BGP and Traffic Engineering with Akamai

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AGENDA

- Akamai Intelligent Platform
- Peering with Akamai
- Traffic Engineering
- Summary
- Q&A

The Akamai Intelligent Platform

Highly distributed, deeply deployed on-demand computing platform that serves any kind of web traffic and applications

The Akamai Intelligent Platform:

200,000+	2,000+	1,300+	1100+	130+
Servers	Locations	Networks	Cities	Countries

Typical daily traffic:

- More than **2 trillion** requests served
- Delivering over **33 Terabits/second**
- **15-30%** of all daily web traffic

Basic Technology

Akamai mapping

How CDNs Work

When content is requested from CDNs, the user is directed to the optimal server

There are 2 common ways to do that:

- anycast: the content is served from the location the request is received (easy to build, requires symmetric routing to work well)
- DNS based: the CDN decides where to best serve the content from based on the resolving name server of the provider it receives the request from, and replies with the optimal server

How DNS based CDNs Work

Users querying a DNS-based CDNs will be returned different A (and AAAA) records for the same hostname depending on the resolver the request comes from

This is called “mapping”

The better the mapping, the better the CDN

How Akamai CDN Work

Example of Akamai mapping

- Notice the different A records for different locations:

```
[NYC]% host www.example.com
www.example.com    CNAME  e5211.b.akamaiedge.net.
e5211.b.akamaiedge.net.  A      207.40.194.46
e5211.b.akamaiedge.net.  A      207.40.194.49

[Boston]% host www.example.com
www.example.com    CNAME  e5211.b.akamaiedge.net.
e5211.b.akamaiedge.net.  A      81.23.243.152
e5211.b.akamaiedge.net.  A      81.23.243.145
```

Peering with Akamai

Why Akamai Peer with ISPs

Performance & Redundancy

- Removing intermediate AS hops gives higher peak traffic for same demand profile

Burstability

- During large events, having direct connectivity to multiple networks allows for higher burstability than a single connection to a transit provider

Peering reduces costs

Backup for on-net servers

- If there are servers on-net, the peering can act as a backup during downtime and overflow
- Allows serving different content types

Why ISPs peer with Akamai

Performance

- ISP's end-users benefit from direct connectivity

Competitive Advantages

- improving performance over competitors
- additional revenue from downstreams

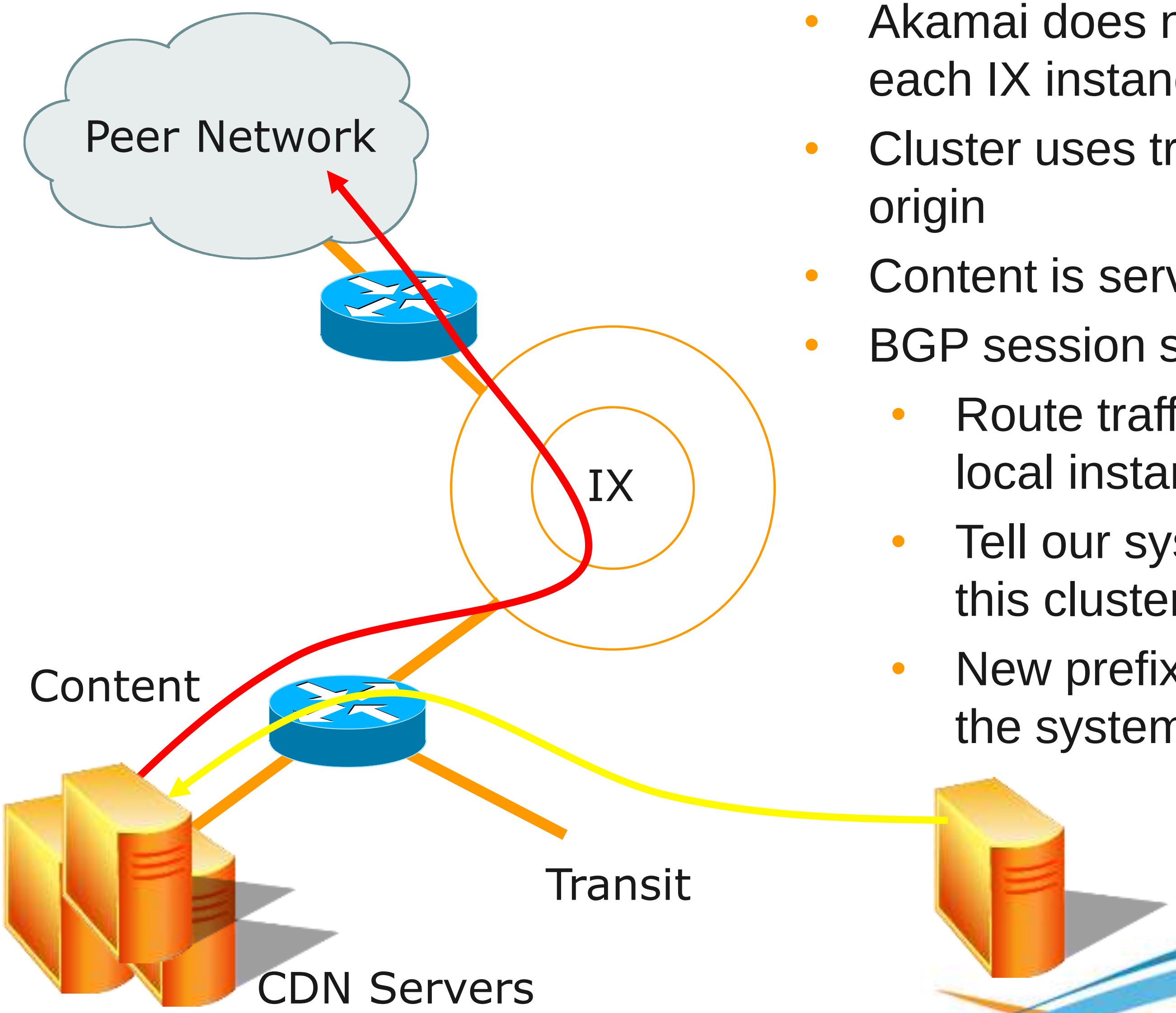
Cost Reduction

- Save on transit bill and potential backbone costs

Redundancy

- Serve as overflow and backup for embedded on-net clusters

How Akamai use IXes



- Akamai does not have a backbone, each IX instance is independent
- Cluster uses transit to fetch content origin
- Content is served to peers over the IX
- BGP session serves 2 purposes:
  - Route traffic strictly within the local instance
  - Tell our system which prefixes this cluster is allowed to serve
  - New prefixes being picked up by the system can take up to 24hrs

