Anycast

Overview
and
Operational Experience

Presented by
Leo Bicknell, Senior Network Architect

Logistics

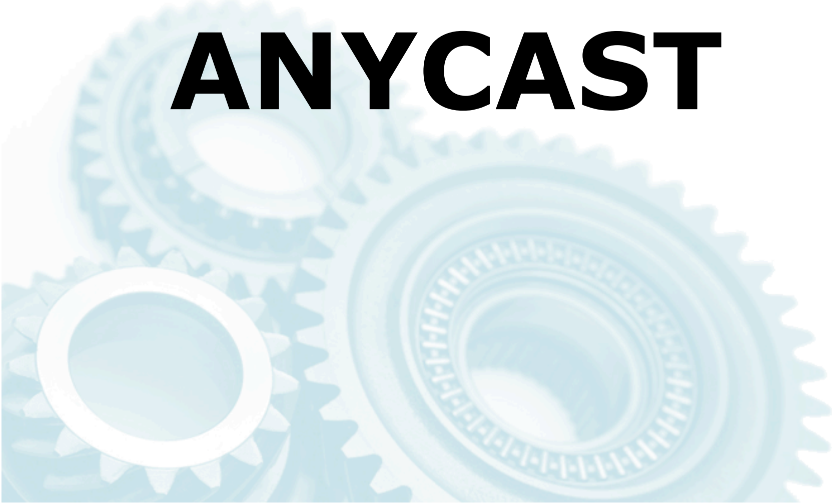
- Webinar is 1 hour long
- A recording will available by May 12
  - http://www.isc.org/webinars
- Participants are muted
- Questions should be entered into the WebEx Q&A tab for the presenter
  - The presenter may defer some questions until the end of the presentation

Agenda

- Define Anycast
- Examine use cases
- Explore the impact on Internet protocols
- Explore Anycast and DNS
- Share ISC's operational experience
- Answer questions

Define

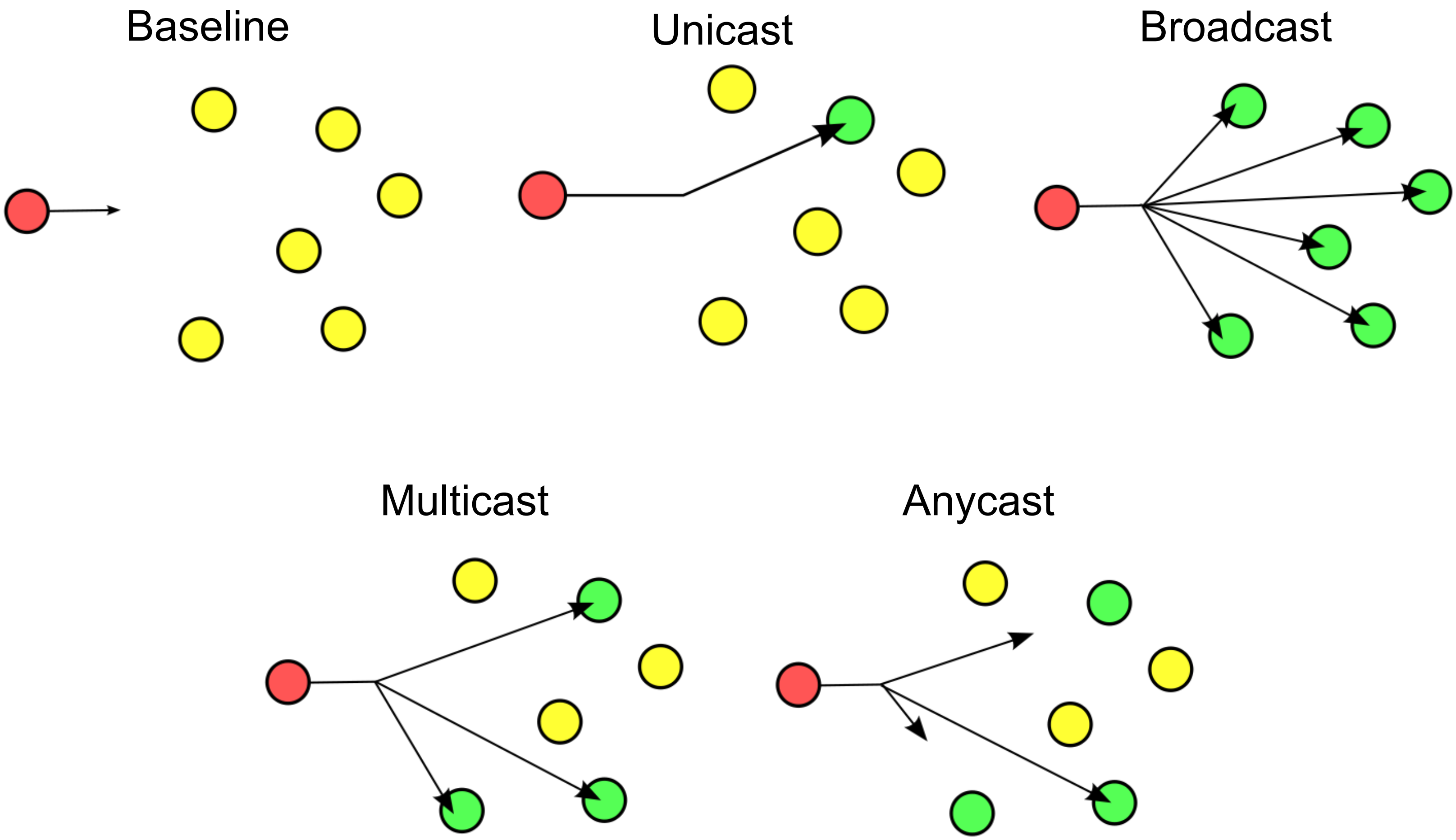
ANYCAST



What is Anycast?

- Anycast describes a method of using the same IP address on multiple servers
- Fundamentally, Anycast is a *routing scheme*
- Anycast is more about the configuration of routers and routing than servers
  - Server admins have to understand what’s going on in order to properly operate the service

Routing Schemes Compared



Baseline

Unicast

Broadcast

Multicast

Anycast

Diagrams from http://en.wikipedia.org/wiki/Anycast, and are public domain.

