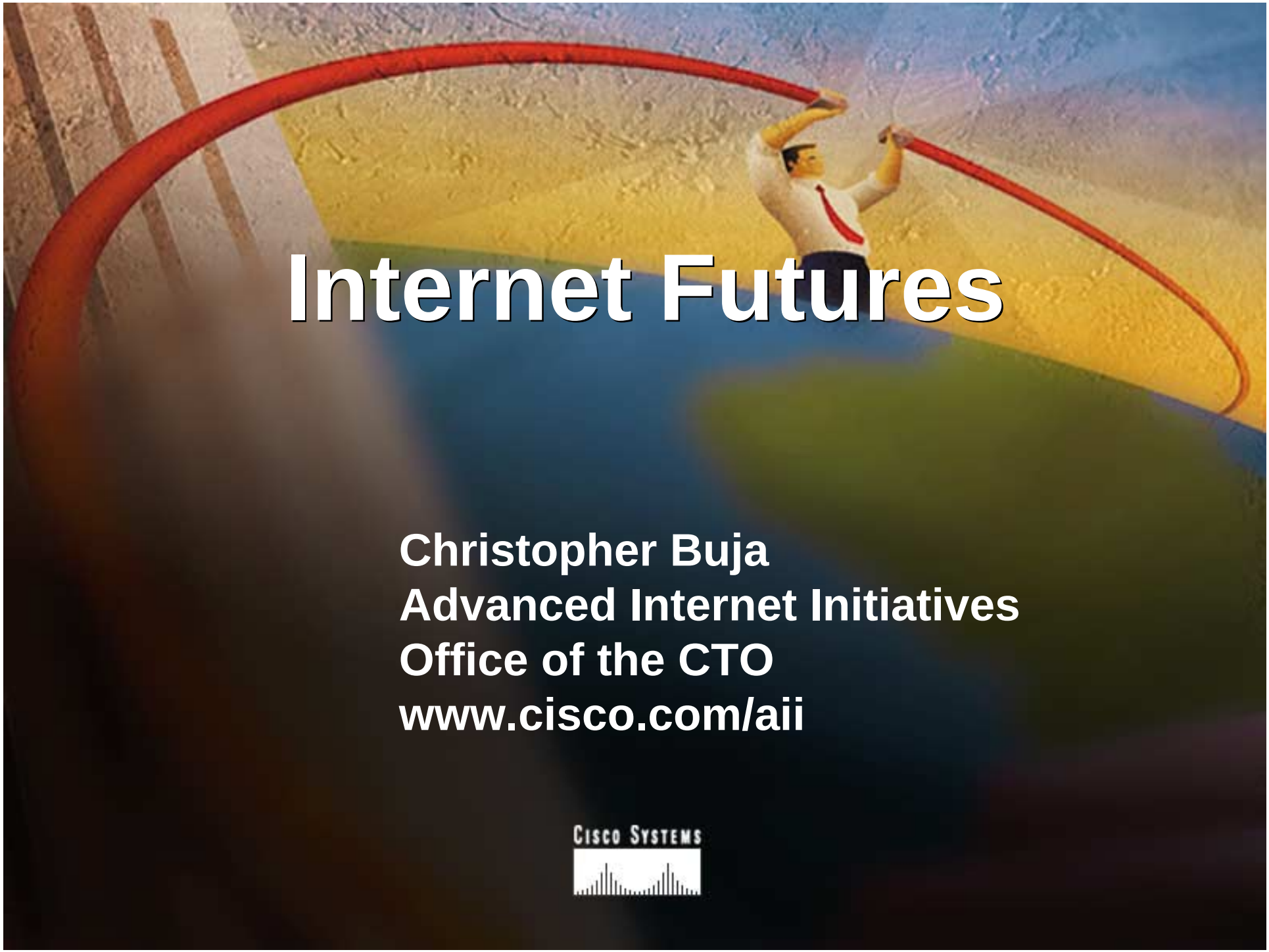


Internet Futures

Christopher Buja
Advanced Internet Initiatives
Office of the CTO
www.cisco.com/aii

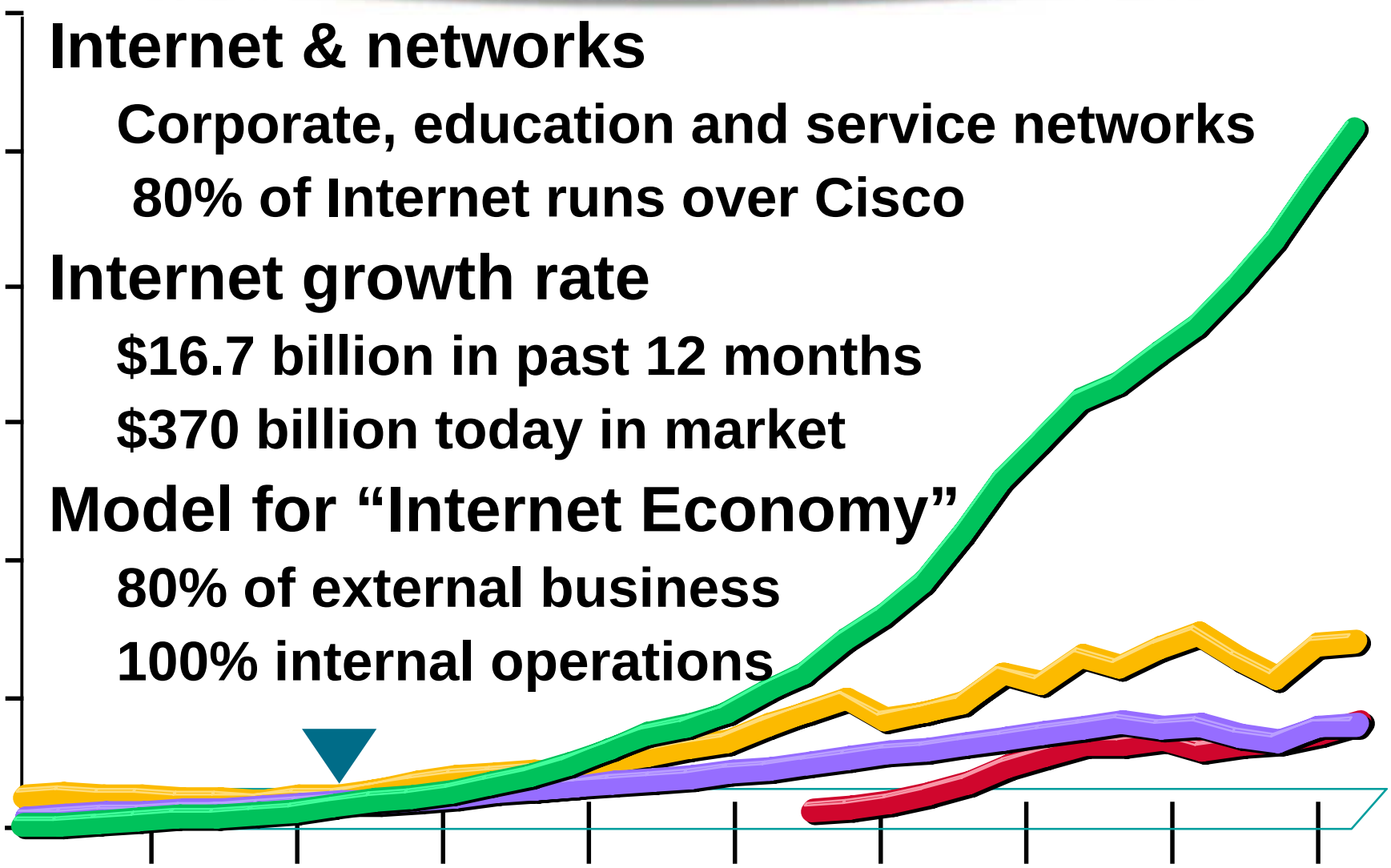
Cisco Systems

Agenda

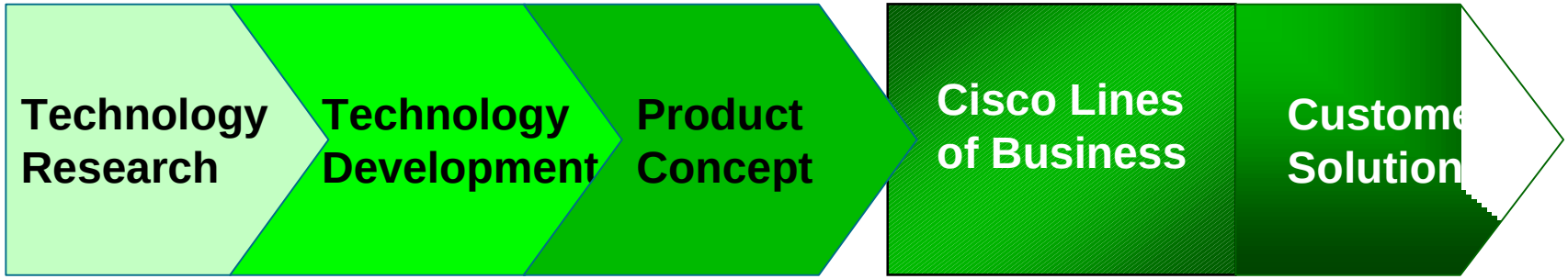
- Introductions
- Advanced Internet Projects
- Applications
- Case Studies
- Next Steps