How Akamai use IXes

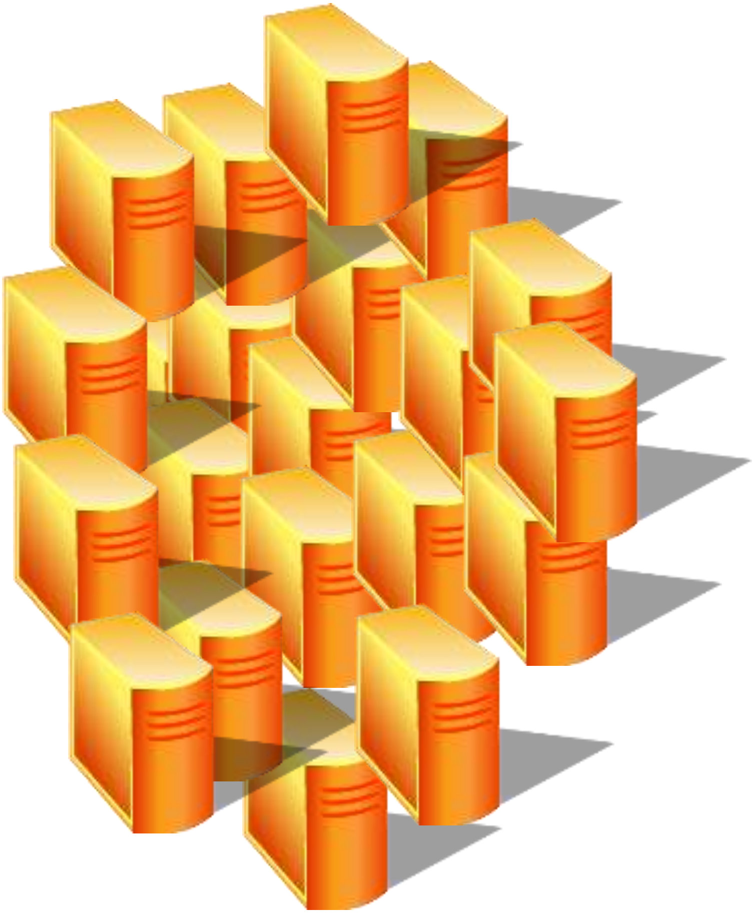
Akamai usually do not announce large blocks of address space because no one location has a large number of servers

- It is not uncommon to see a few small prefixes (/22, /23) from Akamai at an IX

This does not mean you will not see a lot of traffic

- How many web servers does it take to fill a 10G these days?

Why don’t I get all the Akamai content via the Peering?



CDN Servers

- No single cluster can accommodate all Akamai content
- Clusters get more efficient with with size
- Some content requires specialized servers only present in Infrastructure clusters
- Some content is only present in specific geographies
- Do you want to host Akamai Cluster?

After Peering With Akamai….

DO and DON'T's of Traffic Engineering

Typical BGP-based TE Techniques

AS Path Prepending

- **Before**

```
Akamai Router#sh ip b 100.100.100.100
BGP routing table entry for 100.100.100.0/20, version Paths: (1 available, best #1, table
Default-IP-Routing-Table)
Multipath: eBGP
  Advertised to update-groups:
     2          7
  4635 1001
    202.40.161.1 from 202.40.161.1 (202.40.161.1)
```

- **After**

```
Akamai Router#sh ip b 100.100.100.100
BGP routing table entry for 100.100.100.0/20, version
Paths: (1 available, best #1, table Default-IP-Routing-Table)
Multipath: eBGP
  Advertised to update-groups:
     2          7
  4635 1001 1001 1001 1001
    202.40.161.1 from 202.40.161.1 (202.40.161.1)
```

MED

- **Before**

```
Akamai Router#sh ip b 100.100.100.100
BGP routing table entry for 100.100.100.0/20, version Paths: (1 available, best #1, table
Default-IP-Routing-Table)
Multipath: eBGP
  Advertised to update-groups:
     2           7
  4635 1001
    202.40.161.1 from 202.40.161.1 (202.40.161.1)
    Origin IGP, metric 0, localpref 100, valid, external, best
```

- **After**

```
Akamai Router#sh ip b 100.100.100.100
BGP routing table entry for 100.100.100.0/20, version Paths: (1 available, best #1, table
Default-IP-Routing-Table)
Multipath: eBGP
  Advertised to update-groups:
     2           7
  4635 1001
    202.40.161.1 from 202.40.161.1 (202.40.161.1)
    Origin IGP, metric 1000, localpref 100, valid, external, best
```

More Specific Route

- **Before**

```
Akamai Router#sh ip b 100.100.100.100
BGP routing table entry for 100.100.96.0/20, version
Paths: (1 available, best #1, table Default-IP-Routing-Table)
Multipath: eBGP
  Advertised to update-groups:
     2          7
  4635 1001
    202.40.161.1 from 202.40.161.1 (202.40.161.1)
```

- **After**

```
Akamai Router#sh ip b 100.100.100.100
BGP routing table entry for 100.100.100.0/24, version Paths: (1 available, best #1, table Default-IP-Routing-Table)
Multipath: eBGP
  Advertised to update-groups:
     2          7
  4635 1001
    202.40.161.1 from 202.40.161.1 (202.40.161.1)
```

These will not have the desired effects

Why doesn’t it have the usual effect?

