Message Agents and IPv6 interoperability problems

Research Project
Universiteit van Amsterdam
System and Network Engineering (MSc)
Conducted at SARA

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Research Question

What e-mail architecture components and configurations introduce connectivity problems in an IPv4/IPv6 mixed environment?

Why

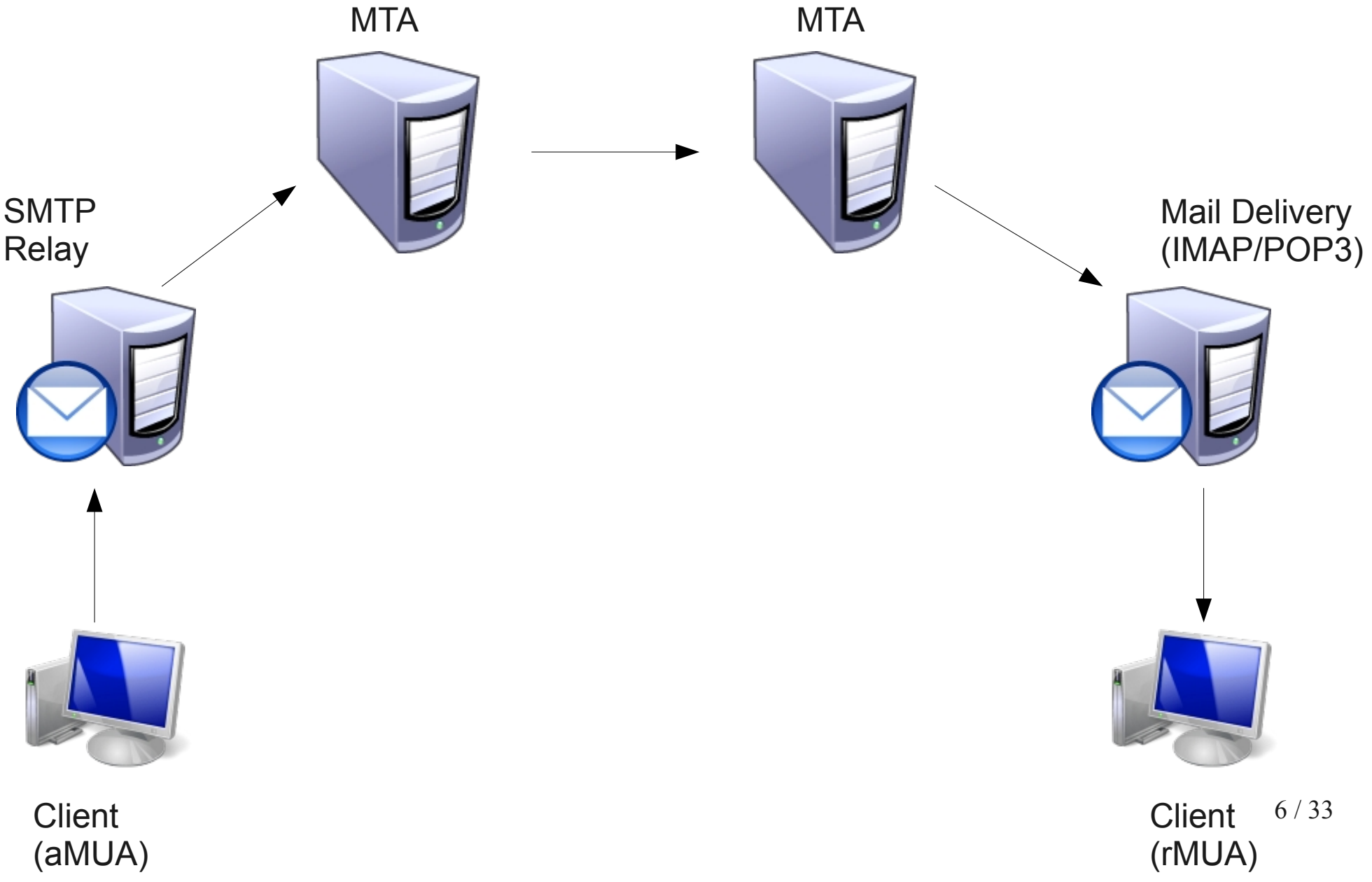
IPv6 on your public facing services will only become more and more important. Therefore study is needed to see where problems originate to be able to fix or avoid them.

