Innovation and the Internet

29 April 2005

Christopher Buja, Deputy Director

Academic Research & Technology Initiatives, Cisco

cbuja@cisco.com

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Agenda

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

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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

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Network Convergence

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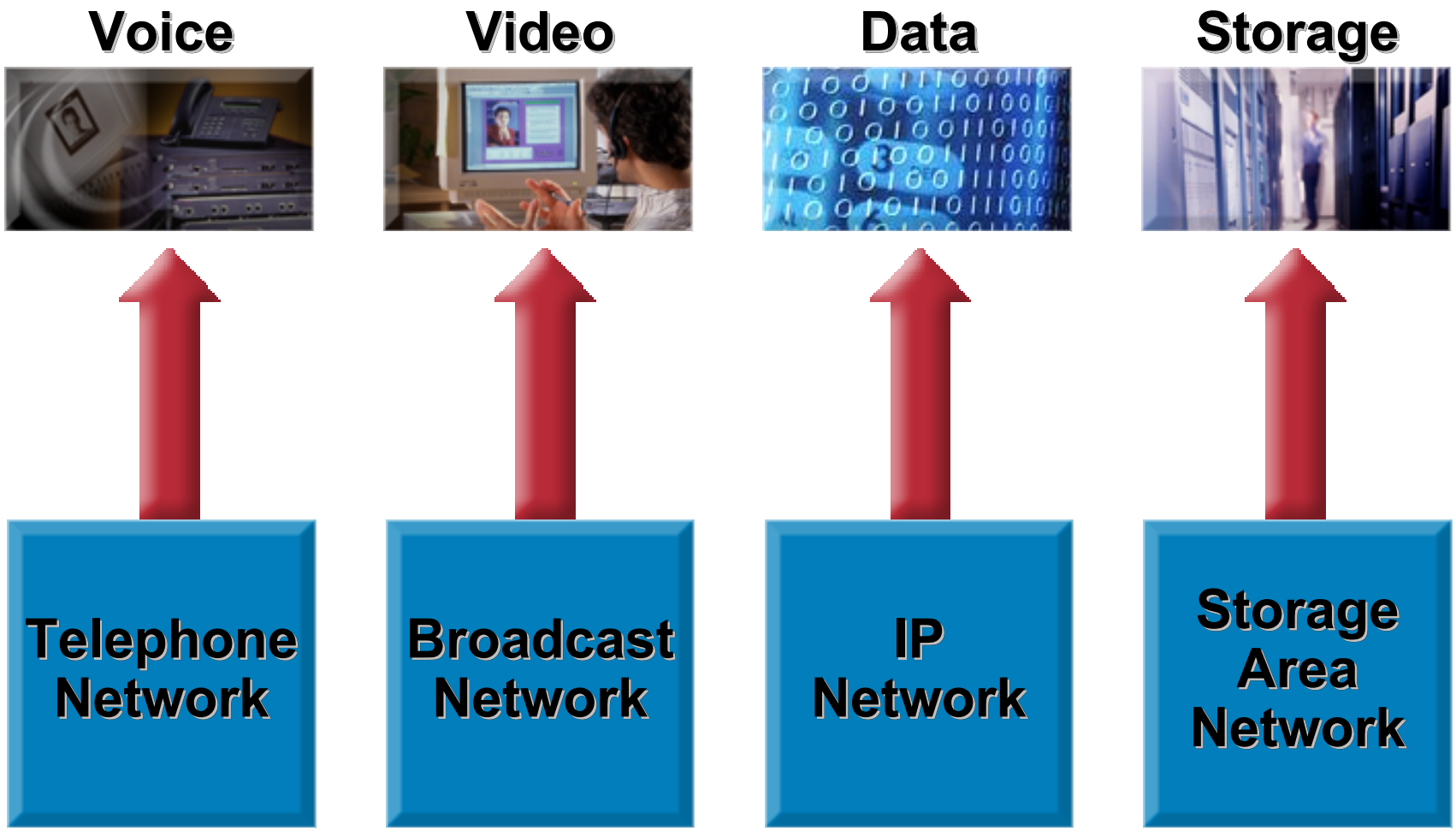

