



Content Delivery Networks

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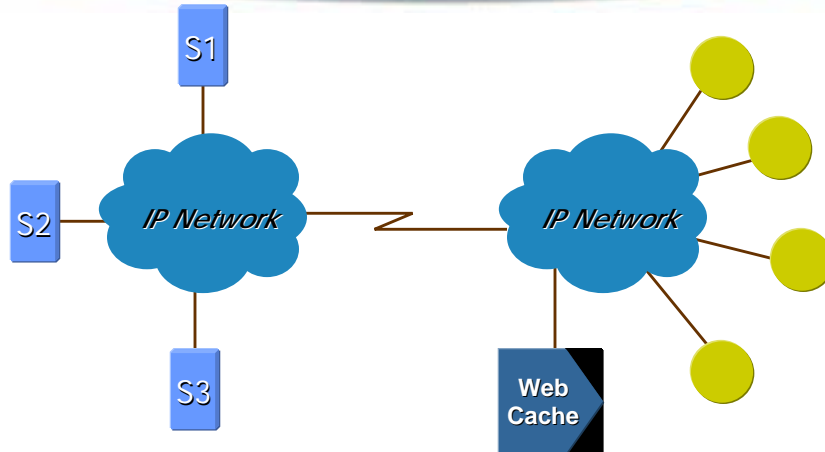
1



Agenda

- **What are Content Delivery Networks?**
- **DNS based routing**
- **Server Load Balancing**
- **Content Routers**
- **Ethical questions**
- **Conclusion**

At the beginning were Web Caches



A Web Cache is a device that stores a local copy of more recently required HTTP objects and reacts as proxy server to clients' requests

CDN

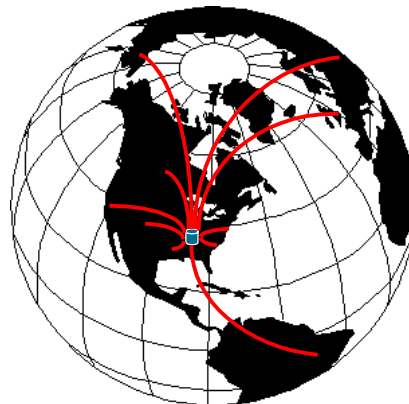
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Motivations for Content Delivery Networks

- A set of caches “working” together
- Server farms are far from users.
- Internet congestion fails the best server architectures.
- Traffic peaks crash sites



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Content Delivery Networks (CDNs)

- Distributed Web Hosting
- Video-On-Demand
 - MPEG on LAN
 - Low/Mid-rate streaming on WAN
- Scalable Live Streaming
- Dynamic Content
- Conditional-Access Content
 - advertisements

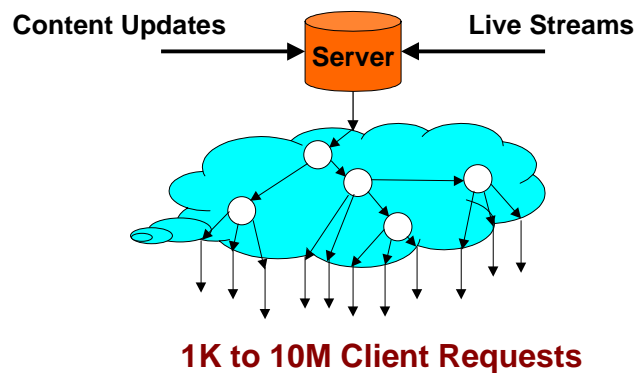
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Example of CDN



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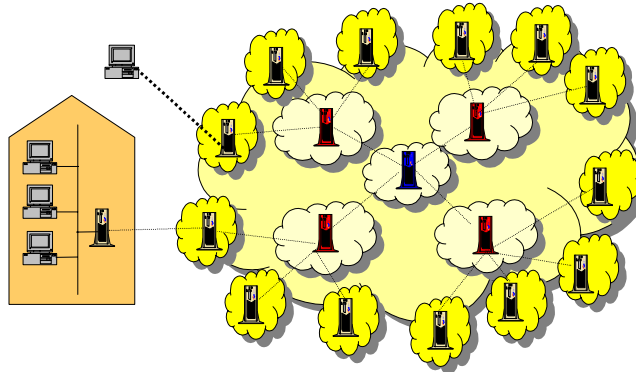
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An Overlay Network over Internet