Test environment

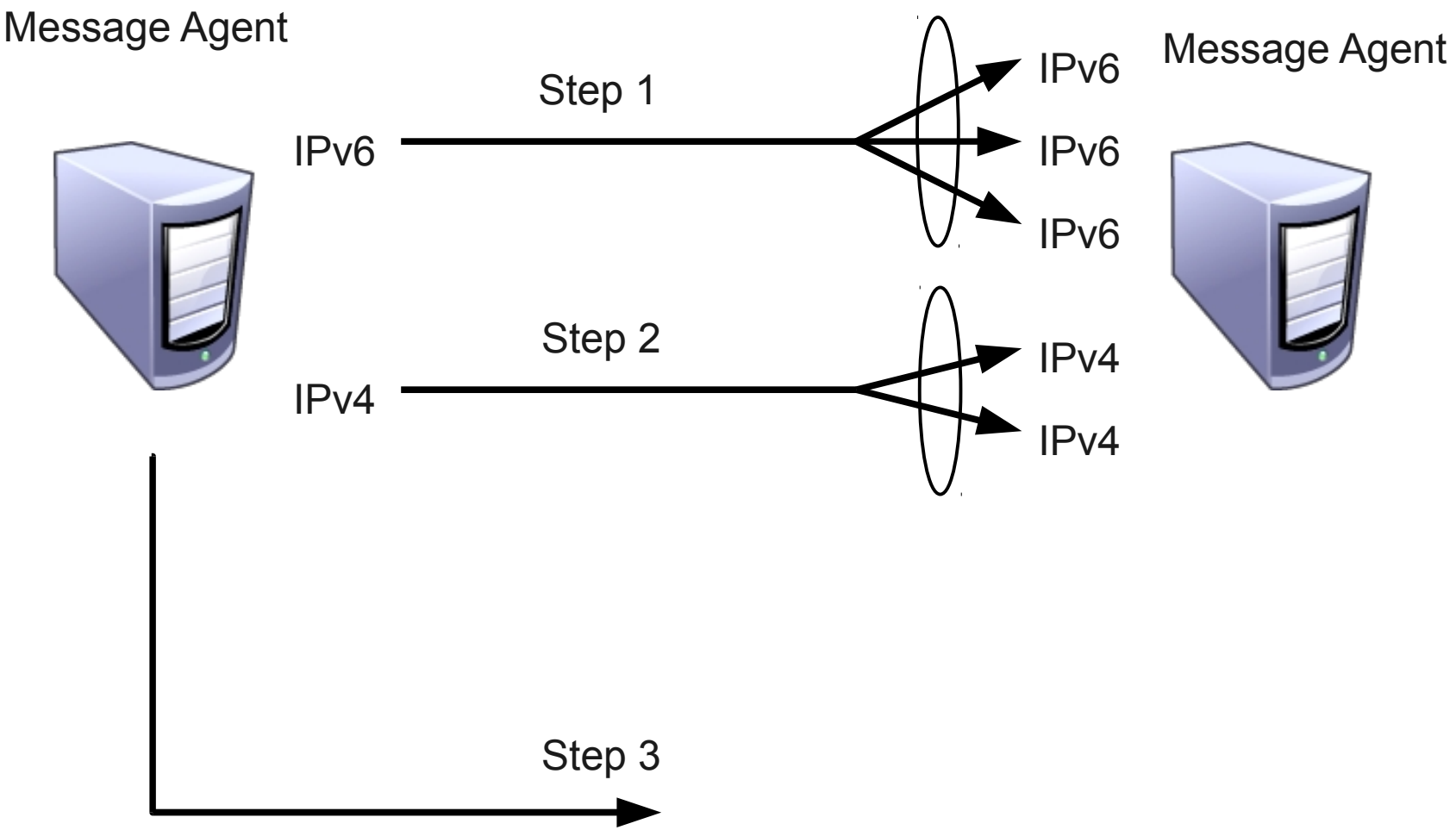
- SARA network
  - /28 for IPv4 and /64 for IPv6
- OS3 Lab
  - /27 for IPv4 and /64 for IPv6

- Approximately 20 machines
  - Ubuntu 10.04, Windows, Mac OSX 10.6
  - Exim, Sendmail, Postfix, Exchange 2007 SP1

Message Agents - Intro



Address Selection



DNS A and AAAA

- Round robin for load balancing your services:
  - With MXs of equal preference
  - With multiple A or AAAA records
- RFC 3484 brakes this behaviour
  - Longest matching prefix (section 6, rule 9)
  - Draft “Things To Be Considered for RFC 3484 Revision”
- RFC 3484 does not recognize private IPv4 addresses as native (Section 6, rule 7)