Properties of Anycast

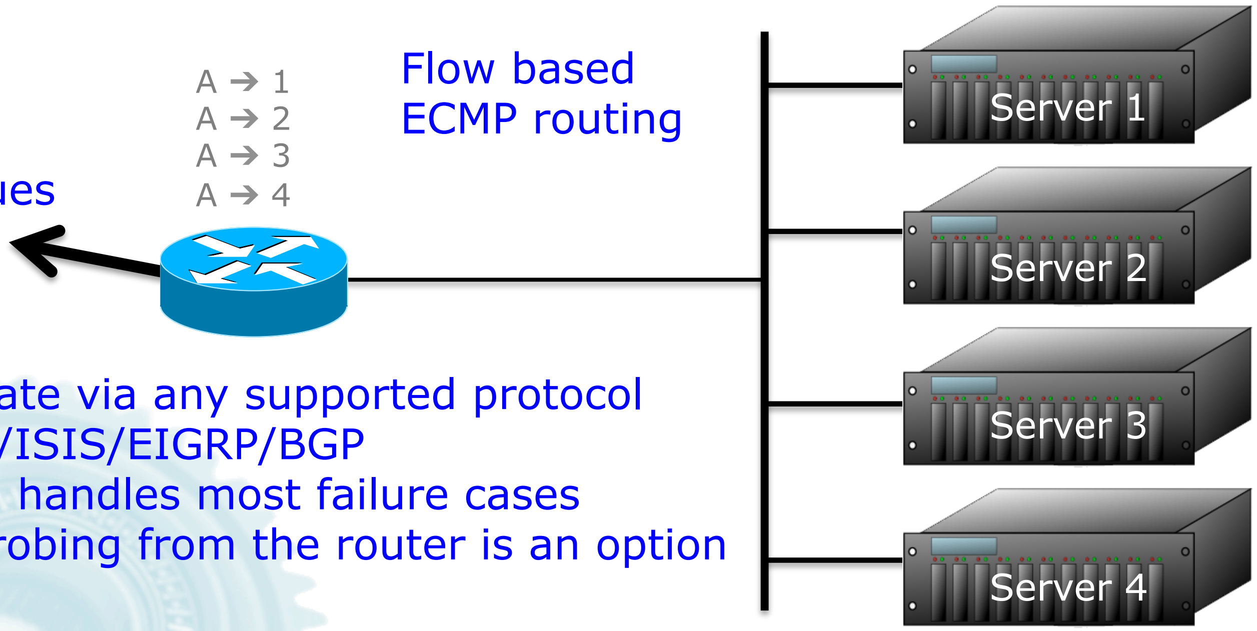
- Each packet sent to an Anycasted IP address may reach a different server
- Packets are routed to the IP address with the best ***network metric***
  - This is often the nearest server, but not always. Metrics could be set based on other factors, such as bandwidth, cost, load or reliability
- Servers with an Anycast address must also have a Unicast IP address
  - Management functions can’t be done to the Anycast address as they would only reach one server!

Examine

USE CASES

Use Cases

- Local Anycast
  - Distributes load across multiple servers on same subnet
  - Eliminates need for load balancer by making the network (router) distribute traffic



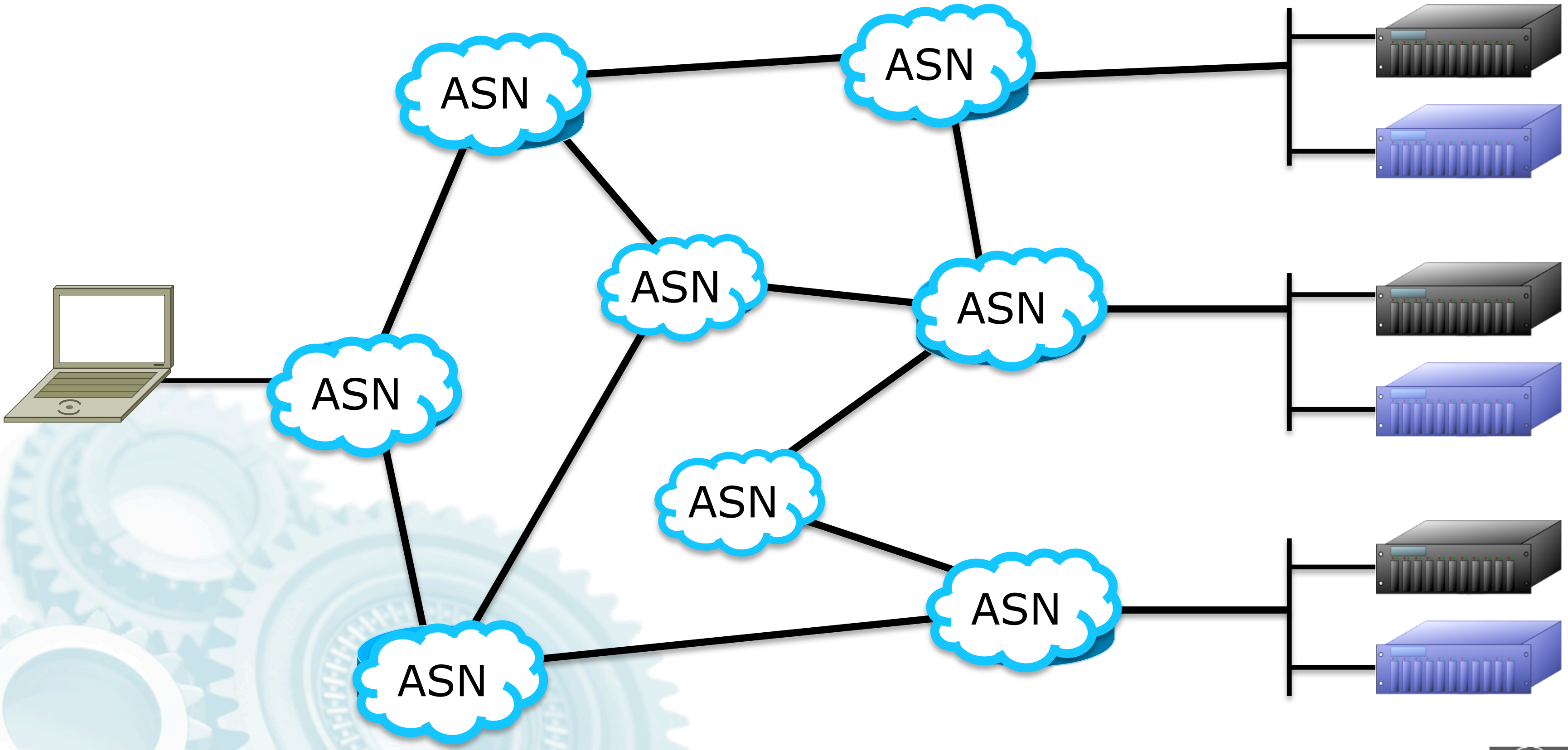
ONE ROUTE!
Reduces routing issues

Flow based
ECMP routing

Routes may originate via any supported protocol
- static/RIP/OSPF/ISIS/EIGRP/BGP
- dynamic routing handles most failure cases
- active service probing from the router is an option

Global Anycast

- Distributes load across multiple locations
- Provides redundancy



Use Cases

- Most popular things to Anycast:
  1. DNS, recursive servers
     - Configured by IP address on clients
     - Latency is important
     - Distribute load across multiple devices
  2. DNS, authoritative
     - Limited number of authority IP's can be listed in a single reply packet
     - Latency to the server is important
     - Redundancy a large concern
     - Distribute load across multiple devices
  3. NTP
     - Generally only in ISP's that have a large amount of CPE that requires configuring NTP by IP address and not name, or enough clients that load distribution is required.
  4. HTTP Redirect Servers
     - HTTP servers that redirect a user to another local instance.

