

# Internet Topology and Terminology

Rick Lamb  
German Valdez  
Bill Woodcock

# Introductions

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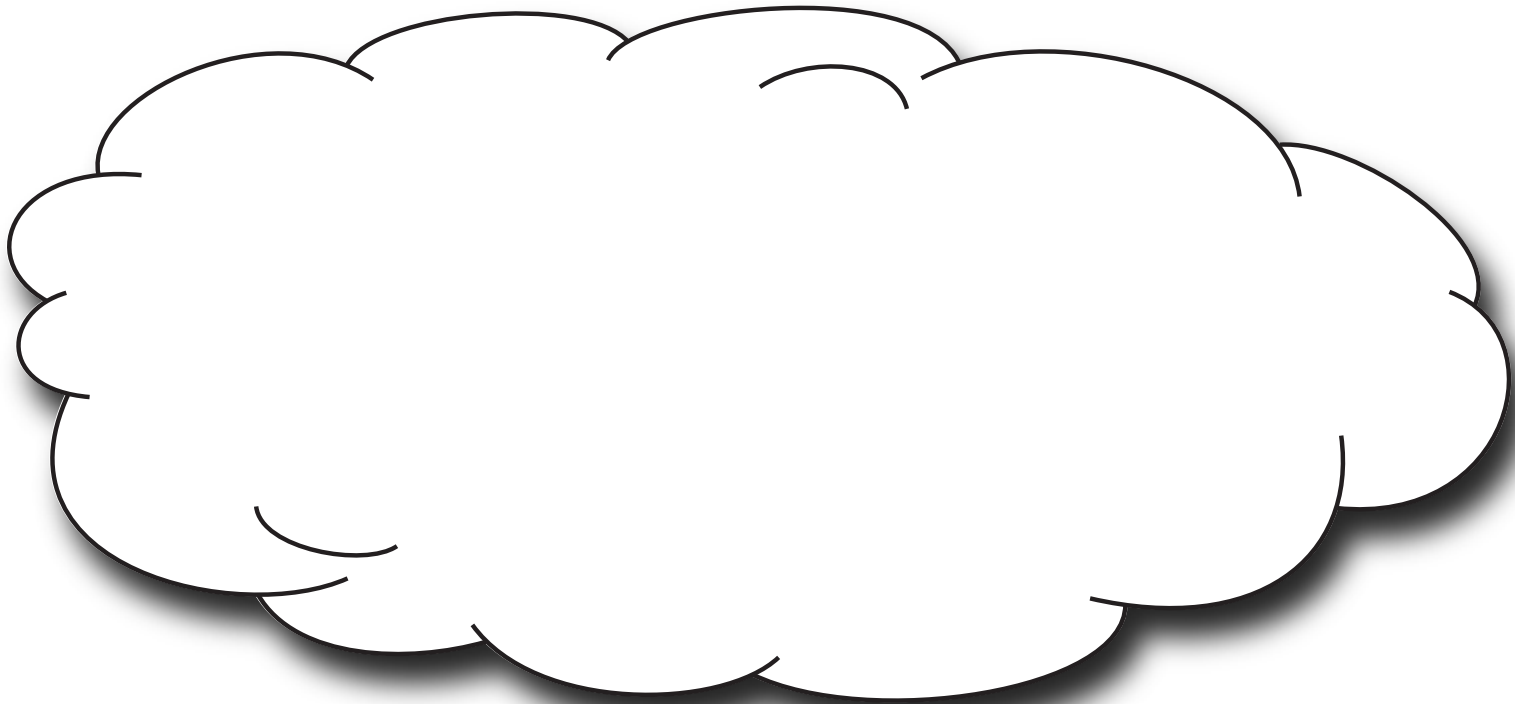
**Bill Woodcock:** Research director at Packet Clearing House, ARIN board member, and past network architect at Zocalo, a global ISP based in California.

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What is the Internet?

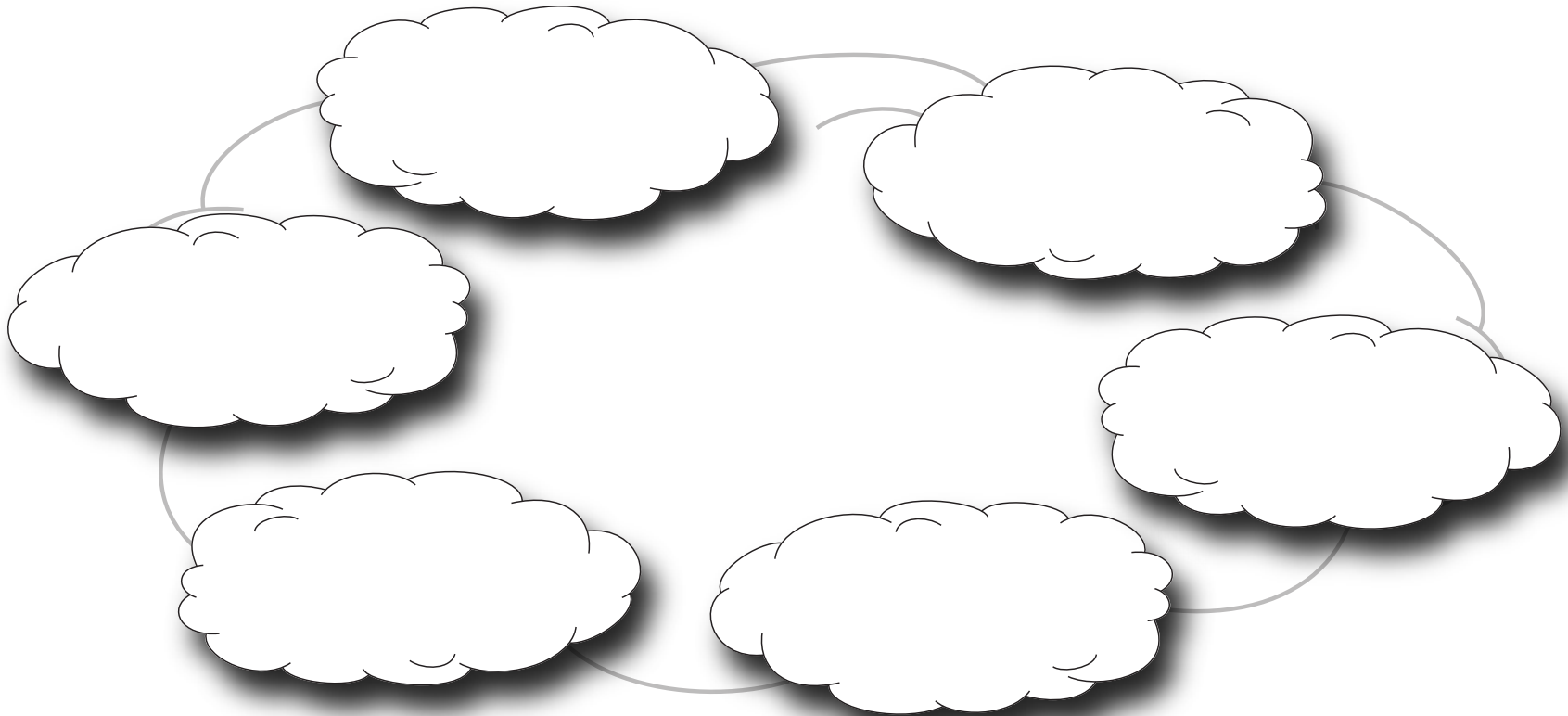
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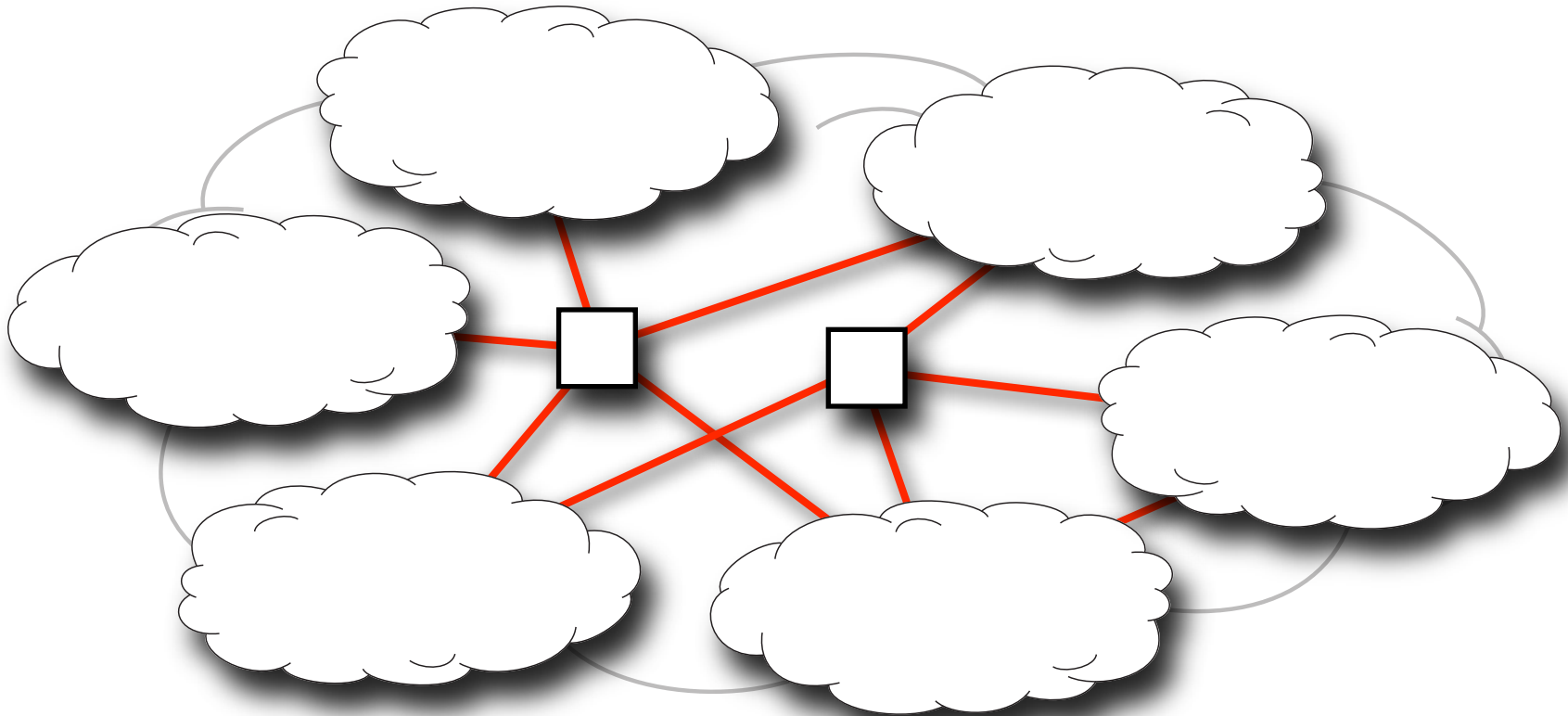
What is the Internet?