Cisco and the Internet

- **Internet & networks**
  - Corporate, education and service networks
  - 80% of Internet runs over Cisco
- **Internet growth rate**
  - $16.7 billion in past 12 months
  - $370 billion today in market
- **Model for “Internet Economy”**
  - 80% of external business
  - 100% internal operations

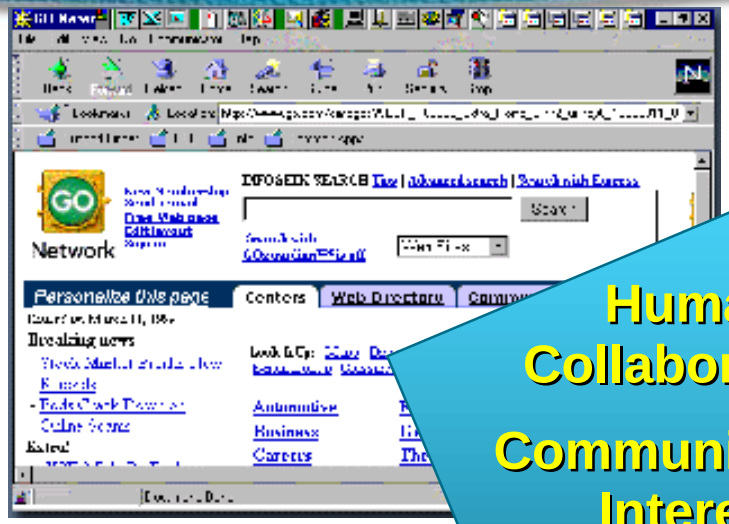


Introductions



- **Mission: engage forward-looking projects and topics**
  - **Engineering leadership**
  - **Organizational direction**
  - **Application support**

Evolution of Information Networking



Remote Terminals

E-Mail

File Sharing

Print sharing

Information Search

Customer Service

Business Processes

Electronic Marketplace

Human Collaboration

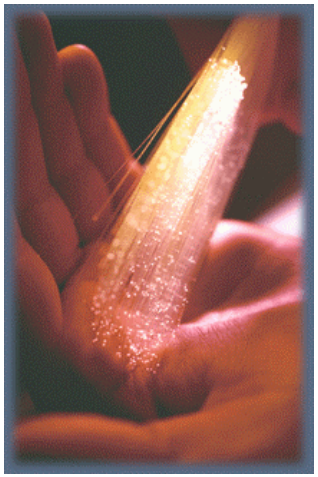
Communities of Interest

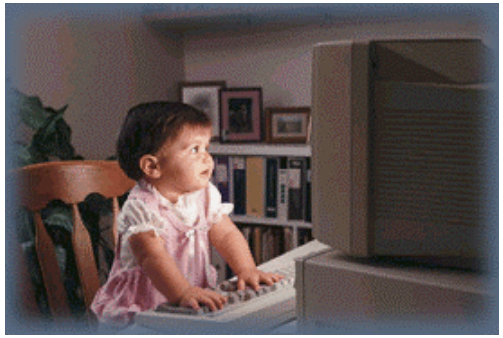
Personalized Portal to the World

Internet Ubiquity

Reaching Ubiquity

Bandwidth & Access





Data/Voice/Video Convergence

Network awareness of users, operations, and applications

Cisco Research

- **Business Units**

  Service Provider, Enterprise, Small/Medium Business, Consumer

- **Chief Strategy Office**

  Merger & Acquisitions, Investments

  University Research

  Advanced Internet Initiatives

Business Research

- **Backbone**
  - **Optical, IP, ATM**
- **Voice and IP**
  - **Voice, IP Services, Mobile Wireless**
- **Intelligent Networking**
  - **Content Services, Scalability, Applications, Management / Provisioning**
- **Broadband Access**
  - **Access, Consumer, Video, Silicon**

Current Research Topics

- **OPTICS, WDM**
- **DIFFSERV, MPLS, QOS**
- **Security, Intrusion Detection, Multicast**
- **Web caching, IOS ORB**
- **Routing / Congestion control**
- **Active routing and Micronets (risky)**
- **HW design and analysis languages**

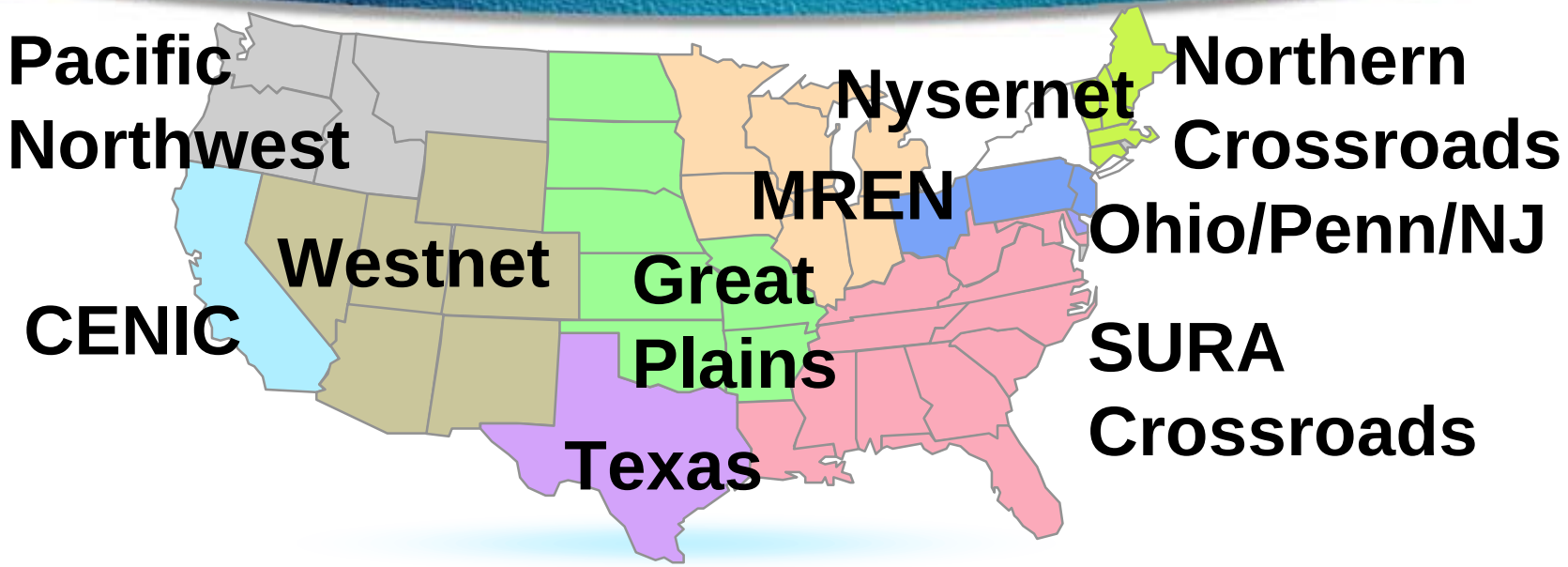
Additional Research Topics

- **Electronic persistent presence (EPP) & ubiquitous computing (e.g. bluetooth)**
- **Mobile, wireless, and nomadic access**
- **Middleware (e.g. DIRS, Policy servers,…)**
- **SOHO/Customer networks and services**
- **Network management (smart nets,ENA, management of capacity)**

