Introduction to DNS and its vulnerabilities

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DNSSEC

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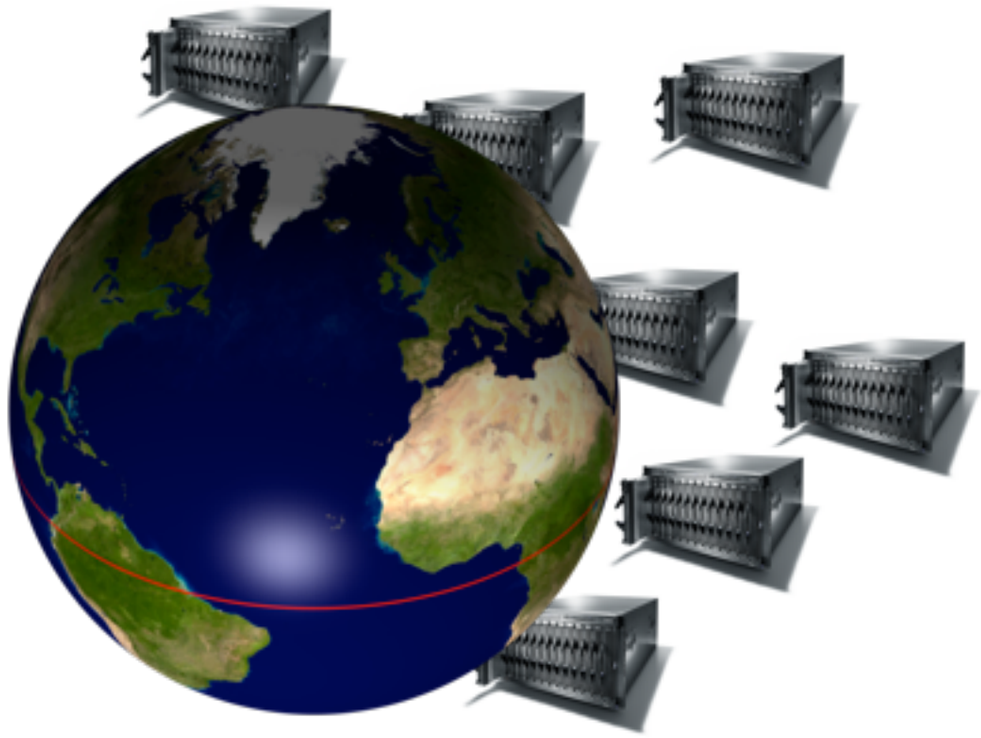
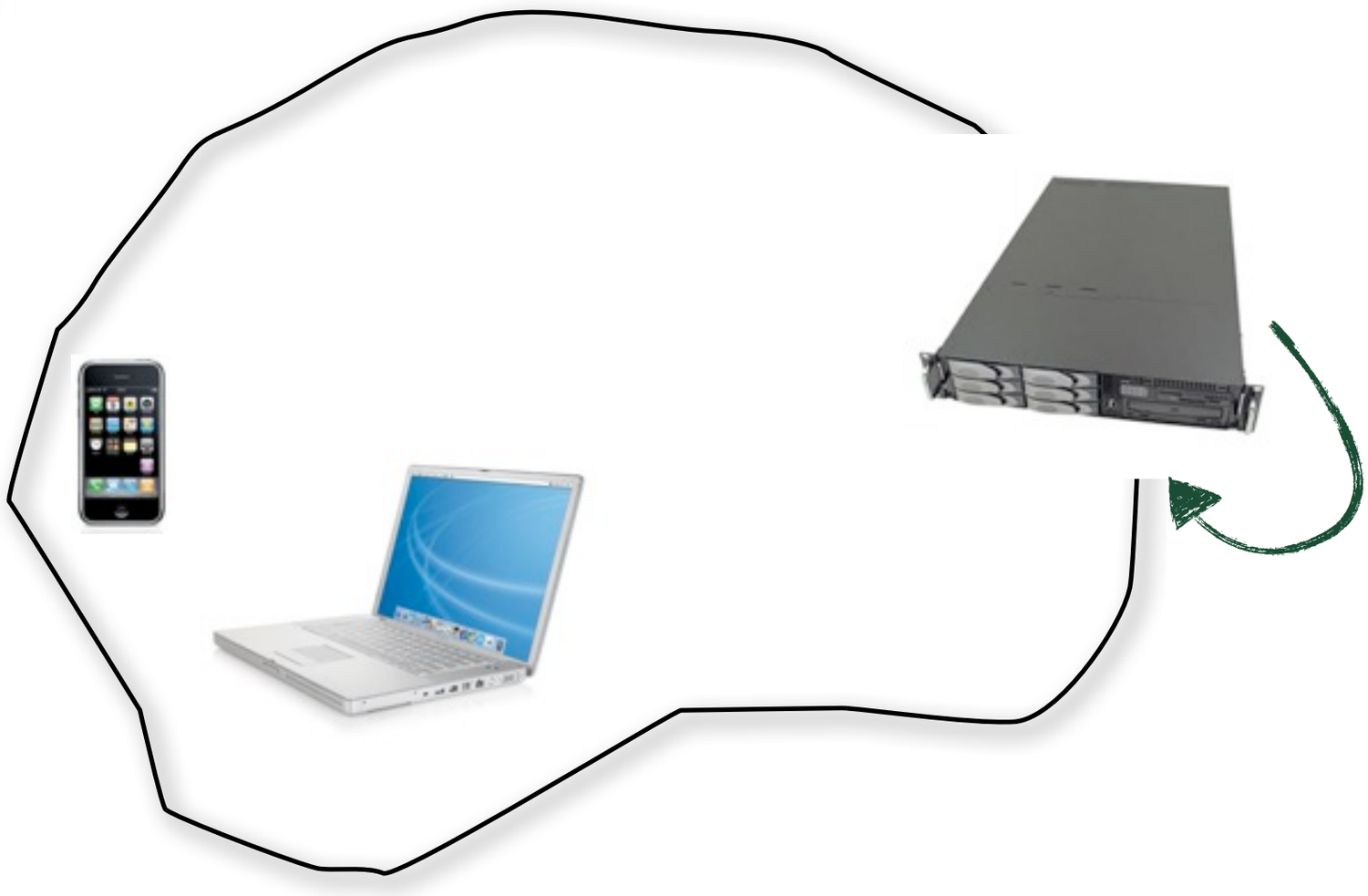
source: http://upload.wikimedia.org/wikipedia/commons/b/b7/KoreanPineSeeds.jpg

