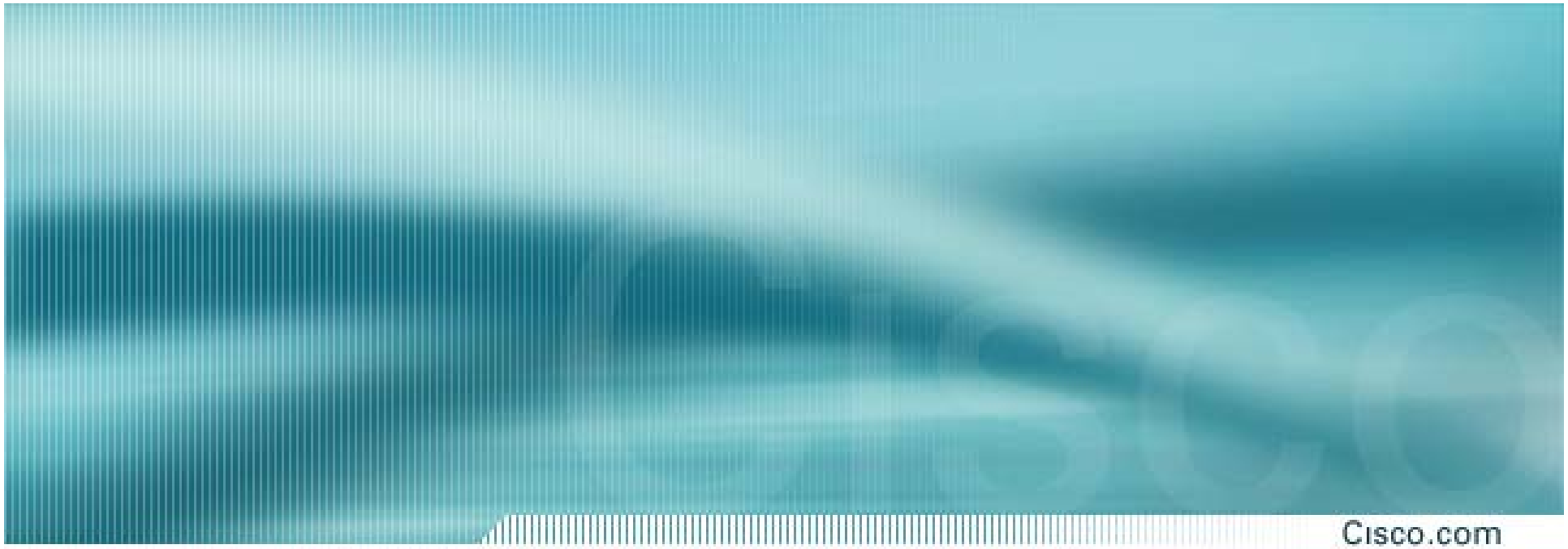

The Global Internet: Developments and Challenges

Fred Baker

Cisco Fellow

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What I'd Like to Talk About

- Growth in deployment
- Key developments
- Issues in development
- Key issues facing us

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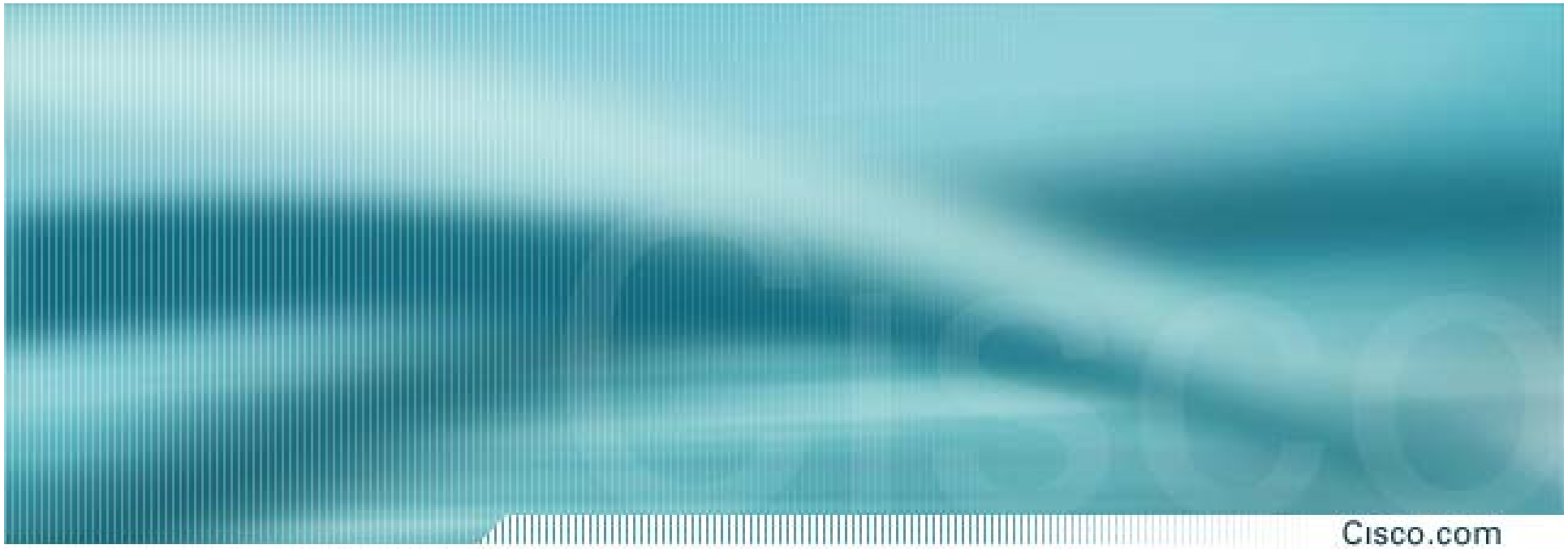