SMTP Relay - Problems

client

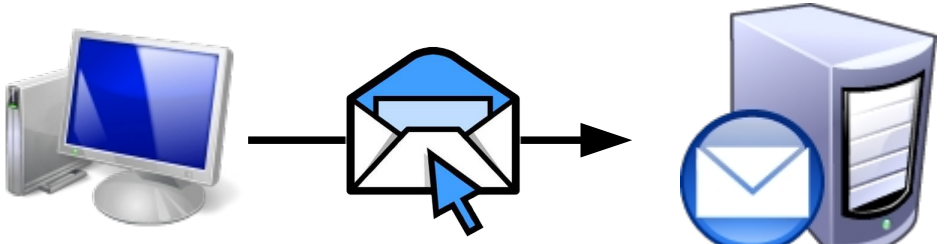
SMTP Relay
IPv4-only

MTA: brainbird.nl
IPv4/IPv6

From: user@skimbee.net (IPv6)
To: unknown_user@brainbird.nl (IPv4/IPv6)

SMTP Relay - Problems

Client will send message to SMTP Relay



client

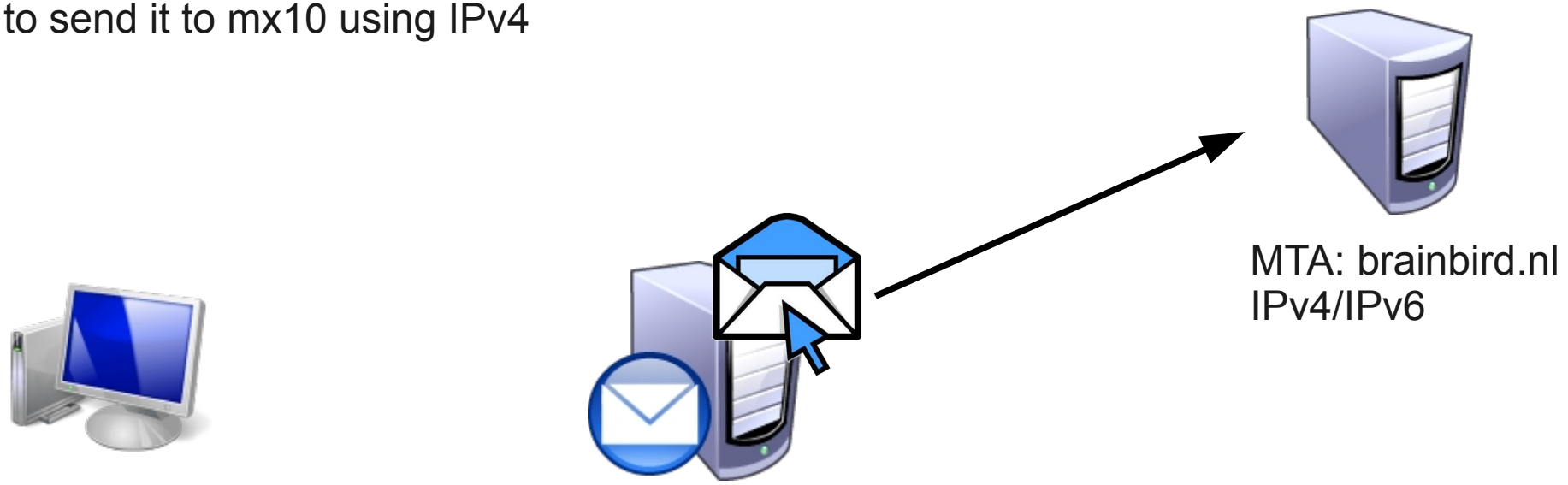
SMTP Relay
IPv4-only

MTA: brainbird.nl
IPv4/IPv6

From: user@skimbee.net (IPv6)
To: unknown_user@brainbird.nl (IPv4/IPv6)

