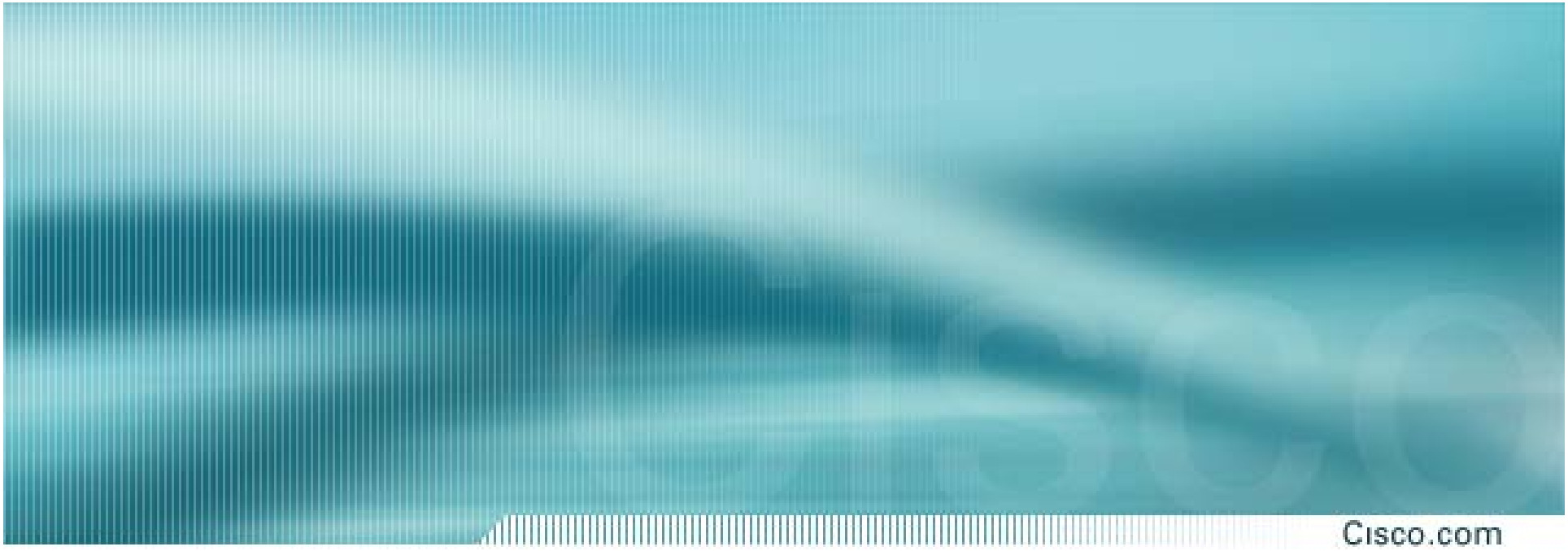

Innovation and the Internet

29 April 2005

Christopher Buja, Deputy Director

Academic Research & Technology Initiatives, Cisco

cbuja@cisco.com

Agenda

- Introduction
- Diverse Players in Research
- Cooperative Success
- The New World of Research Networks
- Research Avenues

Academic Research & Technology Initiatives (ARTI)

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- **National Research Networks (NRN)**
  - **Research leadership**
  - **Operational leadership**
- **Research Partnerships**
  - **University Research Program (URP)**
  - **Cisco Applied Research & Development (CARD)**
  - **Partner Projects**
- **Internal and External Research Leadership**
  - **Technology Research Councils**
  - **Distinguished Engineers / Cisco Fellows**
  - **Acquisitions, internal R&D and standards bodies**