- A CDN is an overlaid network of **Caches**, a.k.a. **Content Servers**, a.k.a. **Delivery Nodes**, a.k.a. **Replicas**



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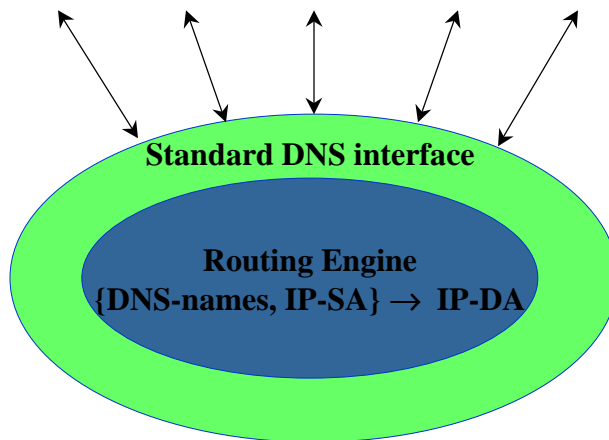
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The idea: a new DNS Server Architecture

DNS queries for **www.terena2000.com**



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DNS-based CDNs

- **Host Names are used to redirect the traffic to the best replica**
 - the replica selection happens when the name is translated to an IP address
- **DNS servers become “Content Routers”**
 - they measure as many metric as possible (RTT, Server Load, Layer 3 metrics, response time, etc.) to compute a **replica routing table** **{DNS-names, IP-SA} → IP-DA**
 - Metric measurement is not easy
 - Layer 3 metrics alone are not particularly meaningful

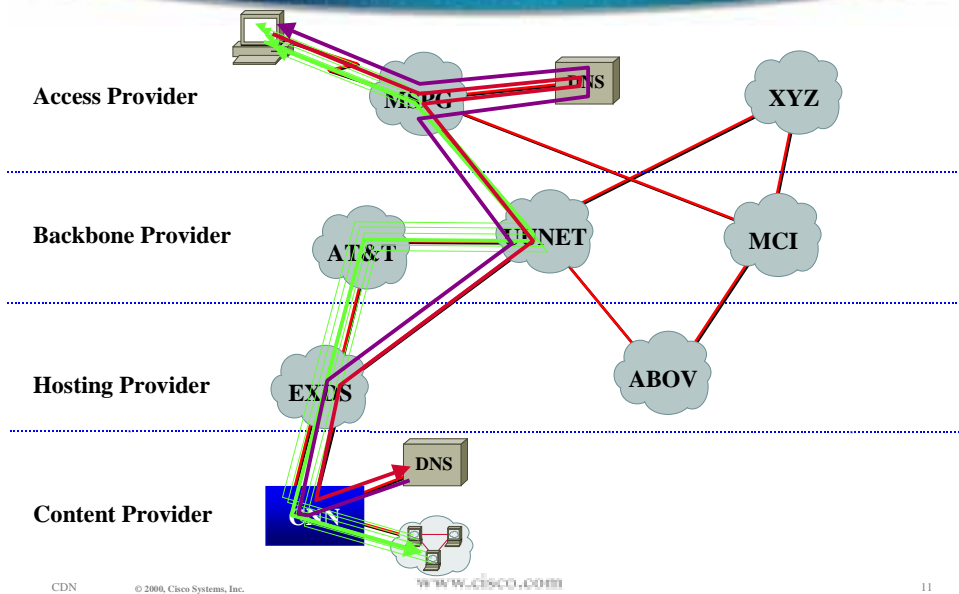
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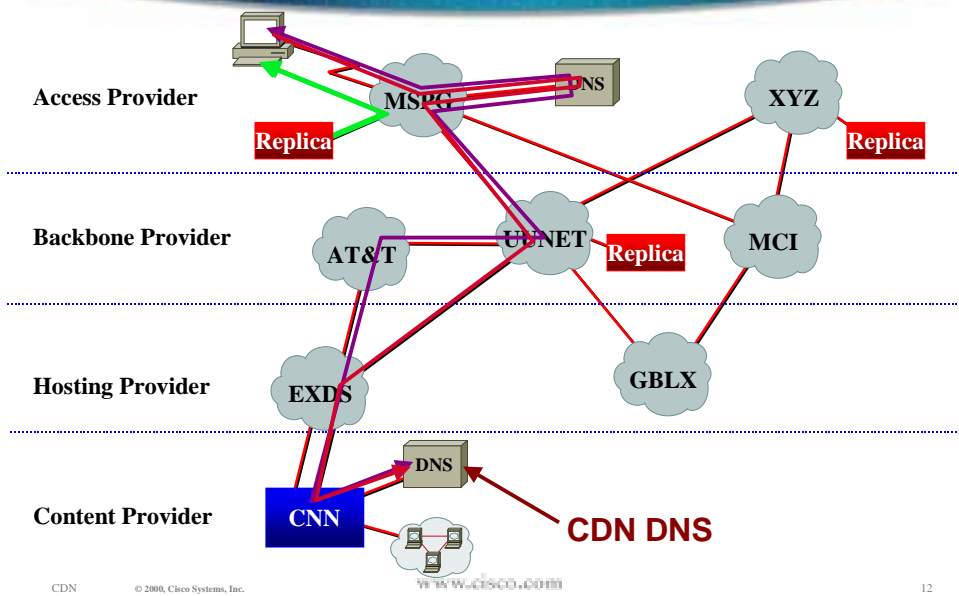
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Traditional Browsing