SMTP Relay - Problems

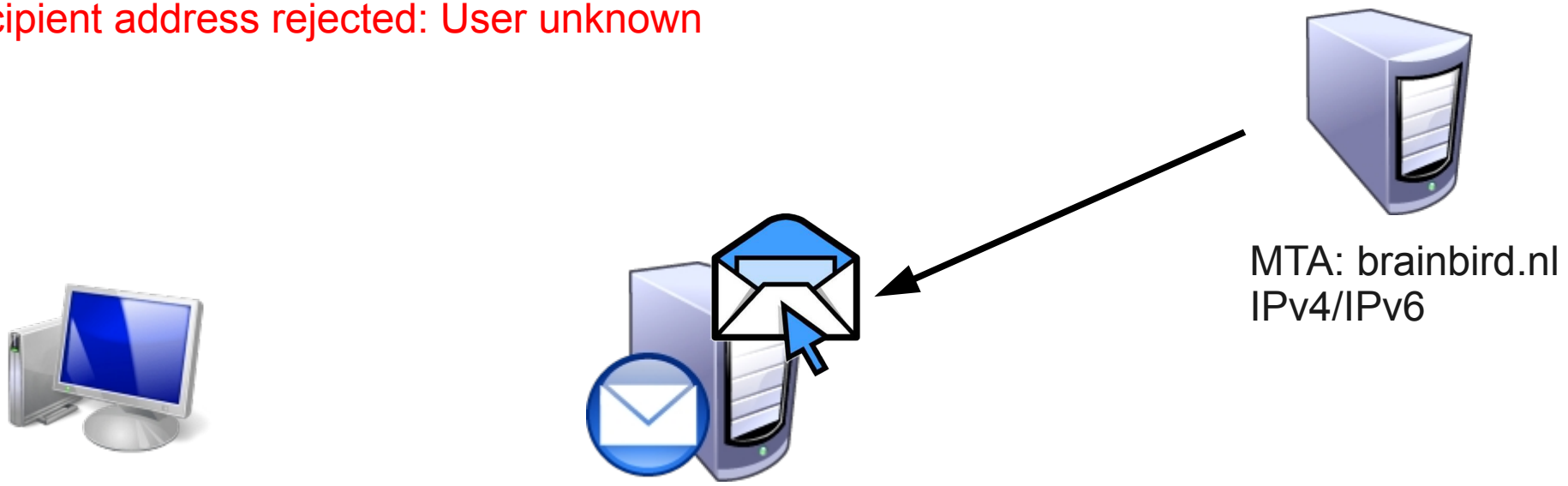
Try to send it to mx10 using IPv4



From: user@skimbee.net (IPv6)
To: unknown_user@brainbird.nl (IPv4/IPv6)

SMTP Relay - Problems

Recipient address rejected: User unknown



From: user@skimbee.net (IPv6)
To: unknown_user@brainbird.nl (IPv4/IPv6)

SMTP Relay - Problems

E-mail error needs to be send to sender,
Not possible as domain is IPv6-only

MTA: brainbird.nl
IPv4/IPv6

client

SMTP Relay
IPv4-only

MTA: skimbee.net
IPv6-only

From: user@skimbee.net (IPv6)
To: unknown_user@brainbird.nl (IPv4/IPv6)

SMTP Relay - Problems

E-mail does not reach receiver and error code does not get returned to sender

client

SMTP Relay
IPv4-only

MTA: brainbird.nl
IPv4/IPv6

From: user@skimbee.net (IPv6)
To: unknown_user@brainbird.nl (IPv4/IPv6)

MTA: skimbee.net
IPv6-only

MX Routing - Problems

mx10 is down

IPv4/IPv6
mx10

SMTP Relay
IPv4-only

IPv6-only
mx20 relay

IPv4/IPv6
mx30 relay

From: user@skimbee.net
To: unknown_user@brainbird.nl

MX Routing - Problems

No connectivity possible between
SMTP Relay and mx20

IPv4/IPv6
mx10

SMTP Relay
IPv4-only

IPv6-only
mx20 relay

IPv4/IPv6
mx30 relay

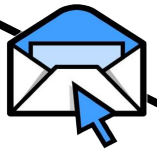
From: user@skimbee.net
To: unknown_user@brainbird.nl