Network Convergence

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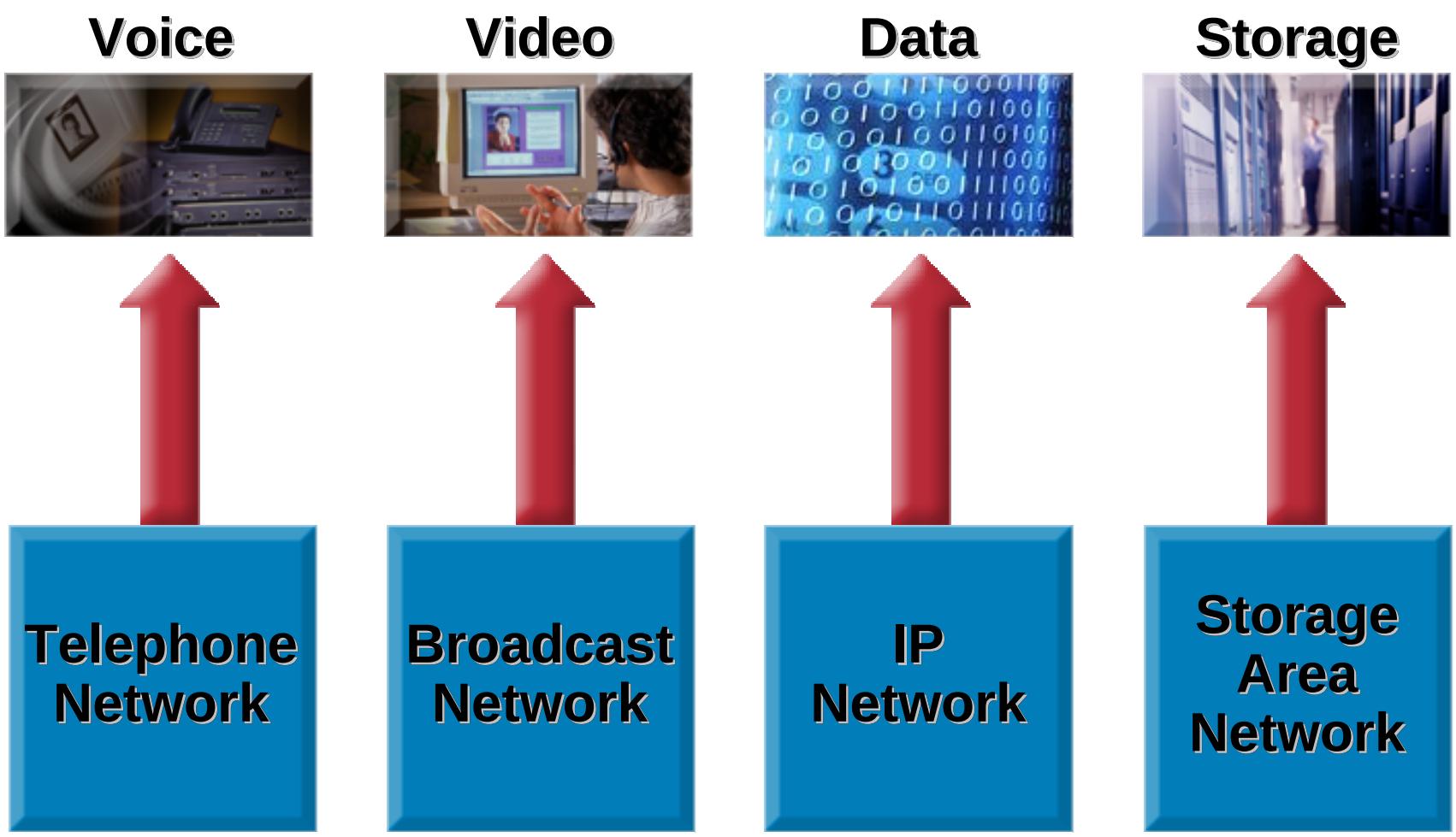
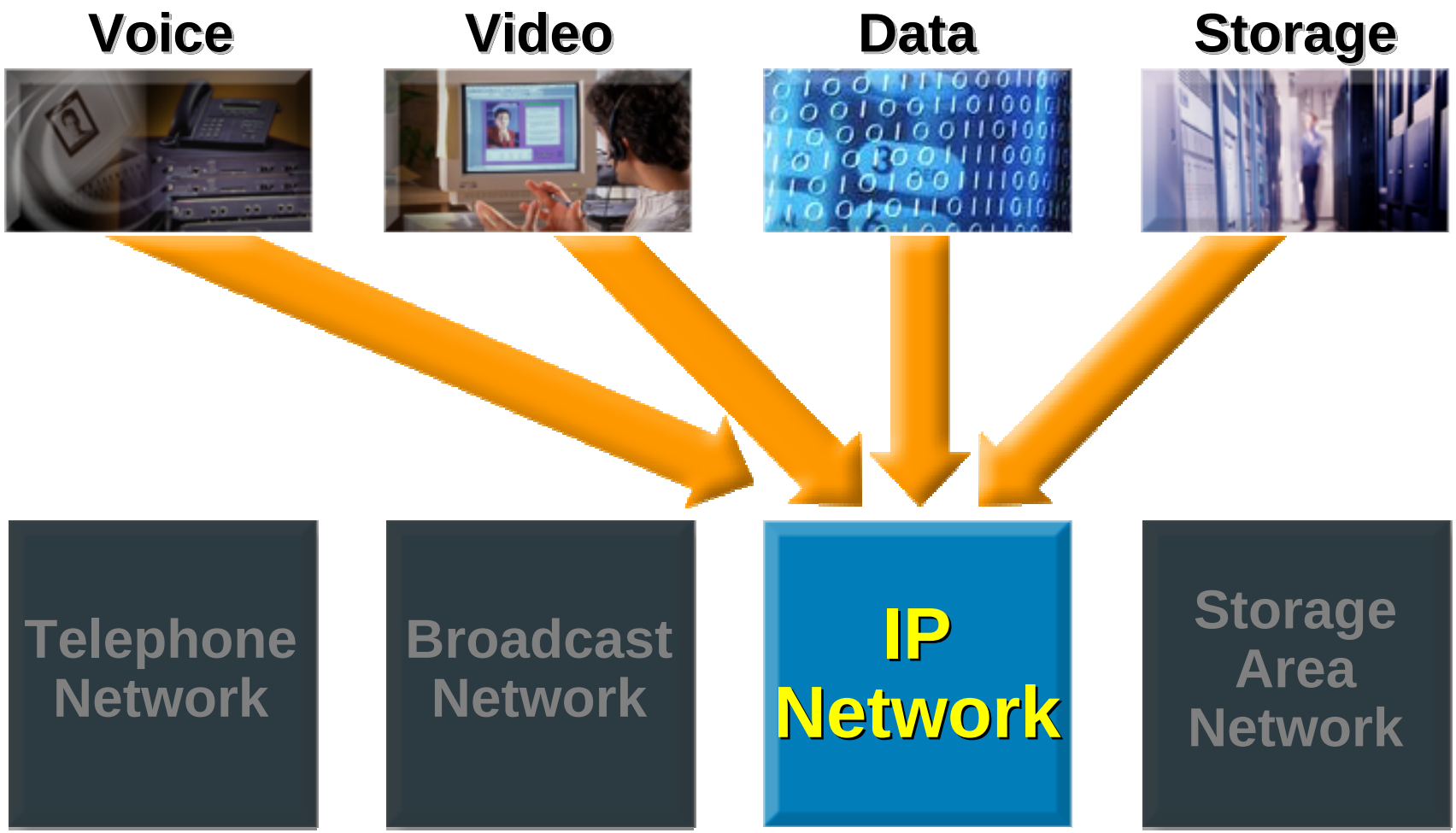


