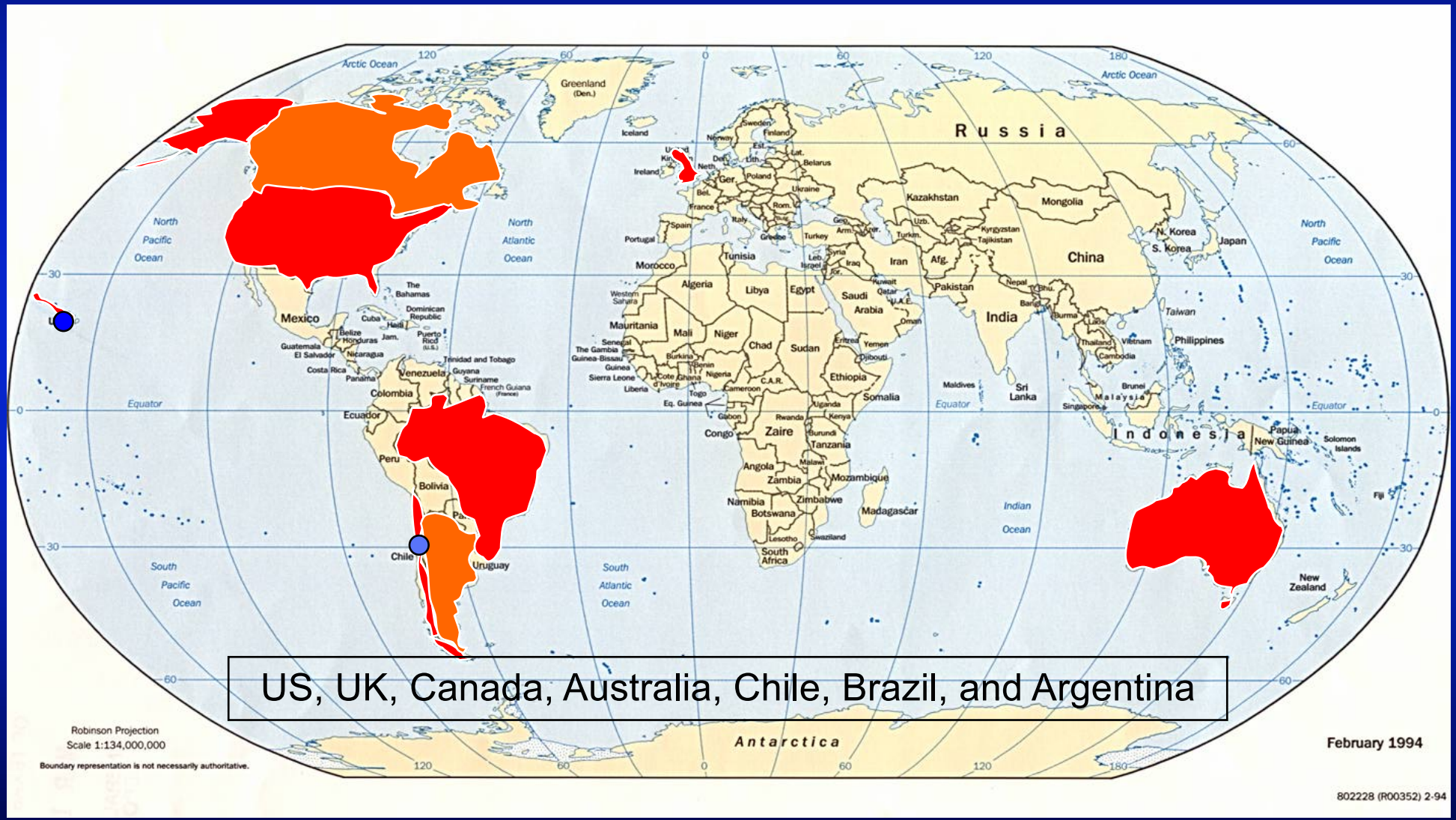
Generally, somewhere far, far away!

Where people can breath, plants grow, and shopping malls are handy.

Consider Gemini, for example...