DNS and DNSSEC in a Nutshell

source: http://upload.wikimedia.org/wikipedia/commons/b/b7/KoreanPineSeeds.jpg





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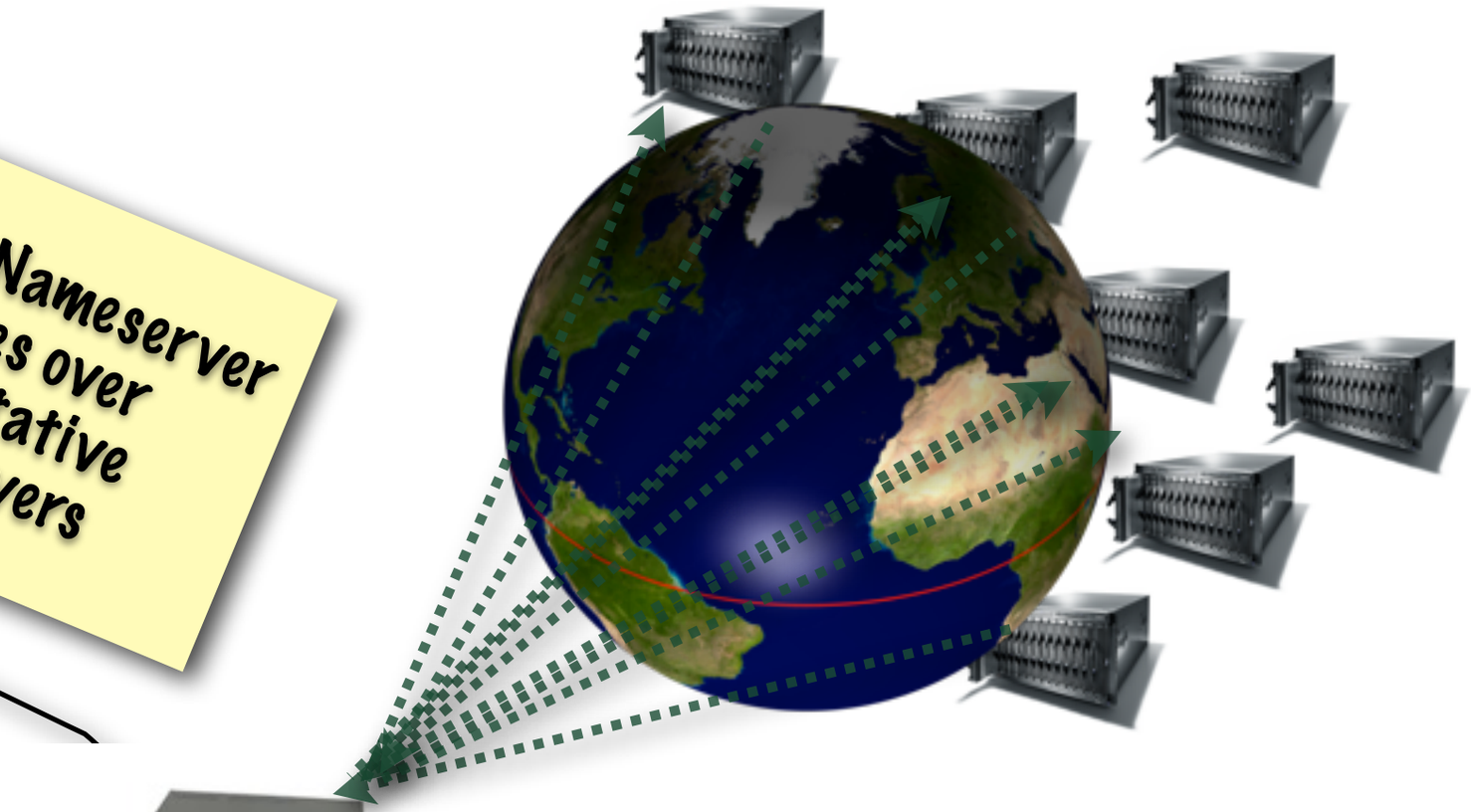
Recursive Nameserver Recurses over Authoritative nameservers



Device queries Recursive Nameserver

Results are cached

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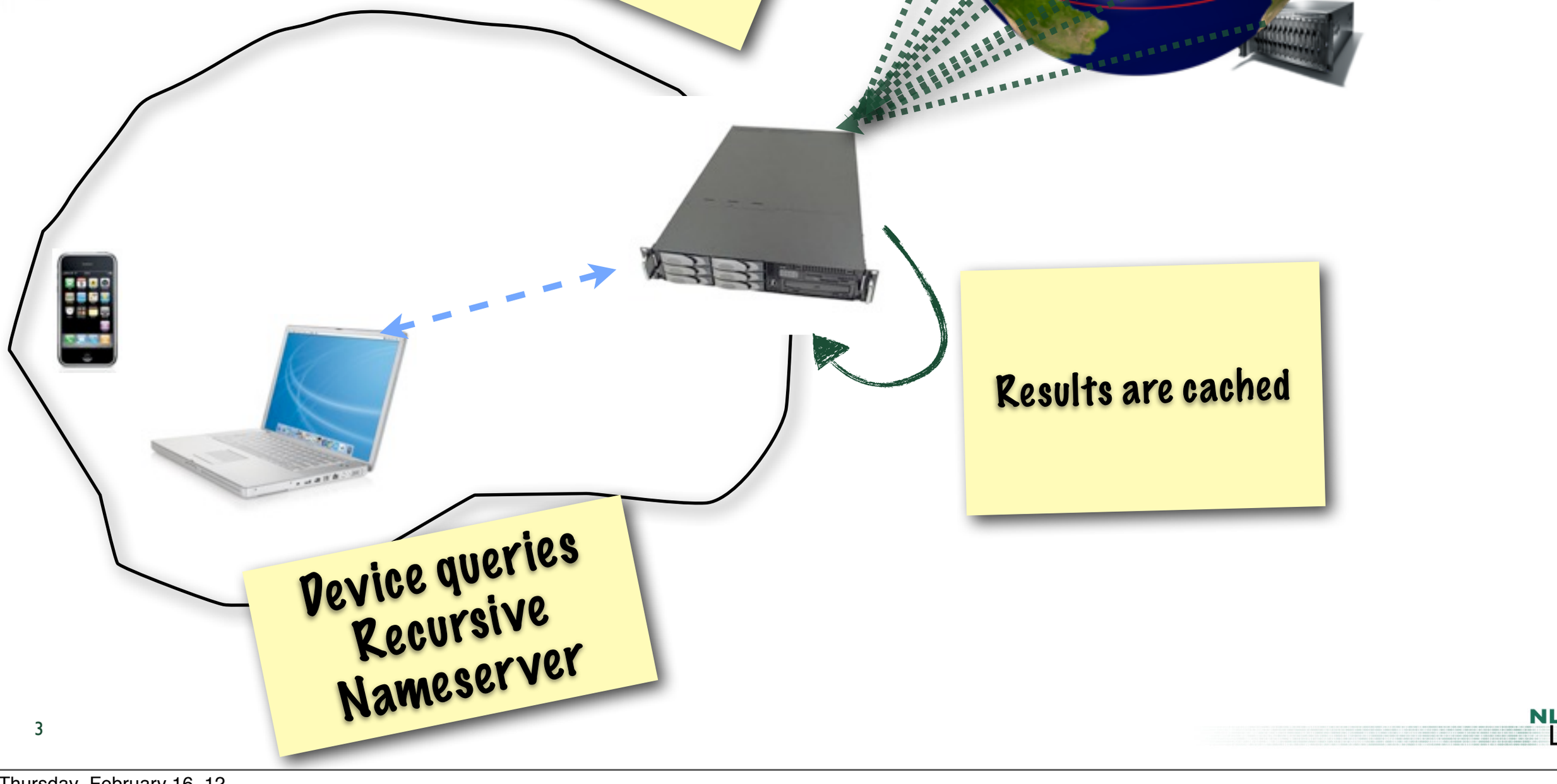
The DNS is highly distributive