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## What is the Internet?

*Internet:* The network of networks. The proper-noun, capital-I Internet is the network of all networks which provide global end-to-end Internet Protocol connectivity between their nodes.

*internet:* Any set of interconnected networks. A lower-case-i internet doesn't necessarily use Internet Protocols, nor need it be interconnected with the Internet. No longer in widespread use.

# How the Internet Works

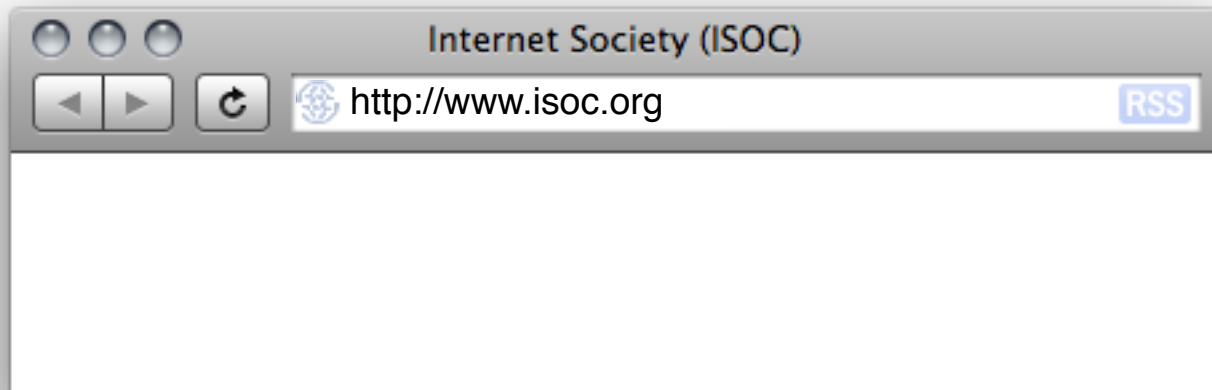
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# Web Browsing: An Example

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Uniform Resource Locator: A URL consists of a “scheme” or protocol by which a resource can be contacted or retrieved, followed by an address or “network location.” In addition to web pages, URLs can encode addresses for email, voice and video communications, and other network resources.

# Extracting the Domain Name from the URL

The URL contains a “domain name” which will be our computer’s clue where to find the web page we’re looking for.



Internet Society (ISOC)



<http://www.isoc.org>

RSS

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**HTTP**, or HyperText Transfer Protocol, is an IETF standard for transporting web pages and other objects across the Internet.

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<http://www.isoc.org>



The fully-qualified **domain name** “www.isoc.org” identifies the location on the Internet where this web page can be found.

# Parsing the Domain Name

That domain name, in turn, consists of several parts.

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“**org**” is a “generic top level domain” or gTLD which is available for the use of noncommercial organizations anywhere in the world.



<http://www.isoc.org>

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Internet Society (ISOC)



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“**isoc**” in the “second level” of this domain name is identifying an organization which possesses its own named domain.

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“**www**” in the “third level” of this domain name, as read right-to-left, is identifying a named service, in the case, a World Wide Web service.

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That domain name, in turn, consists of several parts, but our computer doesn't know, or need to know, the difference between these parts. It treats the domain name as a single string.

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Top Level Domain: The most common types of TLDs are "Generic" and "Country Code." gTLDs like .com, .net, and .org, are available globally, while ccTLDs like .ar (Argentina) and .za (South Africa) are administered nationally. New top level domains are formed through an ICANN administrative process.

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Internationalized Domain Names: But what if a name contains accented characters, or is written in a non-roman script? IDNs allow faithful representation of other languages in some second-level domains today, and will likely be possible in top-level domains in the future.



# Resolving the Domain Name to an Internet Address

Just like the user of a 20th-century telephone needed to look up the name of the person they wanted to call in a telephone book to find a telephone number to dial to complete the call, our computer needs to **resolve** the **domain name** found in the **URL** to a numeric **Internet Protocol address** in order to address the **packet** which will contain the **query** for the web page.

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Resolve: Resolution is the process of converting a human-readable domain name to a machine-readable Internet Protocol address, or vice-versa.

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Internet Protocol Address: an IP version 4 address is a 32-bit binary number which a computer uses to identify a destination on the Internet. IPv4 addresses are usually written in “dotted quad” notation, like this: 206.131.241.137.

There are about 4.3 billion IPv4 addresses, and one is needed for each Internet-connected computer, so in 1996 the Internet Engineering Task Force defined IP version 6, which has  $2^{128}$  addresses, or 100,000,000,000,000,000,000,000,000,000 times more than IPv4.

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Packet: The smallest unit of communication sent across the Internet, a packet is like an envelope: it has the IP addresses of the sender and recipient on the outside, and it contains a message encoded in binary ones and zeros. Very simple transactions may only require a single packet in each direction and complete in a few milliseconds, while complex ones may require millions and take hours or days.

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Query: A message which usually originates with a human requesting something like a web page. A query is usually a very small packet containing a simple “question” like “give me your web page,” which may result in a much larger reply, containing text, images, or video.

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# **Resolving the Domain Name to an Internet Address**



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The Nearest  
Root Nameserver



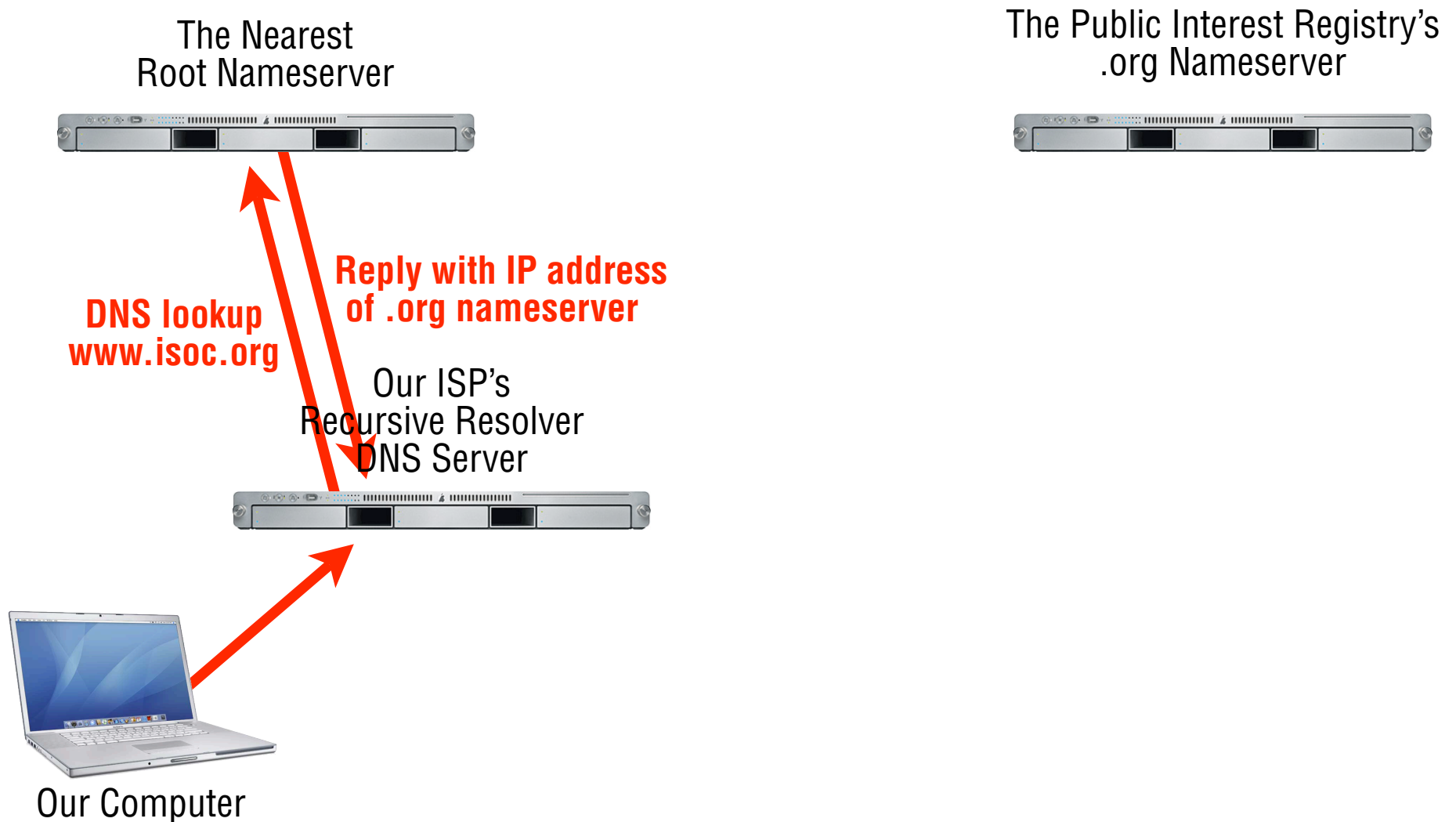
Our ISP's  
Recursive Resolver  
DNS Server