Network Convergence

Cisco.com



Challenge of the Ideal Next Generation Network

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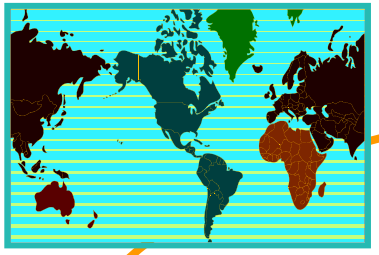
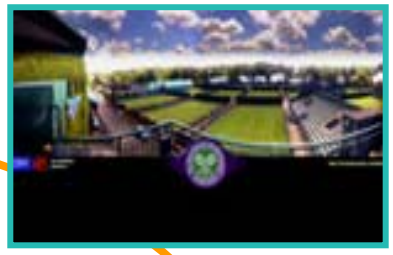
Fusing the Best Properties of Today's Networks onto a Common Lowest Cost Infrastructure



Ubiquity & Reliability of the PSTN

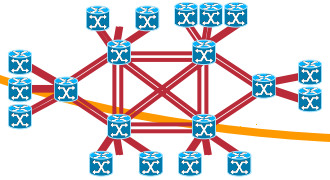
Mobility of the GSM Network



Content Richness of Cable & Television

Next Generation Network

Bandwidth of an Optical Network

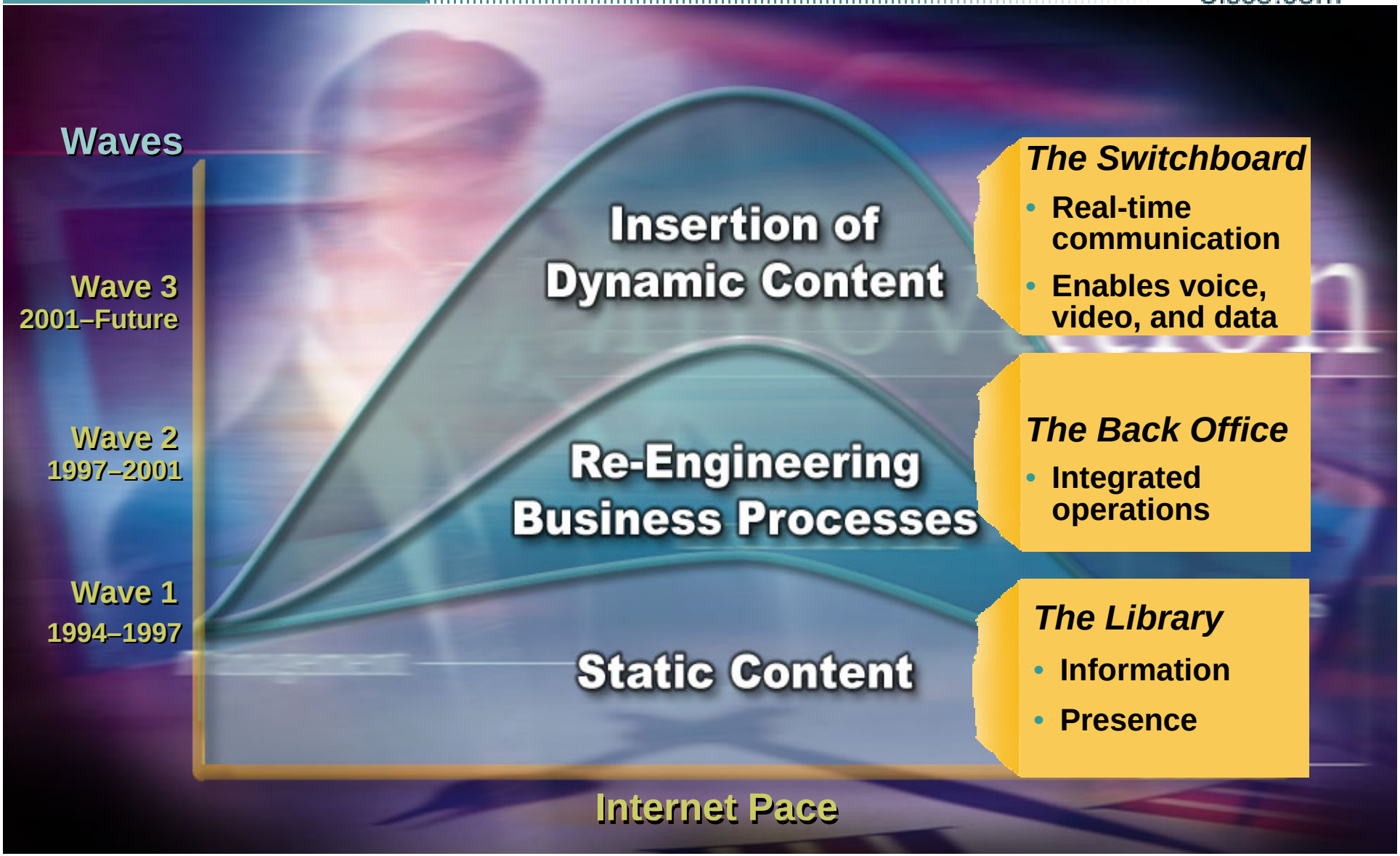


Latency Control of an ATM Network

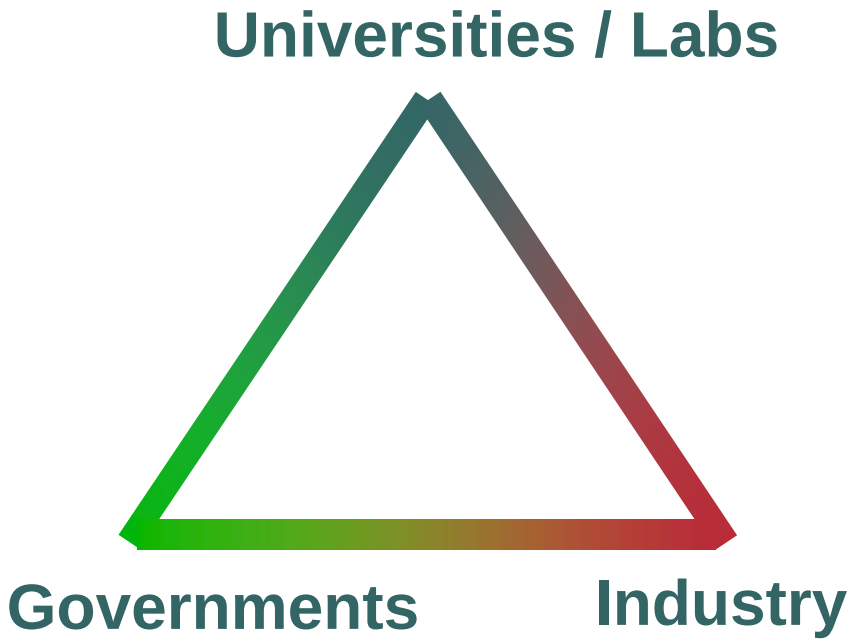
Operational Ease of Ethernet

Flexibility of the Internet

Network-Enabled Application Waves



Multiple Players in Research



Tensions

- Timeframe