...ve Nameserver
...rses over
...ritative
...meservers



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Device queries
Recursive
Nameserver

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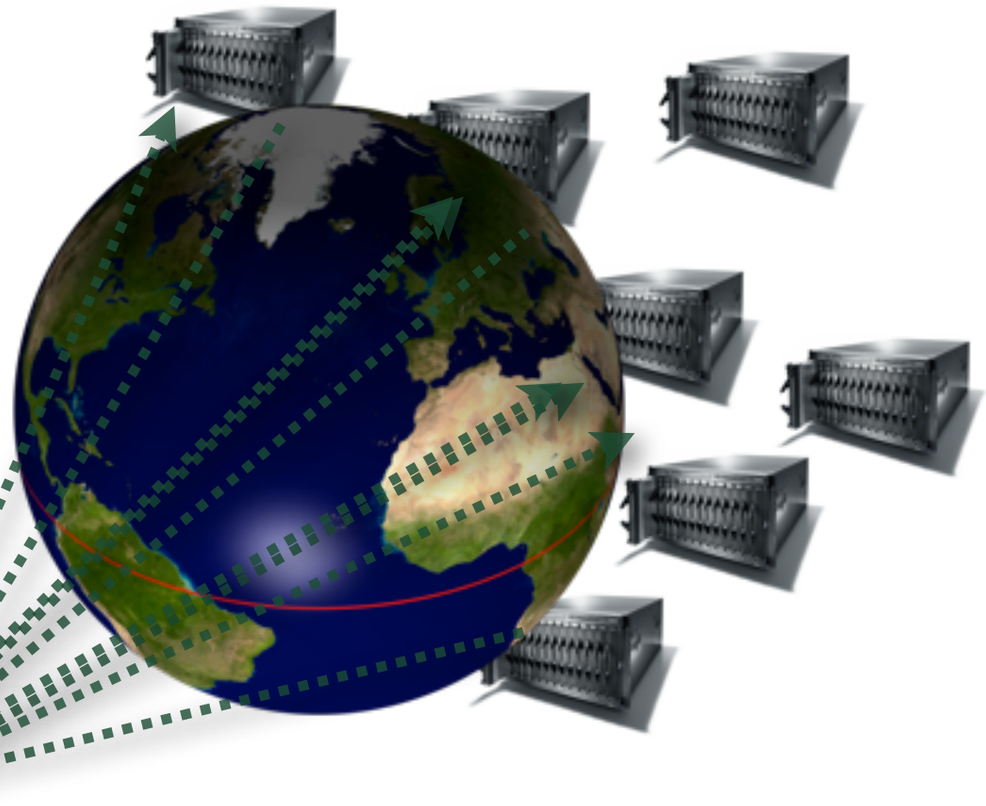