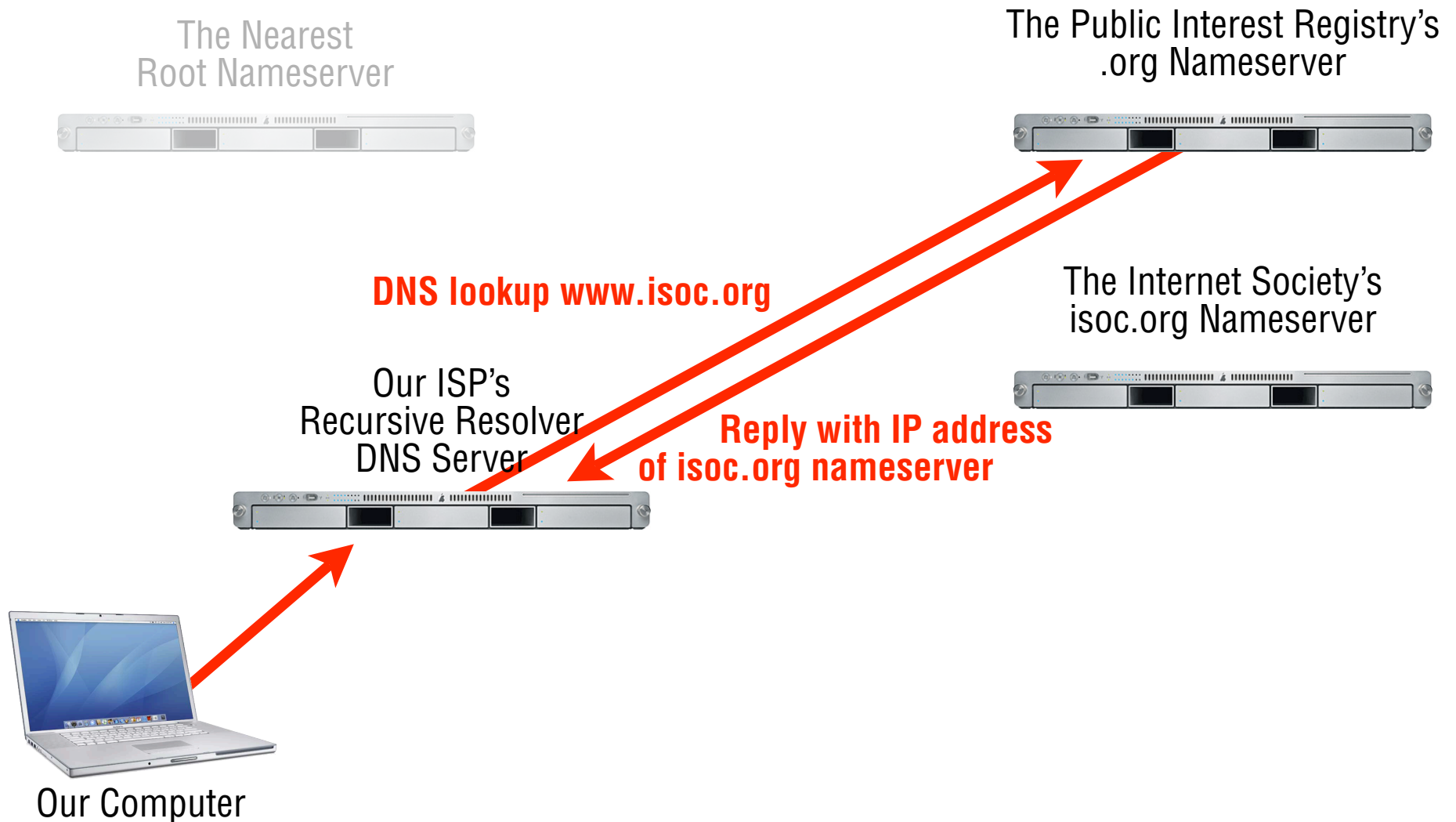
**Domain Name lookup  
to resolve [www.isoc.org](http://www.isoc.org)**

Our Computer

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The Public Interest Registry's .org Nameserver



The Internet Society's isoc.org Nameserver



Our ISP's **DNS lookup www.isoc.org**  
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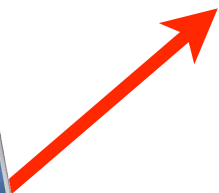
**Reply with IP address  
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Our Computer



The Internet Society's  
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Our ISP's Recursive Resolver DNS Server



Our Computer

Reply with IP address of [www.isoc.org](http://www.isoc.org) web server



The Internet Society's [www.isoc.org](http://www.isoc.org) Web Server

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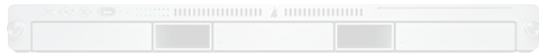
Our Computer



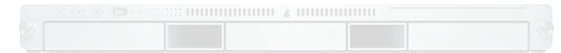
The Internet Society's [www.isoc.org](http://www.isoc.org) Web Server

# Now We're Ready to Request the Web Page...

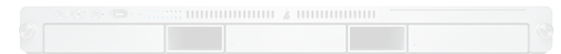
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Our ISP's Recursive Resolver DNS Server



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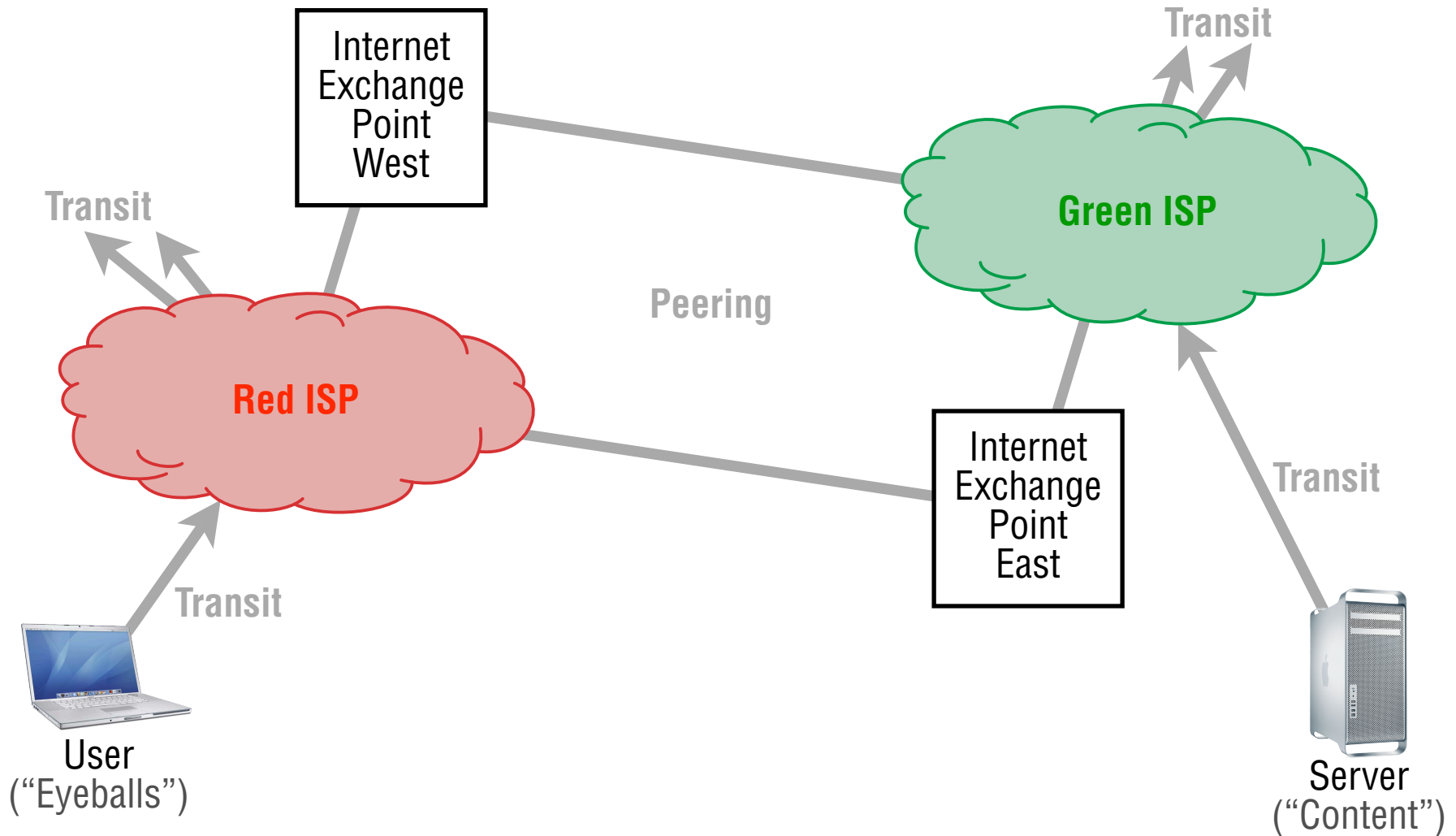
Routing: The decision-making process by which data packets are forwarded through a branching network. At each fork, each packet is routed in a direction which will take it nearer to its destination.

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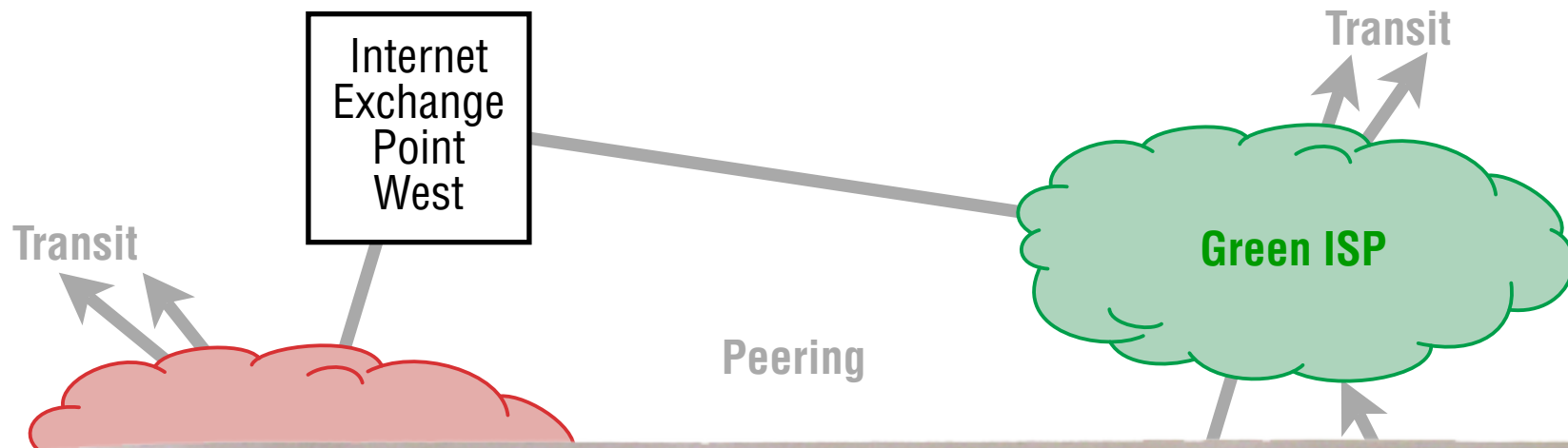
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# The Topology of the Internet