Growth in deployment

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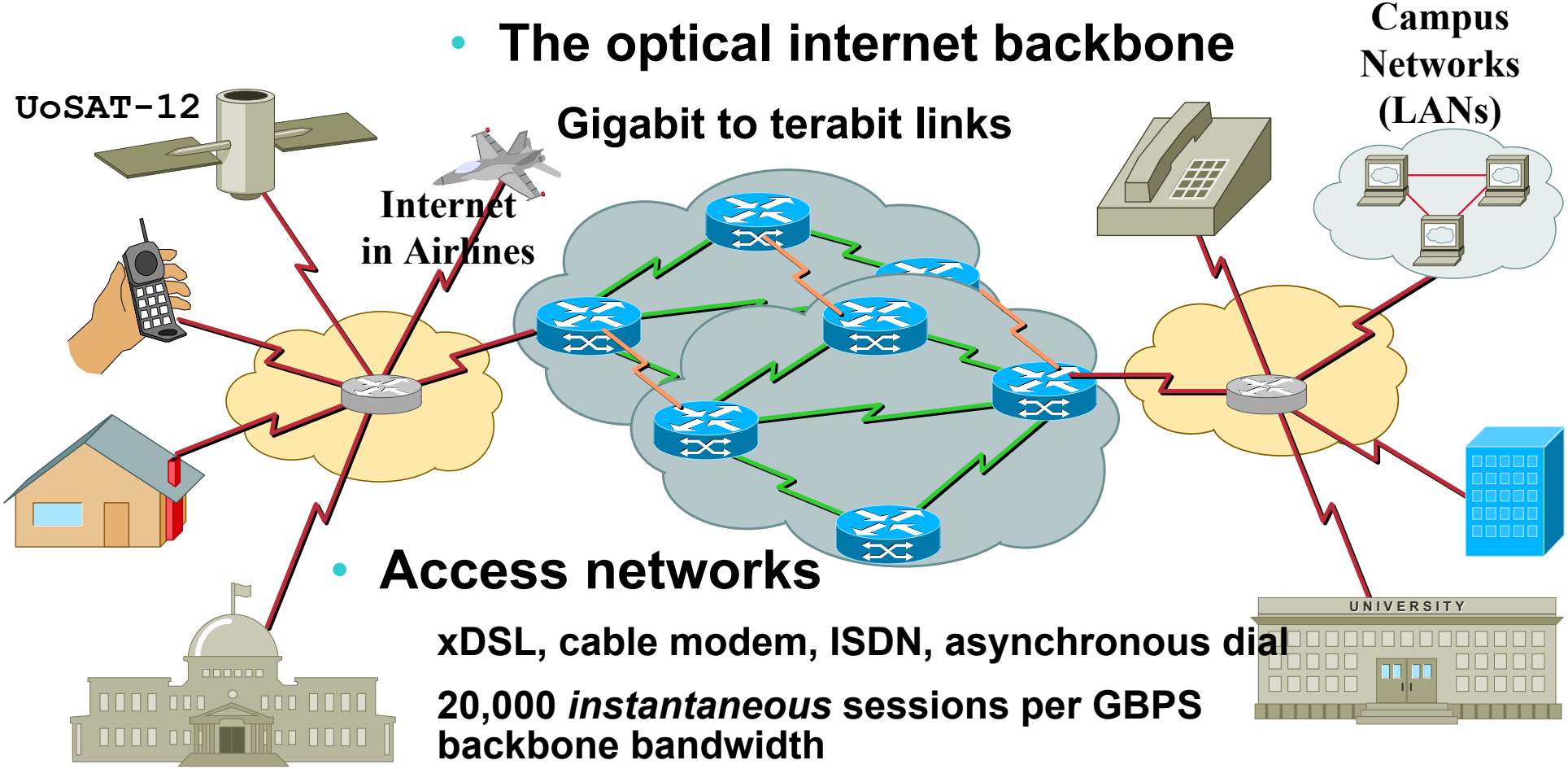
Today's Internet

- The optical internet backbone

Gigabit to terabit links



- Access networks

xDSL, cable modem, ISDN, asynchronous dial

20,000 *instantaneous* sessions per GBPS backbone bandwidth

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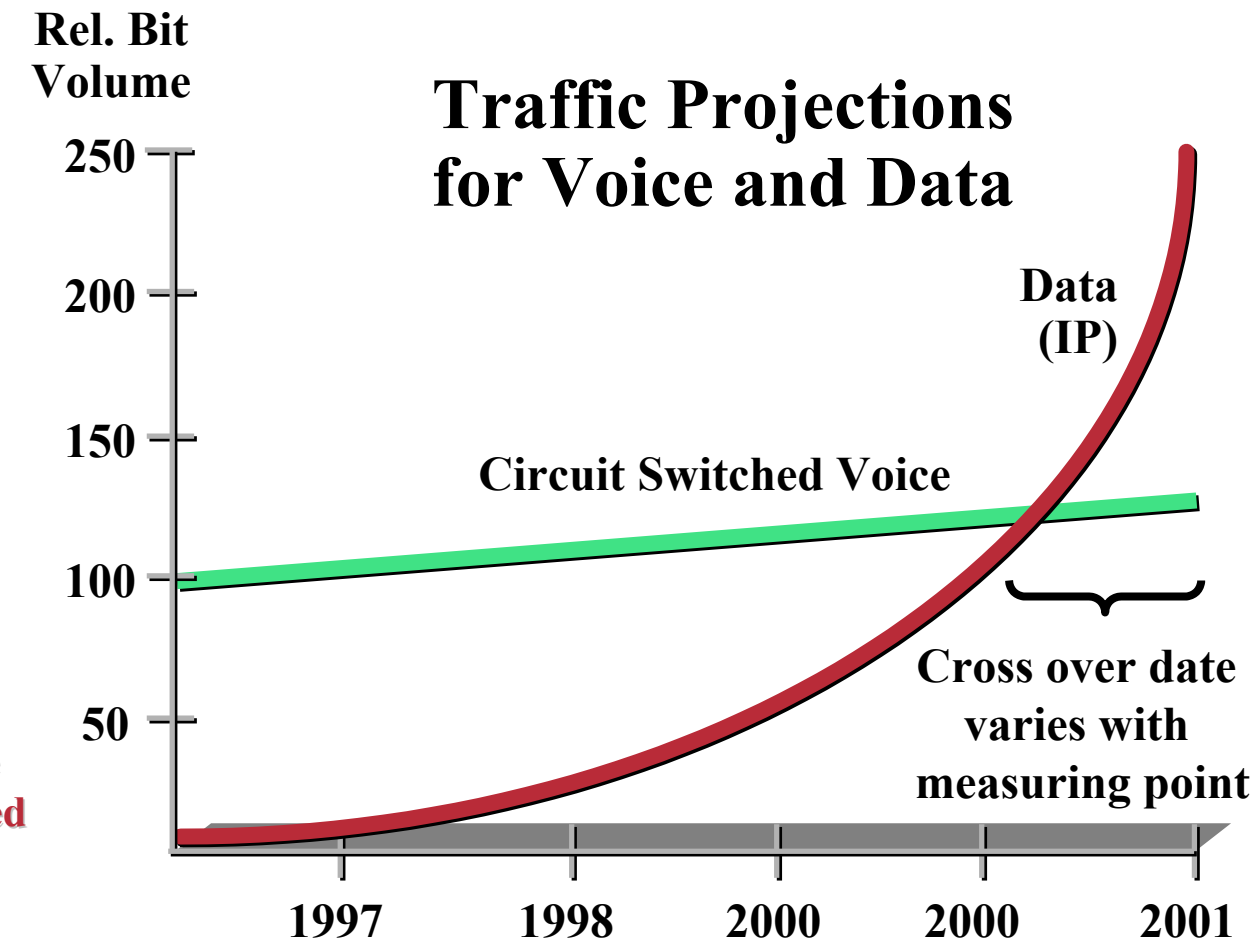
Growth of IP Traffic

- Email
- Information search/access
- Subscription services/“push”
- Conferencing/ multimedia
- Video/imaging



“From 2000 on, 80% of Service Provider Profits Will Be Derived from IP-Based Services.”
Source: CIMI Corp.