- Measures of Progress
- Profit/Cost/Markets

Resolutions

- Partnerships
- Communication

Successful Partnerships

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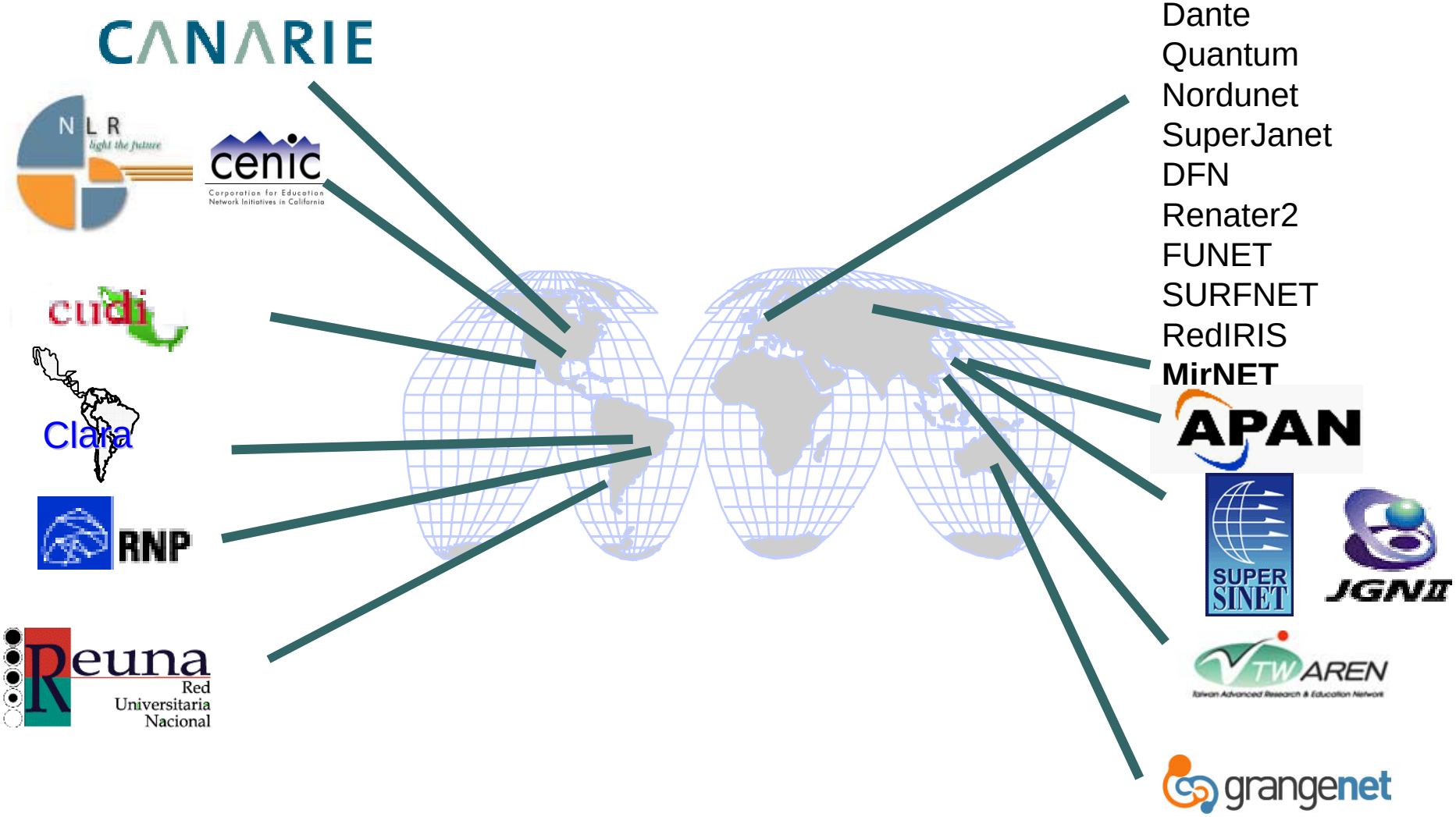
- Standards Bodies
- Centers of Excellence
- Conferences/Workshops
- Network Academies
- Development
  - Products and Services
- Research
  - Harnessing Intellectual Property