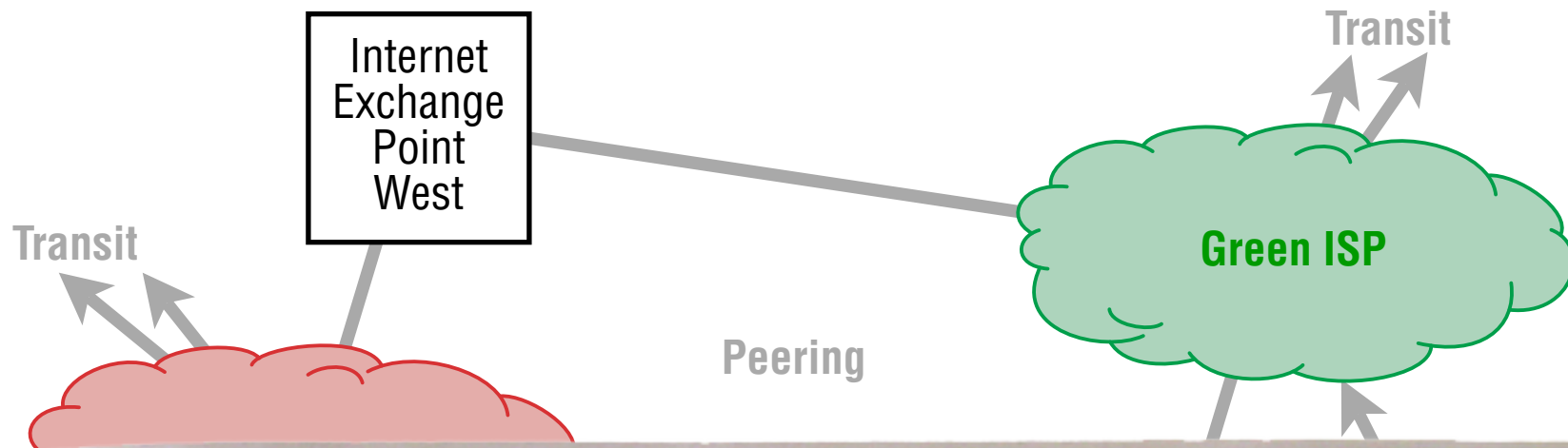


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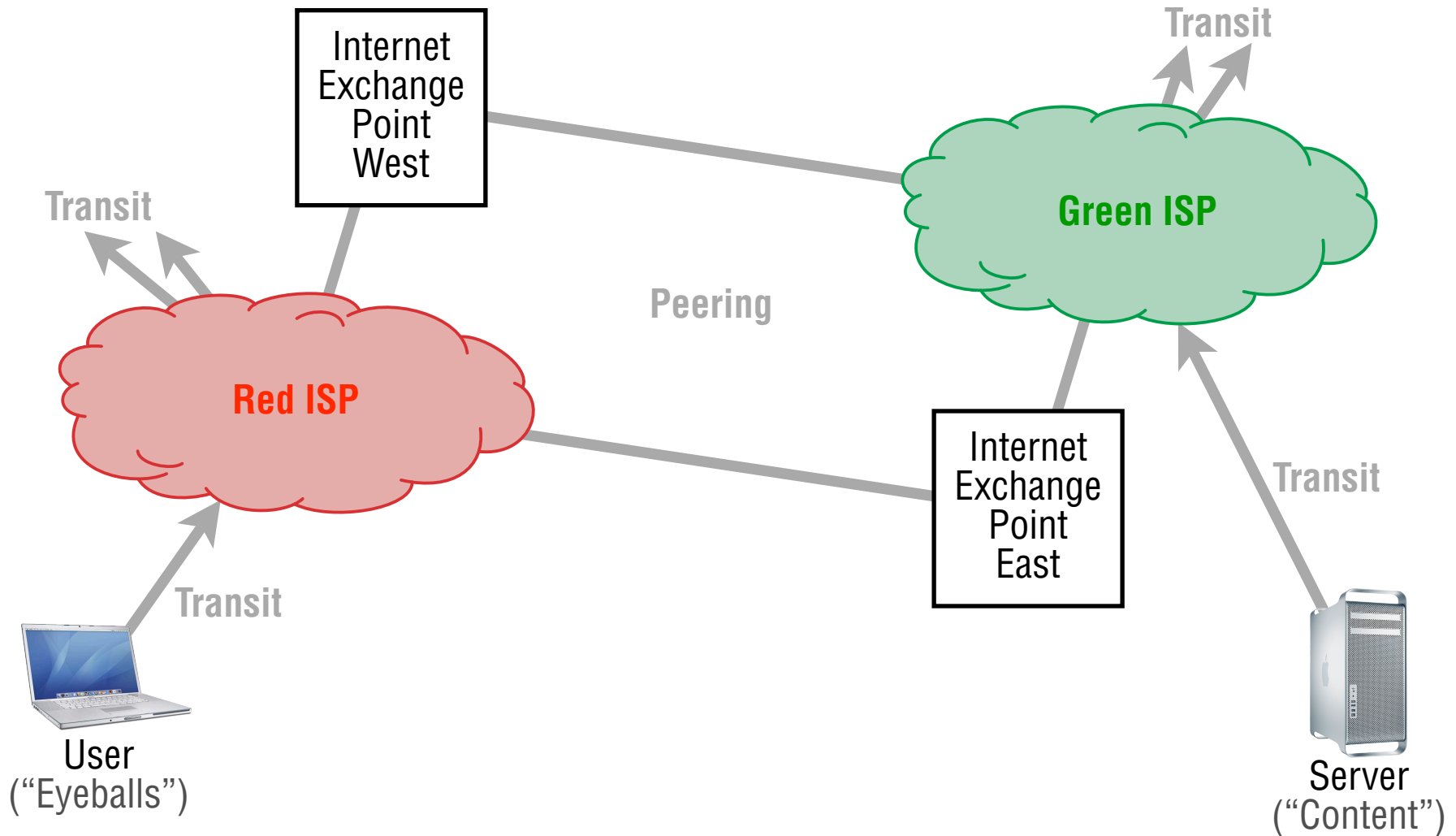
**Transit:** A transaction in which one party purchases the right to send data to any location on the Internet via the other party's network. Transit is how traffic is moved between ISPs and their customers, who may be users, or may be smaller ISPs.

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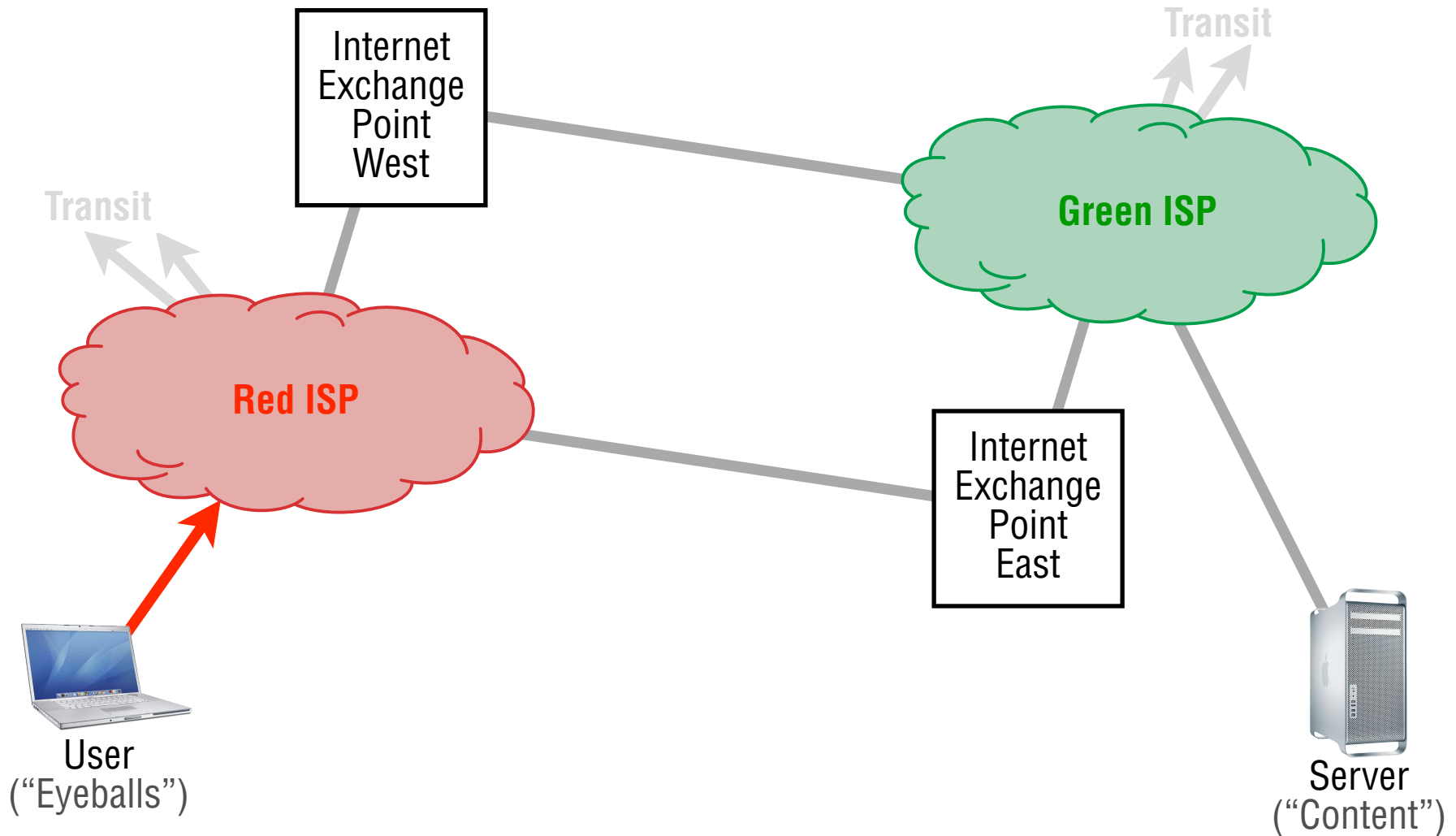


**Peering:** An interconnection between two parties such that each can exchange traffic with the customers of the other at no cost. Internet bandwidth is produced by peering between ISPs, and it is transported to users via transit.