Explore

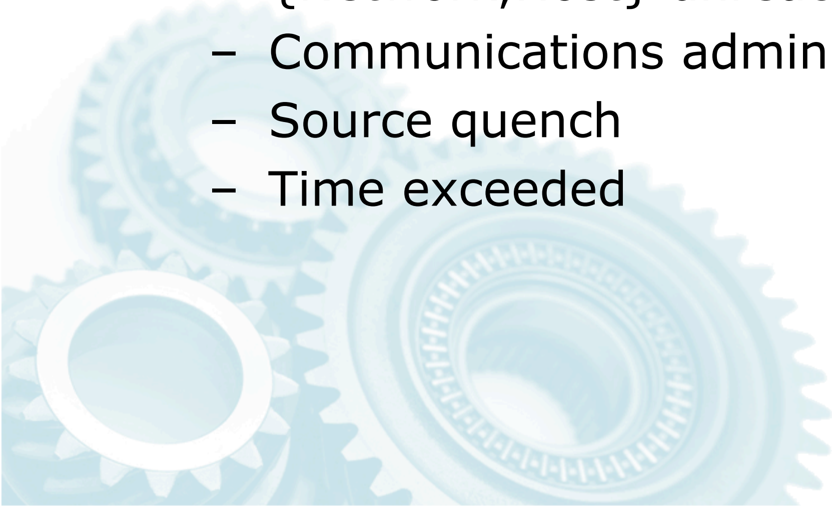
IMPACT ON PROTOCOLS

Impact on Protocols: ICMP

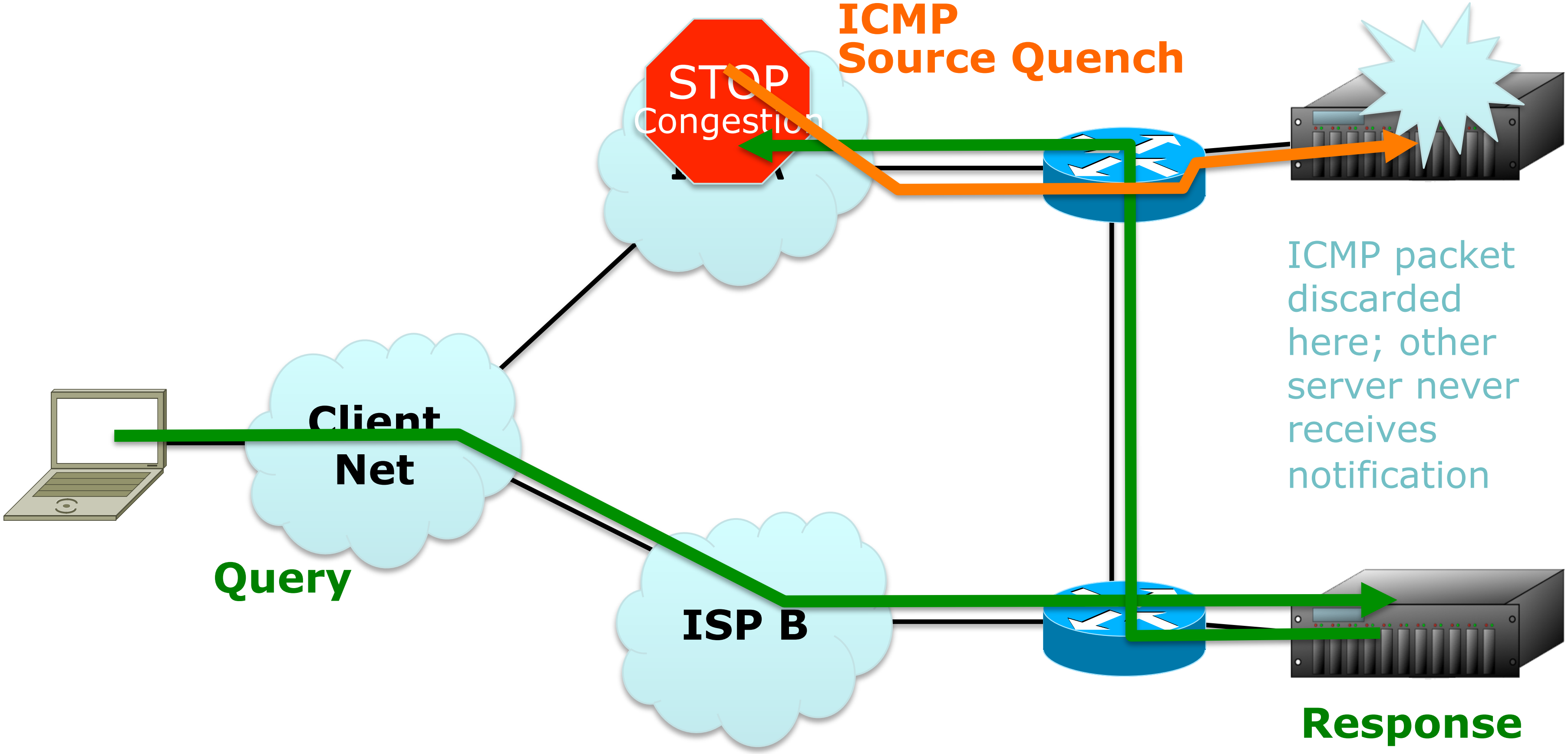
- Global, stateless options work fine
  - Ping request/reply
  - ICMP Traceroute
    - Network instability can produce some odd results with traceroute
- Avoid LAN options
  - Router Advertisement/Solicitation
  - Address Mask Request/Reply
  - Redirect
  - A unicast address on the server can mitigate these issues
  - It’s easy to avoid all of these ICMP options

Impact on Protocols: ICMP

- Transmission failure messages are a problem
  - Destination {network,host,protocol,port} {unreachable,unknown}
  - Fragmentation required
  - Source route failed
  - Source host isolated
  - Network administratively prohibited
  - {Network,Host} unreachable for TOS
  - Communications administratively prohibited
  - Source quench
  - Time exceeded