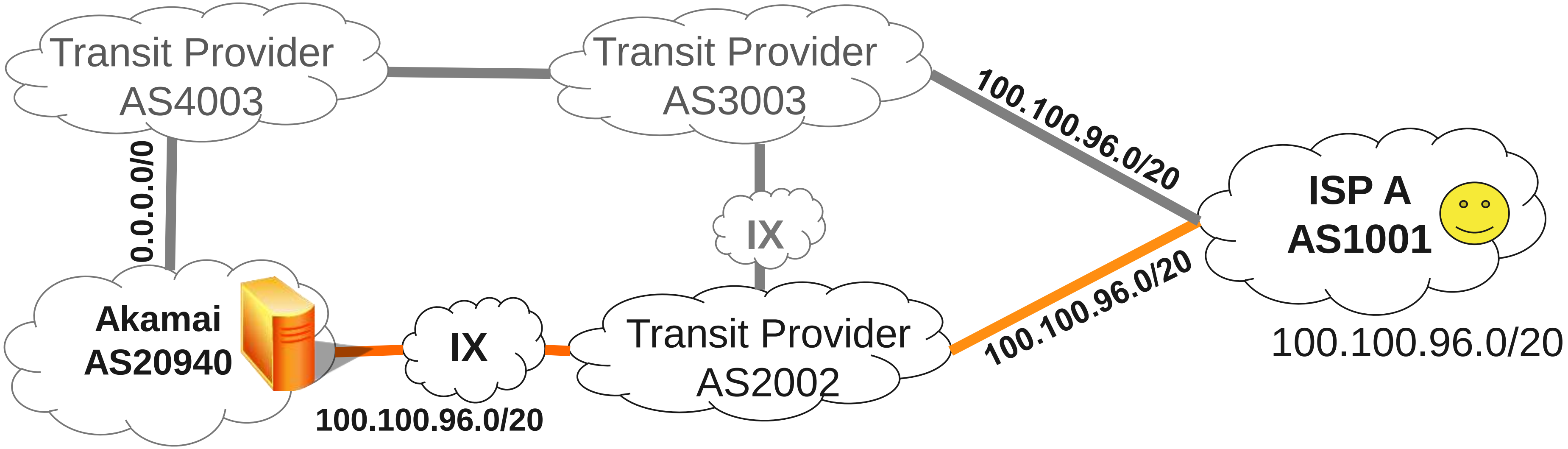
- Akamai uses Mapping, on top of the BGP routing
- Akamai Mapping is different from BGP routing
- Akamai uses multiple criteria to choose the optimal server
- These include standard network metrics:
  - Latency
  - Throughput
  - Packet loss
- as well as internal ones such as:
  - CPU load on the server
  - HD space
  - Network utilization

Typical Scenarios in Traffic Engineering

Scenario 1: Inconsistent Route Announcement

Consistent Route Announcements

- ISP A is multi-homed to Transit Provider AS2002 and AS3003
- Transit Provider AS2002 peer with Akamai
- Transit Provider AS3003 does not peer with Akamai
- Akamai always sends traffic to ISP A via Transit Provider AS2002

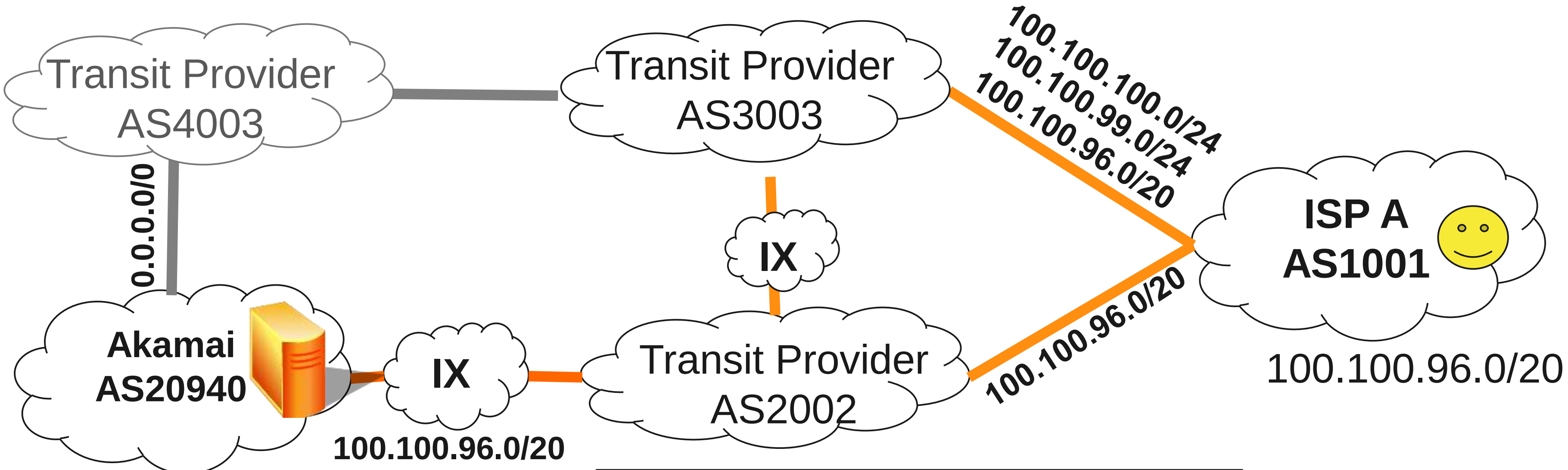


Load-Balancing

- ISP A would like to balance the traffic between two upstream providers
- ISP A prepends, applies MED to Transit Provider AS2002. Unfortunately, no effect on Akamai traffic…..
- Eventually, ISP A de-aggregates the /20 and advertises more specific routes to Transit Provider AS3003
- What will happen?