Device queries
Recursive
Nameserver

DNS is implemented through 100s of thousands of machines

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Authoritative Nameservers

ROOT

Stub Resolver

Recursive Nameservers

NL

NLnetLabs.NL

Authoritative Nameservers

ROOT

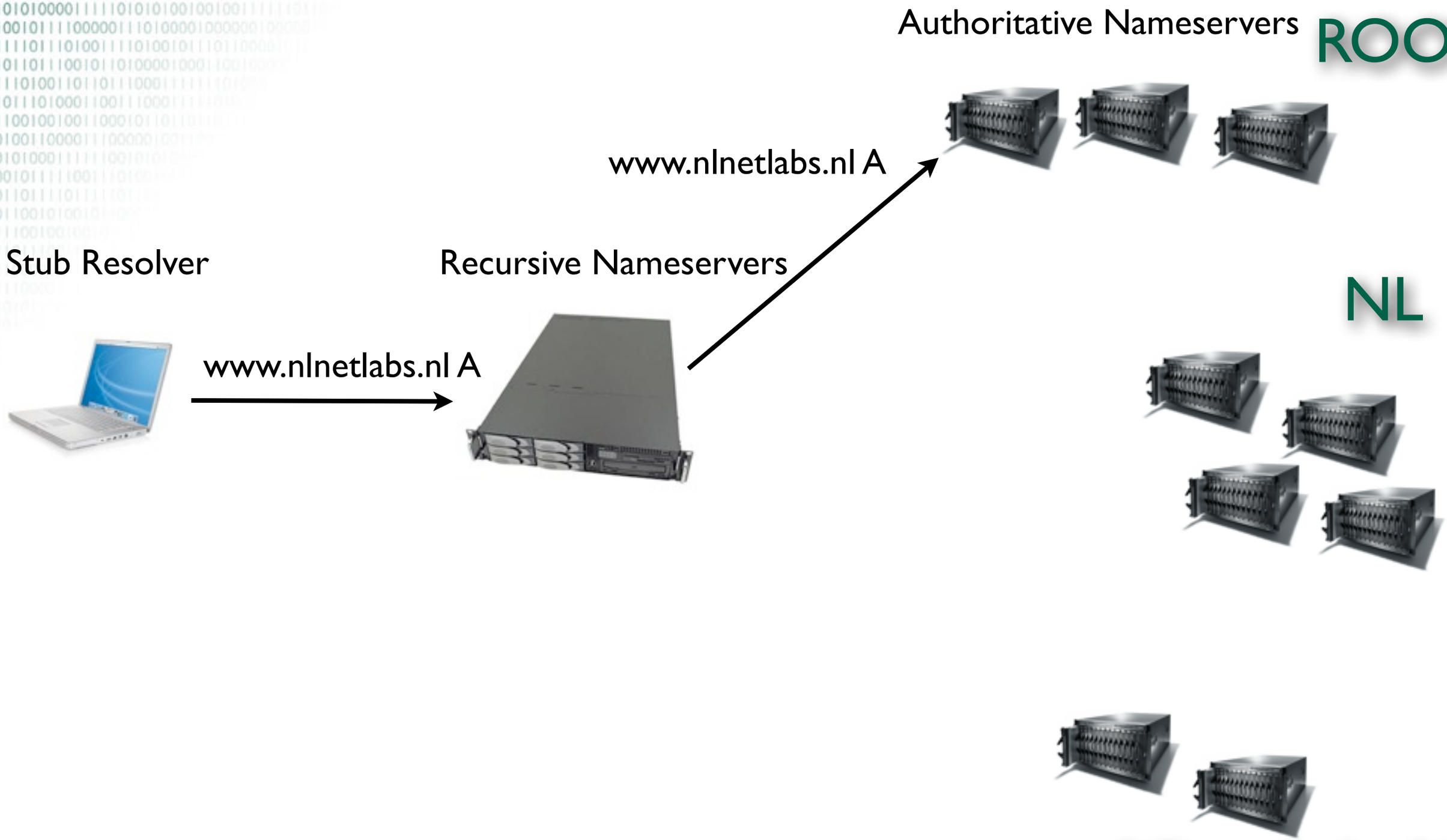
Stub Resolver

www.nlnetlabs.nl A

Recursive Nameservers

NL

NLnetLabs.NL



root.hints: location of the root servers

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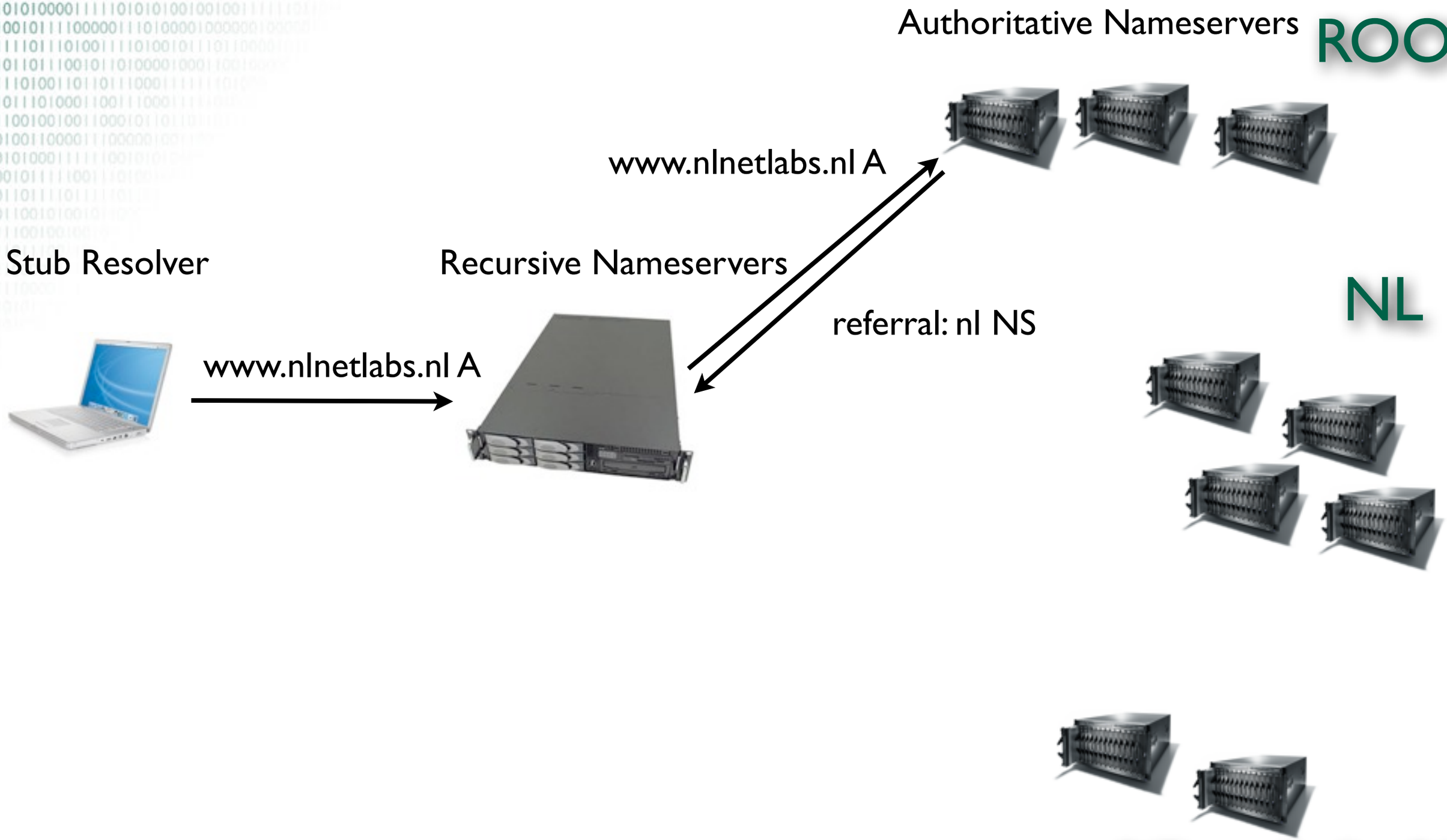