DNS-based CDN Browsing



DNS-based CDNs Limitations

- There are limitations
 - The granularity of redirection is an host name, not a URL
 - Content of large web sites cannot be split into multiple caches
 - It is difficult to use the same host name for static and dynamic content
- The Akamai approach:
 - Akamaized URLs:
<http://a836.g.akamaitech.net/7/836/123/e358f5db0045e/www.terena2000.com/logo.gif>
 - Proprietary request routing schemes based on traffic monitoring

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Extension to DNS-based CDNs

- How to implement more granular DNS-based CDNs (e.g. how to look for the complete URL)?
 - HTTP/RTSP Redirect
- Redirection can be obtained in two ways
 - every server in the farm is capable to redirect
 - An SLB (Server Load Balancer) is capable to redirect
- Effective only in a Local Area

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The Next Step: URL-based CDNs

- URLs are used to redirect the traffic to the best Content Server
- URL routing requires TCP termination
 - TCP termination is complex and expensive
 - TCP termination introduces delay
- There will be only one TCP termination point
 - Close to the client?
 - Close to the server?

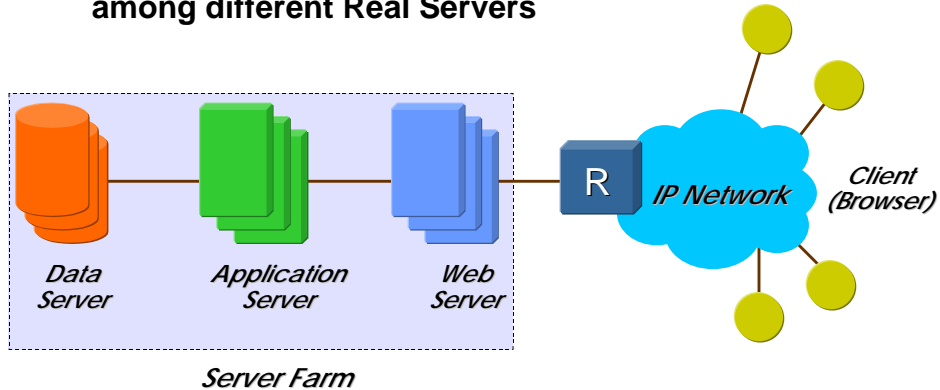


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Server Farms

- A reality today
 - Clients see a unique Virtual Server (IP address)
 - Traffic destined to the Virtual Server is load balanced among different Real Servers