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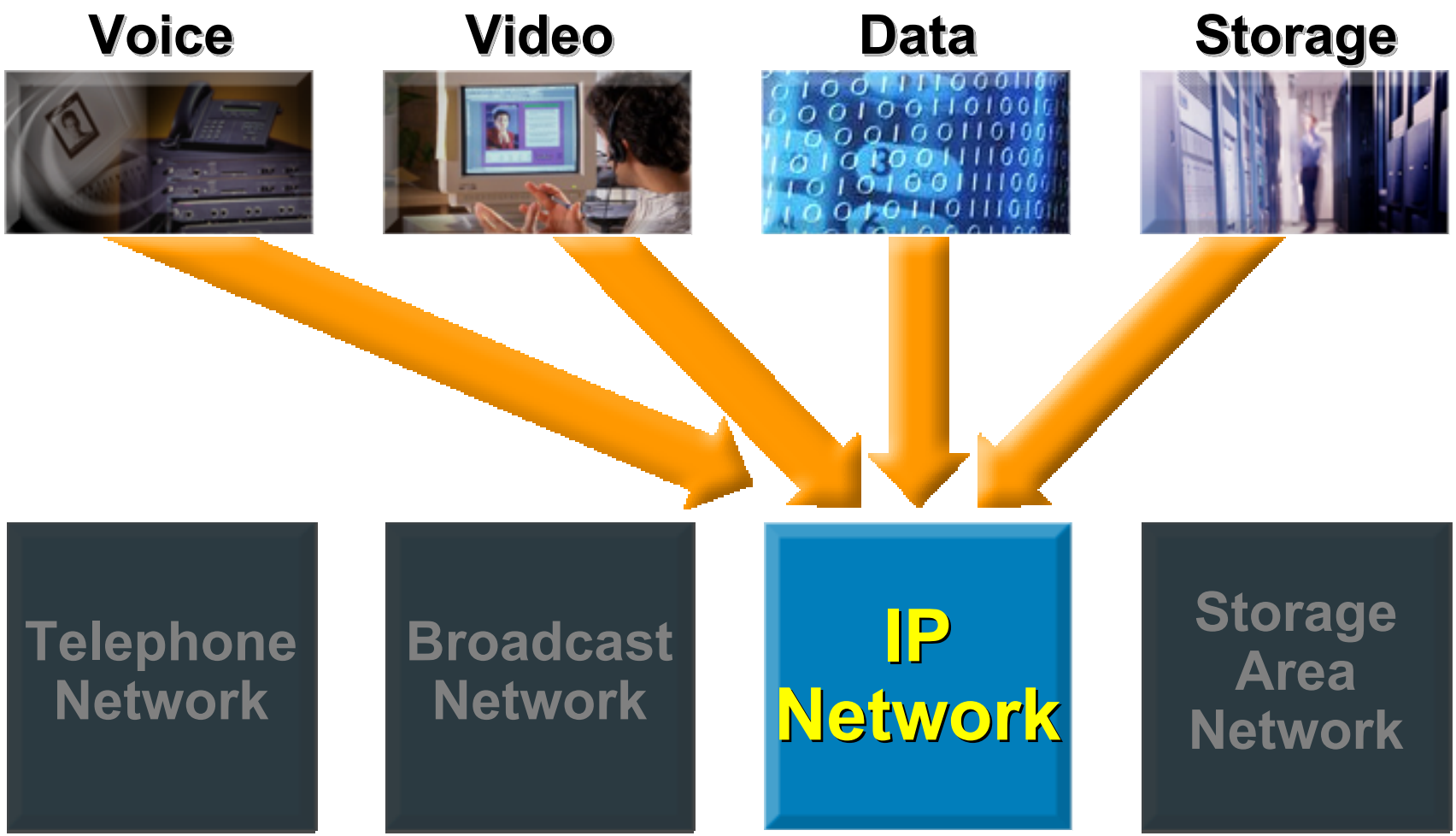
Network Convergence