Advanced Internet Initiatives

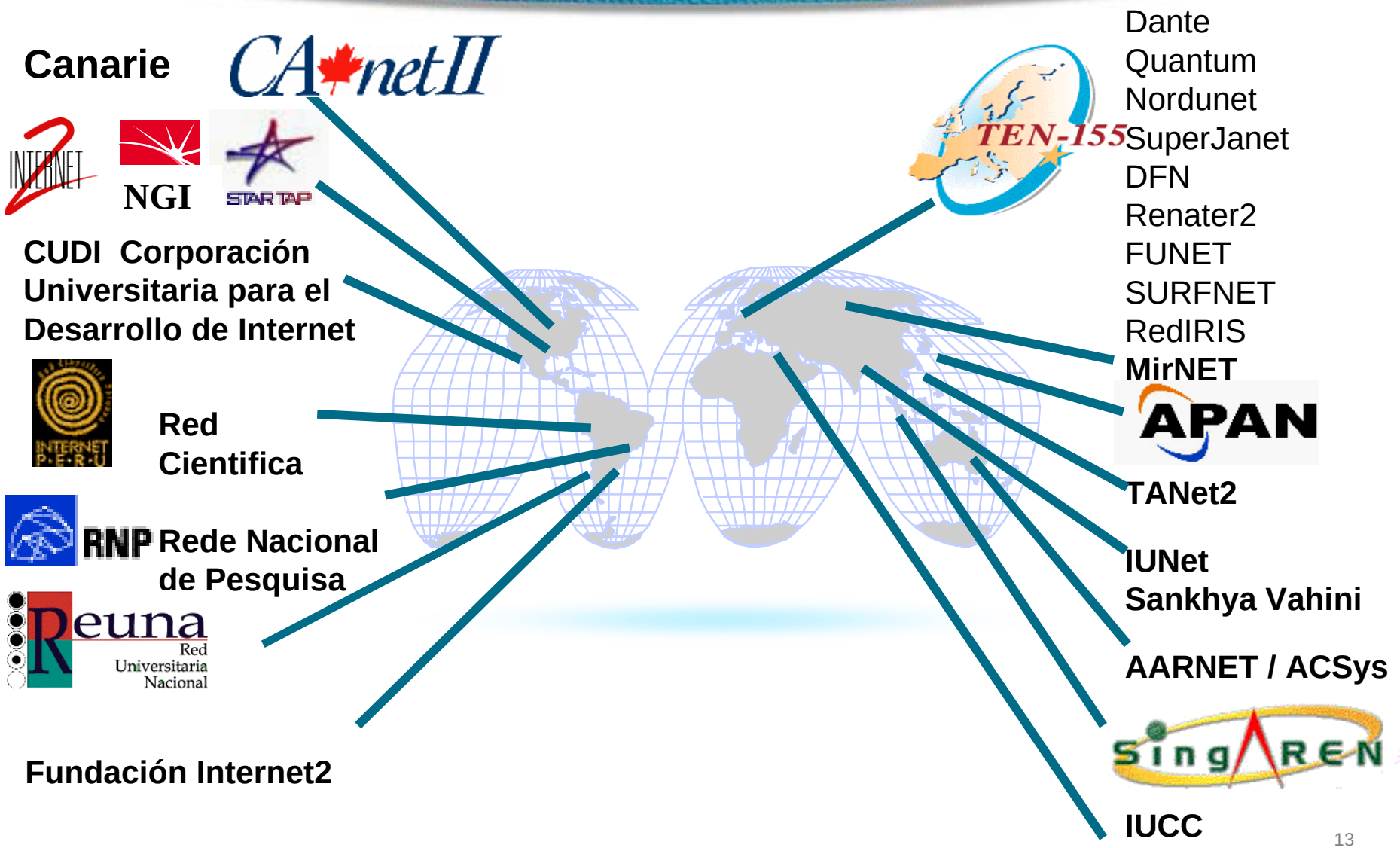
- **Vision: Laboratories to study evolution**
- **Advances in architecture, services and operations**
- **Applications to measure the advances**

Internet2 Regional Diversity



	www.cenic.org	**Corporation for Education Network Initiatives in California**
	www.mren.org	**Metropolitan Research and Education Network**
	www.sox.net	**Southern Crossroads / MidAtlantic Crossroads**
	www.nox.org	**Northern Crossroads**
	www.nysernet.org	**Nysernet 2000**
	www.westnet.net	**Westnet**
	www.greatplains.net	**Great Plains**
		Pacific Northwest
		Texas
		Ohio Pittsburgh, Philadelphia, New Jersey

Advanced Internet Initiatives



http:// ... Advanced Internets

www.canarie.ca

www.internet2.edu
www.ngi.gov
www.startap.net

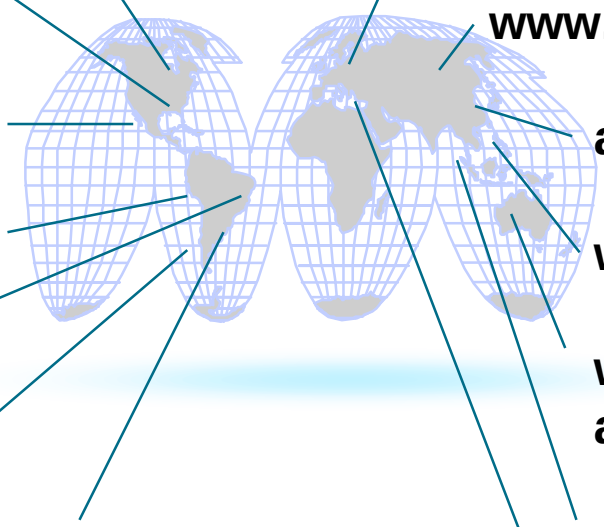
www.cudi.edu.mx/

ekeko.rcp.net.pe/

www.rnp.br/

www.reuna.cl/

www.secom.gov.ar/html/orgaframe.html



www.dante.net/ten-155.html
www.dante.net/quantum.html
www.nordu.net
www.ukerna.ac.uk www.dfn.de
www.renater.fr www.surfnet.nl
www.csc.fi/english/funet