ISP A Load Balance the Traffic Successfully

- ISP A announces more specific routes /24 to Transit Provider AS3003
- Transit Provider AS3003 announces new /24 to AS2002
- Akamai IX router does not have a full-table, so traffic continues to route to the /20 of AS2002
- ISP A is happy with the balanced traffic on dual Transit Providers



Akamai AS20940 Routing Table

100.100.96.0/20	AS2002 AS1001
0.0.0.0/0	AS4003

AS2002 Routing Table

100.100.100.0/24	AS3003 AS1001
100.100.99.0/24	AS3003 AS1001
100.100.96.0/20	AS1001

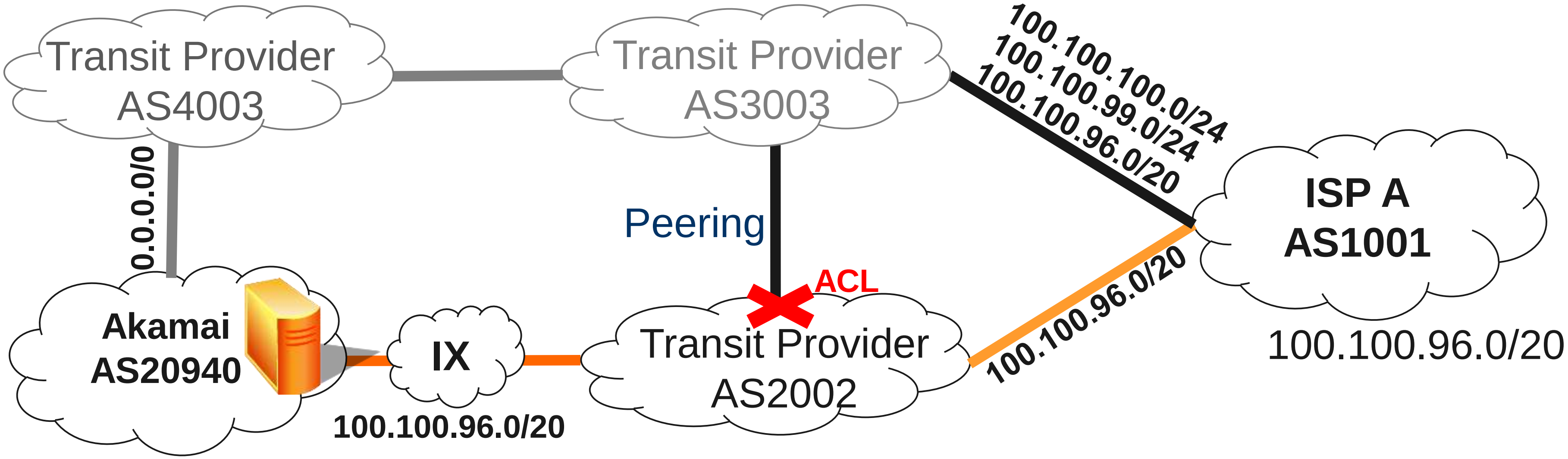
What is the problem?

- Lost of revenue for Transit Provider AS2002 even though their peering/backbone is utilized

- What could happen if AS2002 does not like the peer-to-peer traffic?

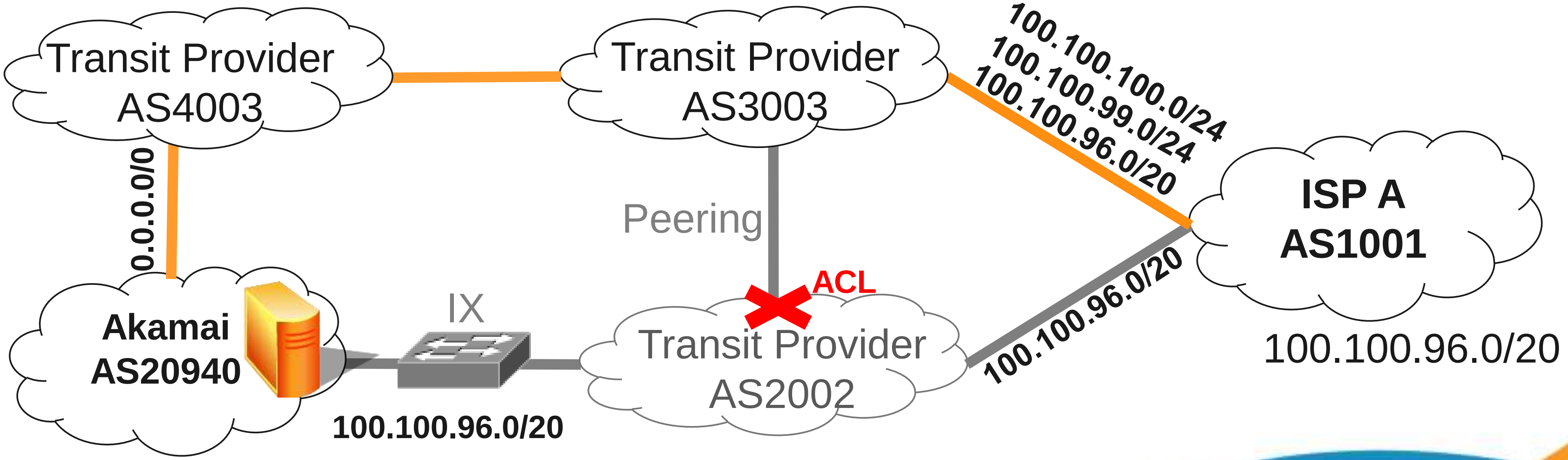
Transit provider filters traffic

- In order to get rid of traffic between peers, Transit Provider AS2002 implements an ACL on IX port facing AS3003
- Traffic gets blackholed, ISP A’s eyeballs don’t receive traffic anymore!