Impact on Protocols: ICMP



ICMP packet discarded here; other server never receives notification

Impact on Protocols: ICMP

- Operationally, what really matters?
- Losing “packet too big” breaks PMTU
  - Packets from an Anycast host should ***never*** be sent with the DF bit set
    - Options are to accept packets being fragmented mid-stream, or to send with the minimum MTU
  - ***IPv6 does not allow for intermediate routers to fragment, all packets must be sent with the minimum MTU of 1280***
- Lost messages prevent orderly teardown
  - Timeouts for end users, may be long waits!
  - Resources consumed on the servers waiting to tear down connections

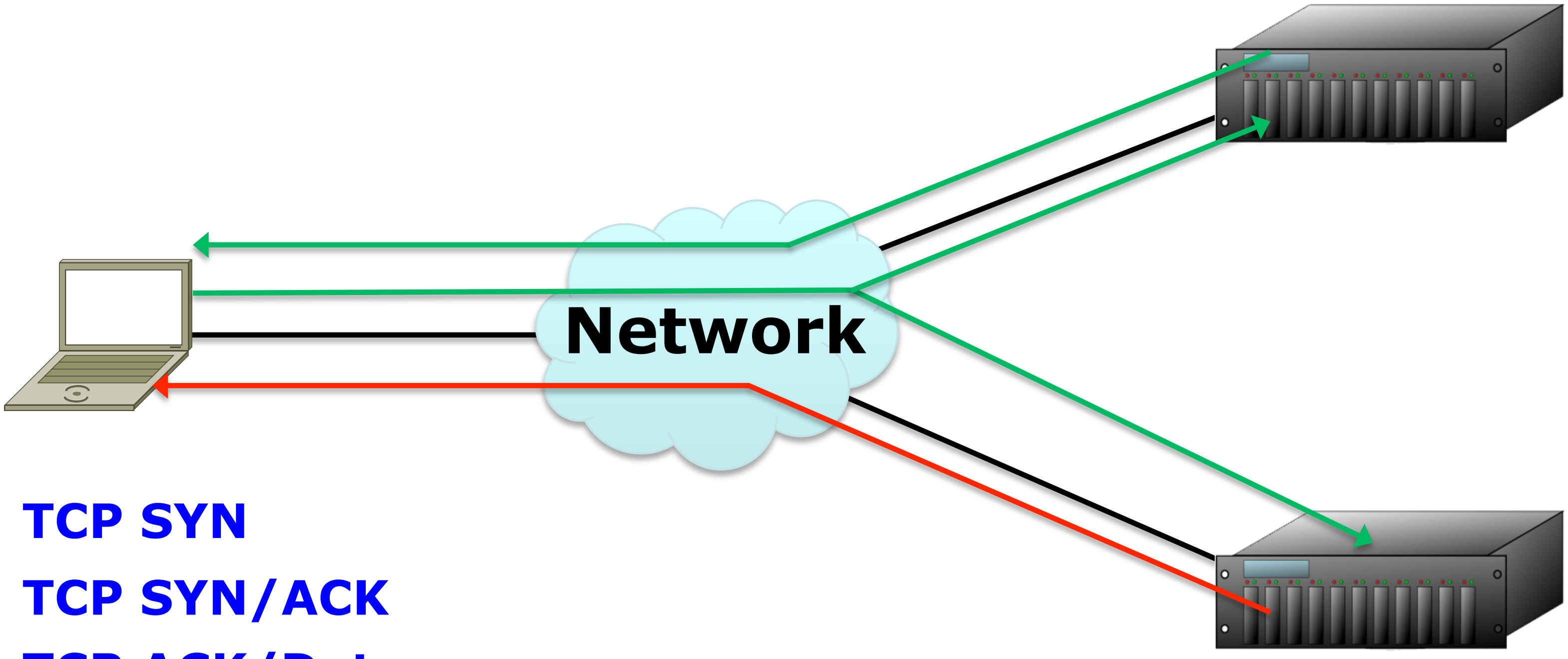
Impact on Protocols: UDP

- Stateless, which is good for Anycast
- Works well when the query is one packet, and the response is 1-n packets, and there is no state between queries
  - Sounds like the majority of DNS queries!
- If the query is more than one packet, or there is state between queries, the behavior tends to be the same as TCP

Impact on Protocols: TCP

- Only works when the network path is stable.
  - This is ***never true in the long term***, but is often true for short periods of time
- **The Unicast sender has to reach the same Anycast destination for the duration of the connection**
  - One packet to the wrong device causes it to generate a TCP Reset, which generally tears down the connection

Impact on Protocols: TCP



TCP SYN

TCP SYN/ACK

TCP ACK/Data

TCP Reset

Path Instability: Sources

1. Load Balancing
   - Per-packet load balancing directs each packet to a different link and possibly server
   - Per-flow load balancing typically hashes on a 5-tuple, which creates a stable path for many topologies, but there are topologies where even this sort of hash won’t be stable
2. Route Churn
   - {Link,Router,Server} failures
   - User configuration; sessions added/removed, metrics changed
3. Middle Boxes
   - “Route optimizers” and load balancers do all sorts of interesting things to packet flows!

Impact on Protocols: TCP

- Operationally, what does it mean?
  - The location of the Anycast servers is important, and depends on the network topology and configuration
  - When properly deployed, there is a high success rate for short duration connections
  - The longer the connection, the greater the risk of failure
- For Internet services it’s not just your network, but ***every network the packet traverses*** to the Anycast server!
- Avoid Anycasting TCP services when there are good alternatives