www.friends-partners.org/friends/mirnet/

apan.or.kr

www.tanet2.net.tw/

www.carno.net.au/rno/aarnet2.html
acsys.anu.edu.au

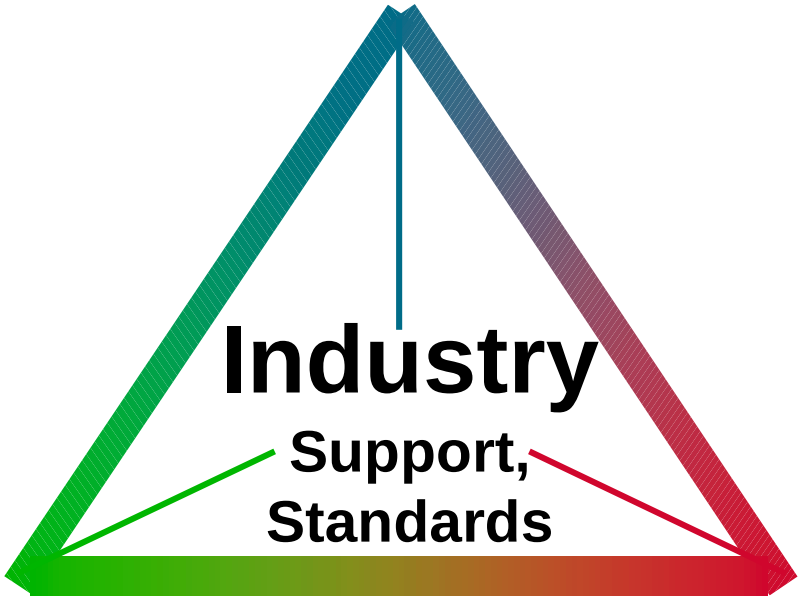
www.singaren.net.sg

www.machba.ac.il/index.html

Partners for Success

Government

Vision, Seed funding



Universities / Labs

Applications, Research, Local Access

Service Providers

Backbone, Scaling

Common Lessons

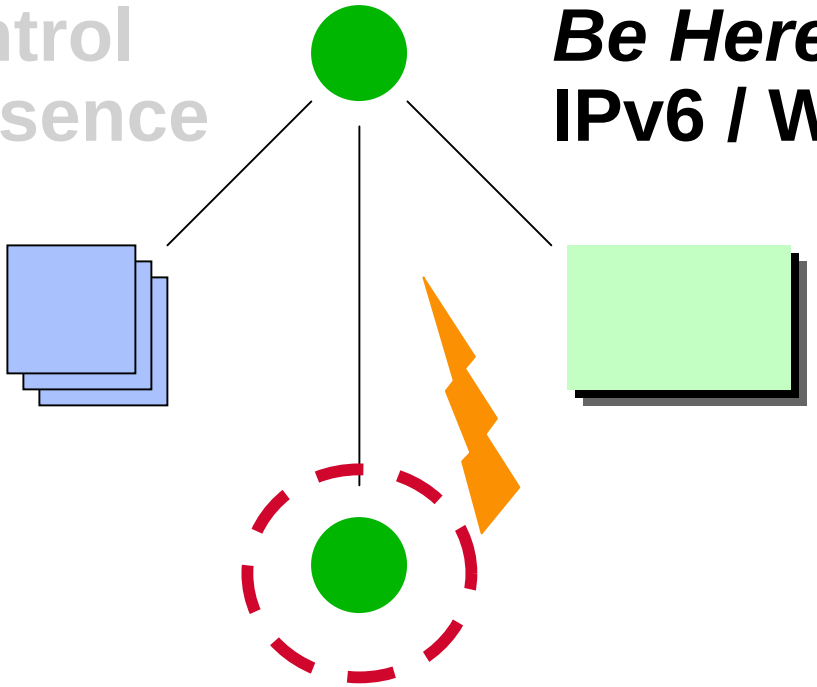
- **Balancing Autonomy & Cooperation**
  - **Decentralization and Communication**
  - **Academic and Empirical**
- **Supporting Production & Research**
  - **Experimentation, Operations and Support**
  - **Government, Service Providers and Universities**
- **Planning for the Unplanned**
  - **Infrastructure and Applications / Services**
  - **Flexibility and Stability; Standards**

How Does Middleware Work?

Application Classes

Large Files
Distributed Use
Collaboration
Real Time Control
Persistent Presence

Streaming Multicast
Napster
Dialpad / Roger Wilco
Be Here
IPv6 / Wireless



Issues: Security, Stability, Traffic Priority, Last Mile Access and Bandwith, Scaling, IP

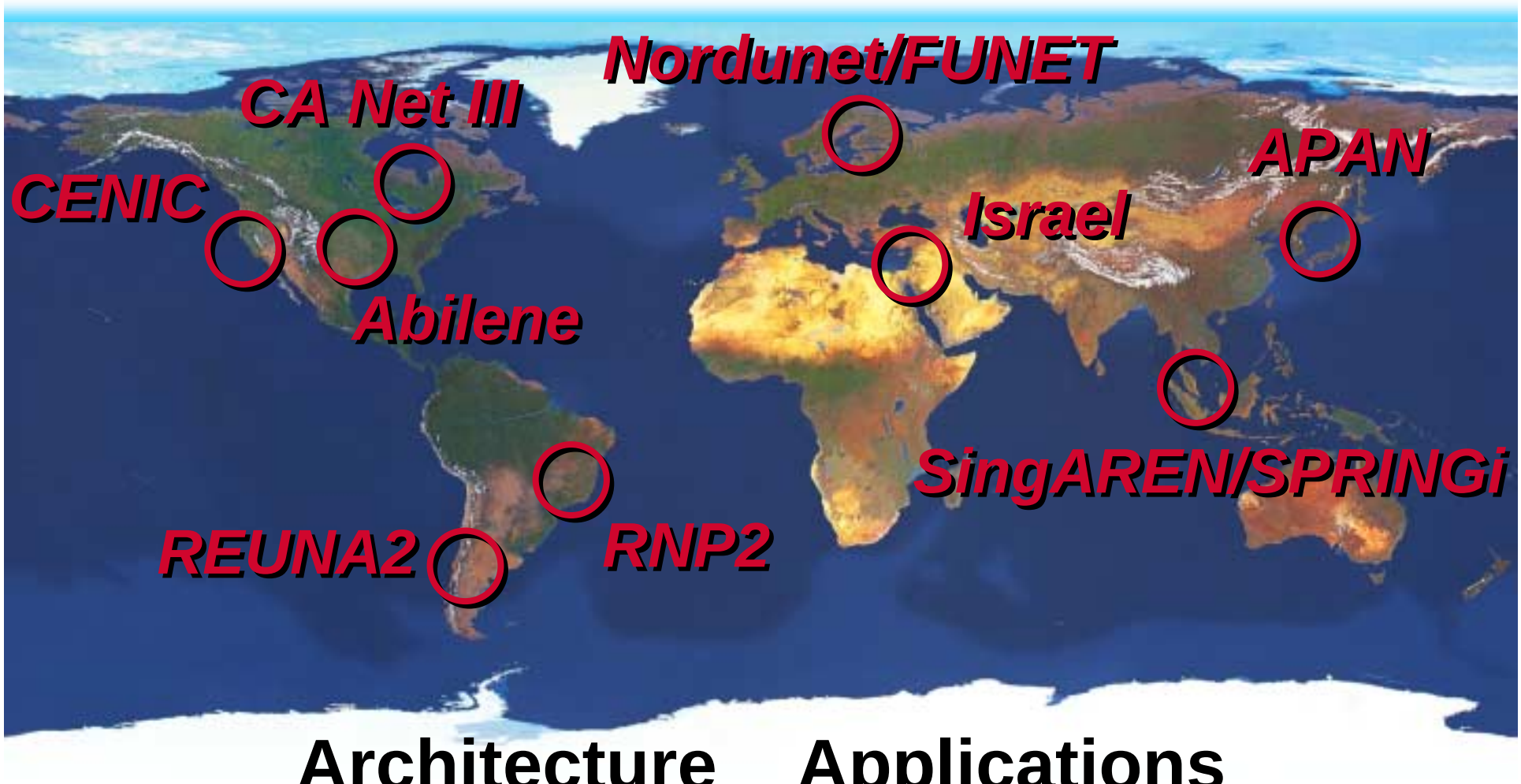
Social Implications

- **Social Interaction**
- **Interface Design**
- **Learning**
- **Collaboration**
- **http://www.utexas.edu/coc/i2sociotech/**