Unintended Result

- Akamai observes ISP A end-users are unable to access some websites
- Akamai stops serving unreliable prefixes received from Transit Provider AS2002, traffic shifts from IX to Transit Provider AS4003
- ISP A can access all websites happily
- Transit Provider AS2002 loses revenue



Issues

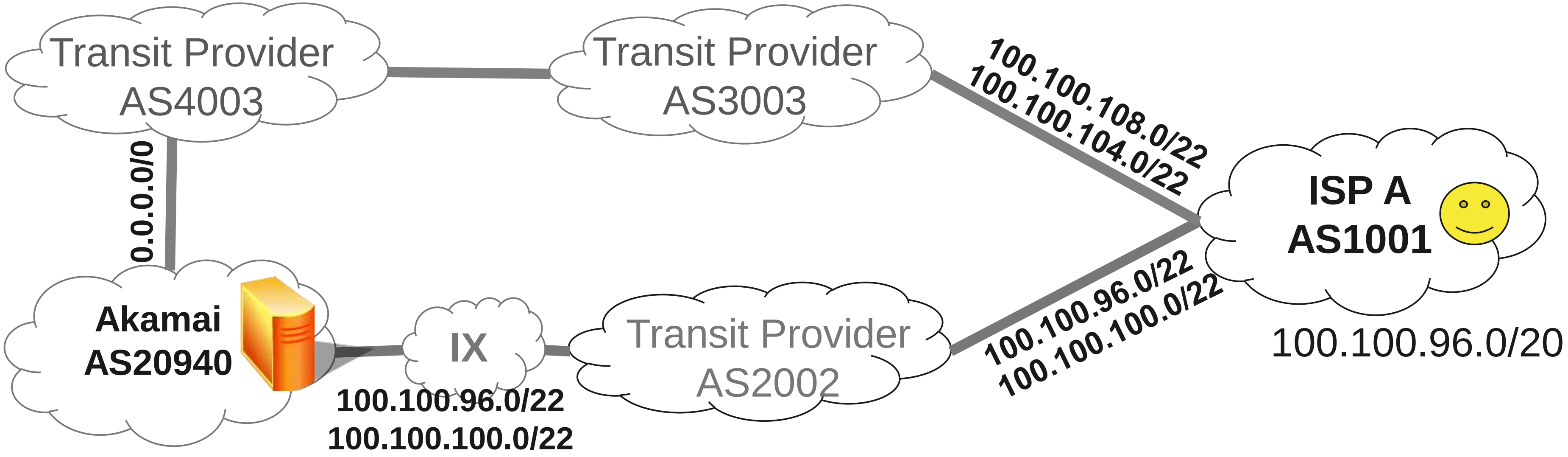
- Don’t assume a full-table on any device on the internet

- Filtering traffic results in:
  - short term traffic blackholing!
  - long term widthdrawal of traffic resulting in revenue loss

Scenario 2: Incomplete Route Announcement

Incomplete Route Announcement

- ISP A is multi-homed to Transit Provider AS2002 and AS3003
- Transit Provider AS2002 peers with Akamai
- Transit Provider AS3003 does not peer with Akamai
- ISP A announces different prefix to different ISP
- ISP A can access full internet



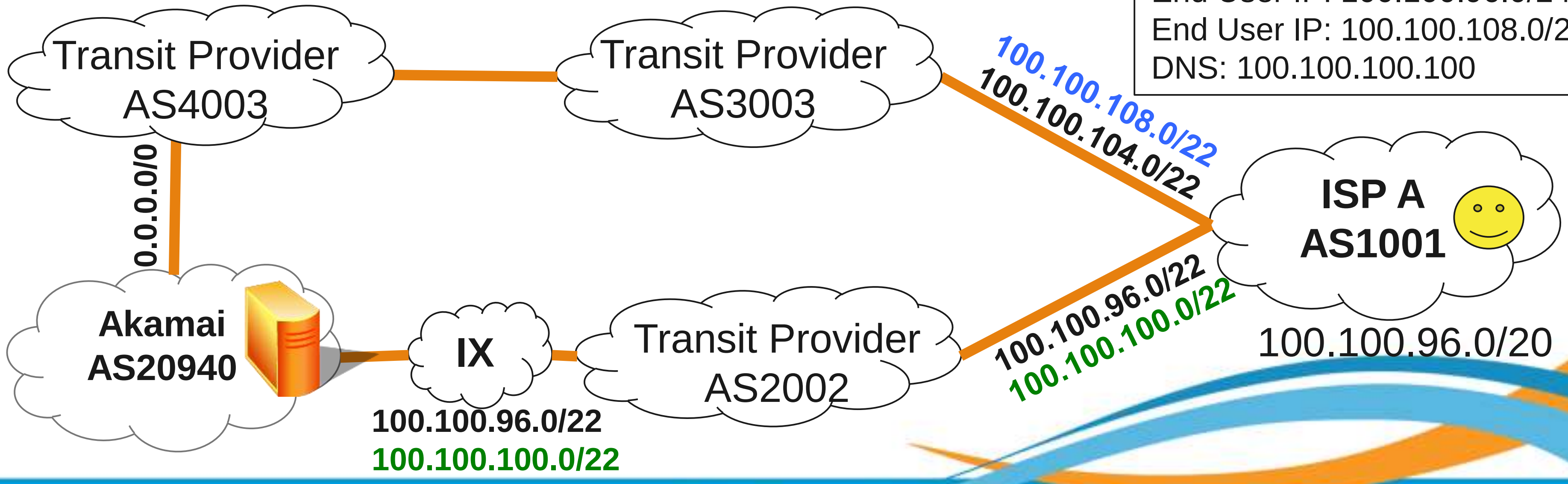
Akamai AS20940 Routing Table

100.100.96.0/22	AS2002 AS1001
100.100.100.0/22	AS2002 AS1001
0.0.0.0/0	AS4003

How will the traffic be routed to ISP A end users?