Source: Multiple IXC Projections

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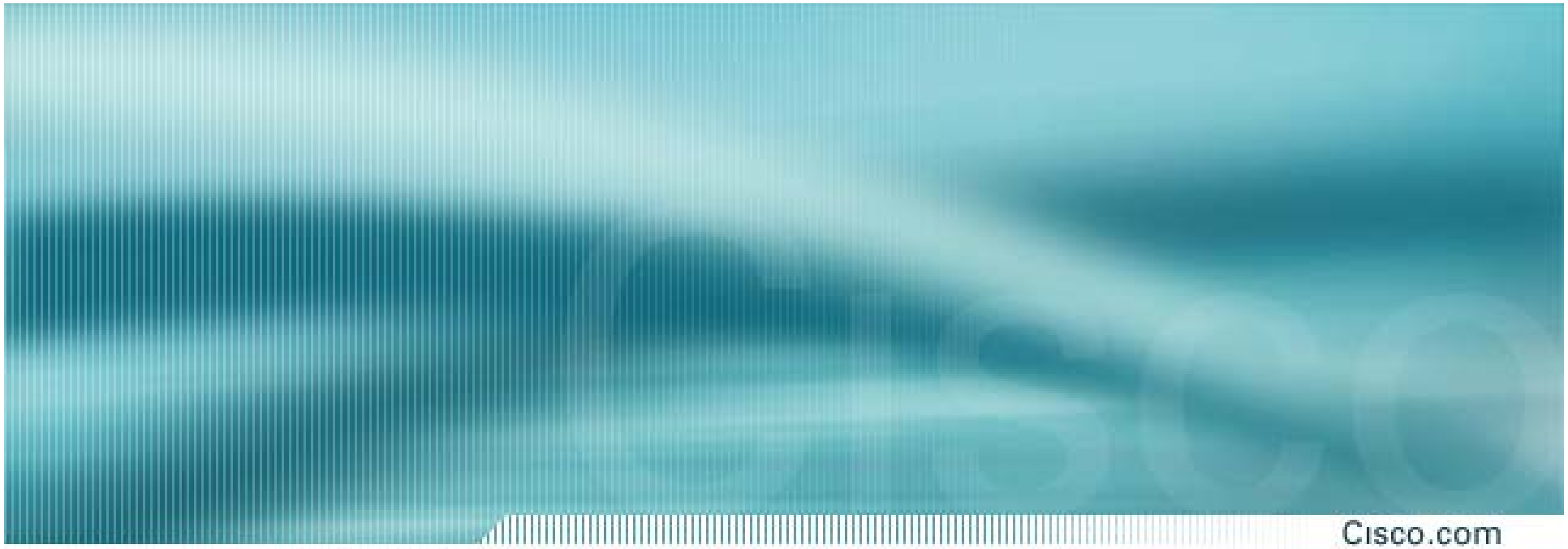

Key Developments in Connectivity and Reliability

There is nothing so constant in the Internet as innovation and change

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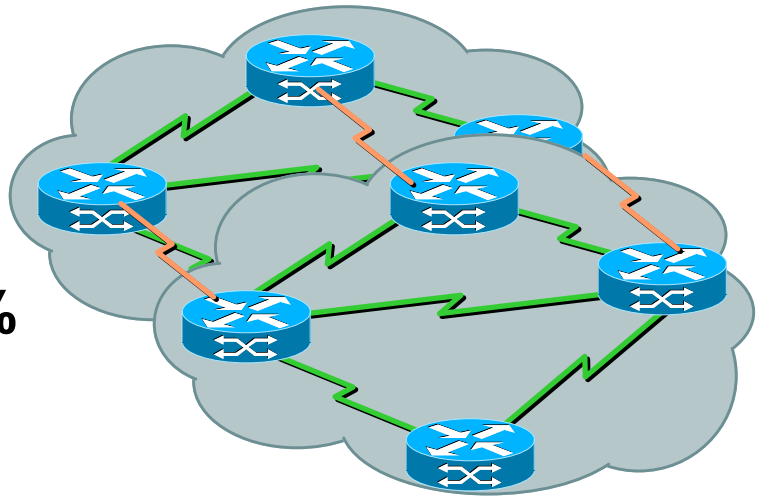
What's doing well?

- In a word, bandwidth
  - In the core
  - In broadband access
  - In Large Corporate Networks
- LANs and Core WANs run < 10% utilized
  - Qwest commented recently that their 10 GBPS backbone is 2.5% utilized



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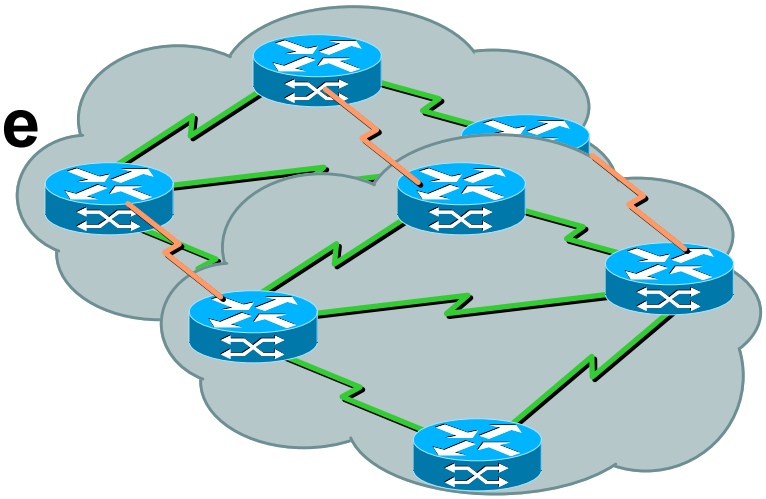
Implications of high bandwidth network:

- **Queuing** delay (and therefore loss) within the Internet backbone and large corporate networks is **nominal**
- **Routing** within backbones and large corporate networks tends to be robust



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Large Bandwidth enables...

- **Bandwidth-hungry applications**
  - **Electronic “mail order” shopping and other commerce**
  - **Music delivery**
  - **Medical imaging**
  - **Wide-scale teleconferencing**
    - **Remote learning, remote presence**
  - **Your idea here...**

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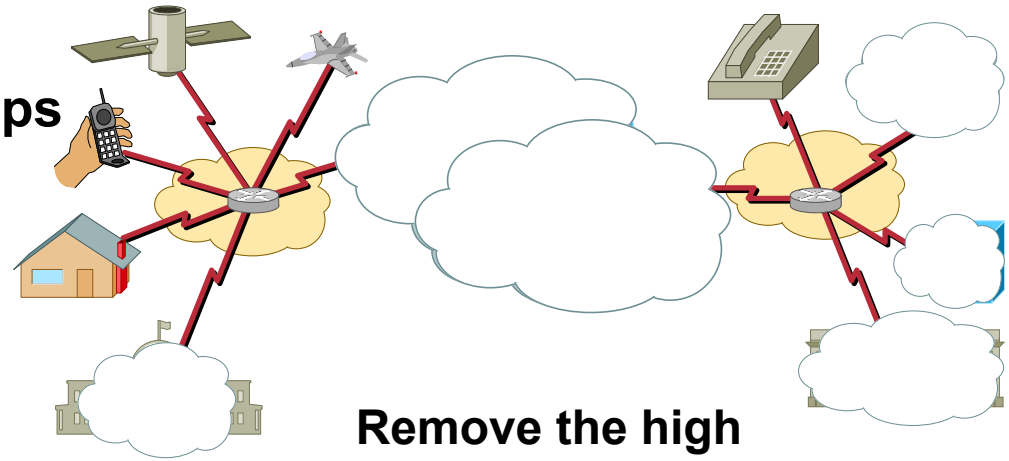
But we experience problems! Where are they?