Application Lessons

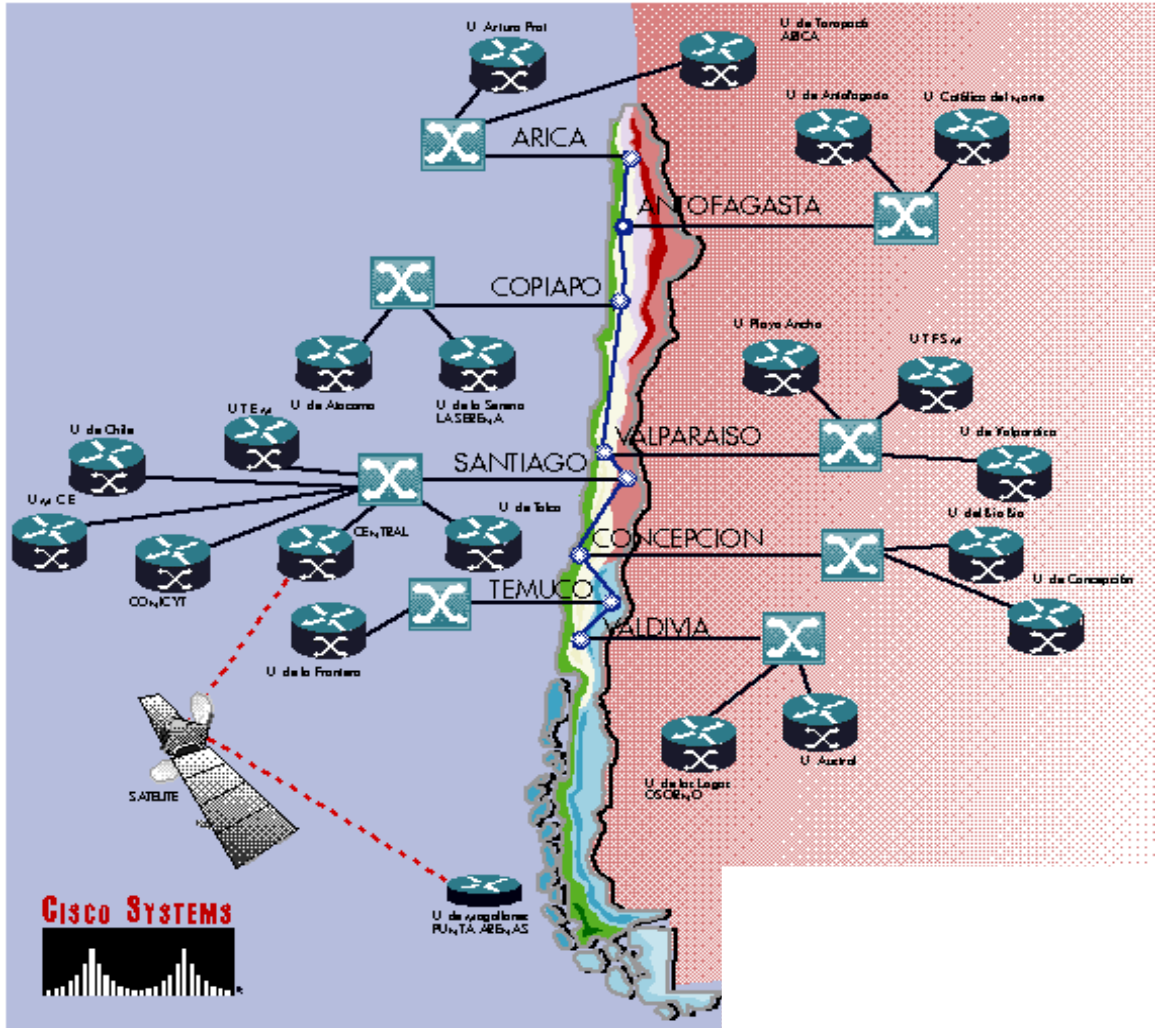
- **Engage Users**
  - **Know research base and collaboration**
  - **Seek out discontent users**
- **Connect Projects**
  - **Demonstrate Results**
  - **Transfer to General Internet**
- **Follow Security, Privacy, Control**
  - **Separate policy, legal and social issues from technical questions**

Case Studies



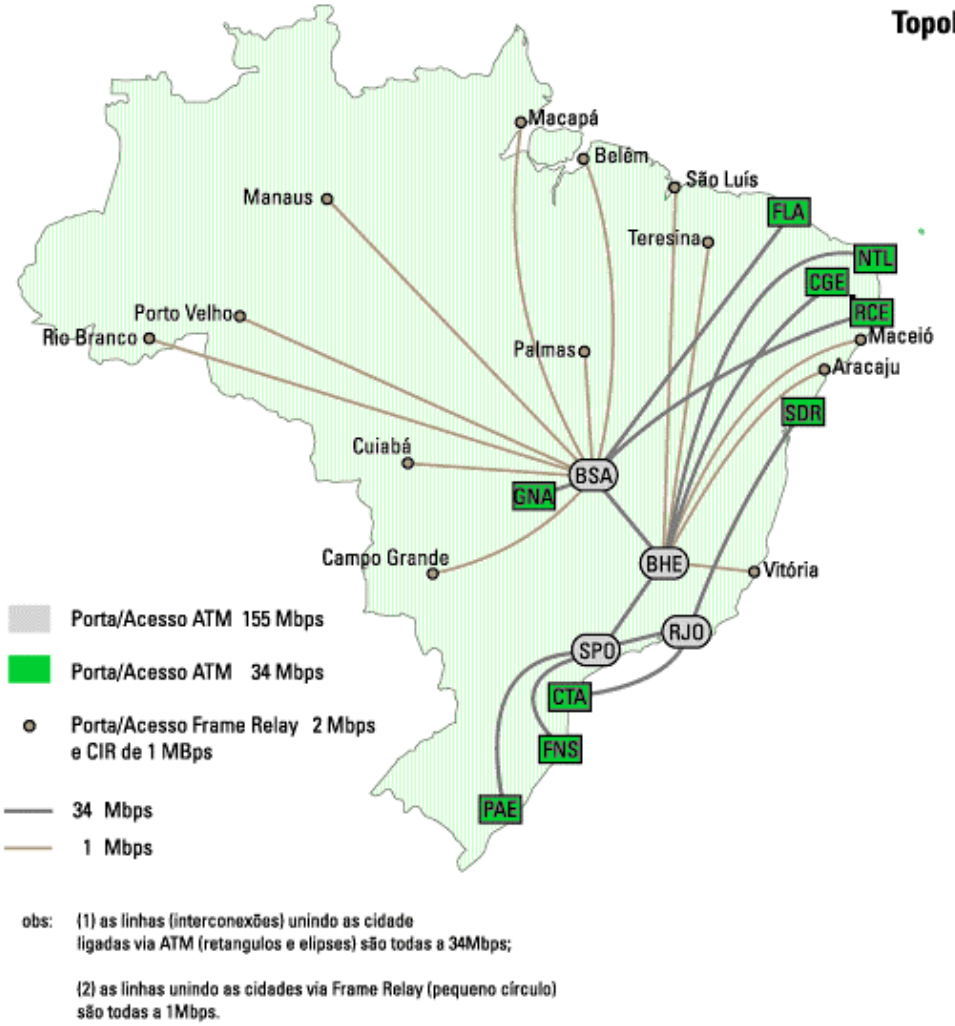
Architecture **Applications**

Chile - REUNA 2



- **Architecture**
  - **ATM co-location**
  - **Satellite to remote sites & Internet**
- **Applications**
  - **Distance Learning**
  - **Astronomy**
  - **Meteorology**

Brazil - RNP2



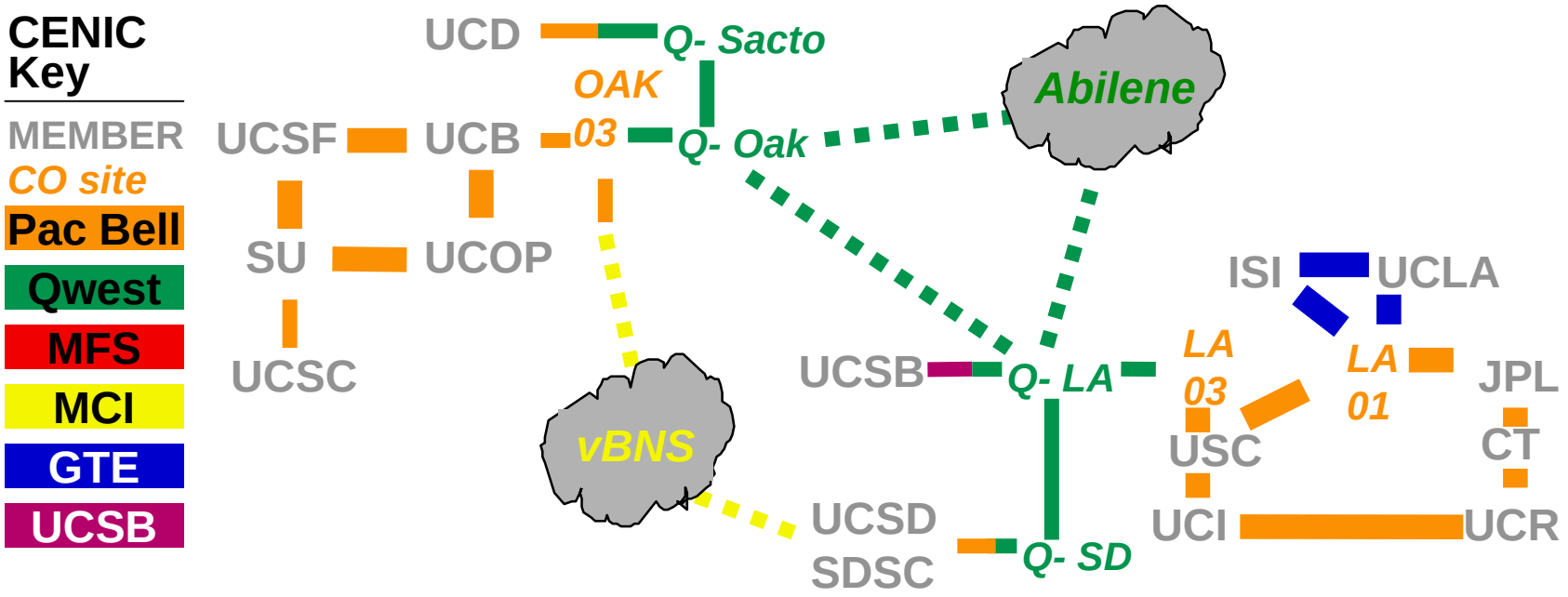
- **Architecture**
  - **ATM >> POS**
- **Applications**
  - **Digital Libraries**
  - **Distance Learning**
  - **Telemedicine**