Gemini's Science Communities

A Seven-Nation Partnership



Typical Issues

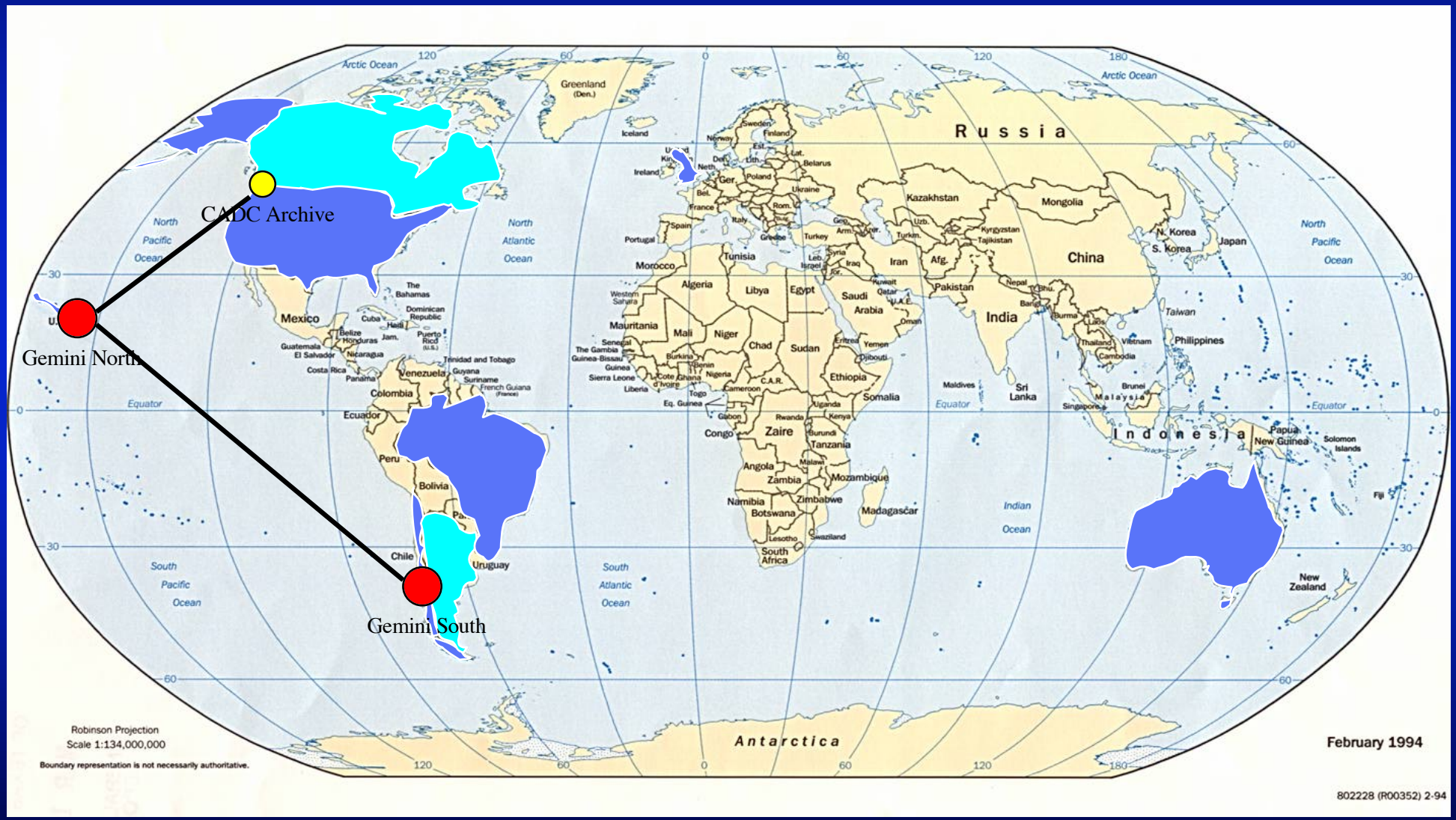
- Harsh and Remote Environments
- Multi-Site, Multinational Coordination
- Geographically Diverse Communities
- Analysis of Large Data Sets
- Economical Operations
- Effective Communication with the Public