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Challenge of the Ideal Next Generation Network

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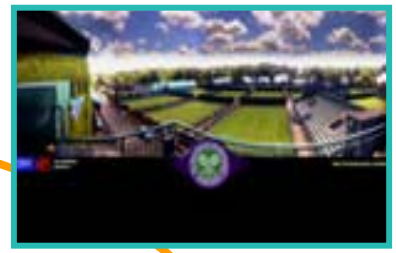
Fusing the Best Properties of Today's Networks onto a Common Lowest Cost Infrastructure

Ubiquity & Reliability of the PSTN

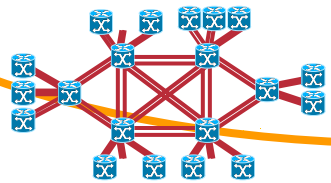
Mobility of the GSM Network



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

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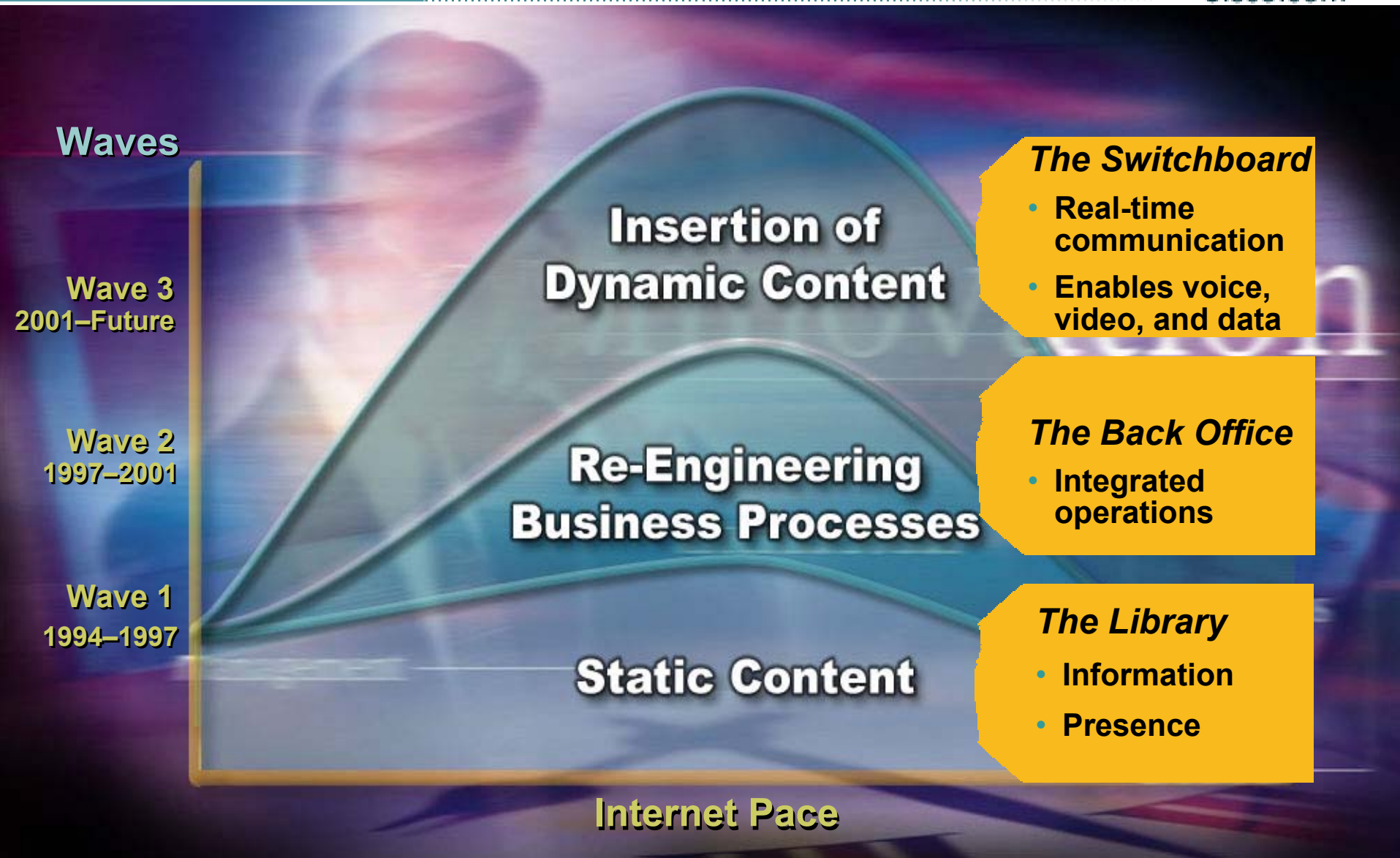
Network-Enabled Application Waves