Successful partnerships are balanced over time

Advanced Internet Partnerships



Research & Education Network Tiers

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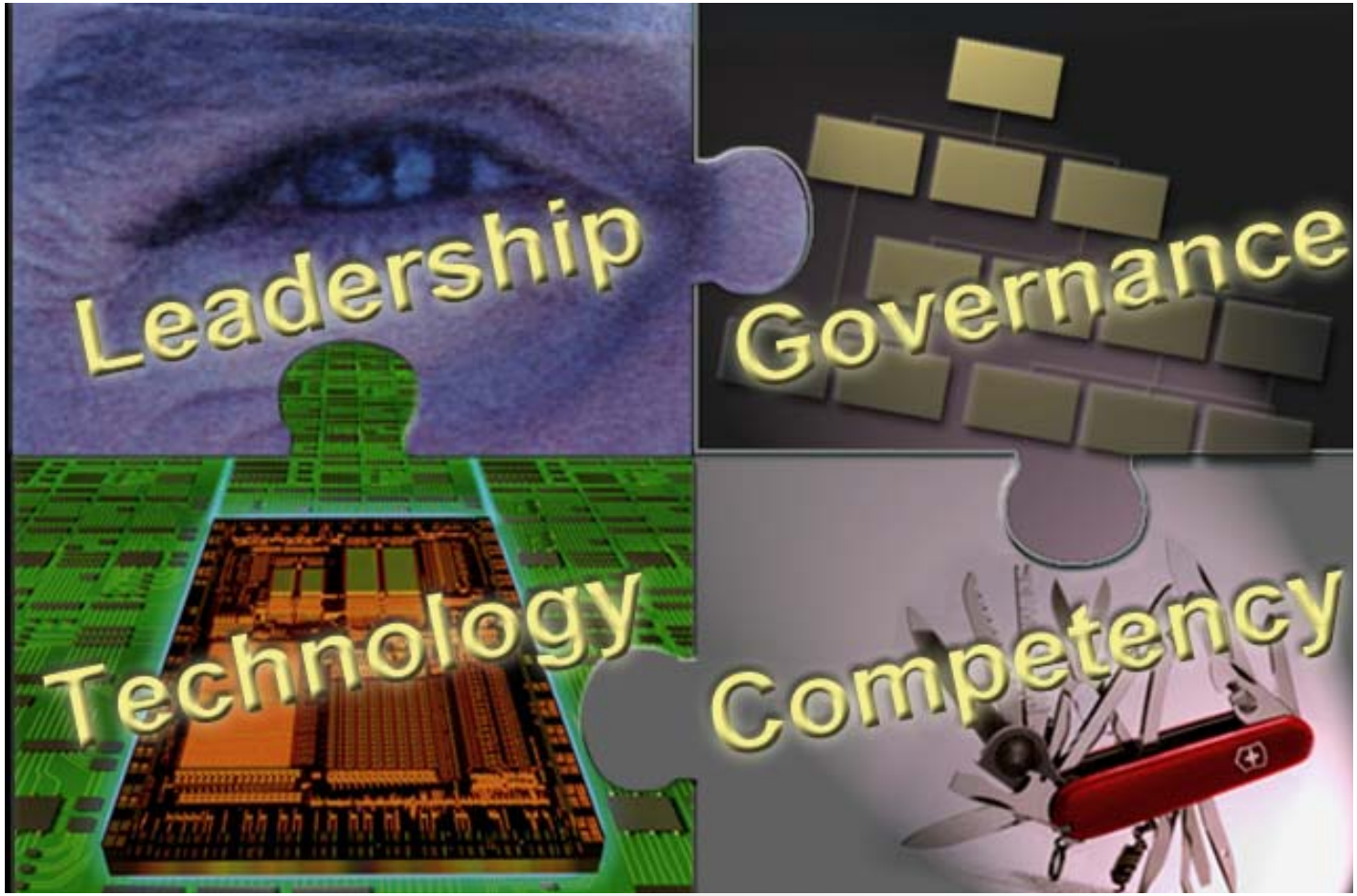
LEADERS	NETWORK TYPE	CAPABILITIES/USERS
Web100 NLR	Research	Experimental environments for network researchers
Teragrid WIDE CALREN NLR	Experimental Networks	Next generation architecture and applications for research community
I2-Abilene, SurfNet 5 CALREN	Advanced Education Networks	Advanced services for education
ISPs	Commodity Internet	General Use

Readiness



Key Success Factor

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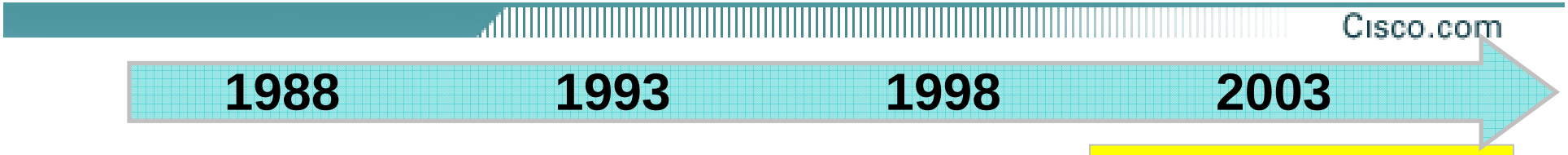
Understand the Potential of Technology