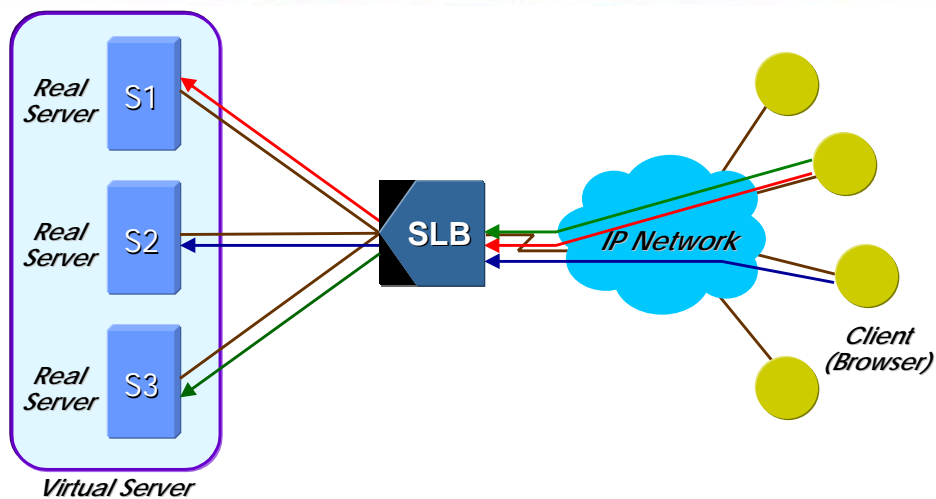
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Server Load Balancing



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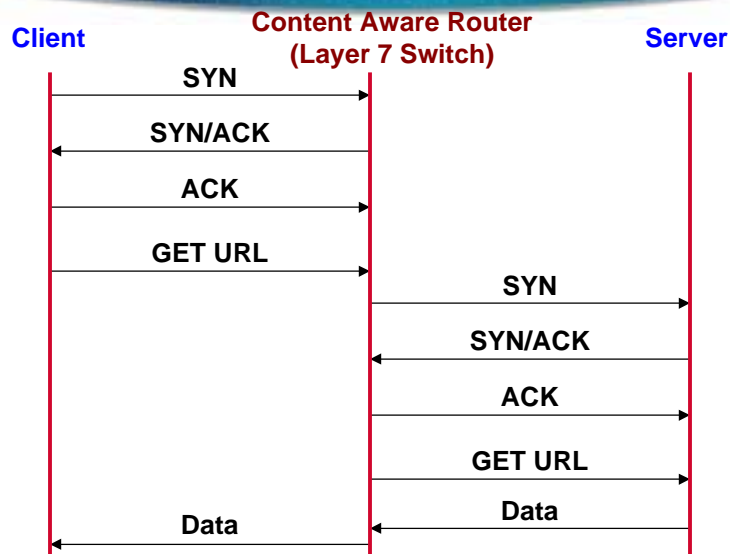
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Server Load Balancing

- **Content-unaware (layer 4 switching)**
 - TCP connections are not terminated by the SLB
- **Content-aware (layer 7 switching)**
 - TCP connections with both clients and servers are terminated
 - To support SSL (https) the SLB requires the server keys

TCP Proxy



Limitations with SLB

- Some applications require that TCP connections from the same client are redirected to the same server (**Sticky Connections**):
 - Shopping Cart
 - Searches
 - Forms
 - Economic Transactions
- Stickiness may be addressed/complicated by:
 - source IP address
 - cookies
 - SSL ID



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URL routing

- Can we build a router that routes on URLs?
- **YES, but:**
 - statefull (we must terminate TCP)
 - complex packet parsing (we need the URL)
 - anycast router (a URL is associated to multiple replicas)
 - Do we have URL routing tables?
 - Do we have URL routing protocols?
 - Do we have metrics? How do we compute them?

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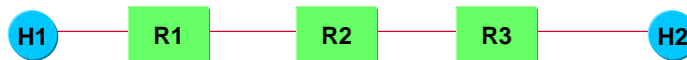
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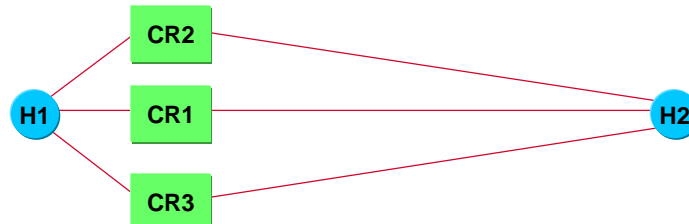
IP vs. Content Routing