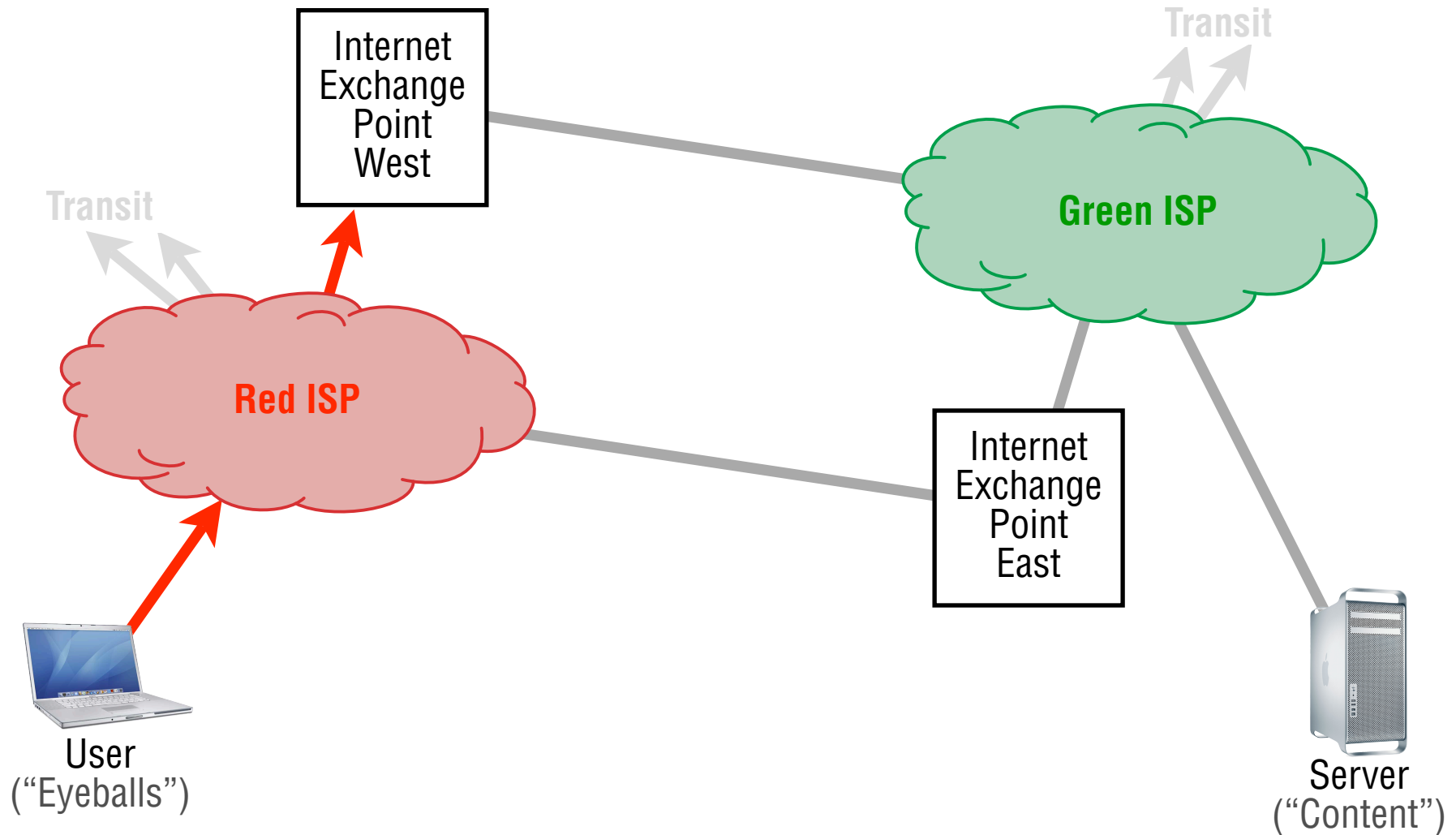
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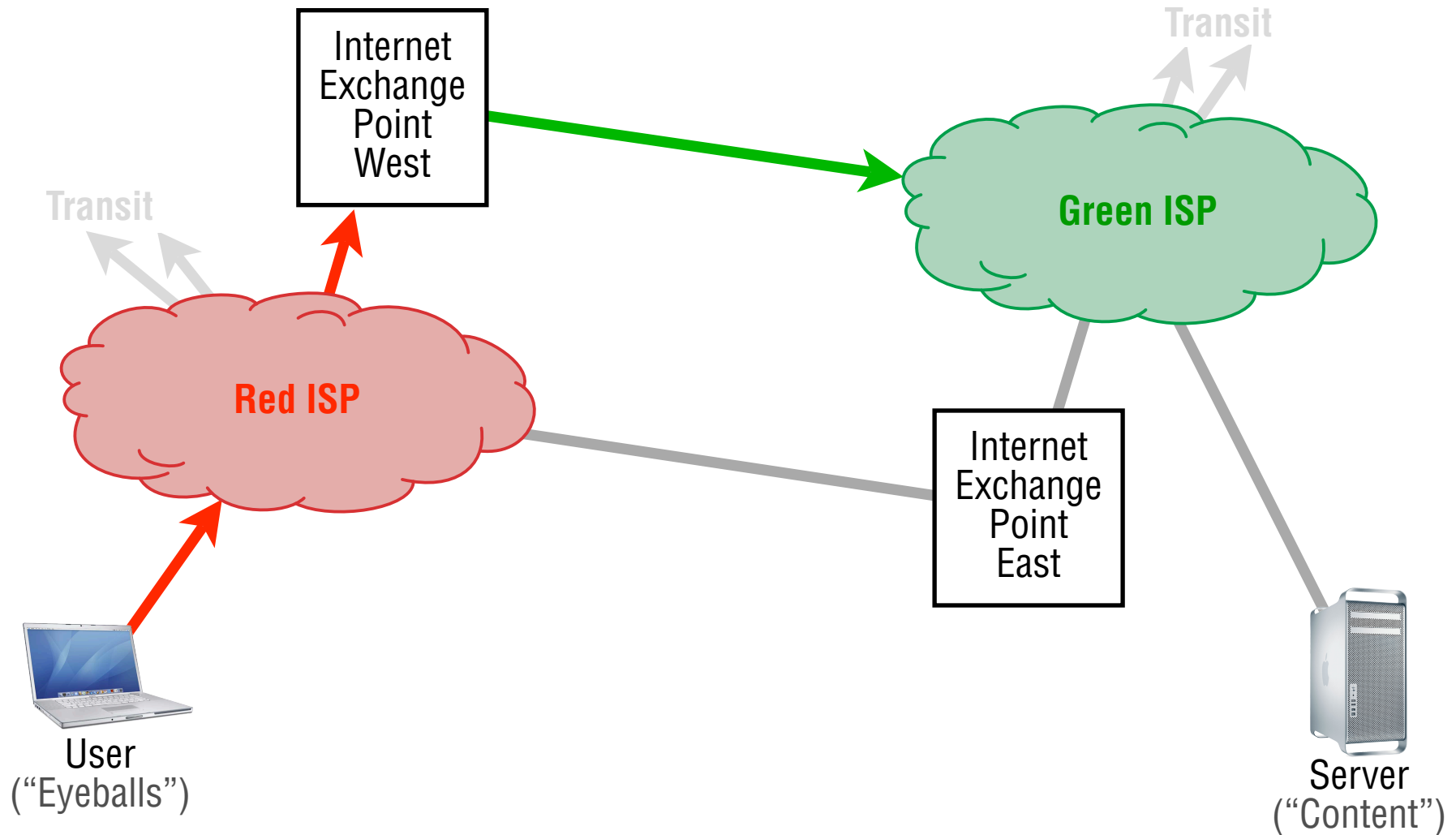