MX Routing - Problems

Deliver to mx30

IPv4/IPv6
mx10

SMTP Relay
IPv4-only



IPv6-only
mx20 relay

IPv4/IPv6
mx30 relay

From: user@skimbee.net
To: unknown_user@brainbird.nl

MX Routing - Problems

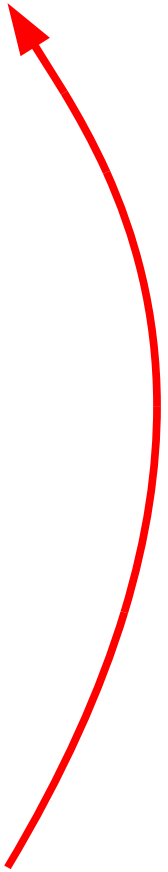
mx10 is still down

IPv4/IPv6
mx10

SMTP Relay
IPv4-only

IPv6-only
mx20 relay

IPv4/IPv6
mx30 relay



From: user@skimbee.net
To: unknown_user@brainbird.nl

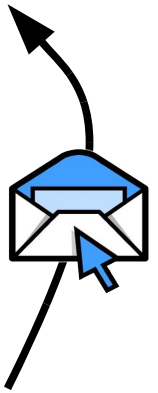
MX Routing - Problems

Deliver to mx20

IPv4/IPv6
mx10

SMTP Relay
IPv4-only

IPv6-only
mx20 relay



IPv4/IPv6
mx30 relay

From: user@skimbee.net
To: unknown_user@brainbird.nl

MX Routing - Problems

mx10 is still down

IPv4/IPv6
mx10

SMTP Relay
IPv4-only

IPv6-only
mx20 relay

IPv4/IPv6
mx30 relay

From: user@skimbee.net
To: unknown_user@brainbird.nl

MX Routing - Problems

E-mail error needs to be send to sender,
Not possible as domain is IPv4-only

IPv4/IPv6
mx10

SMTP Relay
IPv4-only

IPv6-only
mx20 relay

MTA: skimbee.net
IPv4-only

IPv4/IPv6
mx30 relay

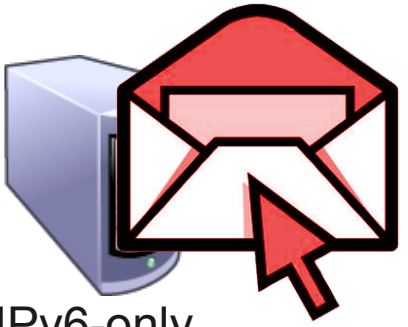
From: user@skimbee.net
To: unknown_user@brainbird.nl

MX Routing - Problems

E-mail does not reach receiver and error code does not get returned to sender

IPv4/IPv6
mx10

SMTP Relay
IPv4-only



IPv6-only
mx20 relay

IPv4/IPv6
mx30 relay

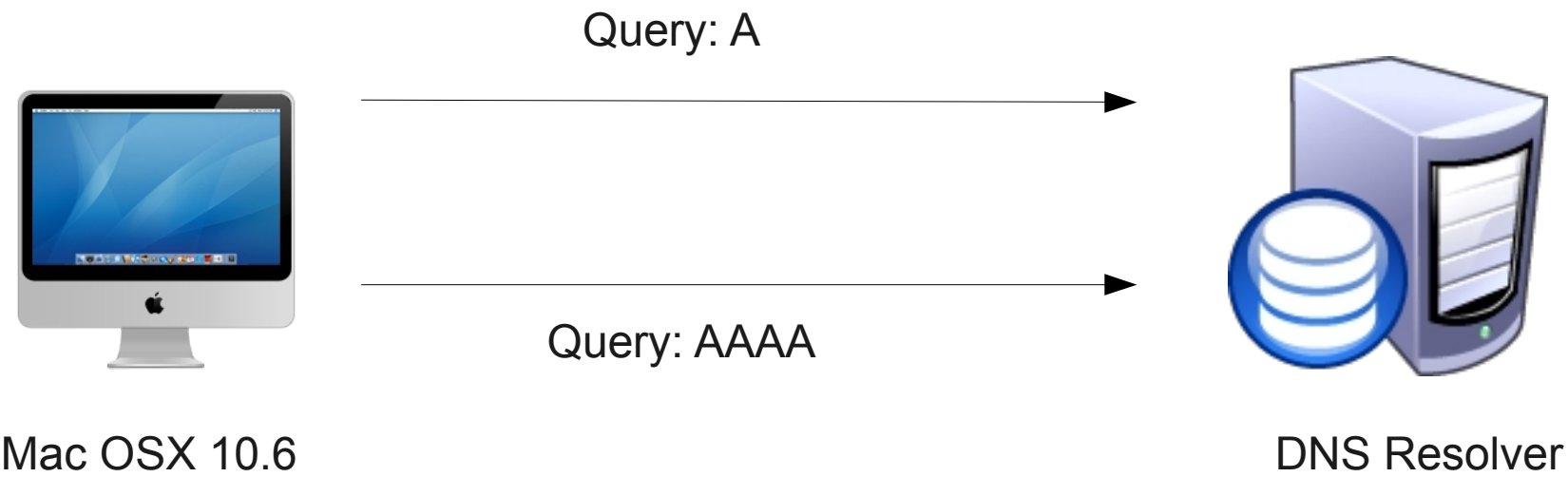
From: user@skimbee.net
To: unknown_user@brainbird.nl

Implementation problems on clients

- Most of the implementation problems were found on the client side
- Clients don't implement RFC 3484 correctly
  - Windows will end up with the same metric for tunnels and native
- Outlook 2007/2010 does not fall back to IPv4
- Apple Mac OSX 10.6 is broken by design...