Multiple Players in Research

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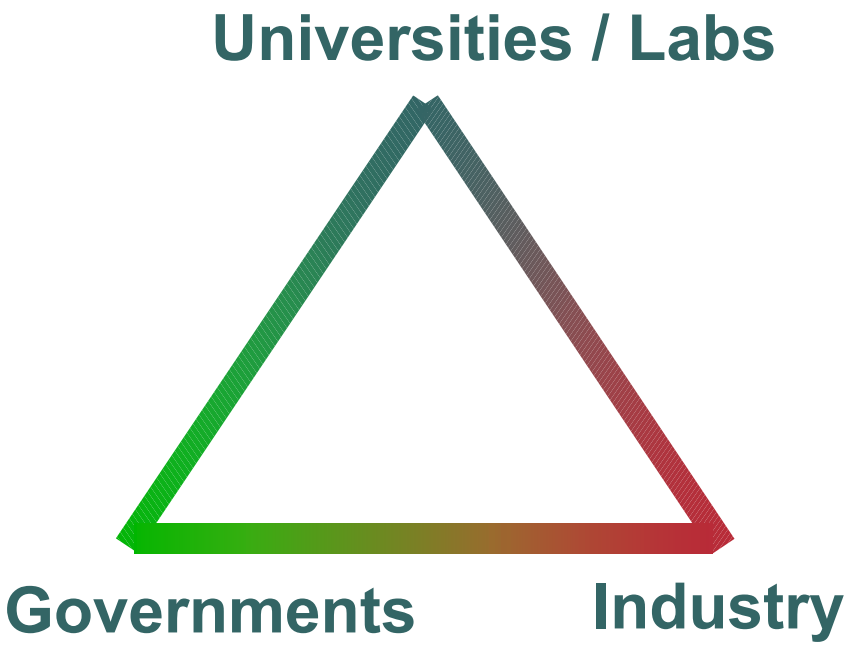

Tensions

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

Resolutions

- Partnerships
- Communication

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Successful Partnerships

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

Successful partnerships are balanced over time

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Advanced Internet Partnerships