Typical Network Approaches

- Telepresence:
  - Putting the Operators at the Telescope – Virtually Sea-level Control Rooms
  - Putting the Scientist at the Telescope – Virtually Videoconferencing, Access Displays, Participate
- Remote Observing Rooms
- Data Delivery to Scientists and Archives
- Off-site Back Up (!)
- Remote Analysis of Data, Grid Processing
- Network-based Education – StarTeachers

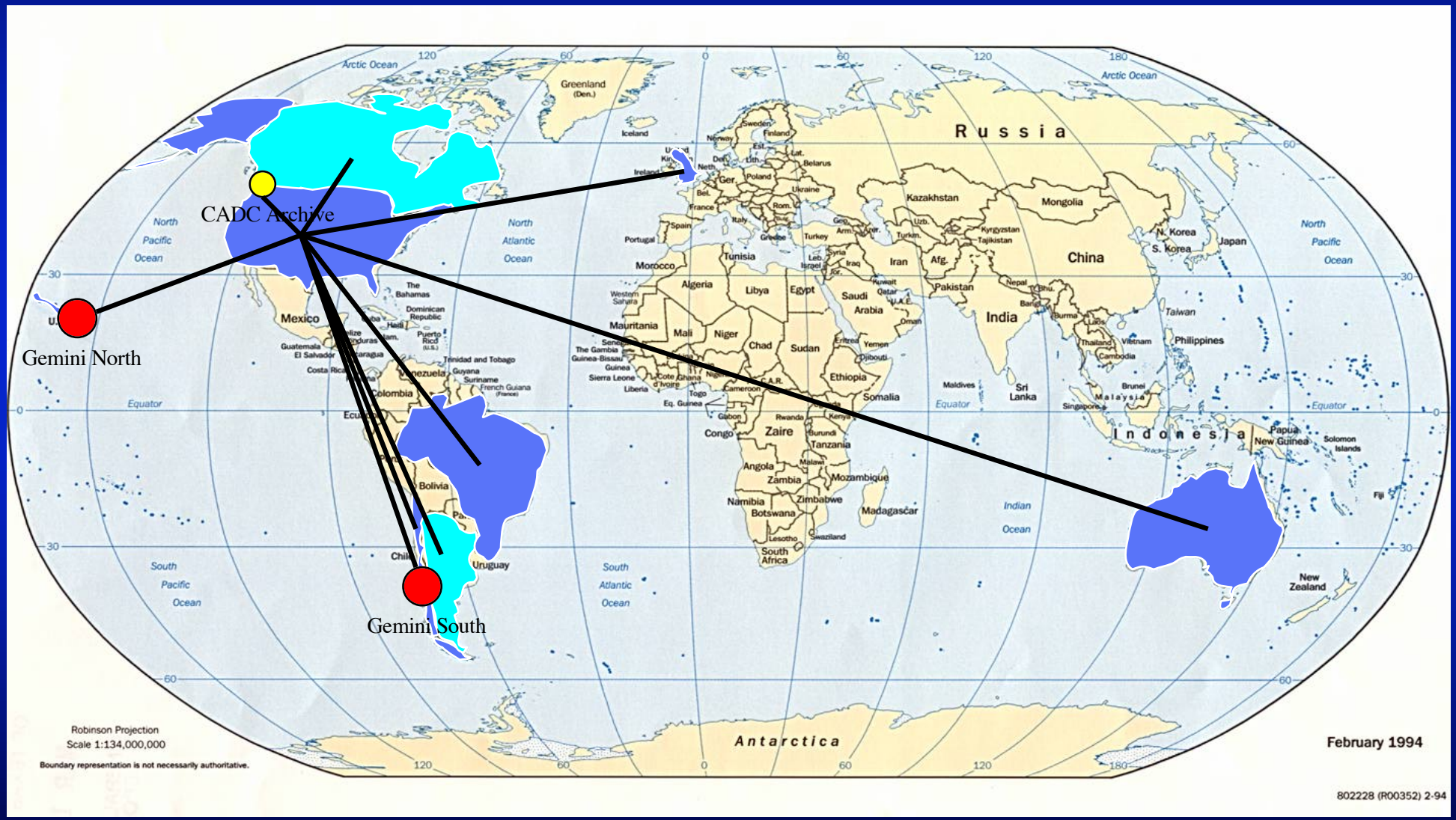
Primary Operational Links

(Between the Sites)