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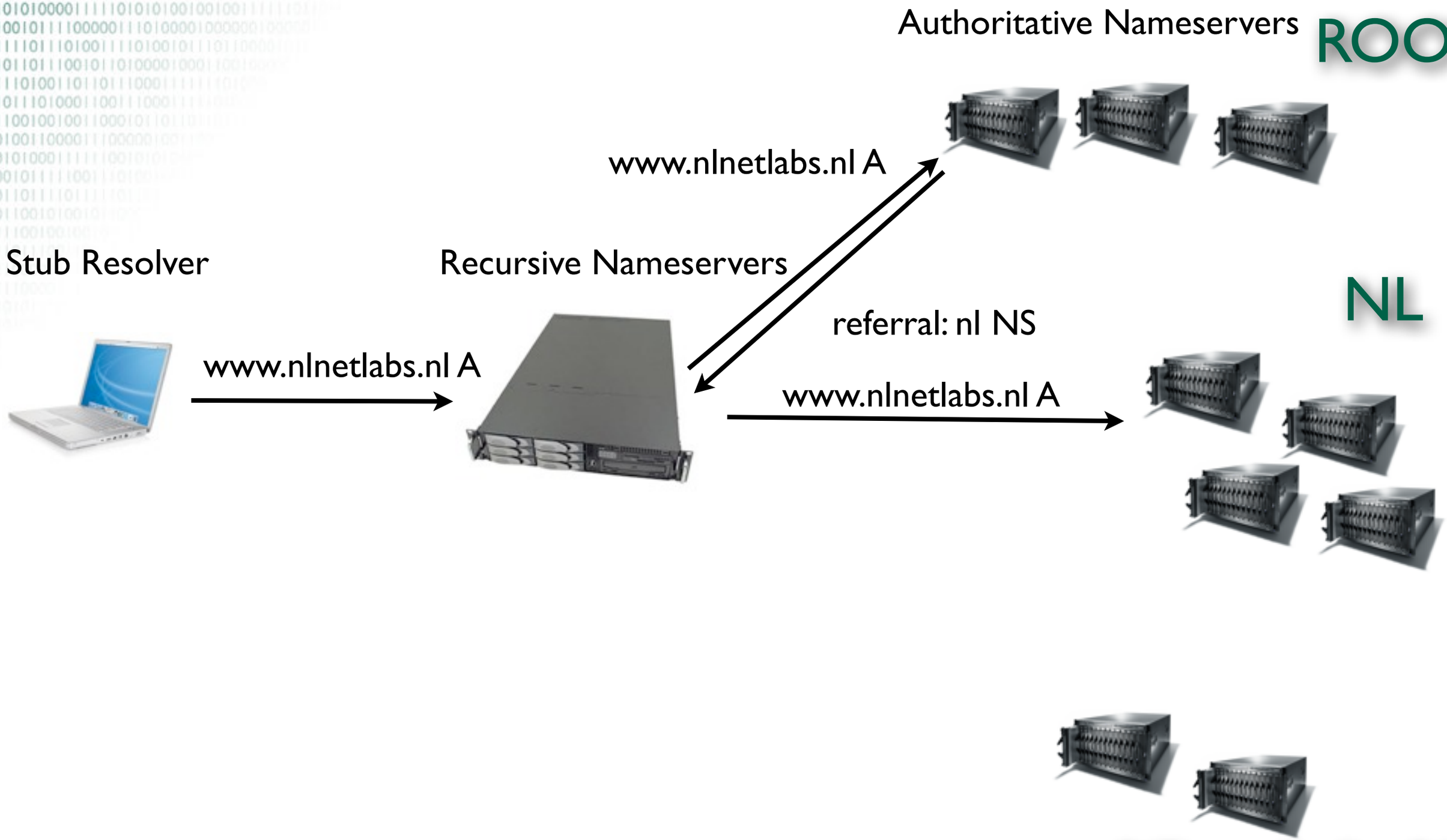

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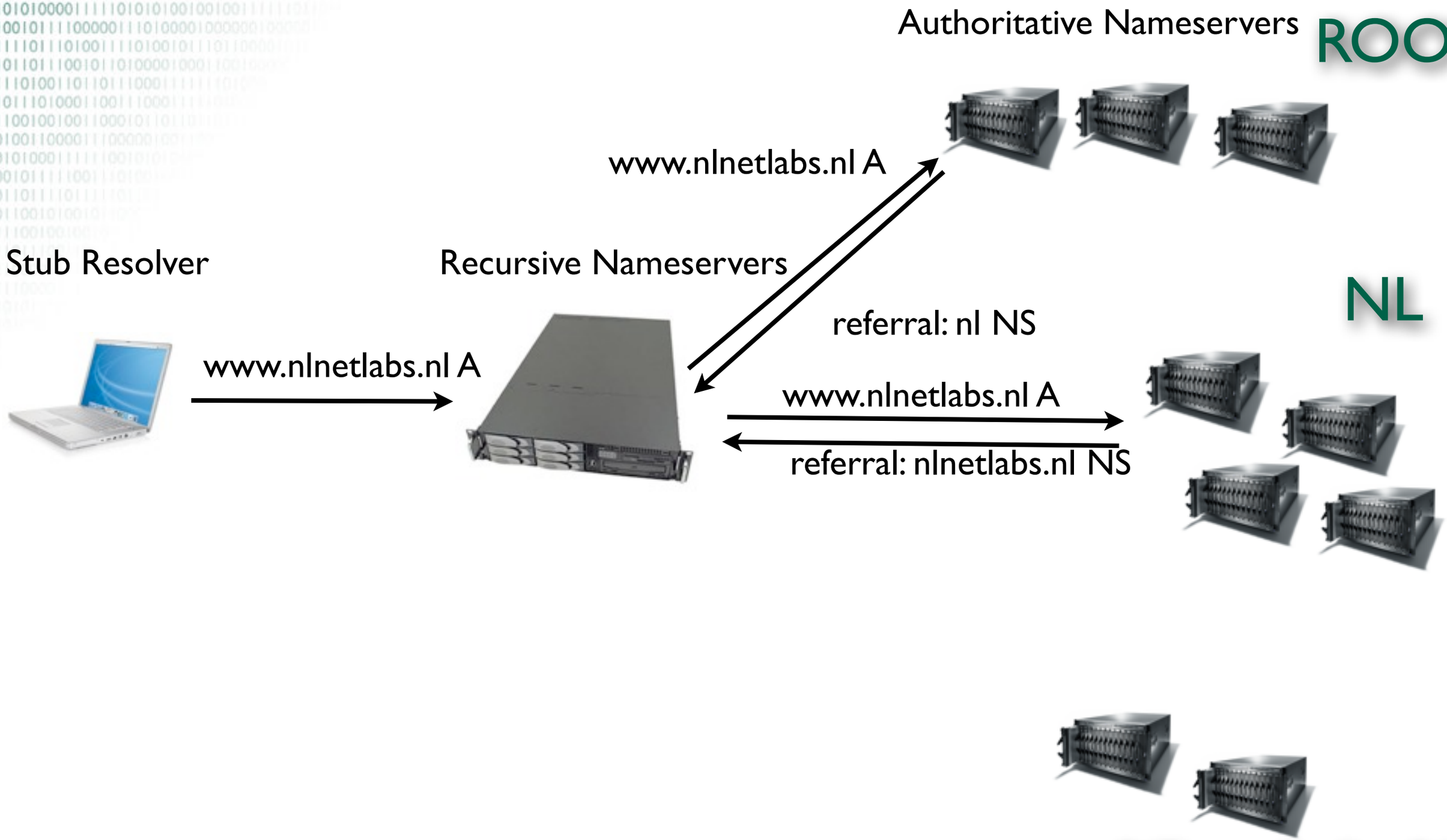