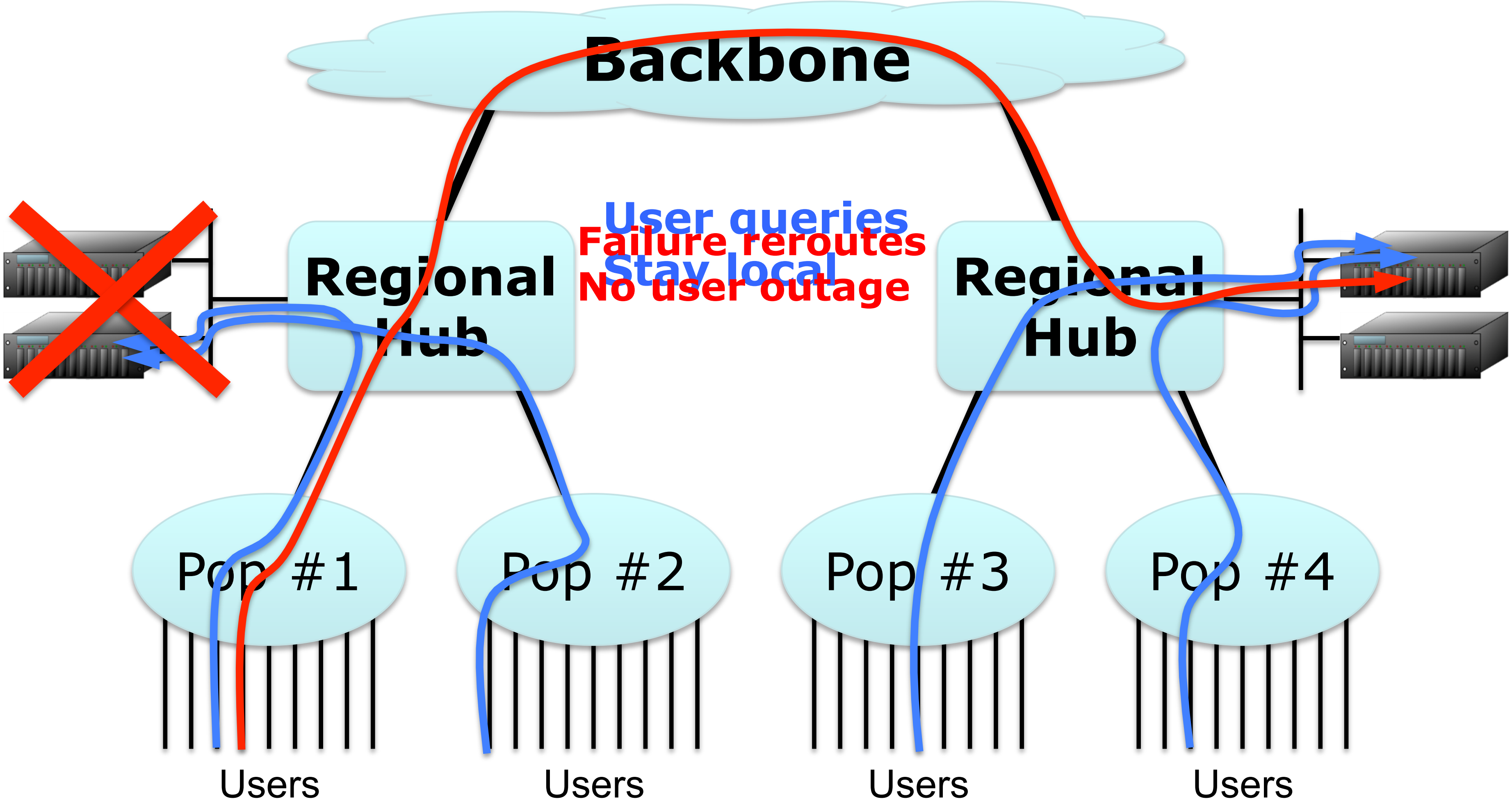
Explore

DNS & ANYCAST

DNS & Anycast

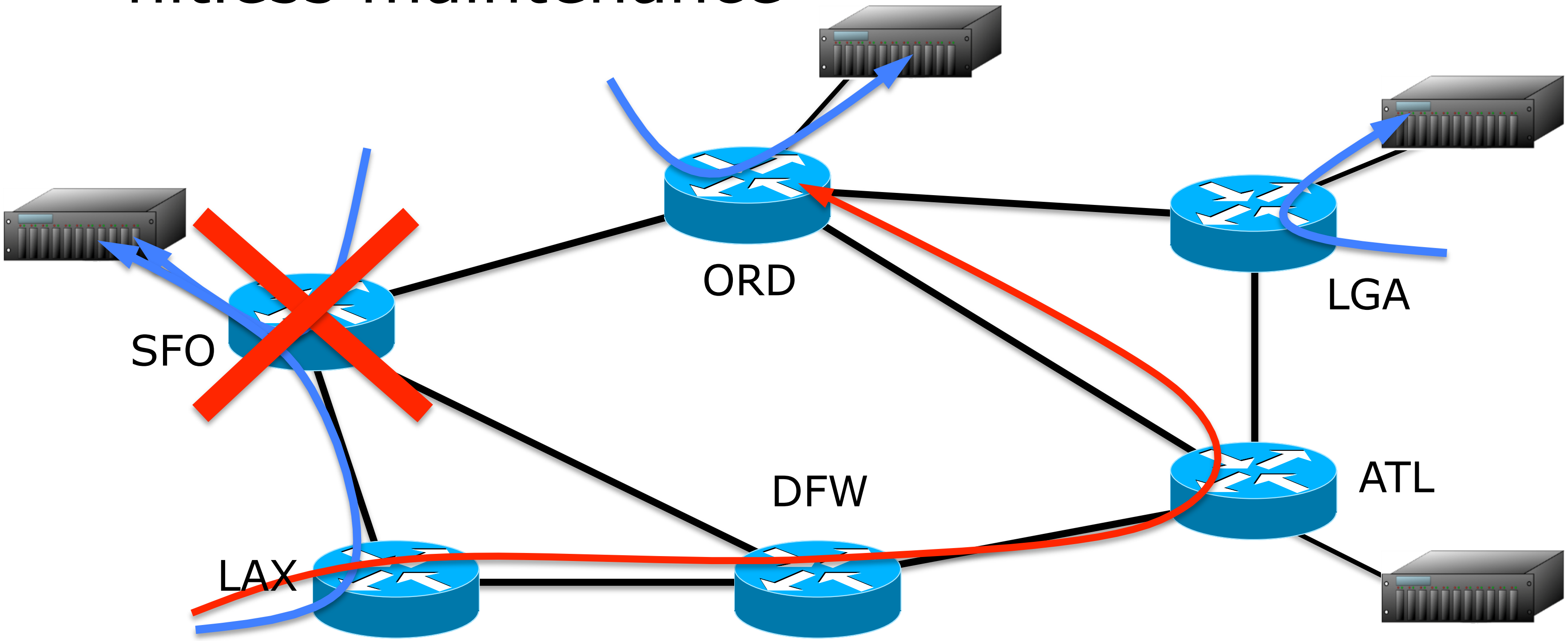
- Most common queries are a single UDP packet, with 1-3 UDP packets of response
- TCP queries are extremely short lived
  - User->Server: SYN, ACK w/query, ACK/FIN
  - Server->User: SYN/ACK, ACK w/Data, ACK/FIN
    - Maybe an additional data packet
  - The FIN can be lost in some implementations and the data still be received
- Zone transfers are long lived TCP queries
  - Length depends on zone size
  - Some zones don’t allow, mitigating the issue