Learning is not Training

It is information, communication, collaboration, and education

Evolution of US Research Networks



	NSFnet	*vBNS*	*Abilene*	*NLR*
Funding	• NSF	• NSF	• Universities via membership	• Research universities equity ownership
User	• Regionals & backbone	• Supercomputing centers & NAPs; later all research universities	• GigaPoPs and universities	• New generation of 'regionals'
Carrier	• Lease circuits own IP service	• MCI managed ATM and IP service	• Qwest managed Sonet & wave service; own IP service	• Own dark fiber (from Level3), DWDM, Ethernet and IP services
Traffic	• Production with limited experiments	• Production with separate testnet	• Production traffic only	• 'Dual-mission' production and experimental

Every 5 years, US national research networks evolve.

Research & Production Infrastructure

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Infrastructure	Research	Production
1:Fiber 2:Wave 3:Router/Ethernet	***breakable, mutable***	***stable, reliable***
	- Measurement of real user Internet traffic - Internet BGP	- AUP-free use for higher ed & K-12 - inter-Gigapop transit
	- L2 R&D on complex topologies, not speed ***multicast routing***	- dedicated IP service without 10G waves ***remote instruments***
	- L1 R&D or dedicated 10G bandwidth R&D ***large MTU, XTP***	- dedicated 10G bandwidth ***DTF/ETF supercomputer cluster, federal mission***
	- Dark fiber full spectrum ***optical packet switch, optical control plane, IP optics***	

Research and Production environments in the same network

Cisco University Research

- **Research awards (every fall and spring)**
  - **$50-100K US**
  - **One year in length**
  - **Peer-reviewed competition**
- **No intellectual property constraints**
- **Communication is central goal**
  - **Standards Bodies**
  - **Academic Journals**
  - **Dialogue among Researchers and Engineers**

Next application deadline is August 2005

URP Proposal and Grant Info

- **Proposals**

  Solicited and unsolicited proposals twice per year

  2 page proposals

  Sample: www.cisco.com/warp/public/750/aii/urp/sample.html

- **Awards**

  1 year awards; renewable but in competition

  Awards range $20K-$100K/year/project – average is $70K; one investigator can have multiple projects

Next submission deadline is August 2005

URP Research Timeline

- **Supporting 5+ year “risky” or challenging research topics for 25% of awards**
- **Supporting 2-5 year out research topics with strong Business Units interest for 75% of awards**
- **Under 15 months is transitions to CARD**

Basic research explores the future of the Internet.

Cisco “Champions”

- **Cisco Champions act as technical liaisons between Cisco and funded researchers**
- **Cisco Champion is a requirement for consideration**
- **Interaction at each stage**
  - **Refine Draft**
  - **Review Proposal (lead among peer review)**
  - **Aid in Research**
  - **Drive Dissemination of Results**
- **Early deadline for proposals lacking champions**

Communication is a critical success factor.

Areas for Research and Development

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- **Design Principles**
  - **Continued race between packet vs circuit (lambdas)**
  - **Peering at all layers**
- **Intelligence and management**
  - **Smart, self managing, self healing, self tuning networks**
  - **Secure, highly available, fault tolerant networks**
- **New Use**
  - **Media convergence: data, voice, video**
  - **Evolving edge: mobile, ubiquitous computing, sensor nets, nano-technologies**

Focus is future growth of the Internet.

Getting Started

- **To apply www.cisco.com/go/research**

1) **Identify your area of interest**
2) **Visit the Cisco Research website for the application sample and access to on-line submission tool**
3) **Have a champion (If you don't have one, submit a draft proposal of study to research@cisco.com 30 days prior to deadline. We'll help find one.**
4) **Enter your application online by August 2005; enter 30 days prior to deadline for a champion match**

External URLs for Academic Research and Programs

- http://www.cisco.com/go/arti
- http://www.cisco.com/go/research

- **Email: research@cisco.com**

“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 11 Apr 1998