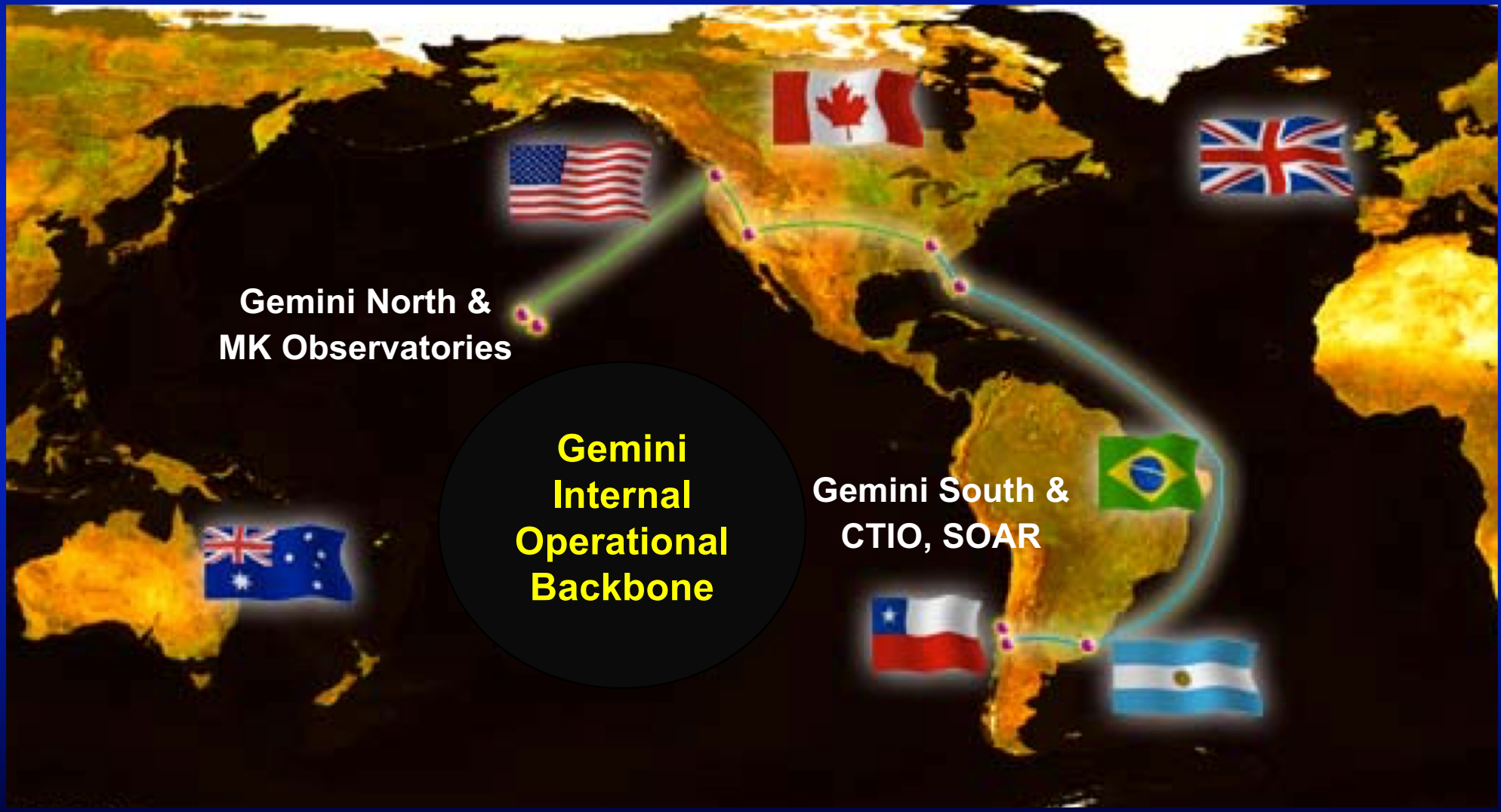


Primary Research Links

(From the Sites to the Users)