- End user bandwidth
  - Broadband deployment not as fast as expected
  - 3G Mobile Internet lacking significant deployment, perhaps due to large startup costs
- Delay and loss experienced by end users is largely due to
  - Server overload
  - Database design
  - Firewalls and Gateways
  - Overloaded access links or smaller ISPs



Remove the high bandwidth regions

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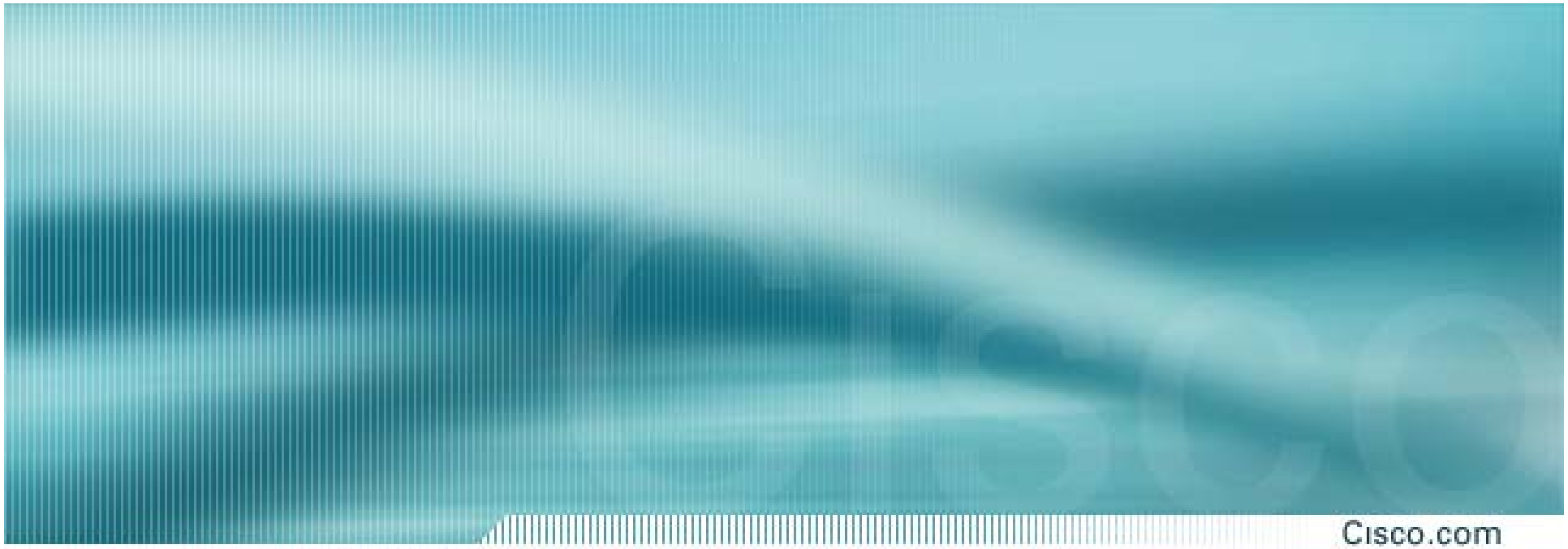

There are significant issues

“Here there be dragons”

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The big issues in the Internet

- Technical Issues
  - Issue #1: Scale
    - The issue in the Internet is scale
  - Issue #2: Trust
    - Increasingly, trust is a major issue
  - Issue #3: Predictability
    - The issue growing over time...
  - Issue #6: Applications and Architectures
    - Can we still deploy new applications?
- Non-technical issues
  - Issue #5:Services, Settlements, and Billing
    - The way a service provider makes his money
  - Issue #6: Political and Regulatory Issues
    - How to make life difficult in a hurry

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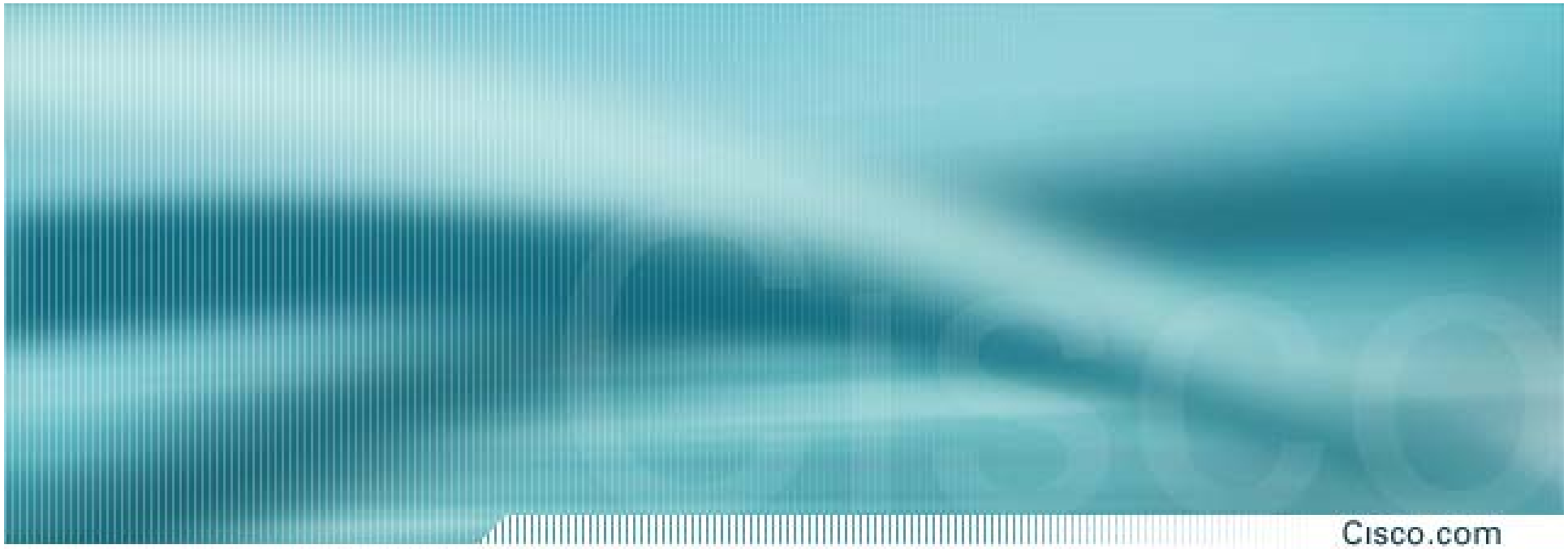

Issue #1: Scale

“Scaling is the issue for the Internet”