- End Users are using IP Address of 100.100.96.0/22, 100.100.100.0/22, 100.100.104.0/22, 100.100.108.0/22
- End Users are using ISP A DNS Server 100.100.100.100
- Akamai receives the DNS Prefix 100.100.100.0/22 from AS2002, so it maps the traffic of ISP A to this cluster
- 100.100.96.0/22 100.100.100.0/22 traffic is routed to AS2002 while 100.100.104.0/22 100.100.108.0/22 traffic is routed to AS3003 by default route

ISP A AS1001
End User IP: 100.100.96.0/24
End User IP: 100.100.108.0/24
DNS: 100.100.100.100

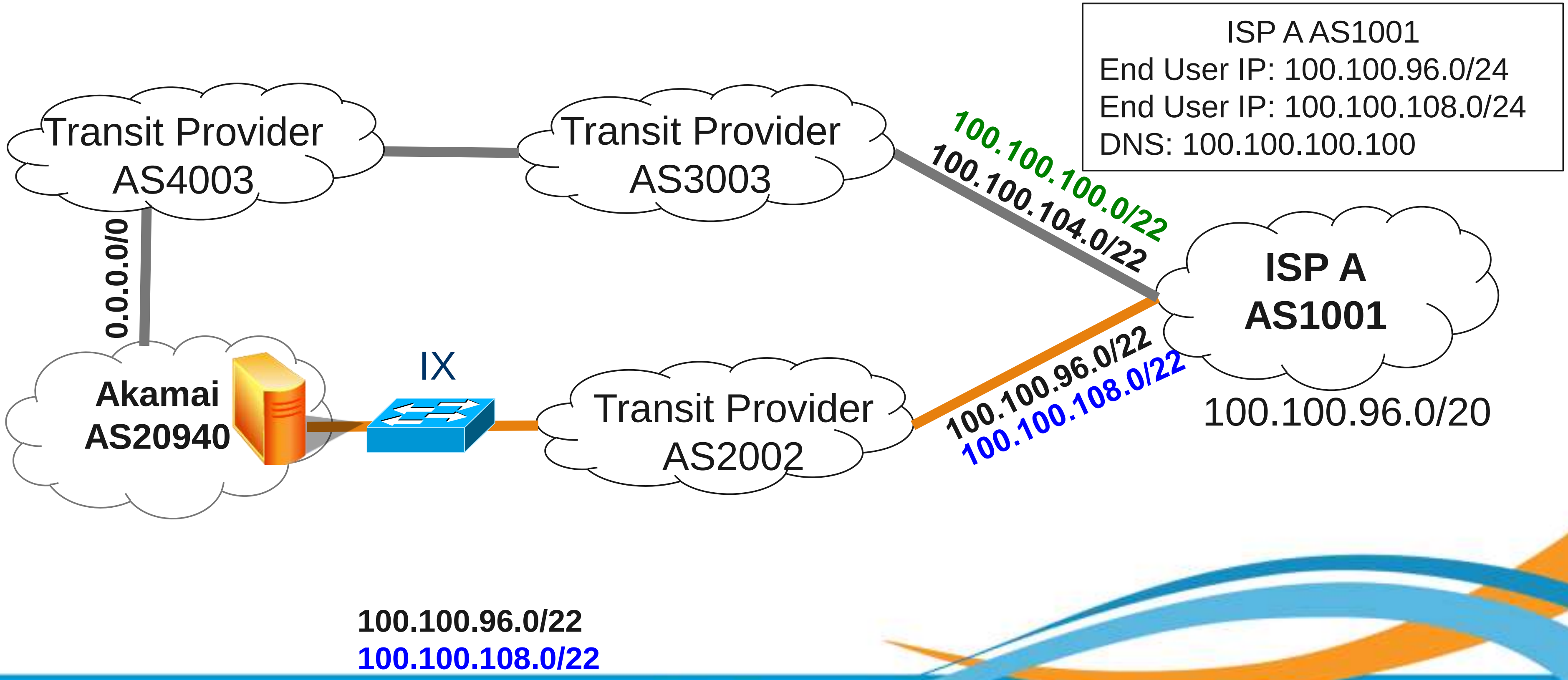


Differing performance

- This can work perfectly fine
- But the path via the transit providers AS4003 & AS3003 might not be as good as the direct peering, 100.100.108.0/22 end users could have significantly worse performance
- What will ISP A do if the user complain?

Problem solved…

- ISP A swaps the route announcements
- Both 100.100.96.0/22 and 100.100.108.0/22 are routed via AS2002 and end-users have the same performance
- The end-user is happy and closes the ticket