IP routing



Content routing

or



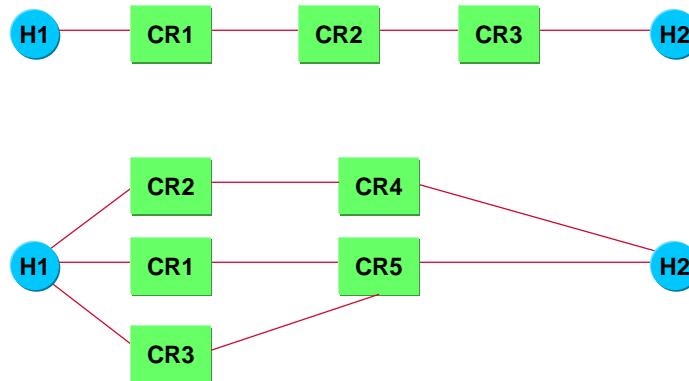
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Or even more complex



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Content Delivery Control Protocols

- **Content Routers in series cannot all terminate the TCP session:**
 - we don't want to reinvent X.25
- **URL must be**
 - extracted by the first Content Router
 - propagate by a **Content Delivery Control Protocol**
- **Some protocols have been proposed:**
 - HUP
 - Christmas Tree
 - ICAP
- **Still in a very preliminary phase:**
 - if successful, they can be integrated in the hosts.

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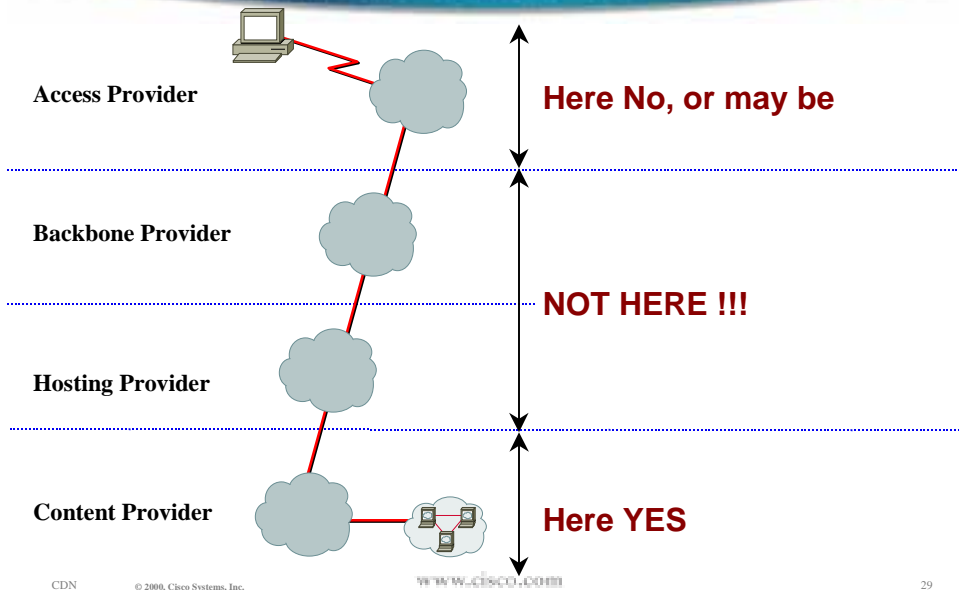
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The Ethical question

- Is it ethical to deploy Content Routers in the Internet?
 - They hijack the packets
 - They spoof the addresses
 - They break the end-to-end model of IP

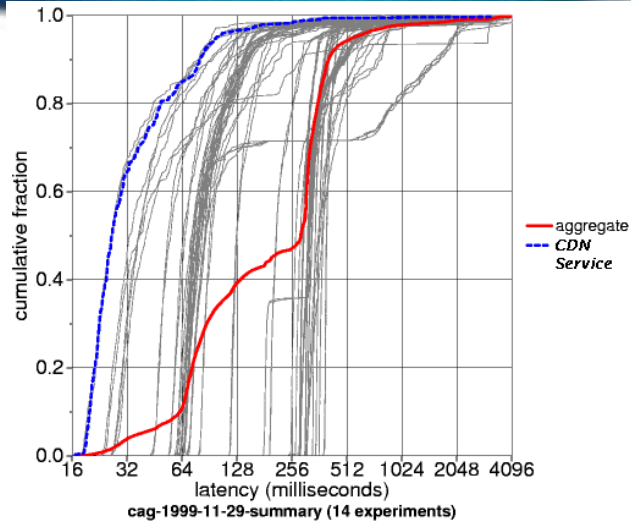
Where, is the question



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Sometime CDNs are very good!