Mike O’Dell, formerly Chief Scientist, UUNET

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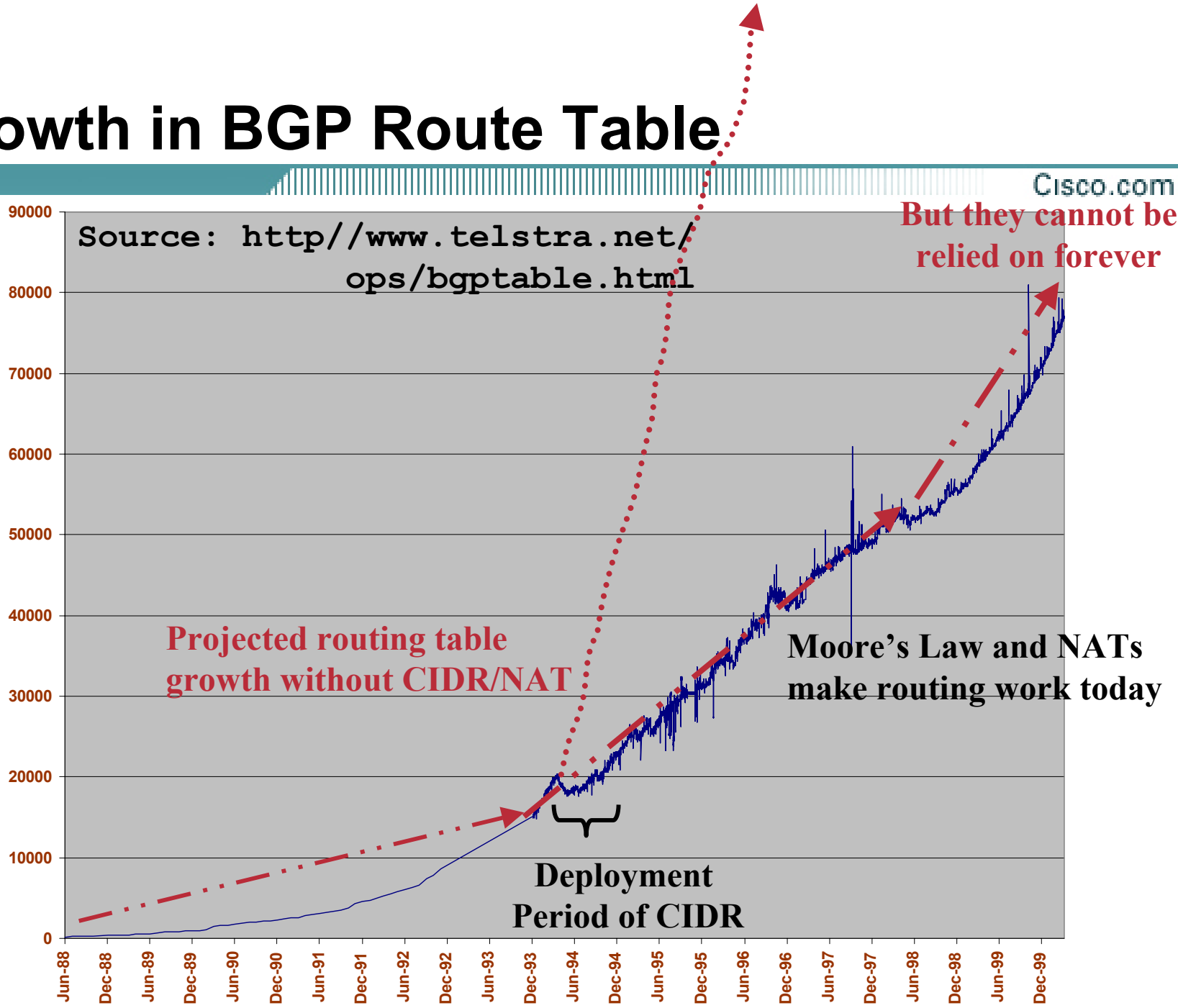
Growth in BGP Route Table



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Routing and Addressing

- What we've done to date:

Address and route aggregation

Using addresses more efficiently

Classless Inter-Domain Routing (CIDR)

Private Addressing

Using less addresses when we can

Network Address Translation (NAT)

Address extension

Getting more addresses

Whither IP6?

- Massachusetts Institute of Technology (18.0.0.0/8) has

~19,000 students and faculty

- It has as many IP addresses as the People's Republic of China

Population 1.3 billion

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Remaining scaling issues

- **Assuring that addresses needed are available**
  - **IP6 deployment an opportunity for leadership**
  - **Multihoming in IPv6 not a solved problem**
- **Routing in Optical Networks**
- **Network configuration management**

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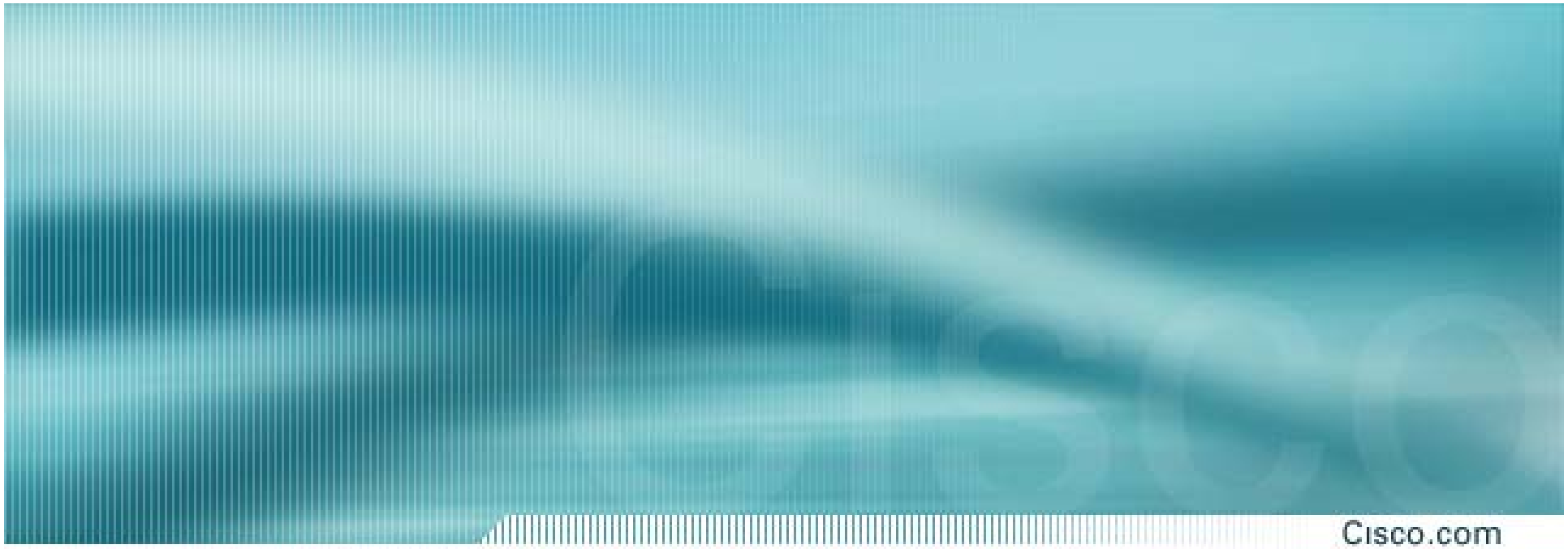

Issue #4: Architectures and Applications

“Scaling is the issue for the Internet”