…but

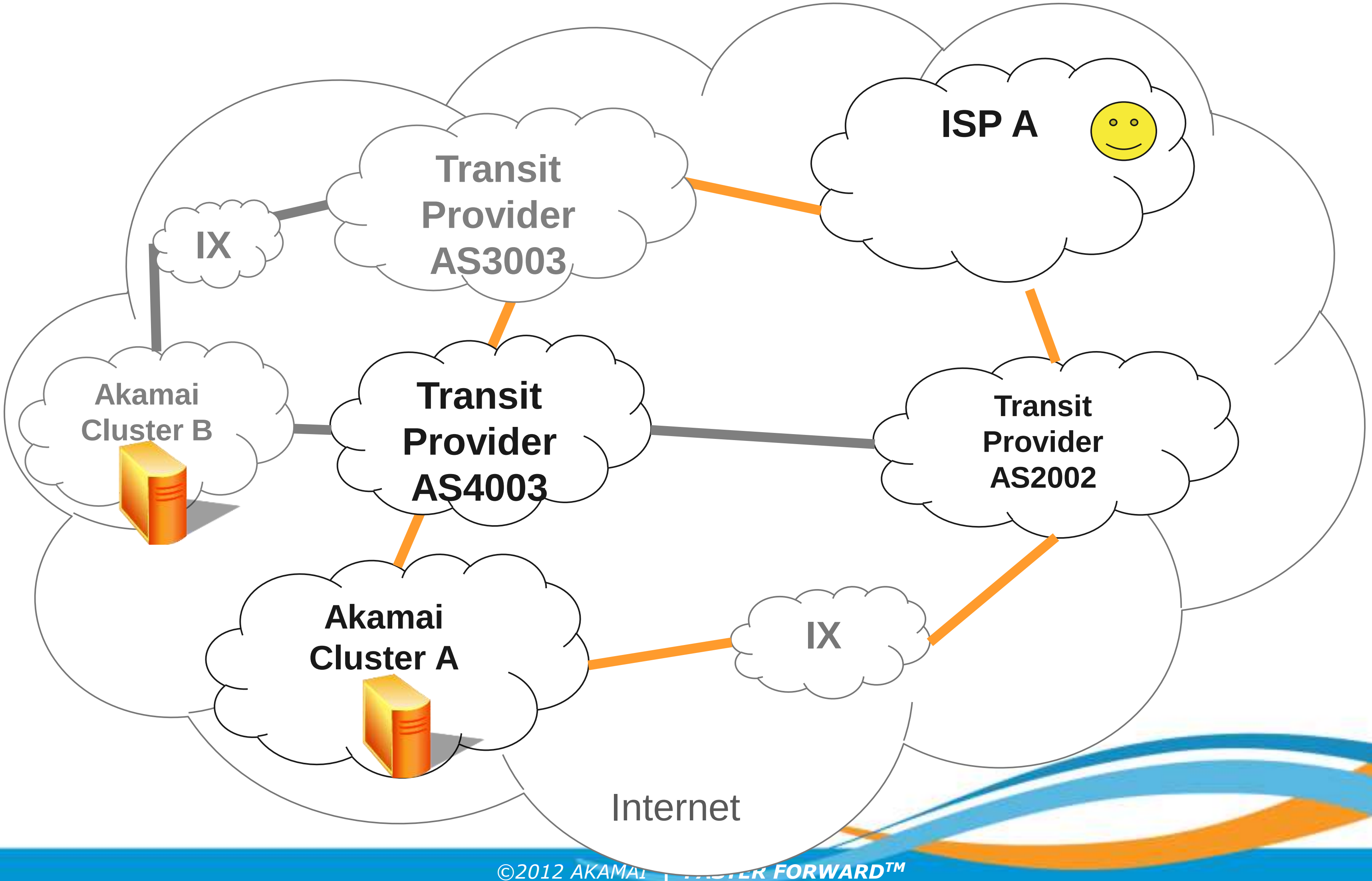
24hrs later:

- Akamai no longer receives NS prefix 100.100.100.0/22 from AS2002
- Akamai maps the traffic of ISP A to Cluster B (where we see AS3003's prefixes) instead of Cluster A (which only peers with AS2002)
- ISP A will receive the traffic from a completely different source potentially all via AS3003 now negating all the TE efforts