root.hints: location of the root servers

Authoritative Nameservers

ROOT

www.nlnetlabs.nl A

Stub Resolver

Recursive Nameservers

www.nlnetlabs.nl A

referral: nl NS

NL

www.nlnetlabs.nl A

referral: nlnetlabs.nl NS

www.nlnetlabs.nl A

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root.hints: location of the root servers

Authoritative Nameservers

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www.nlnetlabs.nl A

Stub Resolver

Recursive Nameservers

NL

referral: nl NS

www.nlnetlabs.nl A

www.nlnetlabs.nl A

referral: nlnetlabs.nl NS

www.nlnetlabs.nl A

Answer: www.nlnetlabs.nl A 213.154.224.1

NLnetLabs.NL

root.hints: location of the root servers

Authoritative Nameservers

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www.nlnetlabs.nl A

Stub Resolver

Recursive Nameservers

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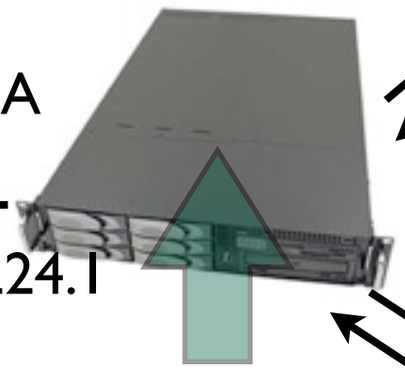

www.nlnetlabs.nl A

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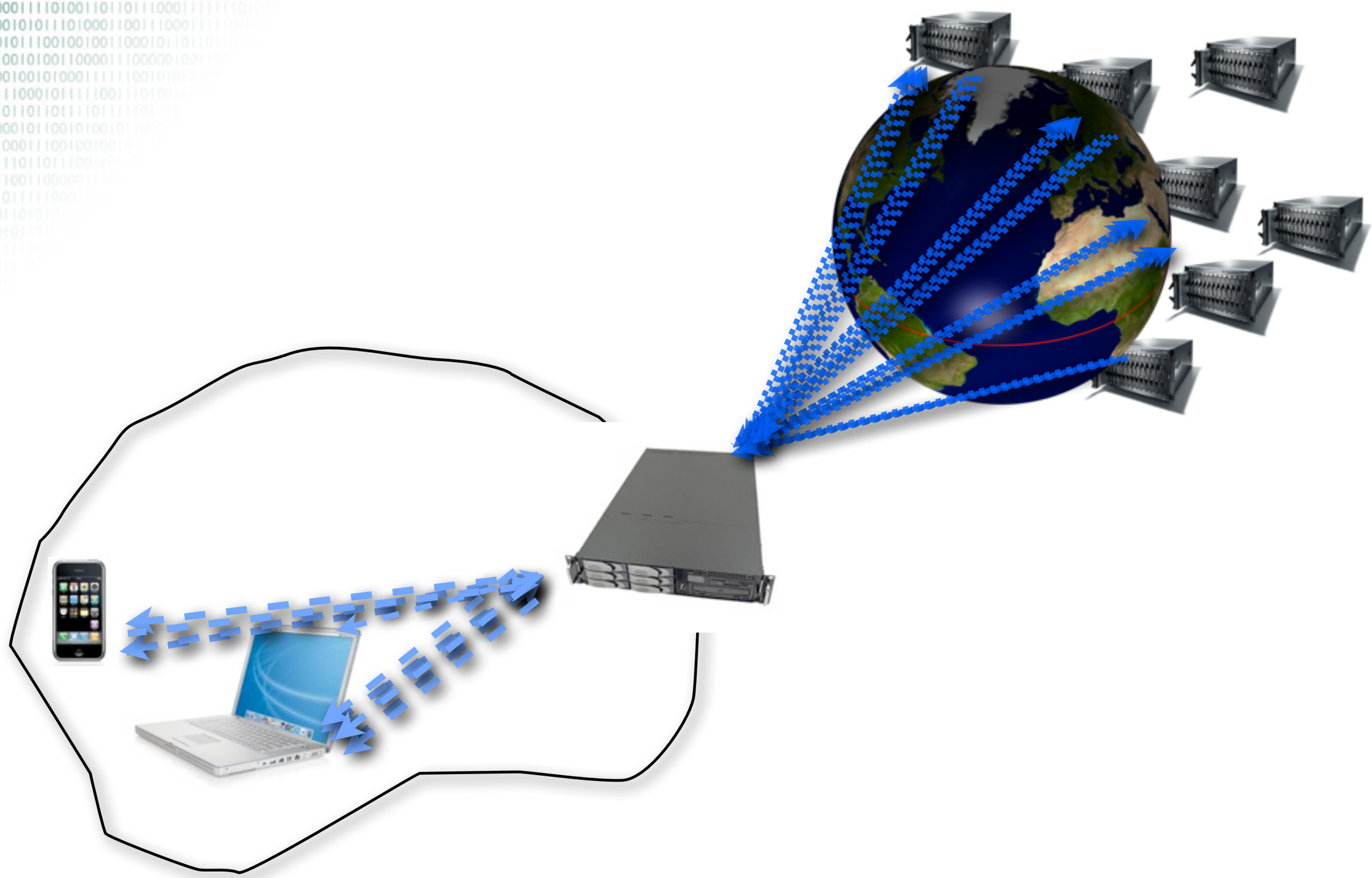