End User Resolvers



Anycast & DNS

- Authority servers across an ISP/Enterprise provide redundancy, load distribution and hitless maintenance

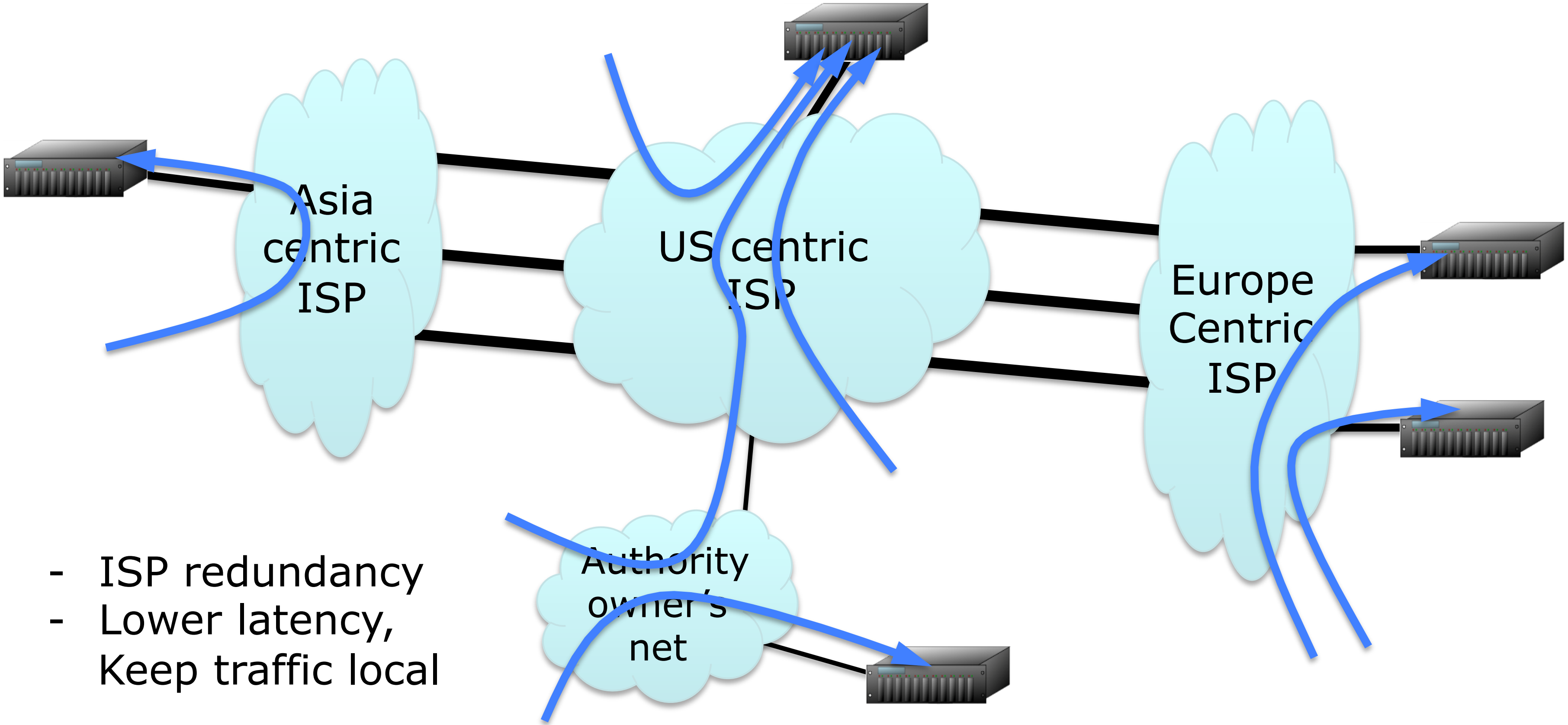


Queries stay local

Pop Failure, service still up

Anycast & DNS

- Authority servers across multiple networks



- ISP redundancy
- Lower latency, Keep traffic local

Queries stay local

Anycast & DNS: Advanced

- Inconsistent content
  - Part of the secret sauce in some CDN's
    - Each Anycast server is loaded with a slightly different data set, and returns answers that direct users to specific servers or to names or IP's that provide some information about the name server the user queried
  - Keep in mind the user generally queries a resolver, so the Anycast Authority server hit was the ***one closest to the resolver***, not the end user
    - That may be good enough
- Routing mechanisms can be used to direct traffic in interesting ways
  - Using multiple super/subnets
  - Metrics that alter dynamically
  - Cisco's "IP SLA" to add/remove routes