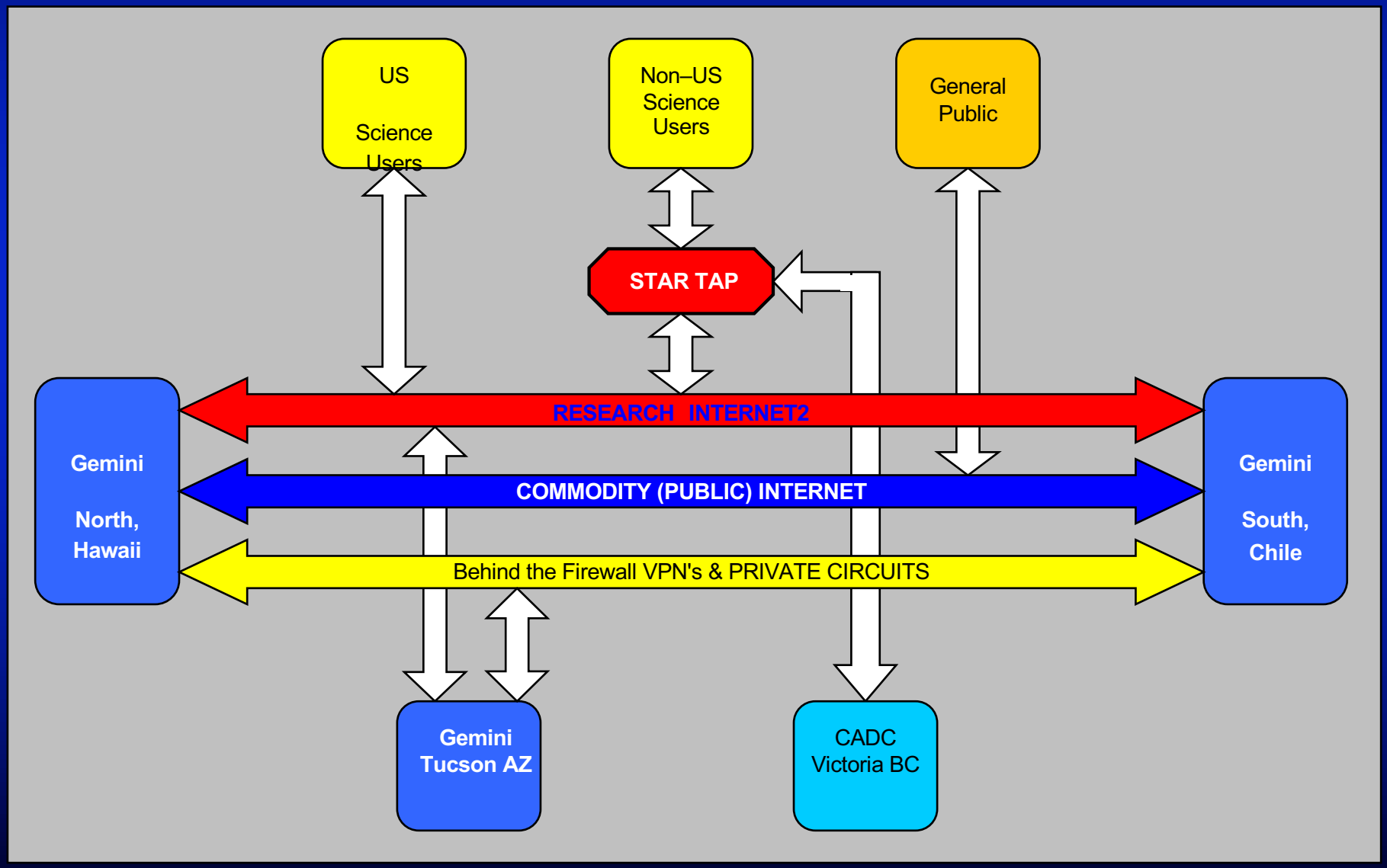


Connecting the Sites
The Gemini Backbone

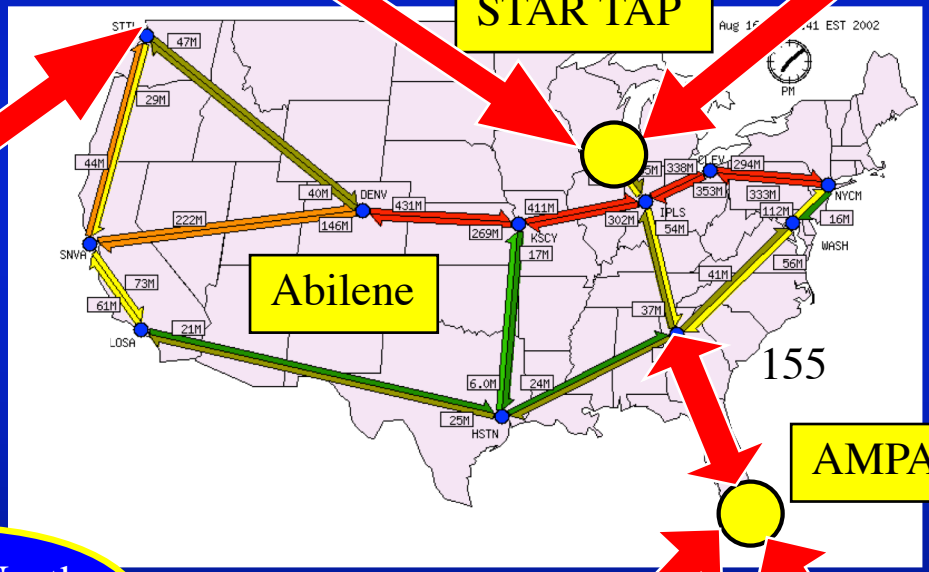


High-Level External Network Concept

Connecting Everybody



Gemini Worldwide Topography



CADC Victoria, BC

Canada

UK

STAR TAP

155

U. Hawaii

155

155

Gemini North Hawaii

155

Australia

AMPATH

3 - 45

10

Chile, Argentina, Brazil

Gemini South Chile

How Much Bandwidth?

One Indicator: Instrument Rates

Future Gemini Instruments, Data Rates, and Storage Rates

Instrument Name	Delivery Date	Format	Bits/ Pixel	Bits/ Frame	Frames/ Hour	Transfer Rate (Mbps)	Storage (MB/hr)	Storage (GB/nite)
GMOS-S	2002	4608x6144	16	4.53E+08	18	9.1	1,019	10.2
bHROS	2003	4608x4096	16	3.02E+08	6	10.1	226	2.3
ALTAIR WFS	2003	80x80	16	1.02E+05	8000	20.5	102	1.0
NIFS	2003	2048x2048	32	1.34E+08	24	26.8	403	4.0
GNIRS	2003	1024x1024	32	3.36E+07	50	33.6	210	2.1
FLAMINGOS-2	2005	2048x2048	32	1.34E+08	24	26.8	403	4.0
GSAOI	2005	4096x4096	32	5.37E+08	15	53.7	1,007	10.1
NICI	2005	2048x1024	32	6.71E+07	60	67.1	503	5.0

These figures represent the demand on the internal network, and the requirements of the ***external*** network when real-time delivery of the images to a remote site is needed.

Open Issues

- ~~Gemini North-South VPN~~ -- Up and Running
- Actually getting the theoretical bandwidth
  - Fine tuning the middleware for long paths
    - "Old" apps like ftp problematic at 250ms RTT
      (Modern apps ok, e.g. H.323)
- Other service enhancements (more next slide)
- Keeping up with the bandwidth/time profile

Coming Enhancements

- Video-conference enhancements
  - Electronic whiteboards
  - Remote PPT
- VoIP linked to Gemini phone plant
- Remote telescope “viewing rooms”
- Explore moving data to archives on line
- Establish Access Grid Node
- Migration to IPv6
- Enhanced Gemini South Bandwidth, as required

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Univ. of Illinois Chicago: STARTAP

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End