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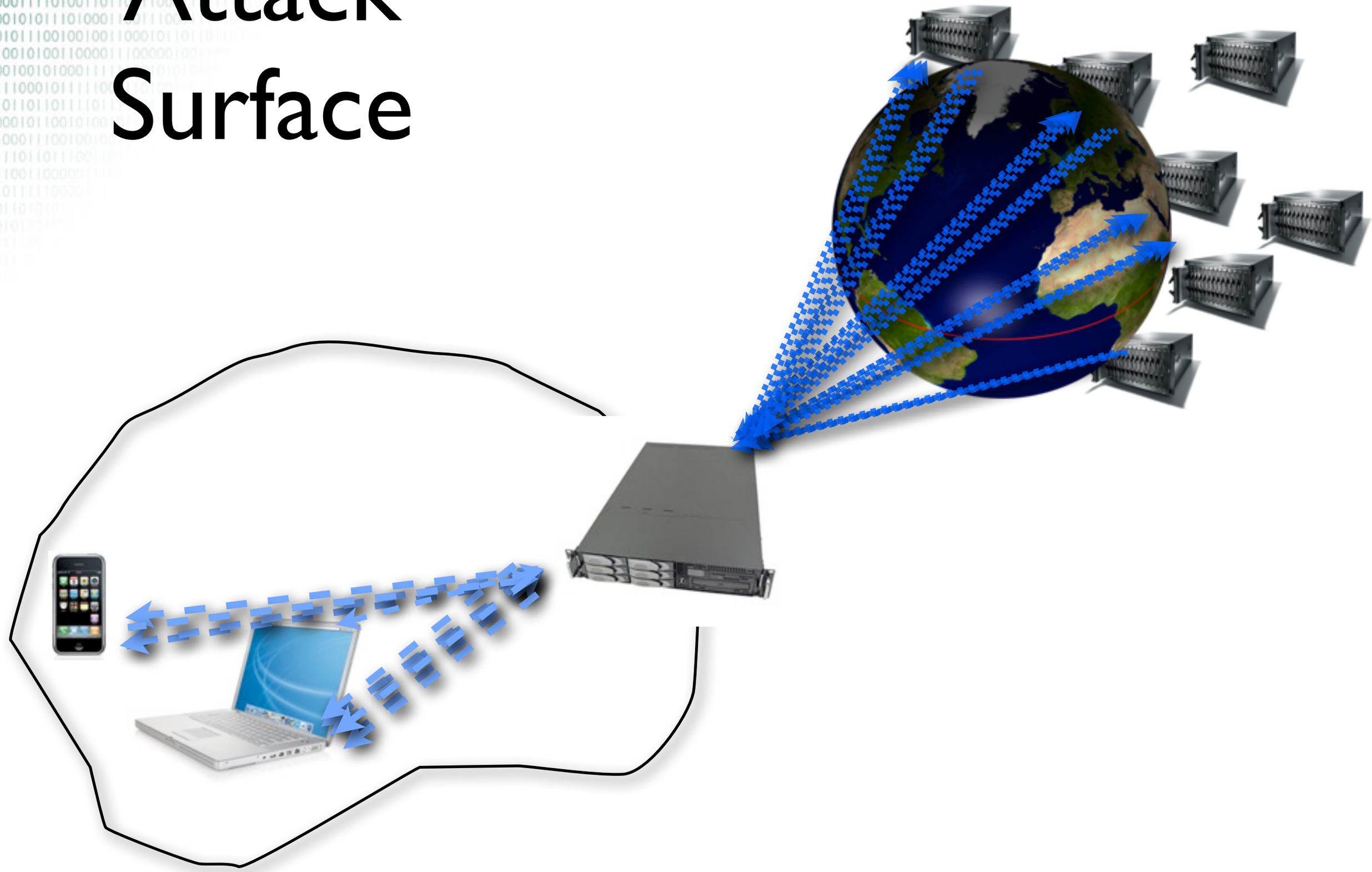
Attack Surface



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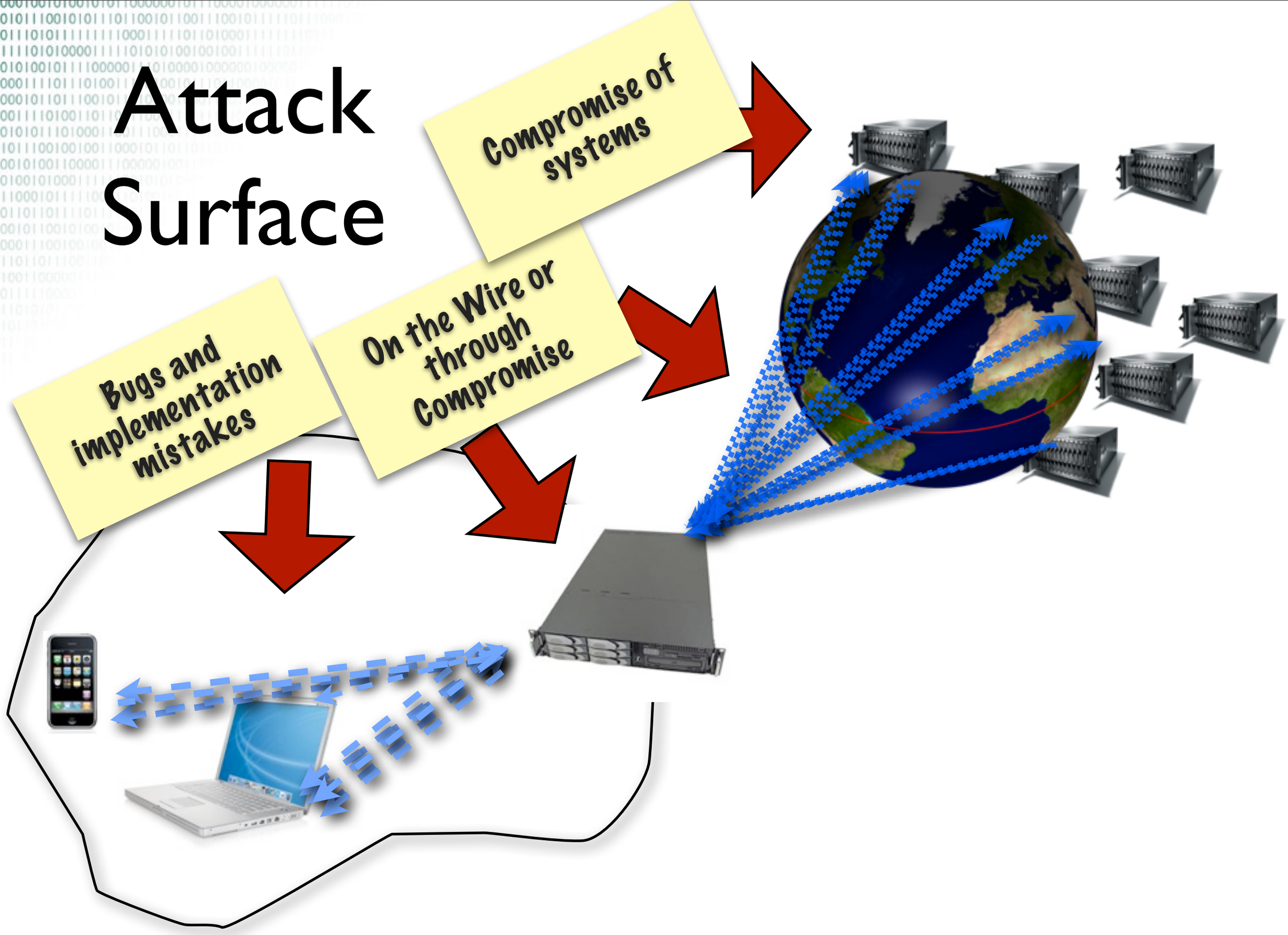