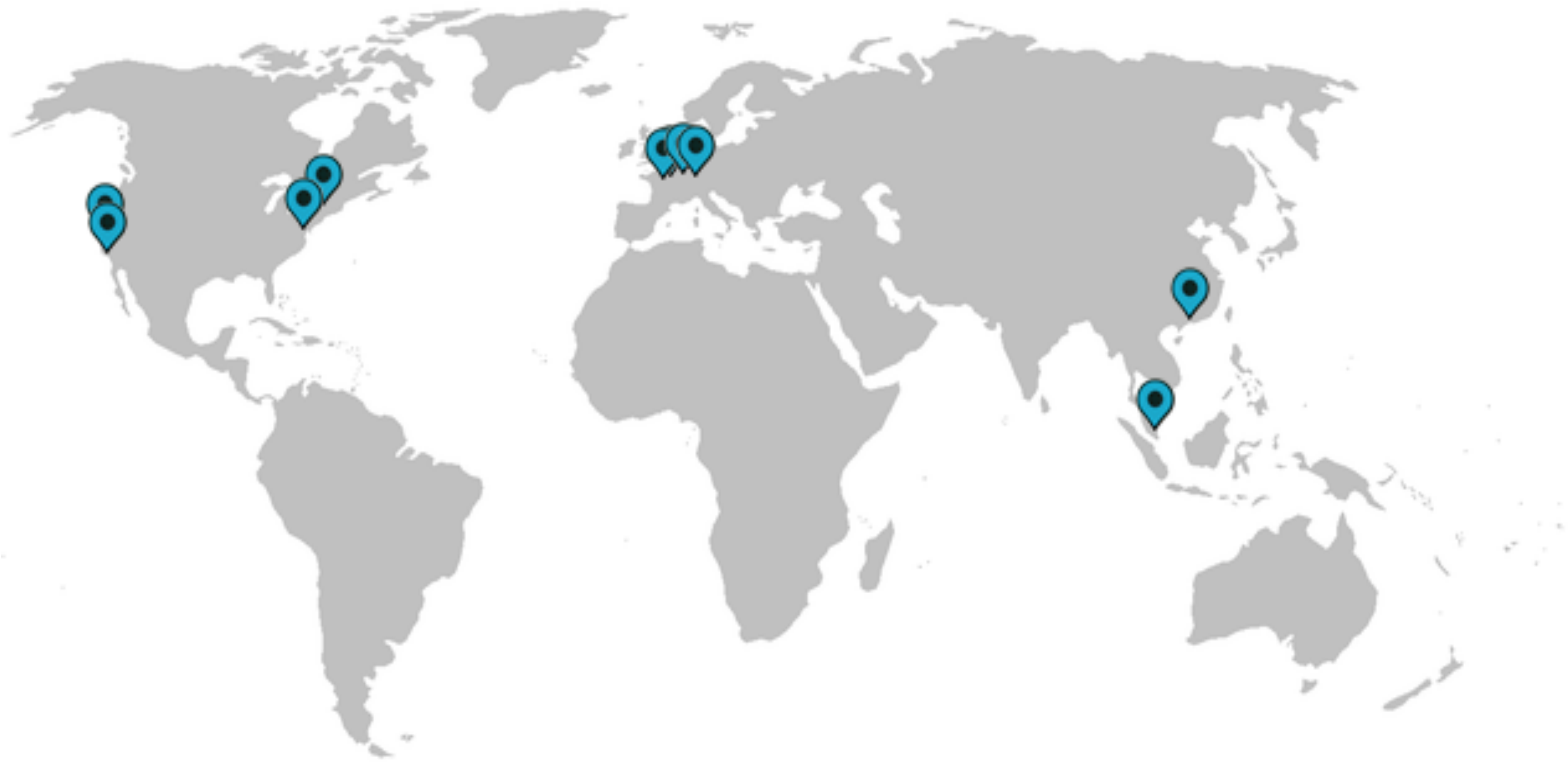
Share

ISC'S OPERATIONAL EXPERIENCE

SNS@ISC

- ISC’s authoritative hosting product
- Present on 3 different ISP networks
  - Cogent, Hurricane Electric, Tata Communications
- Anycast *inside* of each ISP
  - IP address space is used from each ISP inside their own network
  - A minimum of 3 locations on each ISP’s network
- By including 3 NS records in a zone the zone is available across 9 locations worldwide on 3 different ISP networks!

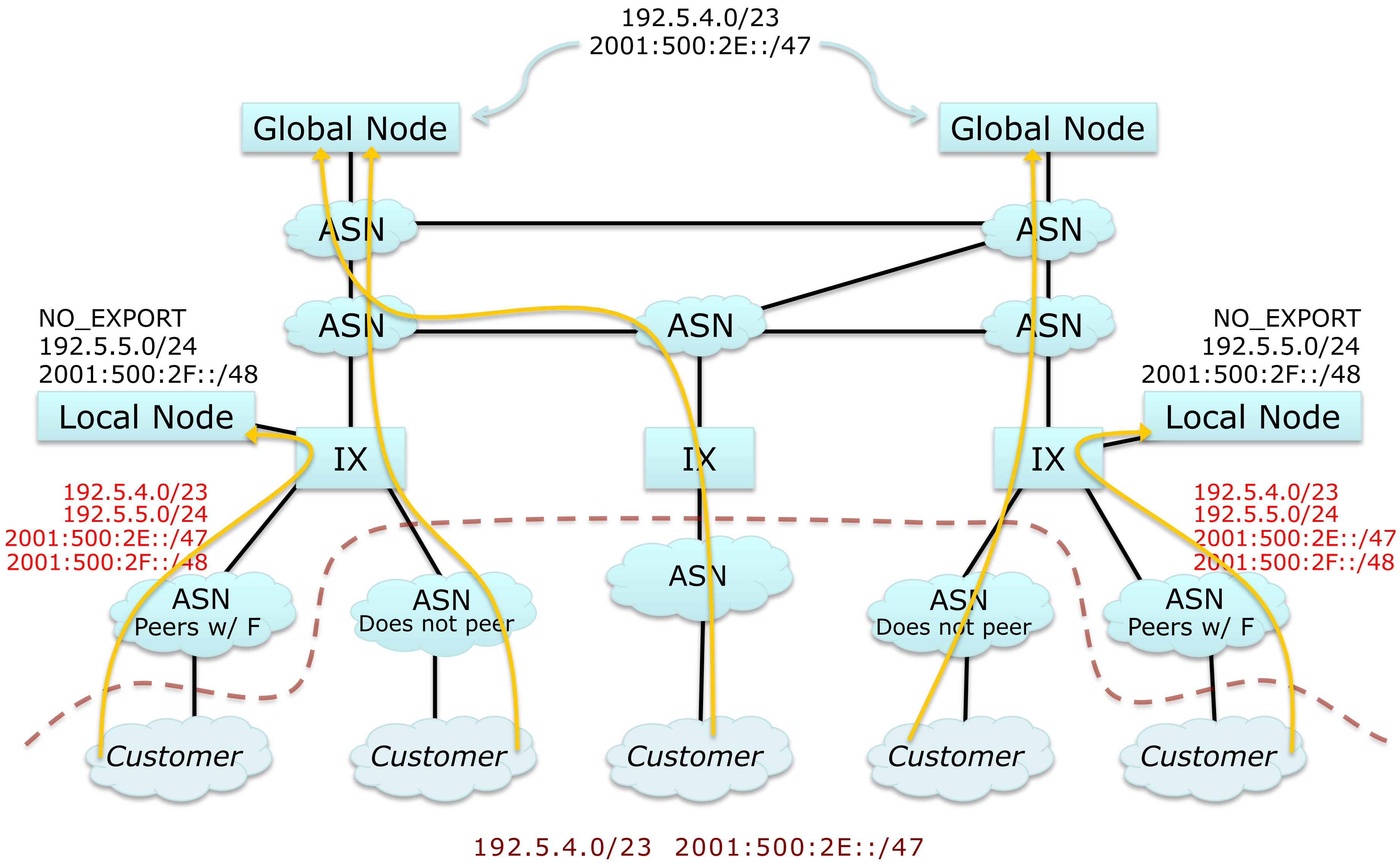
SNS@ISC



F-Root

- Three levels of Anycast
  - Local LAN
    - Each deployment has a minimum of 2 servers on the local network for redundancy, more where necessary
  - Local Nodes
    - A typical F-Root deployment at a exchange point or inside of an ISP network
    - Announces 192.5.5.0/24 and 2001:500:2f::/48 with NO_EXPORT set
      - Because of the NO_EXPORT settings these routes will not be visible to all end users
  - Global Nodes
    - Larger nodes, with significant transit capacity
    - Announce 192.5.4.0/23 and 2001:500:2e::/47, supernets of the local node prefixes
    - These networks should be visible to all end users on the Internet