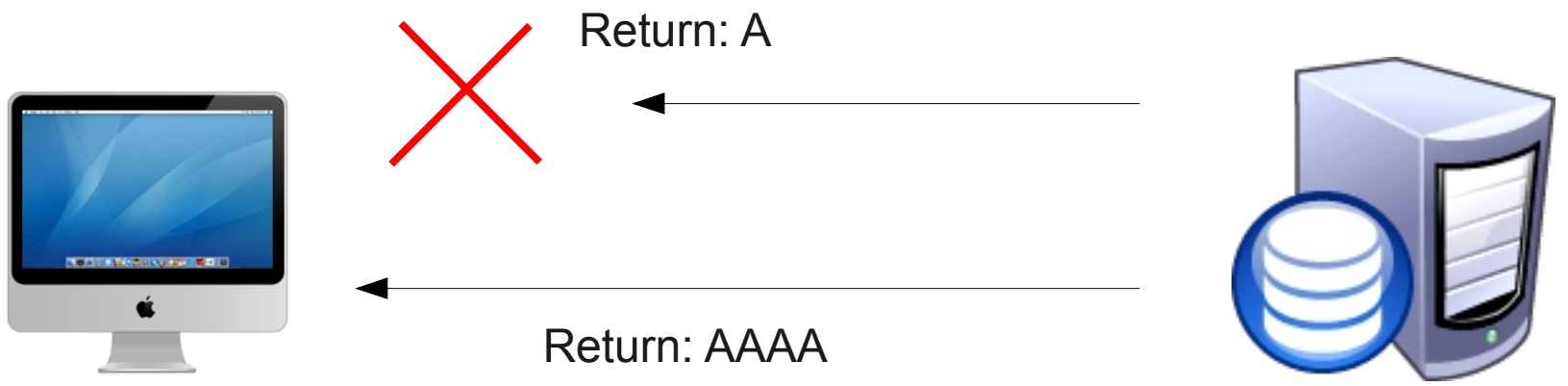
Apple's mDNSResponder

- Introduced in Mac OSx 10.6 (Snow Leopard)
- Simultaneous query for A and AAAA
  - to speed up connectivity if there are DNS lookup problems



Apple's mDNSResponder

- Introduced in Mac OSx 10.6 (Snow Leopard)
- Simultaneous query for A and AAAA
  - to speed up connectivity if there are DNS lookup problems
- Only accepts first response



Apple's mDNSResponder

- This does not comply with RFC 3484.
- Twice the amount of DNS queries on your resolver.
- Clients will randomly access over IPv4 or IPv6 depending on what record is returned first.
- This breaks many things
  - No fall back possible!!!
  - Problems when only AAAA is available but A “NOERROR” is returned first.

Conclusion

- Reflecting back on our research question:

  What e-mail architecture components and configurations introduce connectivity problems in an IPv4/IPv6 mixed environment?

Conclusion - MTA

- No implementation problems.
- Problems in IPv4/IPv6 mixed environments when doing MX routing. RFC 3974.
- Make sure YOU have implemented Dual-Stack (IPv4/IPv6) so in all situations MTAs can reach you.

Conclusion - MUA

- Clients will give the biggest problems.
  - Be careful before announcing AAAA for your SMTP Relay and POP3/IMAP services.
  - Use a controlled environment to test impacted behaviour

Keep in mind

- Transition mechanism are unreliable and unpredictable
  - Do not configure them on a server (disable them on Windows Server 2008).
  - Do not make any services available over transition mechanism, like configuring an AAAA that points to a Teredo interface!!!!
- RFC 4941 - Privacy addresses.
- Double the amount of monitoring.

Acknowledgments

- SARA
  - Ronald van der Pol
  - Freek Dijkstra

Questions?

References

- Wiki for this research
- Apple IPv6 problems
- Things To Be Considered for RFC 3484 Revision