US - Abilene Backbone

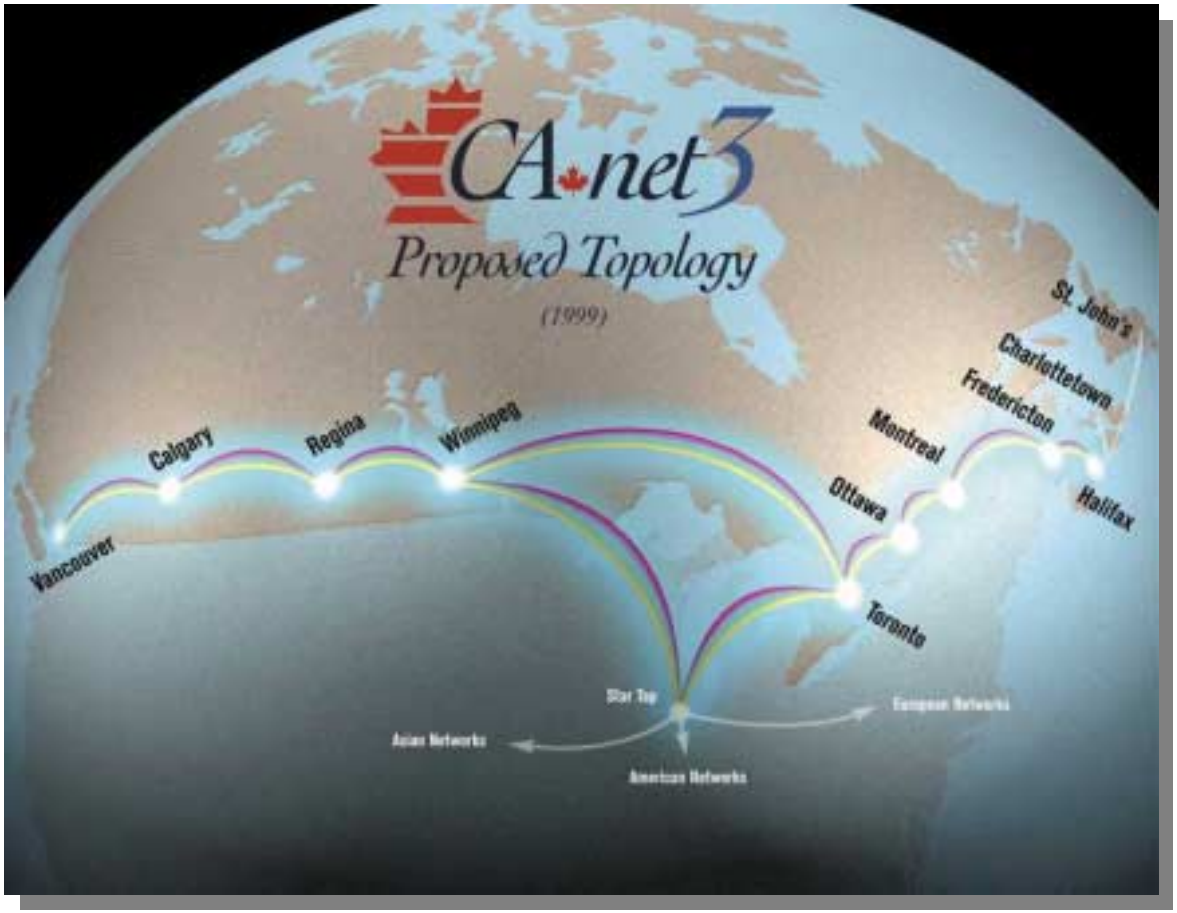
- **Architecture**
  - **Packet over SONET**
- **Applications**
  - **Distance Learning**

US - CENIC

- **Architecture: dual ATM and POS**
- **Applications: astronomy, biomedical, distance education, digital video**