# Hot Potato Routing

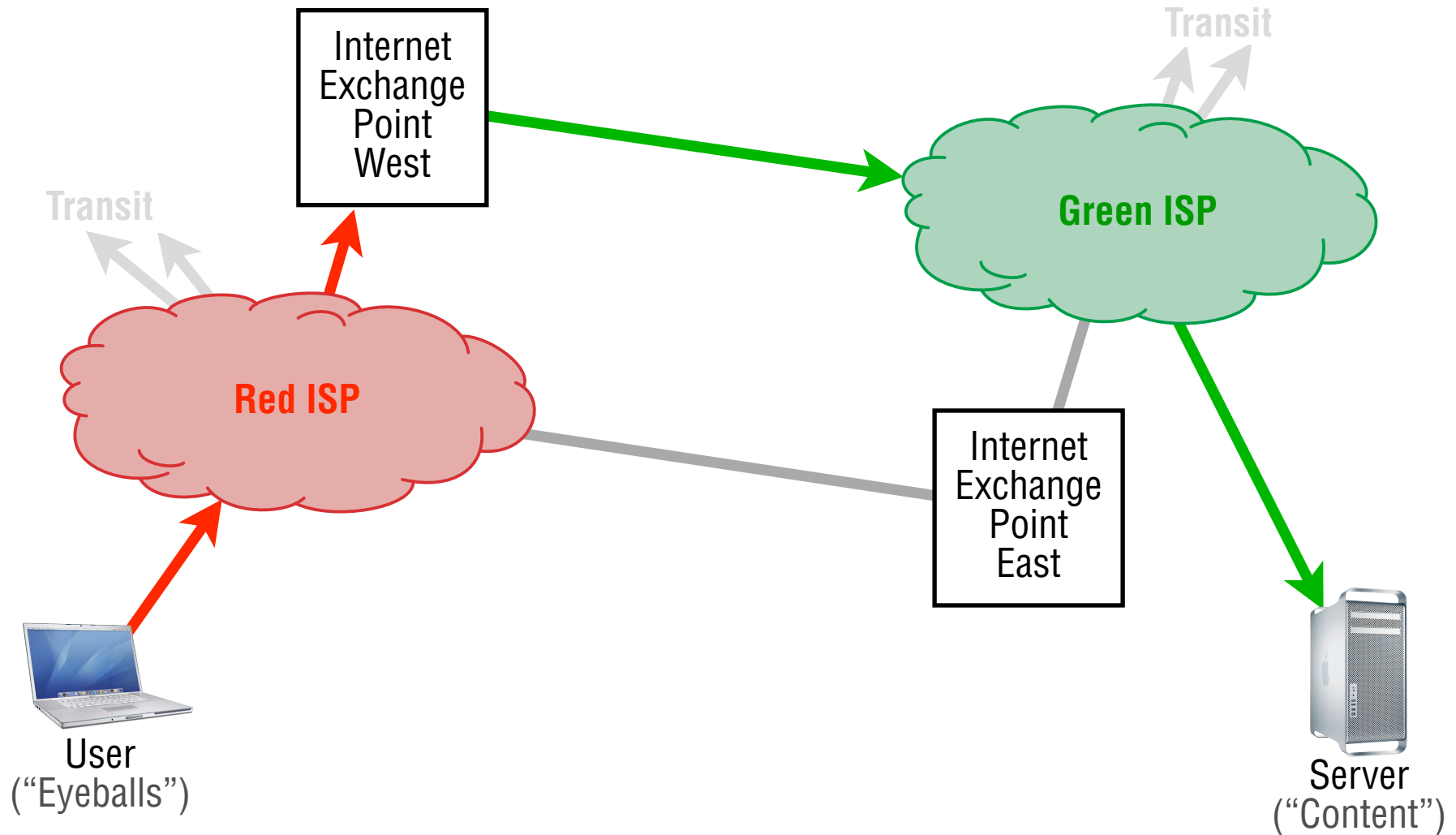




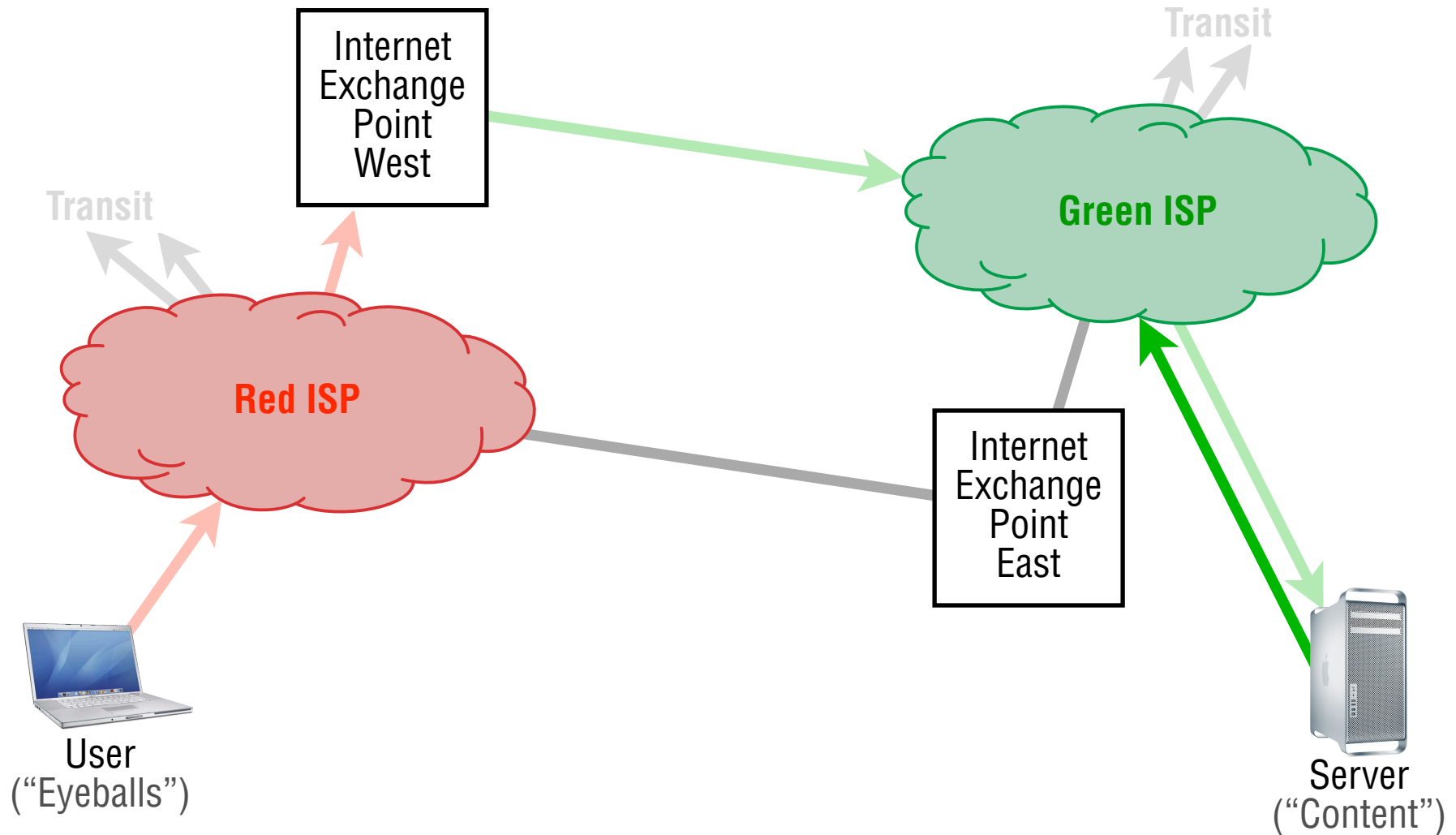
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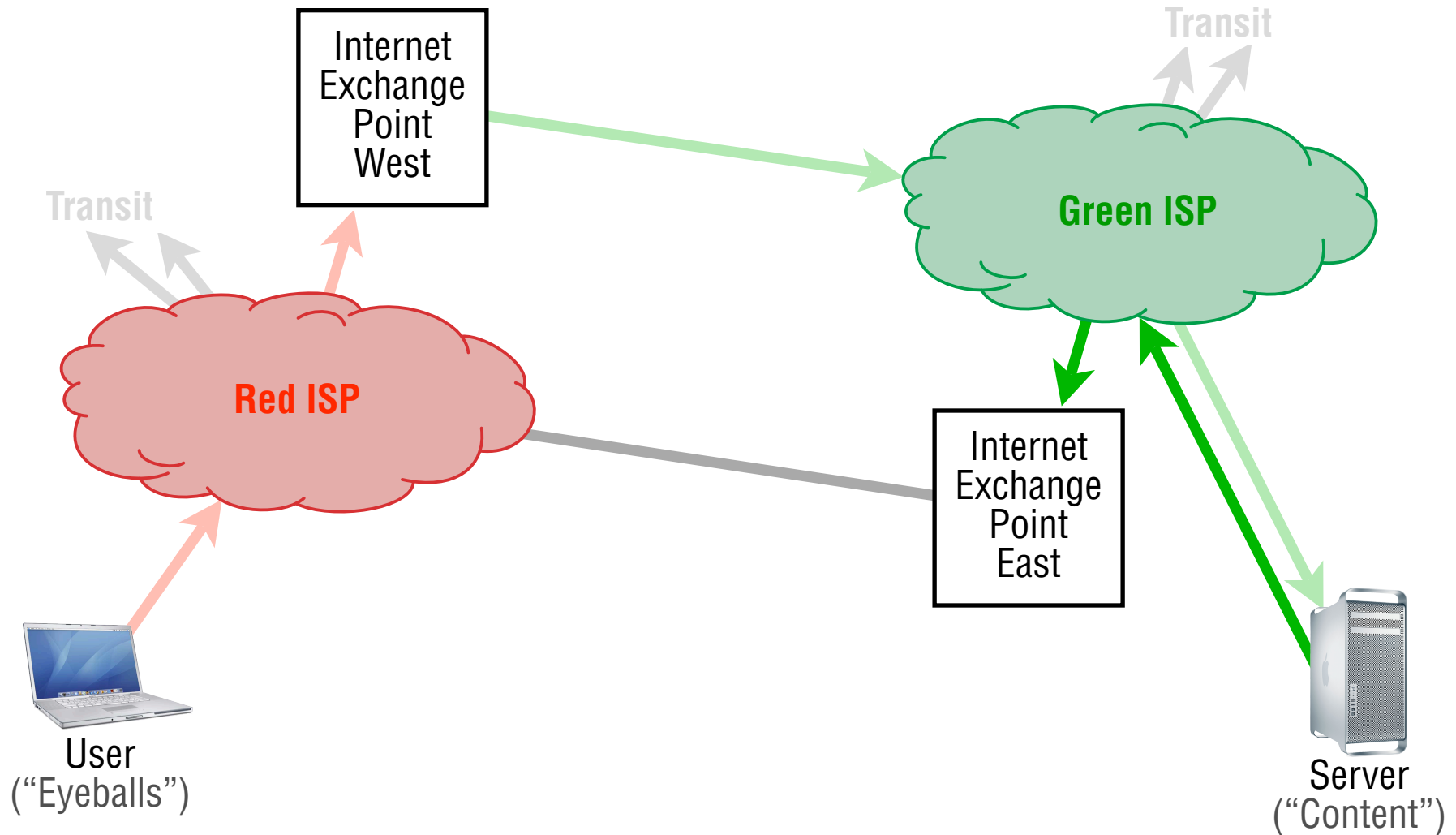
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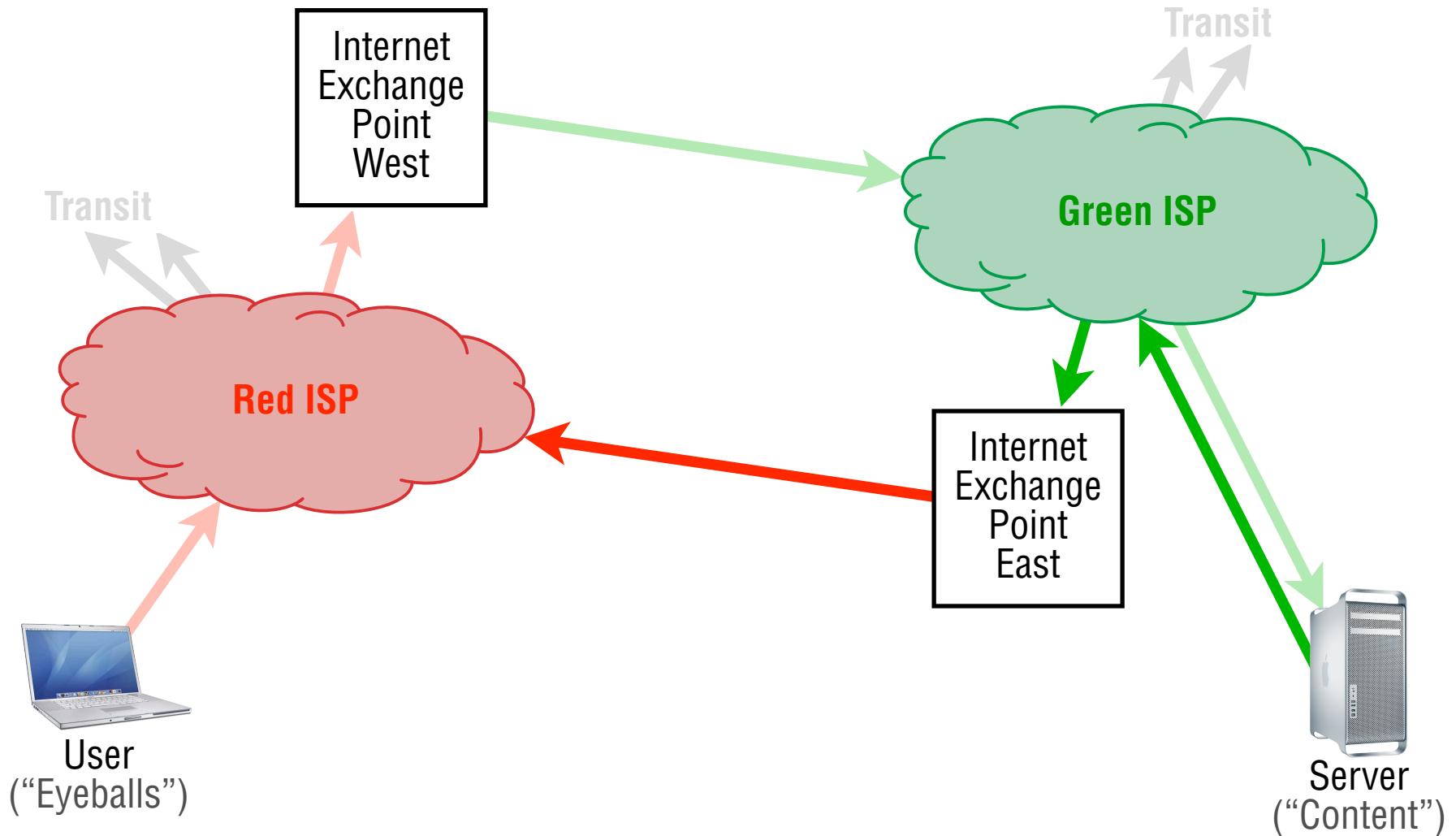