Mike O’Dell, formerly Chief Scientist, UUNET

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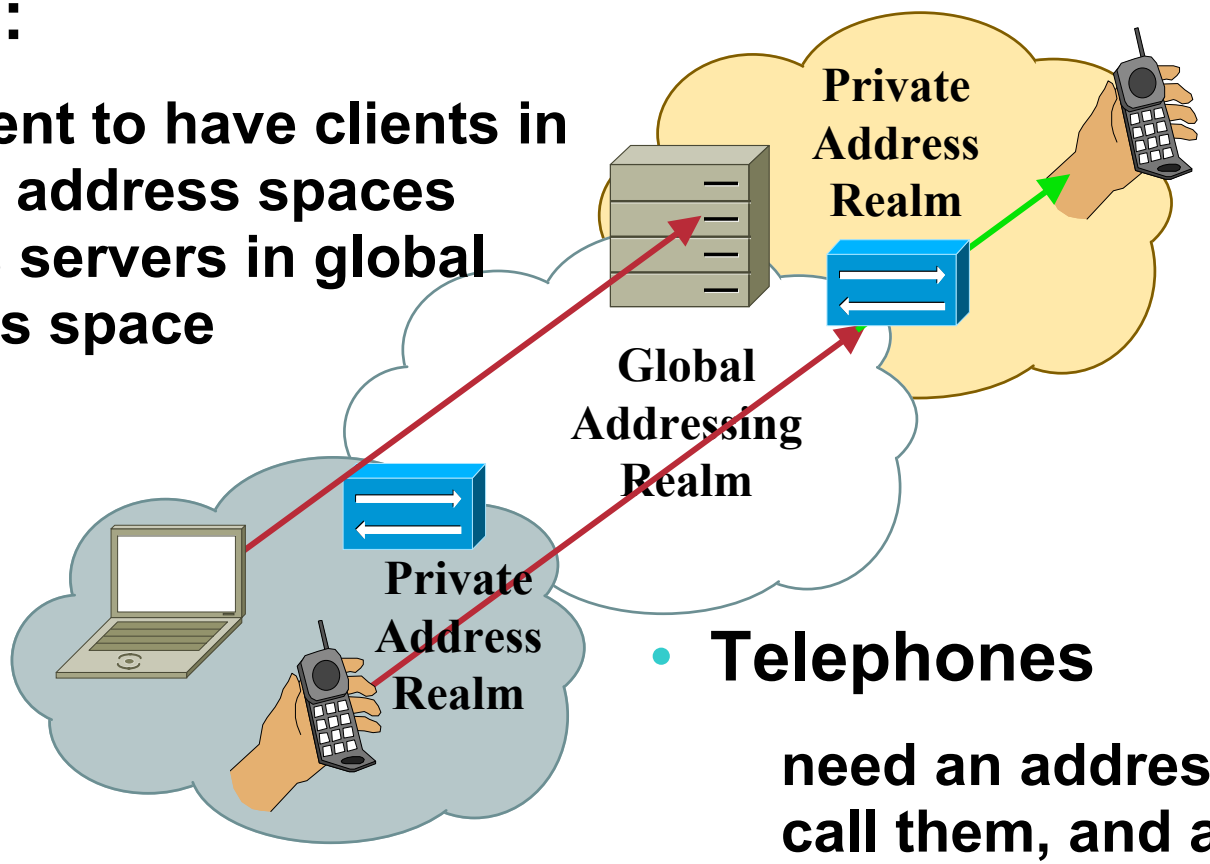
Client/Server Architecture is breaking down

- **For web:**

  Sufficient to have clients in private address spaces access servers in global address space



- **Telephones**

  need an address when you call them, and are therefore servers in private realm

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Implications of breakdown

- **Difficult to deploy new applications**

  Because we have to change the firewalls as well as the end systems

- **Network becoming more complex**

  Therefore more difficult to manage and use

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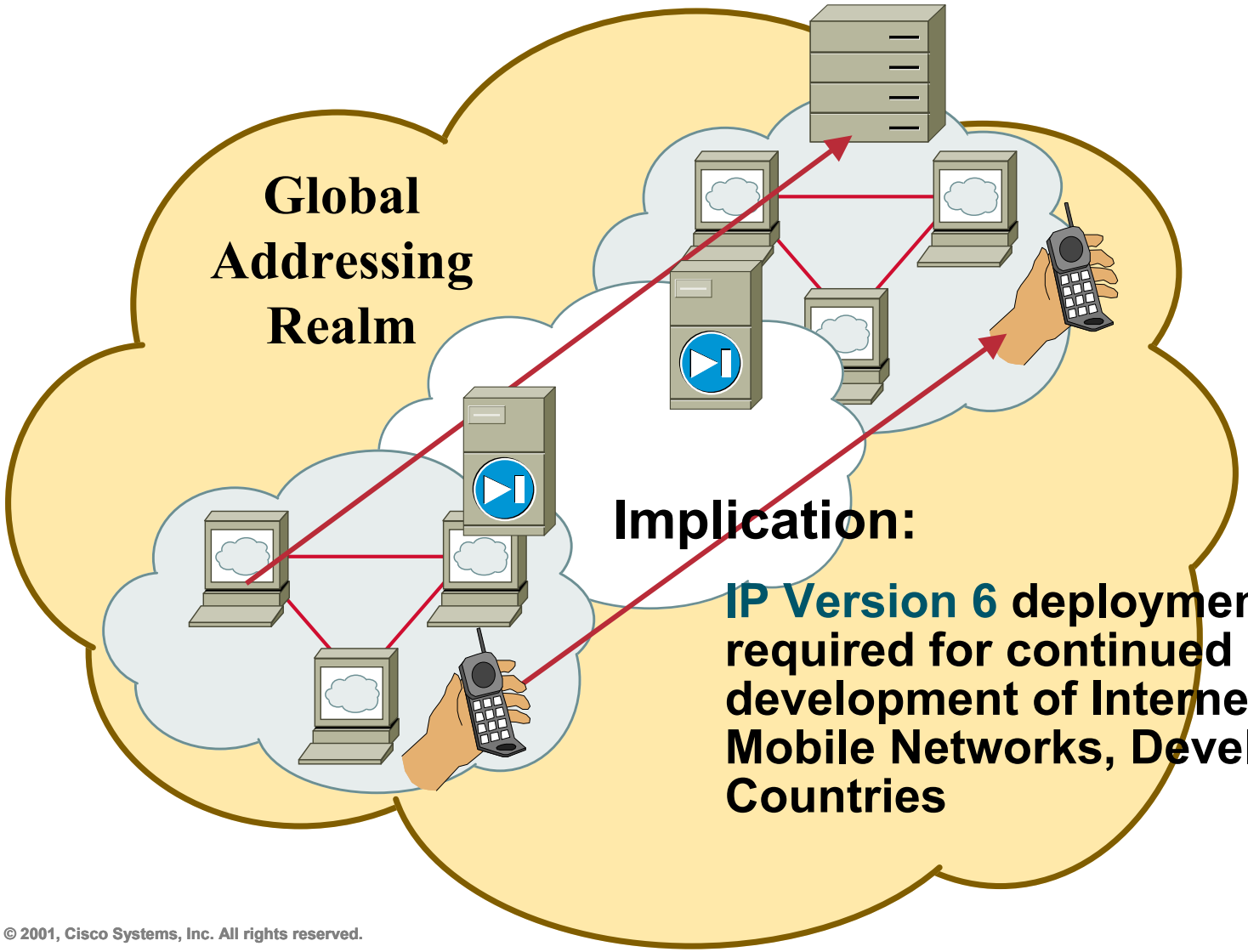
Need an end to end naming and addressing architecture



Implication:

IP Version 6 deployment required for continued development of Internet in Mobile Networks, Developing Countries