Canada - CA Net III



- **Architecture**

  IP/DWDM

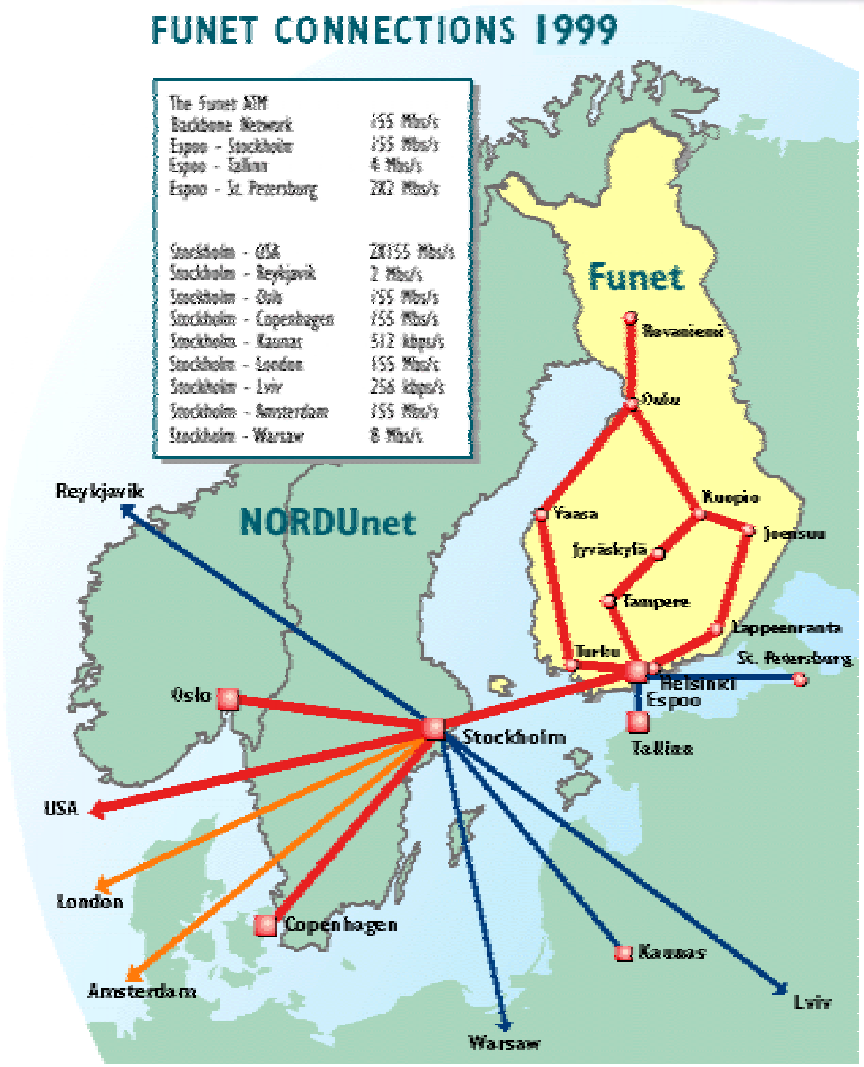
- **Applications**

  Distance Learning

  Remote Operations

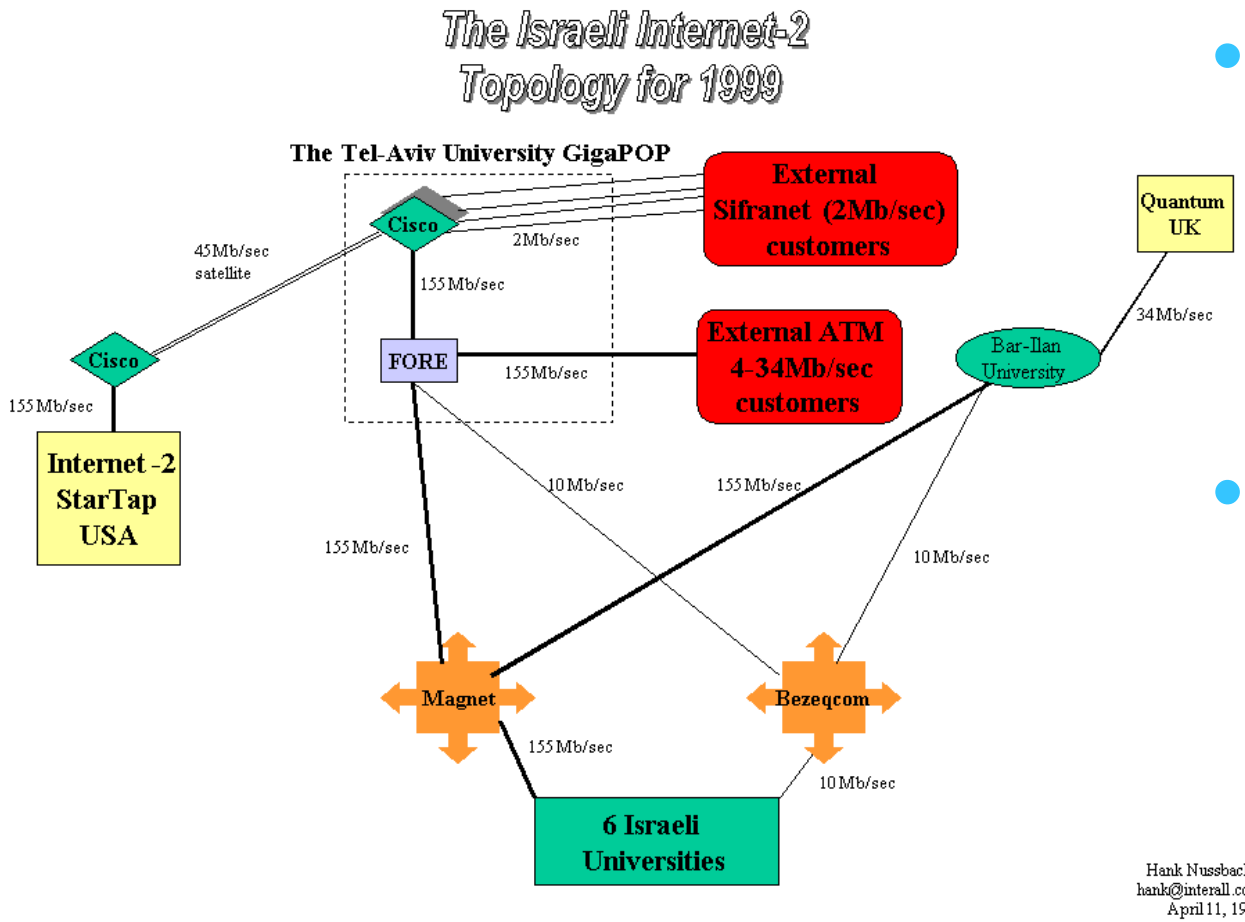
CAnet-3-NEWS@canarie.ca

Finland - FUNET/NORDUnet



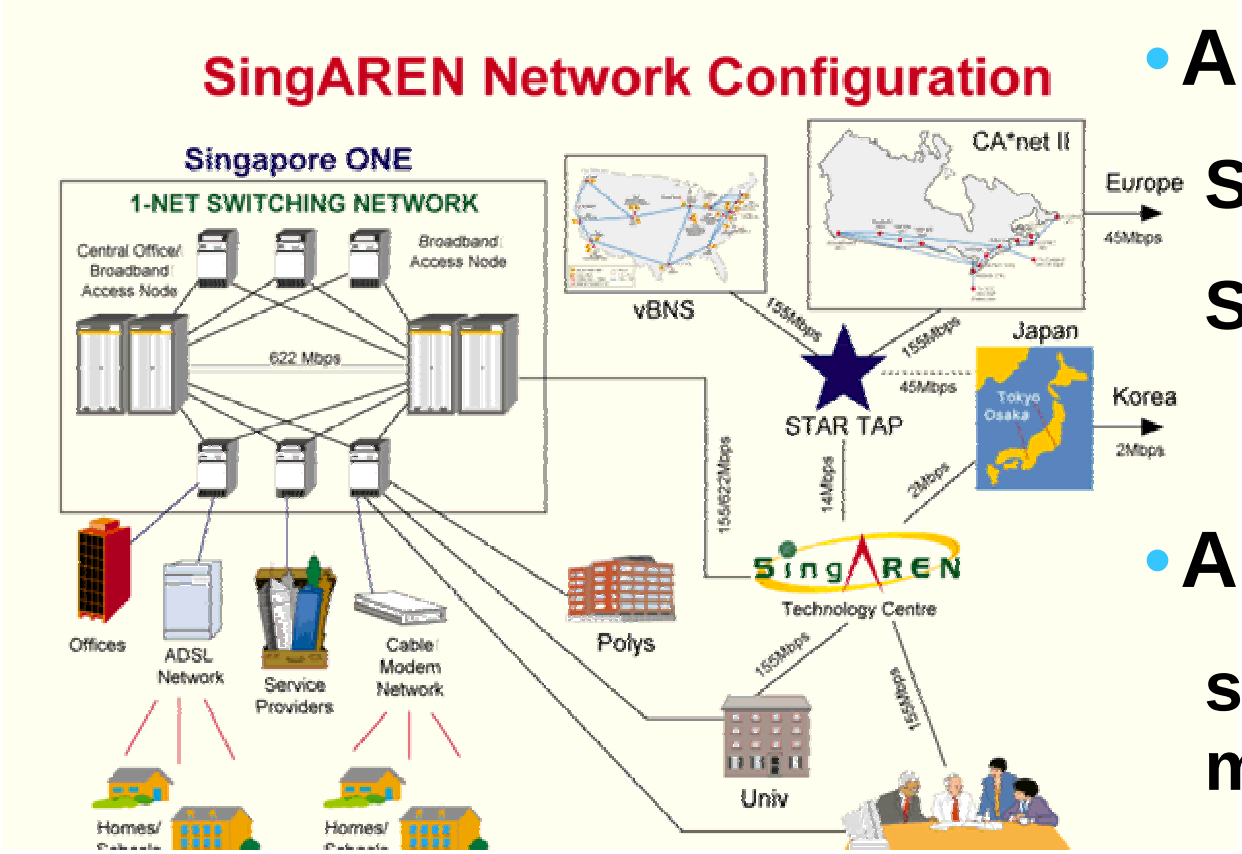
- **Architecture**
  - **ATM**
- **Applications**
  - **Distance Learning**
  - **Multimedia**

Israel



- **Architecture**
  - **ATM**
  - **Satellite**
- **Applications**
  - **Telemedicine**
  - **Distance Learning**