F-Root


192.5.4.0/23
2001:500:2E::/47
Global Node
Global Node
ASN
ASN
ASN
ASN
ASN
NO_EXPORT
192.5.5.0/24
2001:500:2F::/48
Local Node
NO_EXPORT
192.5.5.0/24
2001:500:2F::/48
Local Node
IX
IX
IX
192.5.4.0/23
192.5.5.0/24
2001:500:2E::/47
2001:500:2F::/48
192.5.4.0/23
192.5.5.0/24
2001:500:2E::/47
2001:500:2F::/48
ASN
Peers w/ F
ASN
Does not peer
ASN
ASN
Does not peer
ASN
Peers w/ F
Customer
Customer
Customer
Customer
Customer
192.5.4.0/23 2001:500:2E::/47

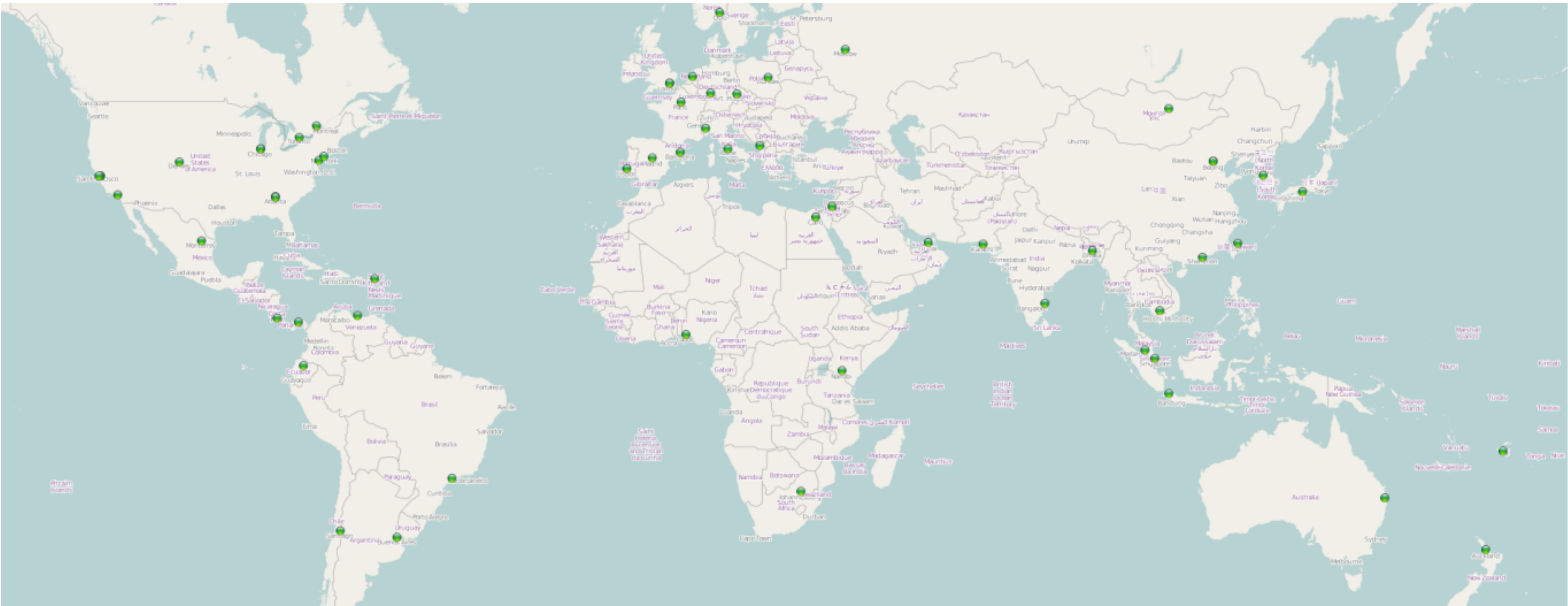
F-Root

- Why 3 levels?
  - A strong desire to keep local traffic local
    - Local nodes may be deployed in bandwidth starved areas, like behind satellite links, and thus shouldn’t draw in queries from far away
    - Provide an incentive for local ISP’s to peer with the local F-Root instance
  - Diversity in the Root Server ecosystem
    - Root operators believe that having different parties deploy in different models allows for more effective service of different user communities, and provides a more difficult attack surface
    - No one else uses this method!
- This does create some confusion
  - ISP’s think that because the local route has NO_EXPORT their customers won’t see F-Root, but this isn’t true due to the covering supernet

F-Root

- Zone transfers are not officially supported, but allowed
  - If the long lived TCP connections fail ISC does not consider it an outage
- Prior to IPv6 and DNSSEC deployment TCP queries were extremely rare
  - 0.00%, before DNSSEC
  - 0.2-0.4% after DNSSEC
  - Most DNS implementations handle a non-responsive server in an intelligent fashion by using other servers
- It may not be wise to have 100% of the authority servers for a domain Anycasted

F-Root



Summarize

ANYCAST

Summary

- Anycast is a routing scheme that can be useful when deploying some applications
- There are some protocol level implications that must be considered when designing an Anycast deployment
- DNS is generally well suited to Anycast deployments, and is one of the most popular services to Anycast
- Lots of other folks are doing it, don’t be afraid!

Learn

ISC EVENTS

Events and Trainings

www.isc.org/webinars

- Despliegue y Experiencia Operativa con Anycast
  - 15 May 2012
- Cyber Crime Remediation
  - 22 May 2012
- IPv6 Lessons Learned
  - 12 June 2012

www.isc.org/support/training

- 3-Day IPv6 Fundamentals
  - 4-6 June 2012, Amsterdam
- 2-Day DHCP Workshop
  - 7-8 June 2012, Amsterdam
- 2-Day Intro DNS & BIND
  - 18-19 June 2012, Virginia
- 5-Day Adv DNS & BIND
  - 18-22 June 2012, Virginia
- 2-Day Intro DNS & BIND
  - 2-3 July 2012, Amsterdam
- 5-Day Adv DNS & BIND
  - 2-6 July 2012, Amsterdam

SPECIAL OFFER

18% discount on any training sessions, now to 30 September 2012!

A thank you for attending!

Coupon code in the follow up e-mail you will receive from this webinar.

www.isc.org/support/training

Ask

QUESTION AND ANSWER

Keep in Touch

www.facebook.com/InternetSystemsConsortium

www.linkedin.com/company/internet-systems-consortium

www.twitter.com/ISCdotORG