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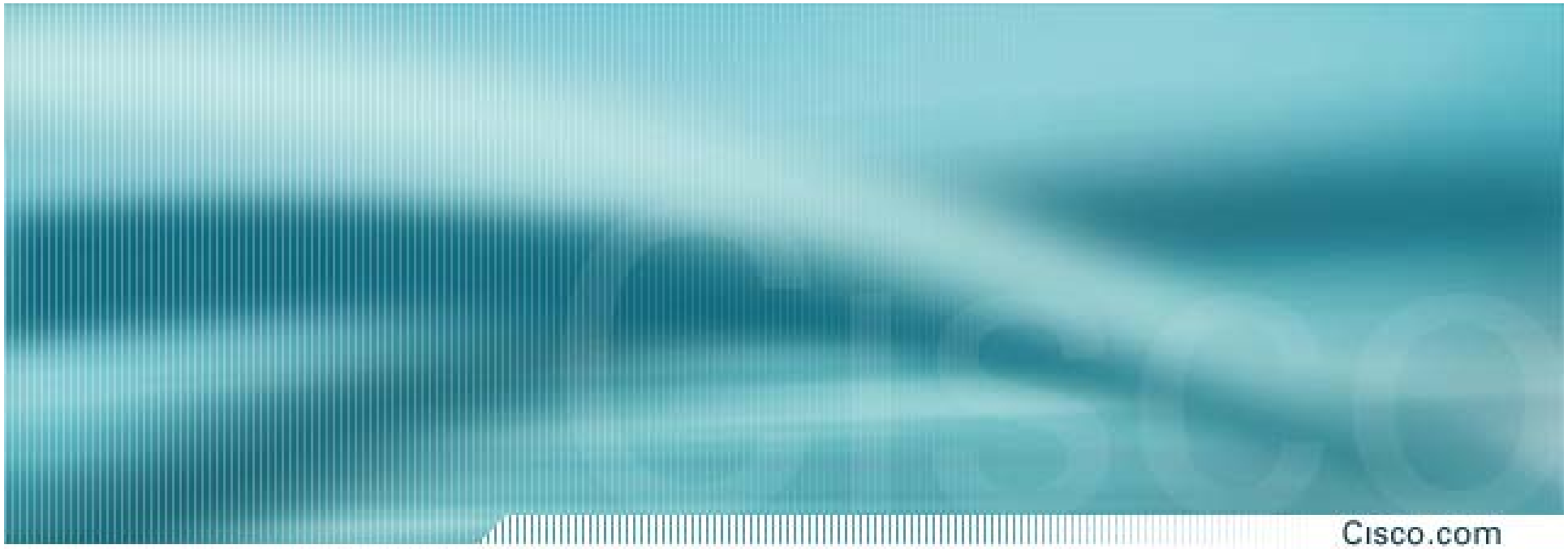

Issue #6: Political and Regulatory Issues

What helps, what hurts

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IETF Issues in Internet Privacy and Security

- **IETF primary concern:**

  Security of the infrastructure

- **Two statements:**

  RFC 1984 - "IAB and IESG Statement on Cryptographic Technology and the Internet"

  RFC 2804 - "IETF Policy on Wiretapping"

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Cryptographic Technology and the Internet

- **Law enforcement needs the ability to track criminals, who are increasingly sophisticated**
  - **September 11 terrorists reportedly used steganographic encryption**
- **Legislative proposals:**
  - **Disallow use of cryptography, or**
  - **Make it easy for authorities to obtain encryption keys**

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Need for Internet cryptography

- **Internet needs strong cryptography for commercial and management reasons**
  - **Authentication of merchants and clients**
  - **Authentication of infrastructure data such as routing**
  - **Encryption of financial information**

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Weak cryptography weakens those who use it

- **Weakening cryptography:**

  Export controls, Weak keys, Weak algorithms

- **Weak cryptography weakens**

  Companies in countries that inhibit it, in competition with foreign competitors

  Internet infrastructure, which is not permitted to use it

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Weak cryptography weakens those who require its use

- **Weak cryptography also enables forgery**

  A key which can be broken or obtained can be used to digitally sign documents

- **Key escrow/recovery defeats legal cases**

  Key constructively available to other parties,

  Forgeries indiscernible from real signatures: cannot be detected or proven false

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RFC 1984 on the use of Cryptography

> As more and more companies connect to the Internet, and as more and more commerce takes place there, security is becoming more and more critical. Cryptography is the most powerful single tool that users can use to secure the Internet. Knowingly making that tool weaker threatens their ability to do so, and has no proven benefit.
>
> RFC 1984

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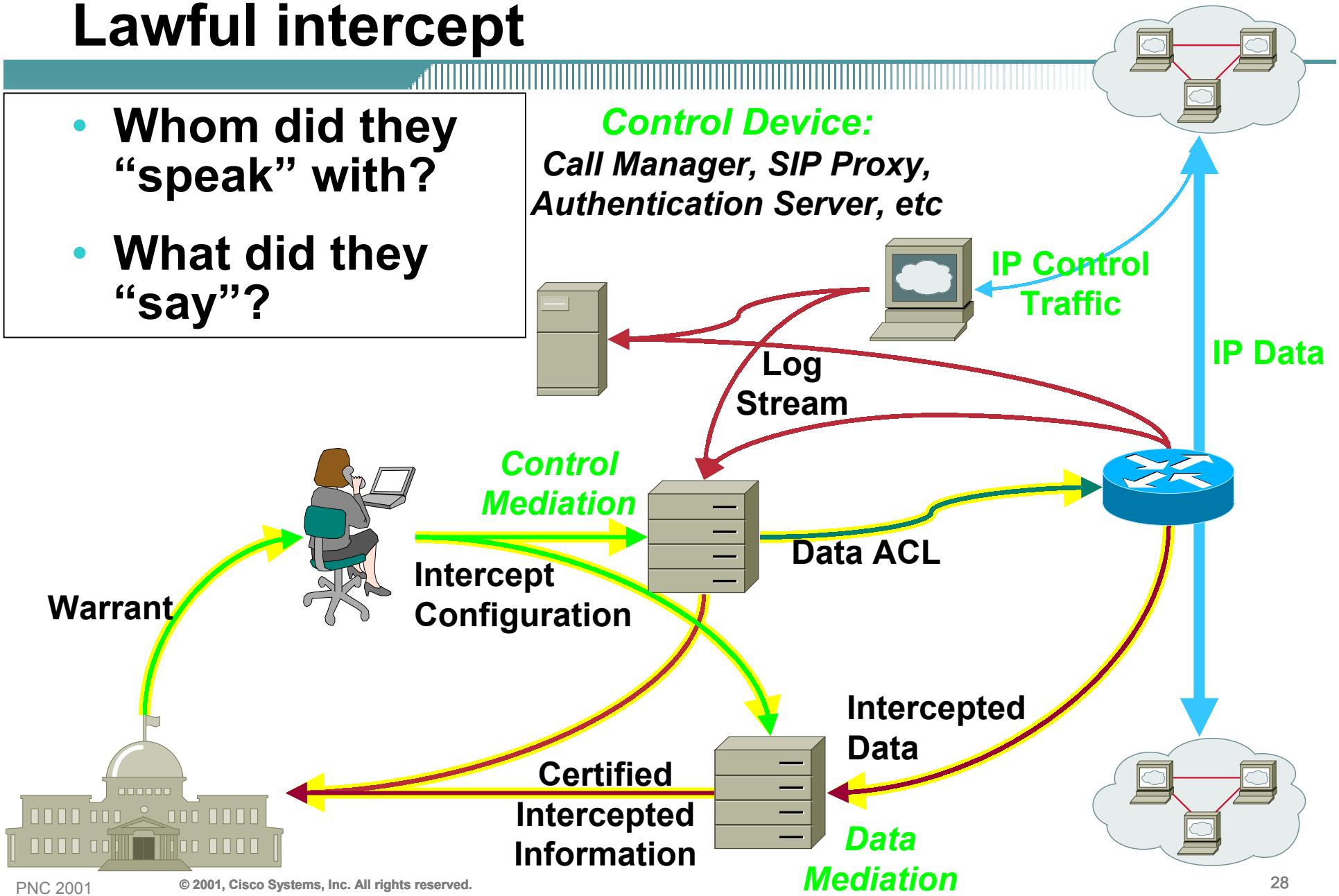
Lawful intercept

- Whom did they "speak" with?
- What did they "say"?