Singapore - SingAREN/Springi



- **Architecture**

  SingAREN - ATM

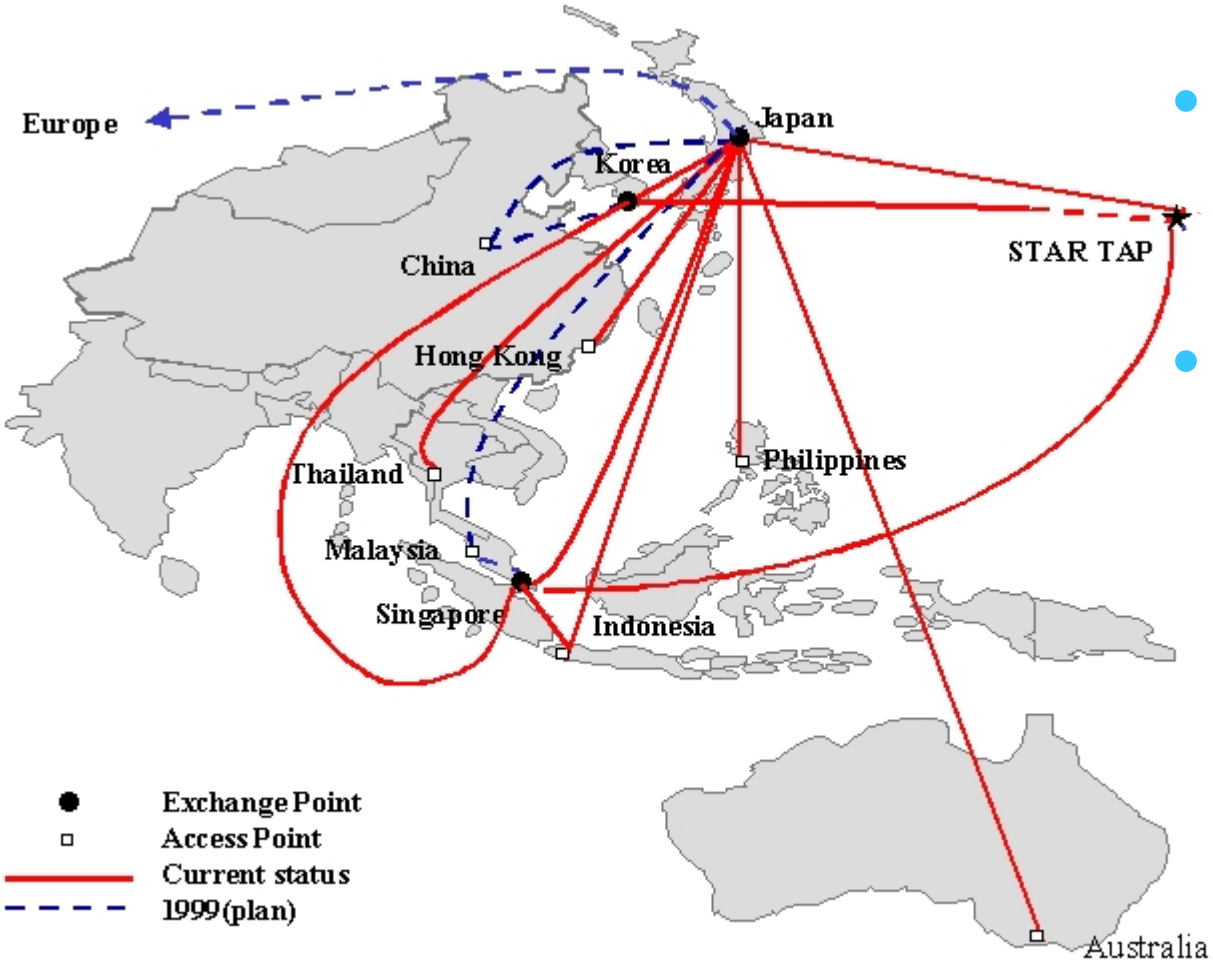
  SPRINGi - IP/Optical

- **Applications**

  satellite/terrestrial multicast

  telemanufacturing, telemedicine

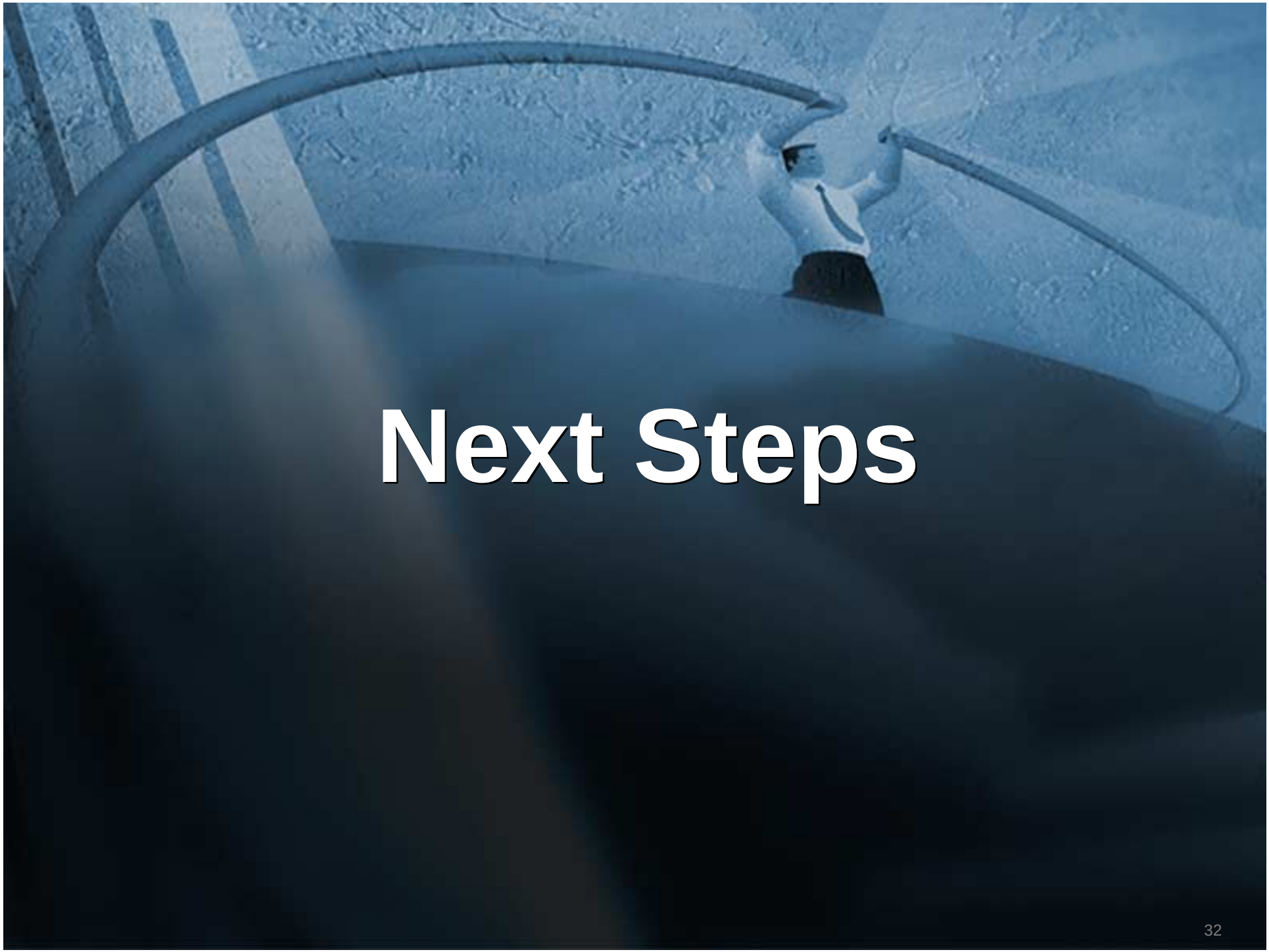
APAN Topology



- **Architecture**
  - **Leased Lines**
- **Applications**
  - **Agriculture**
  - **Distance Learning**
  - **Telemedicine**

Case Study Conclusions

- **International collaboration underway**
- **Applications & operations: new markets**
- **Middleware: research field**
- **Evolution: ATM to PoS to IP/Optics**
- **Carrier deregulation: needs & partners**



Next Steps

Looking Ahead

- **APAN and Internet2 meetings**
  - **Beijing - August & Atlanta - October**
- **Focus on Applications and Operations**
  - **Working examples and general Internet**
  - **Operational experience and exchange points**
- **Evolution of I2**
  - **T + 2 1/2 years**
  - **Carrier deregulation**
  - **Competition & Internet Economy**

The Internet Tornado Waves

Web Browser
(1994-1997)

E-Commerce
(1997- 2002)

Voice/Video/Data Convergence
(1998-2003)

Internet Broadcasting
(2000-2005)

Measuring Progress in the Information Age

“Bandwidth" and "degree of connectivity" are the new measures of power…

Three distinguishing factors to harness power

- **culture to exploit & share knowledge**
- **competitive setting that embraces change**
- **ability to partner**

Thomas Friedman
New York Times
p.11 4/11/98

Internet Futures

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www.cisco.com/aii