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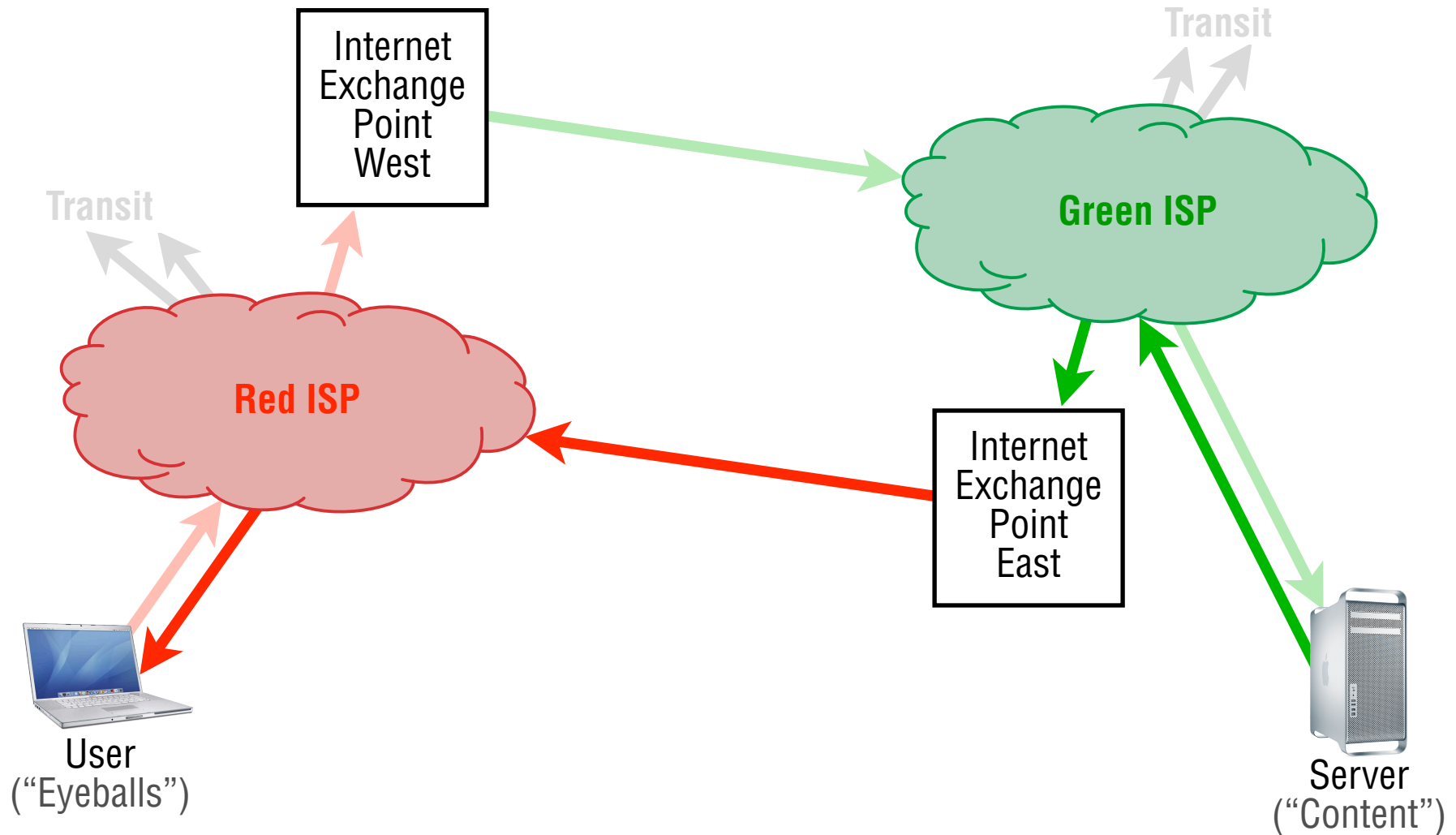
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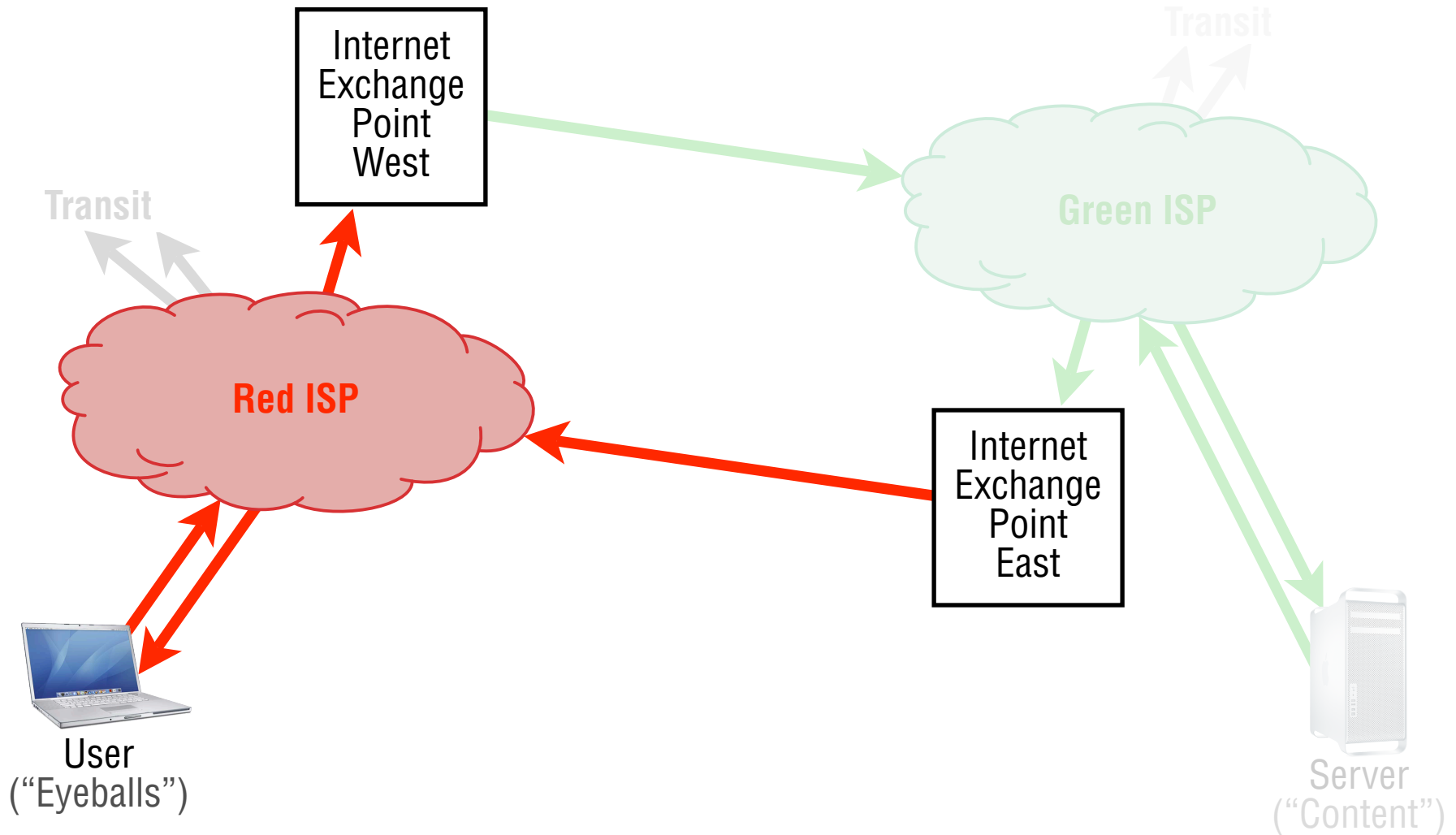
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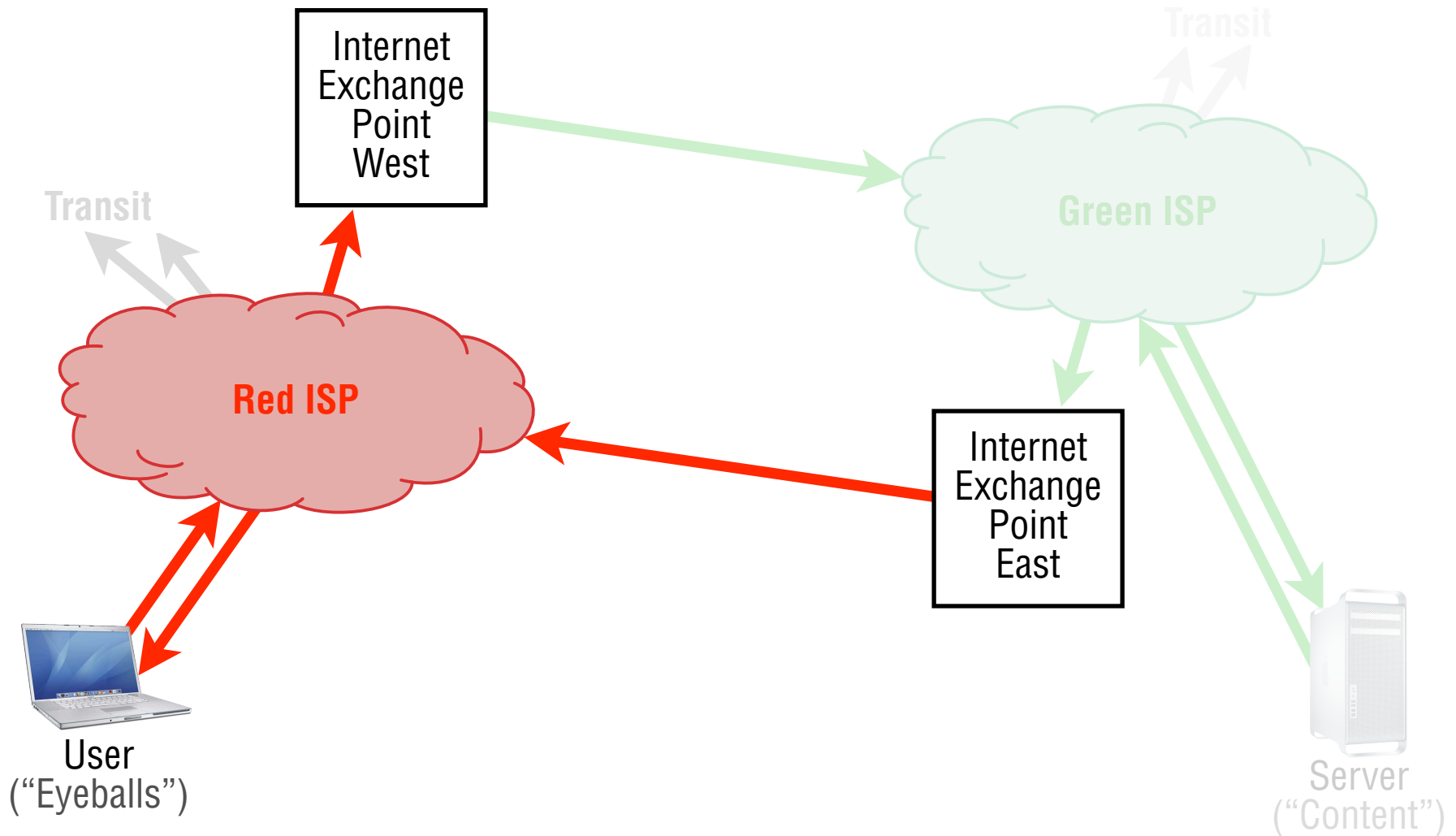
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# “Bill and Keep”