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Cybercrime treaty, Article 21

"Each Party shall …

a. collect or record …

b. compel a service provider…

i. collect or record …

ii. co-operate … in the collection or recording of,

content data, in real-time, of specified communications in its territory transmitted by means of a computer system."

http://conventions.coe.int/Treaty/en/Treaties/Html/185.htm

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RFC 2804 on Lawful Intercept

- **Wiretapping ... releases information that the information sender did not expect to be released.**

  The system is less secure than it could be had this function not been present.

  The system is more complex than it could be had this function not been present.

  Being more complex, the risk of unintended security flaws in the system is larger.

- **Wiretapping, even when it is not being exercised, therefore lowers the security of the system.**

RFC 2804

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Current state of law

- **Cybercrime treaty signed 27 November 2001**
  - **Initial signatories:**
    - **26 European states, US, Canada, Japan, South Africa**
  - **Mandates content controls by anyone who stores data**
  - **Mandates lawful intercept capabilities if you move data**
- **11 September attack used to push legislation in US**
  - **Cryptography limitations and export controls discussed during debate**

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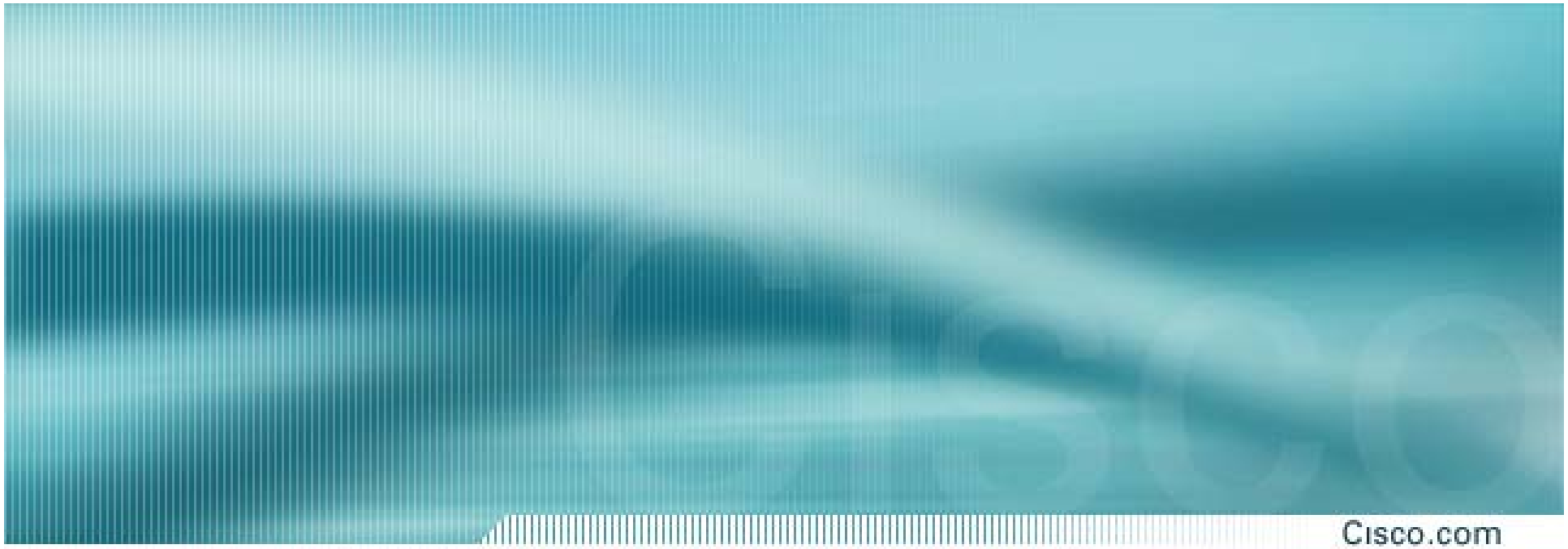

Going forward

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Brave New World filled with opportunities

- **Internet technology is a powerhouse**
  - **Every nation wants to use it**
- **Global communication enhances**
  - **Inter-personal communications**
  - **Domestic and Foreign trade**
  - **Research**

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All opportunities come with challenges

- **Security and scaling of routing and addressing**
- **IPv6**
  - **More addresses, Application deployability**
- **Security vs Privacy**
  - **What is the right balance?**

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Ours to be responsible with

- It is possible for us to make all this fail
- Forces are in place to ensure that we do
- We need to go out of our way make the right things happen

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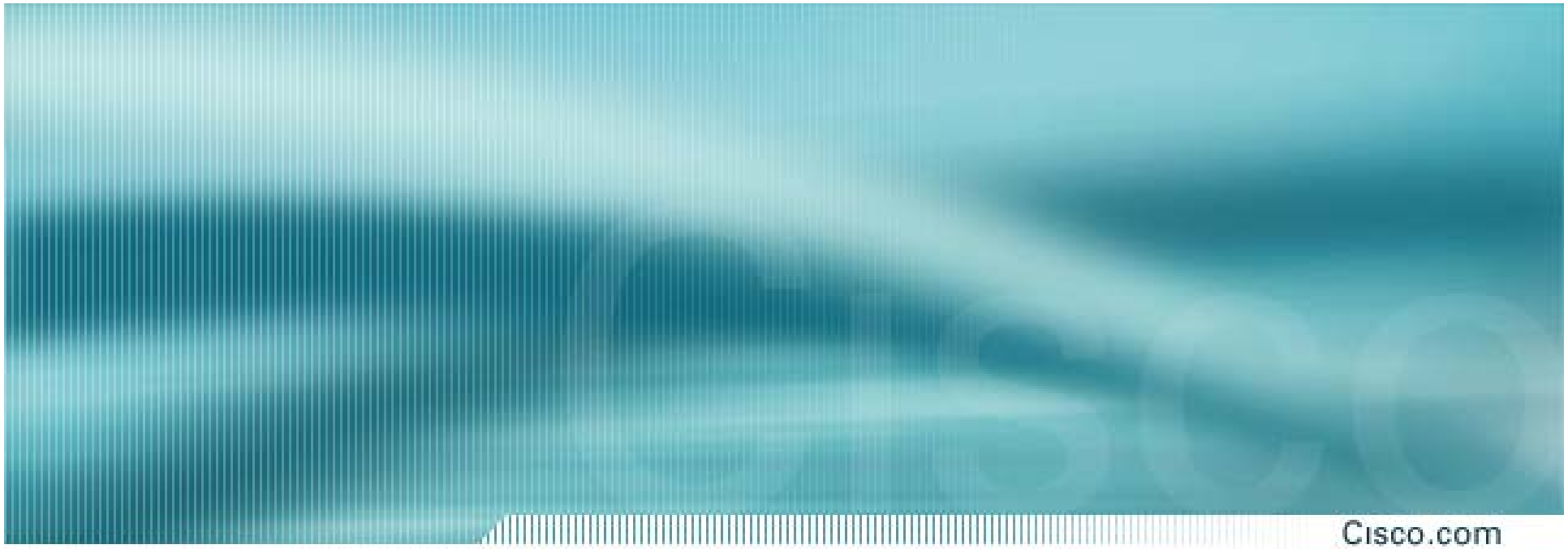

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