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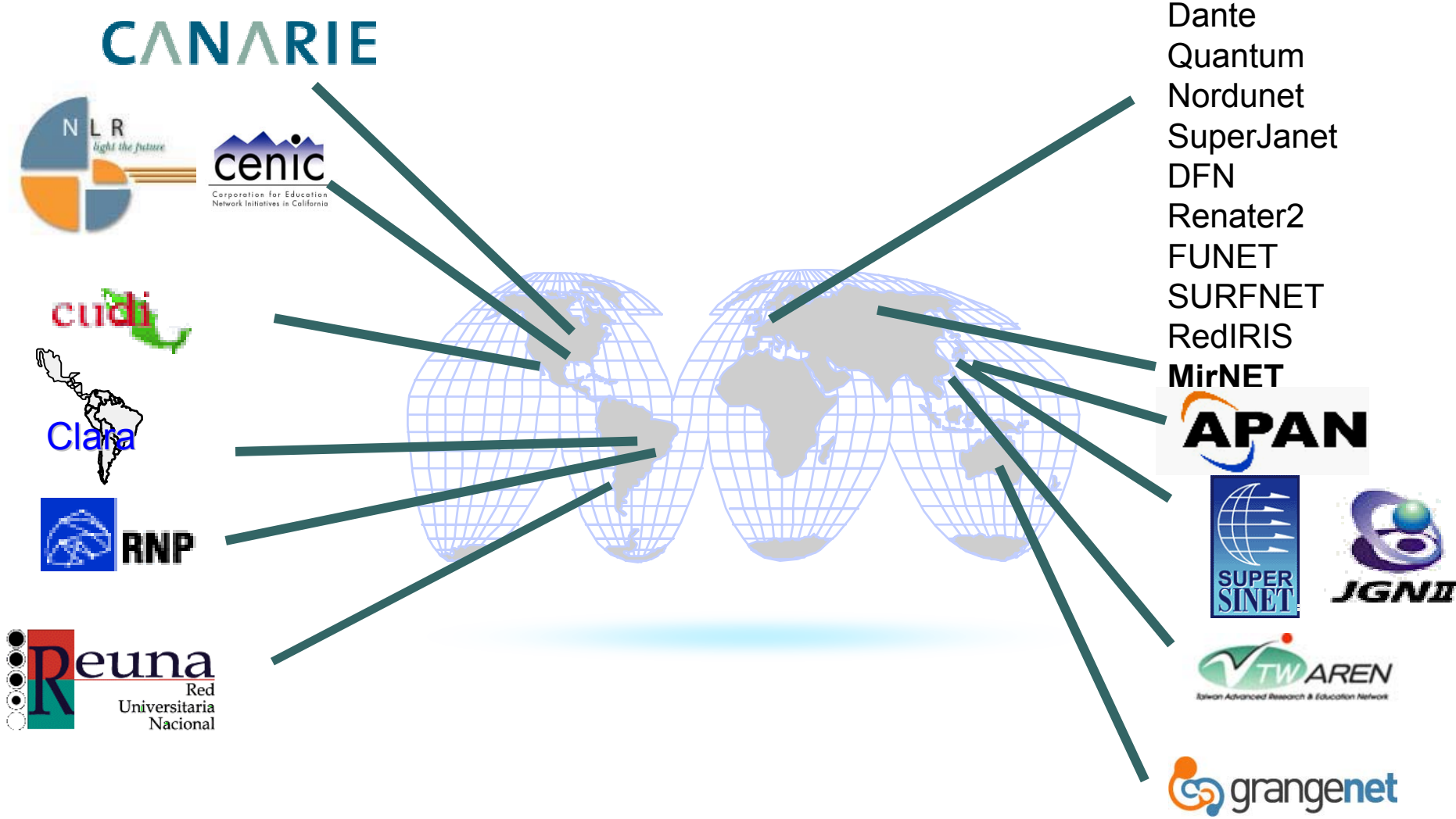

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Research & Education Network Tiers