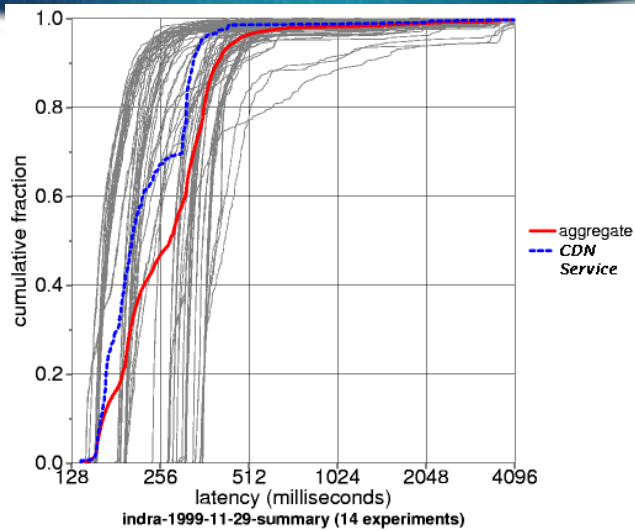
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Sometime are not so good!

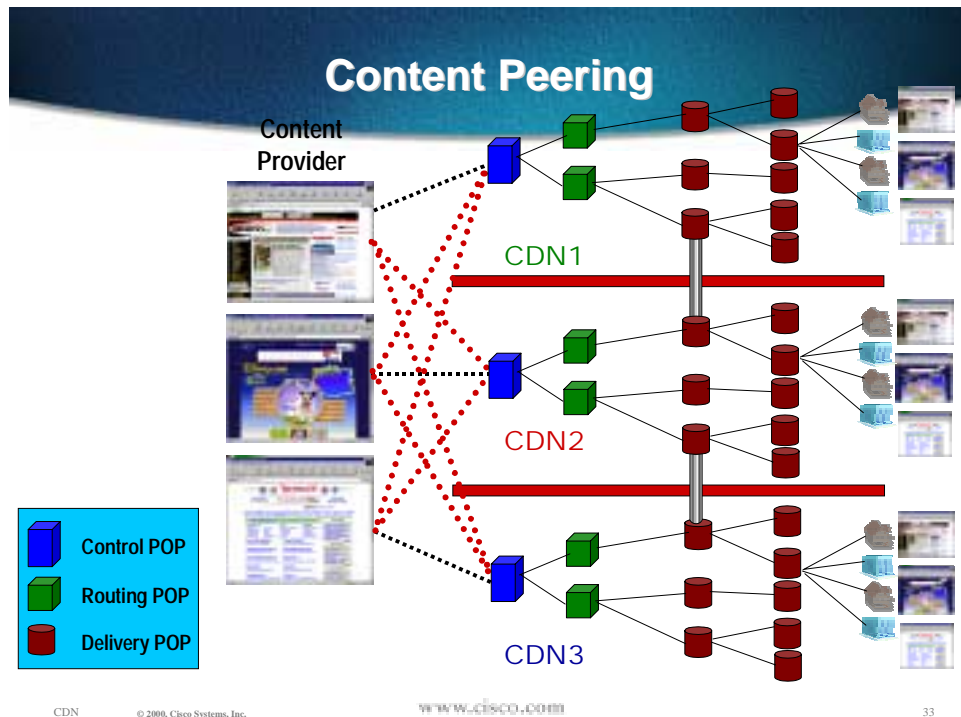


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Conclusions

- **Content Delivery Networks (CDNs) DNS-based will be widely deployed**
 - CDNs are not only for web traffic, but also for multimedia streaming
 - Replicas will have slightly different content (e.g. local advertisement)
 - Content Peering is still an unsolved problem
- **Server Farms and Server Load Balancing will be widely deployed**
- **Intrusive content routing poses:**
 - ethical questions
 - scalability concerns

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