DO NOT split nameserver and end-user prefixes when traffic engineering

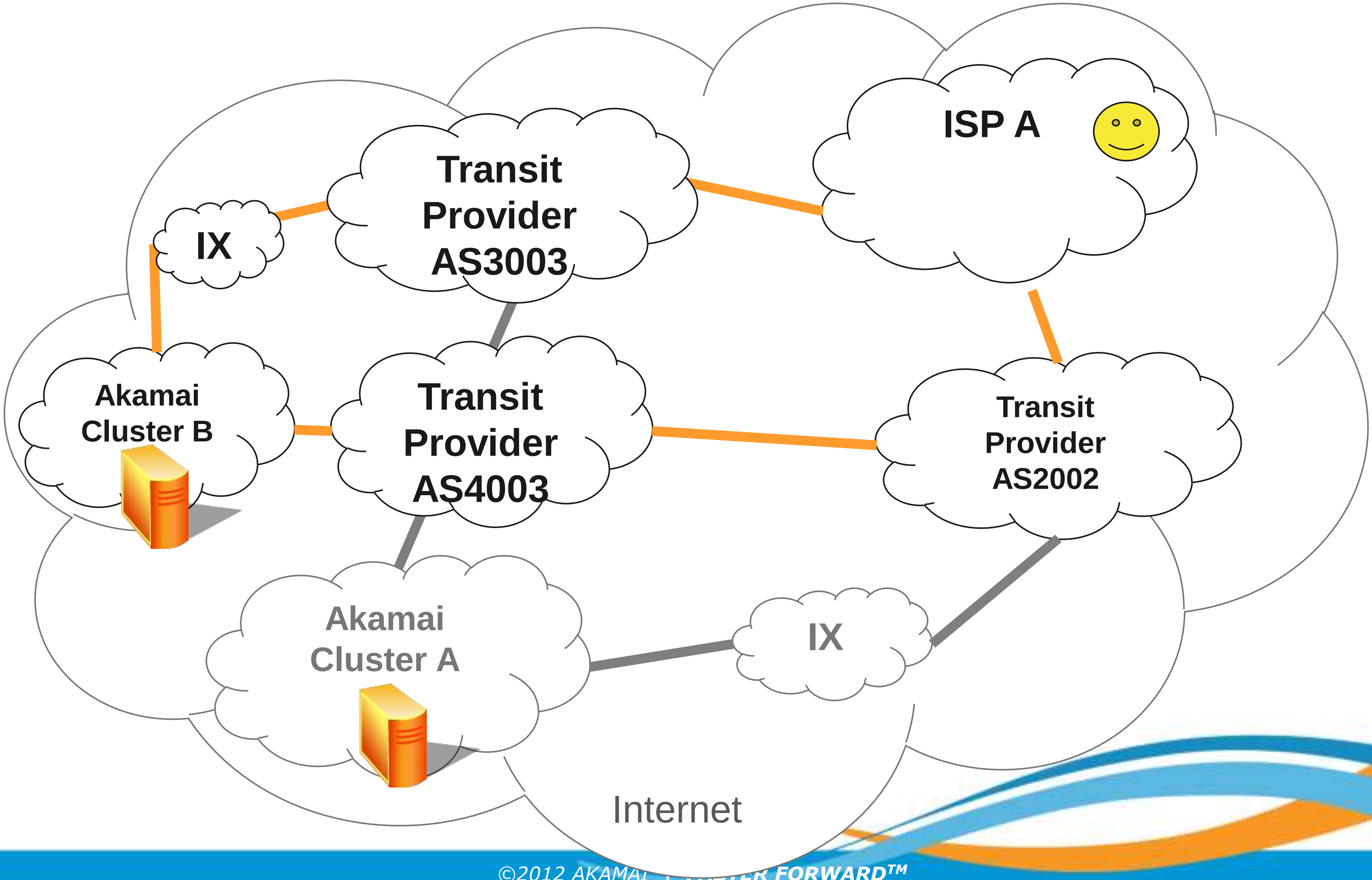
Before Akamai Mapping System refresh

- Akamai maps the traffic to Cluster A



After Akamai Mapping System refresh

- Akamai maps the traffic to Cluster B

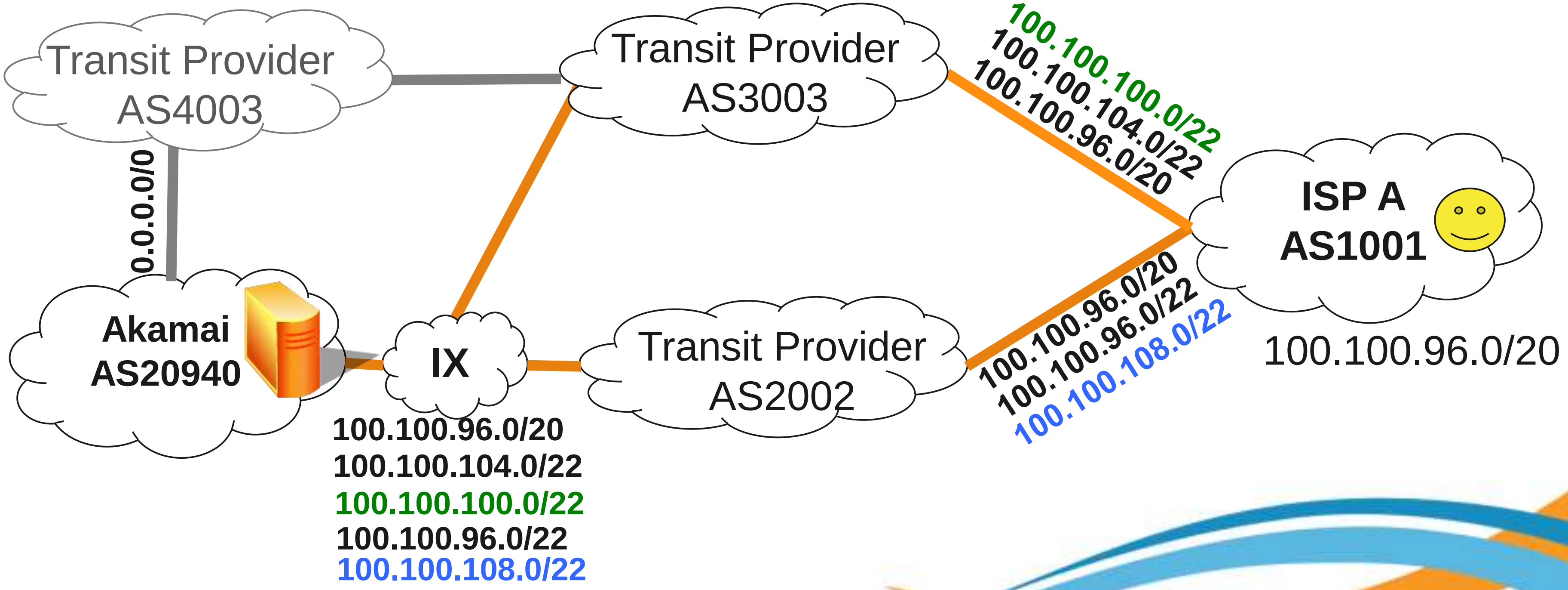


Our Recommendation

- Please maintain complete route announcement
- More specifics can be used but splitting the prefixes might have unintended effect
- Talk to us if there are any traffic or performance issues
- We can work together for traffic engineering

Ideal solution

- ISP A should announce complete prefix in both upstream
- ISP A can work with upstream and Akamai together
- Transit Provider AS3003 can peer with Akamai



Conclusions

Summary

Summary

- Standard BGP traffic engineering will not have the expected results
- Changes in announcements have a delayed effect
- Mapping is based on resolving name server, splitting nameserver and end-user prefixes over different providers will have unexpected effects
- Not all clusters have a full table
  - splitting more specific announcements over different links can cause unintended behavior
  - Announcing prefixes with holes results in blackholing traffic

- Talk to us for fine-tuning traffic

Questions?

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More information:

Peering: http://as20940.peeringdb.com

http://as32787.peeringdb.com

Akamai 60sec: http://www.akamai.com/60seconds