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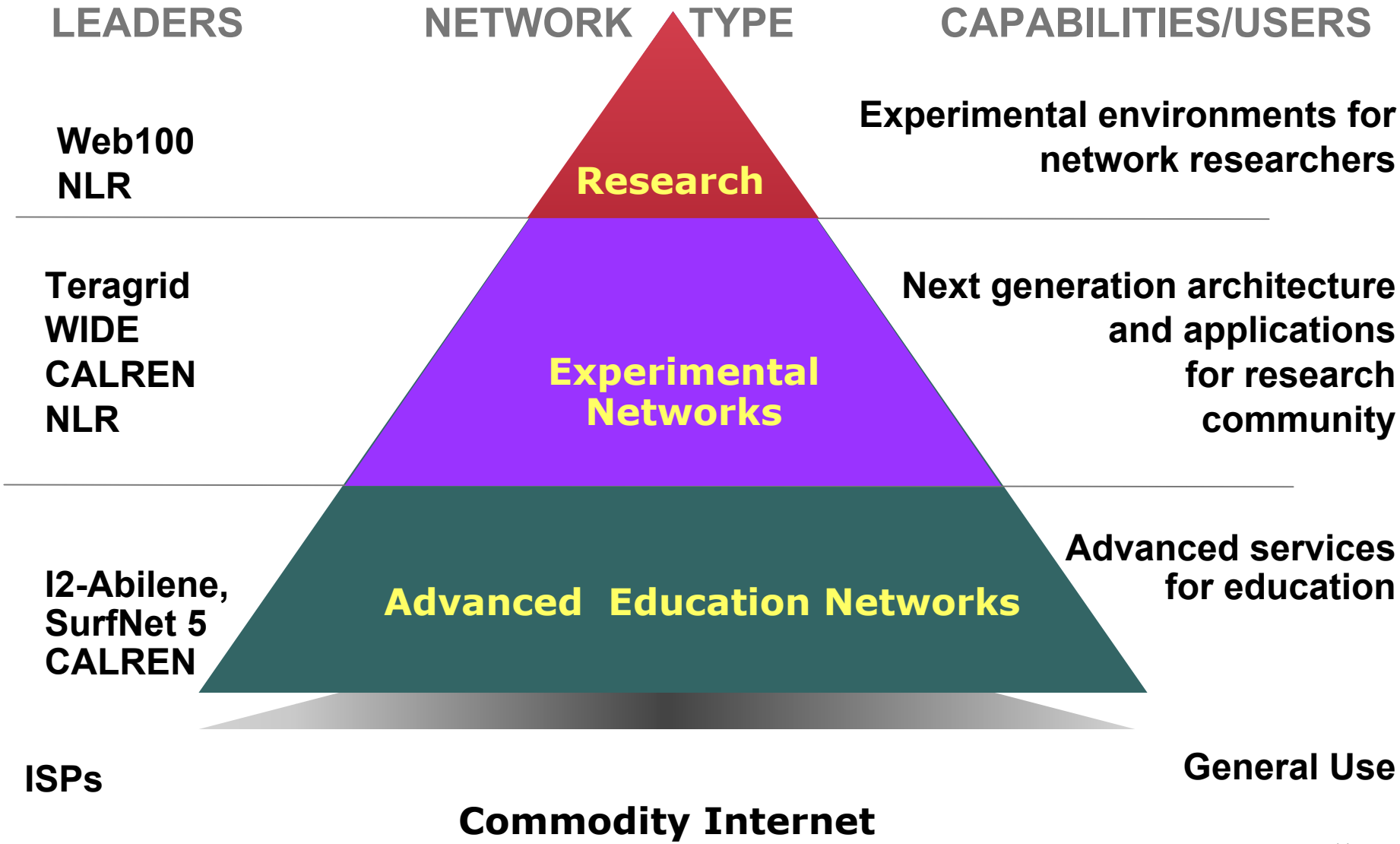