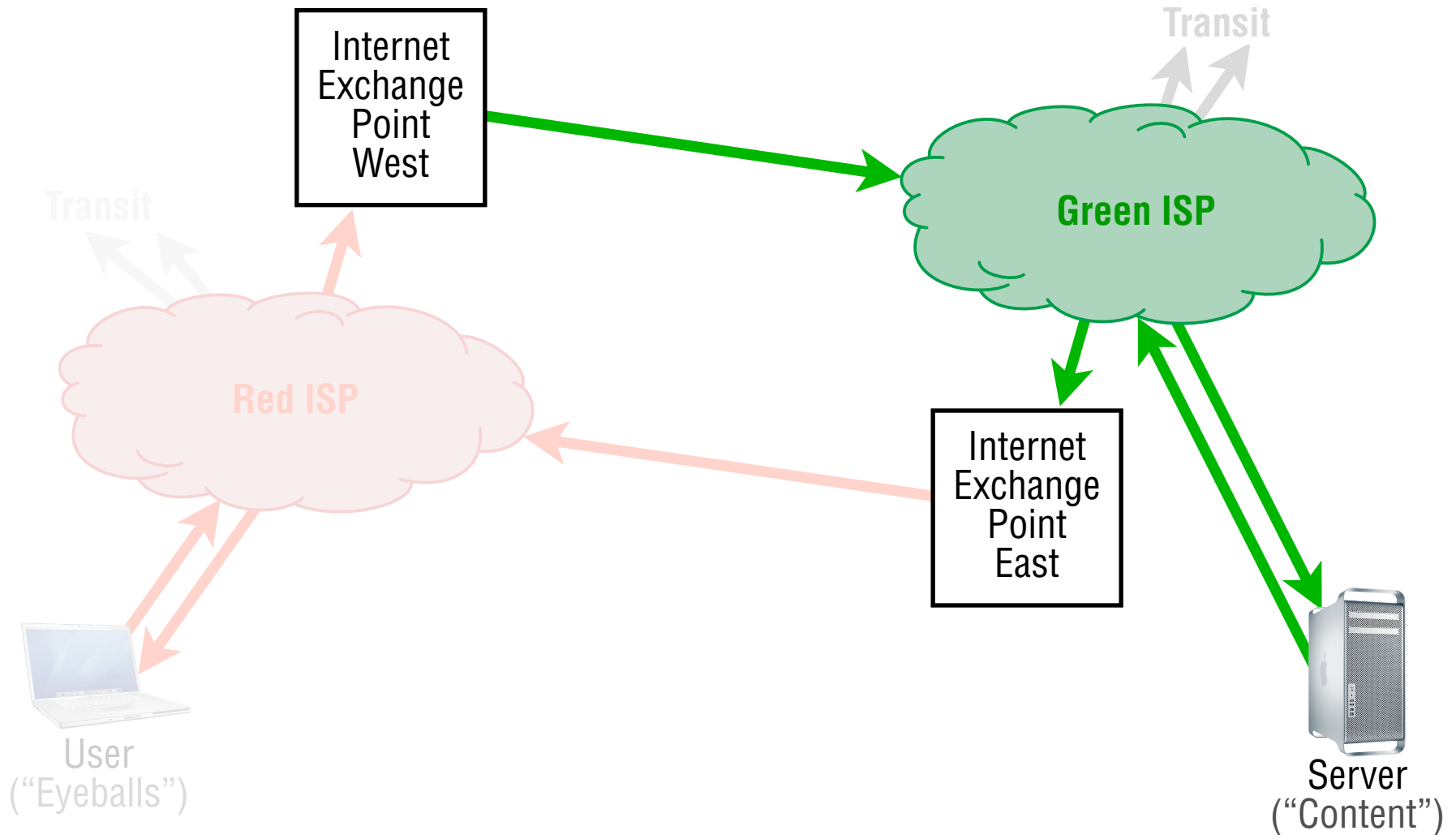


# Symmetry





# Symmetry



“ | \* ”

# The Internet Governance Organizations

German Valdez

# Protocol Definition

**IETF:** the Internet Engineering Task Force meets in person three times each year, and operates continuously online, to collectively define the open protocols by which Internet users are able to transparently communicate with each other.

**IESG:** the Internet Engineering Steering Group consists of the Area Directors of the IETF, who are together responsible for the IETF's day-to-day functioning and productivity.

**IAB:** the Internet Architecture Board is a body of experts across the spectrum of Internet technical knowledge, who provide guidance and oversight of the IETF work-product.

# Operational Standards

**NOGs:** the Network Operations Groups each meet one to three times a year locally or regionally to share technical knowledge and coordinate operational activities.

**NANOG:** the North American Network Operations Group

**SANOG:** the South Asian Network Operations Group

**MENOG:** the Middle East Network Operations Group

**NZNOG:** the New Zealand Network Operators Group ...etc.

## **Exchange Point Operations:**

Regional meetings: **NAPLA**, **Euro-IX**, **APIX**

Annual membership meetings of each IXP

**IEPG:** the Internet Engineering Planning Group meets three times a year, as a global forum for sharing operational knowledge.

# User Advocacy

**ISOC:** the Internet Society consists of local chapters throughout the world, formed through a bottom-up process to represent end-users in the policy-making and regulatory processes.

**ONI:** the OpenNet Initiative is an independent monitor of censorship and transparency in the Internet, protecting end-to-end connectivity.

# Uniquely-Assigned Identifiers

**IANA:** the Internet Assigned Numbers Authority is the root of the delegation hierarchy which maintains uniqueness in domain names, IP addresses, autonomous system numbers, and protocol identifiers. The IANA's operations are defined by the **IAB** via **IETF RFC** standards documents. The IANA delegates specific functions to resource-specific **registries**.

**ICANN:** the Internet Corporation for Assigned Names and Numbers is the community-driven organization that hosts the IANA function.

# IP Addresses and ASNs

**RIRs:** the five Regional Internet Registries are the fora in which Internet users and service providers set addressing policy and share constrained number resources.

**LACNIC:** the Latin American and Caribbean Network Information Center

**AfriNIC:** the African Network Information Center

**RIPE NCC:** Réseaux IP Européens Network Coordination Centre

**ARIN:** the American Registry for Internet Numbers

**APNIC:** the Asia-Pacific Network Information Center

**NRO:** the Number Resource Organization is the coordination body which allows the five Regional Internet Registries to act as a global collective.

**ASO AC:** the Address Supporting Organization Advisory Council represents the NRO to ICANN, and selects one ICANN board member.

# Operational Support

**NSRC:** the Network Startup Resource Center provides training materials to people who are connecting their communities to the Internet.

**PCH:** Packet Clearing House provides operational support and services for the critical infrastructure at the core of the Internet; IXPs and the Domain Name System.

**FIRST:** the Forum of Incident Response and Security Teams coordinates Internet emergency responders around the world.



# Discussion

# Thank You.

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