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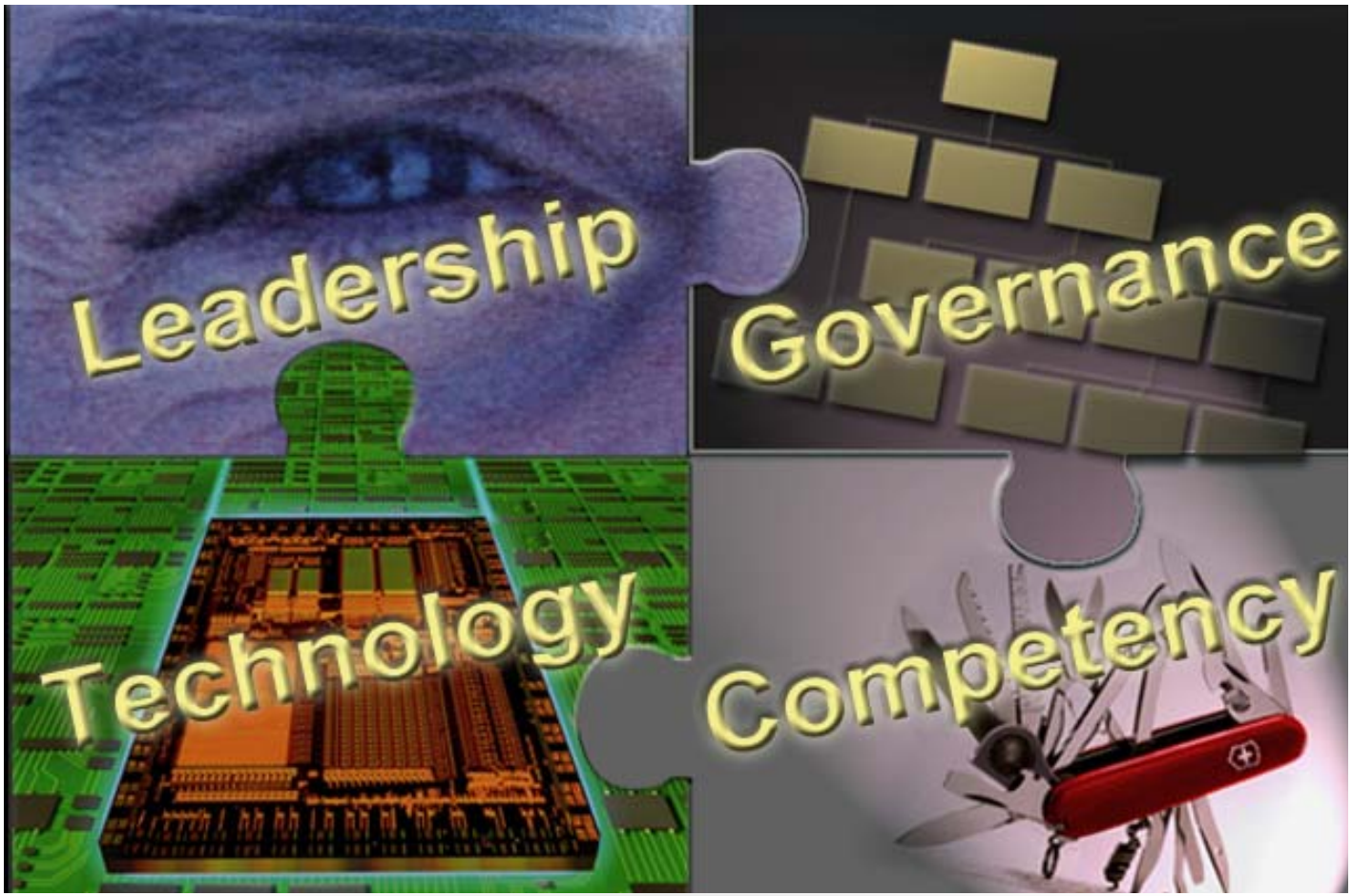
Readiness



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Key Success Factor

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Learning is not Training

It is information, communication, collaboration, and education

Evolution of US Research Networks

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1988 1993 1998 2003

	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.

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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

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Cisco University Research

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- 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

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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

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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.

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Cisco “Champions”

- Cisco Champions act as technical liaisons between Cisco and funded researchers
- 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.

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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.

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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**
  3) **Identify a champion who works in your area of interest If not readily available, we'll help find one.**
  4) **Enter your application online by August 2005; enter early for a champion match**

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External URLs for Academic Research and Programs

Cisco.com

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

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

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“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

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