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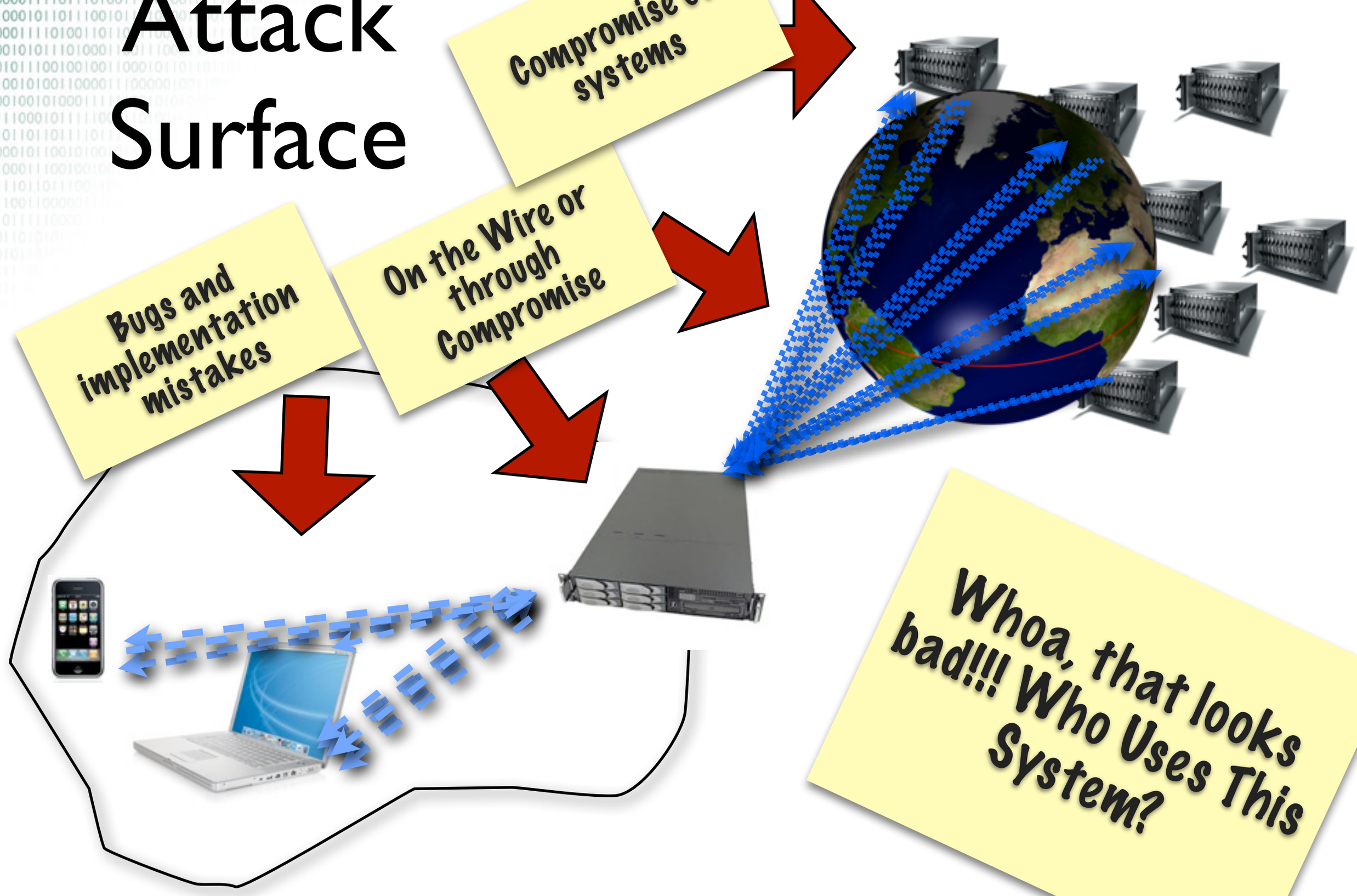
Attack Surface

Compromise of systems

On the Wire or through Compromise

Bugs and implementation mistakes



Whoa, that looks bad!!! Who Uses This System?

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enterprise

Recursive DNS

Mail server

Internet

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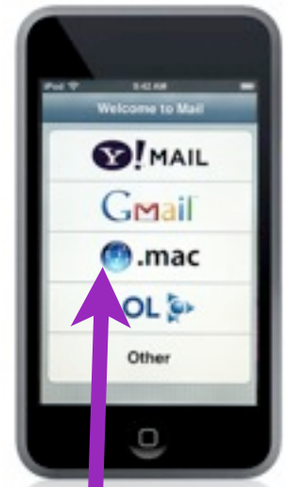
enterprise

Recursive DNS



Mail server

Mail server

Internet

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enterprise

Recursive DNS

Mail server

Internet

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enterprise

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Mail server

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enterprise

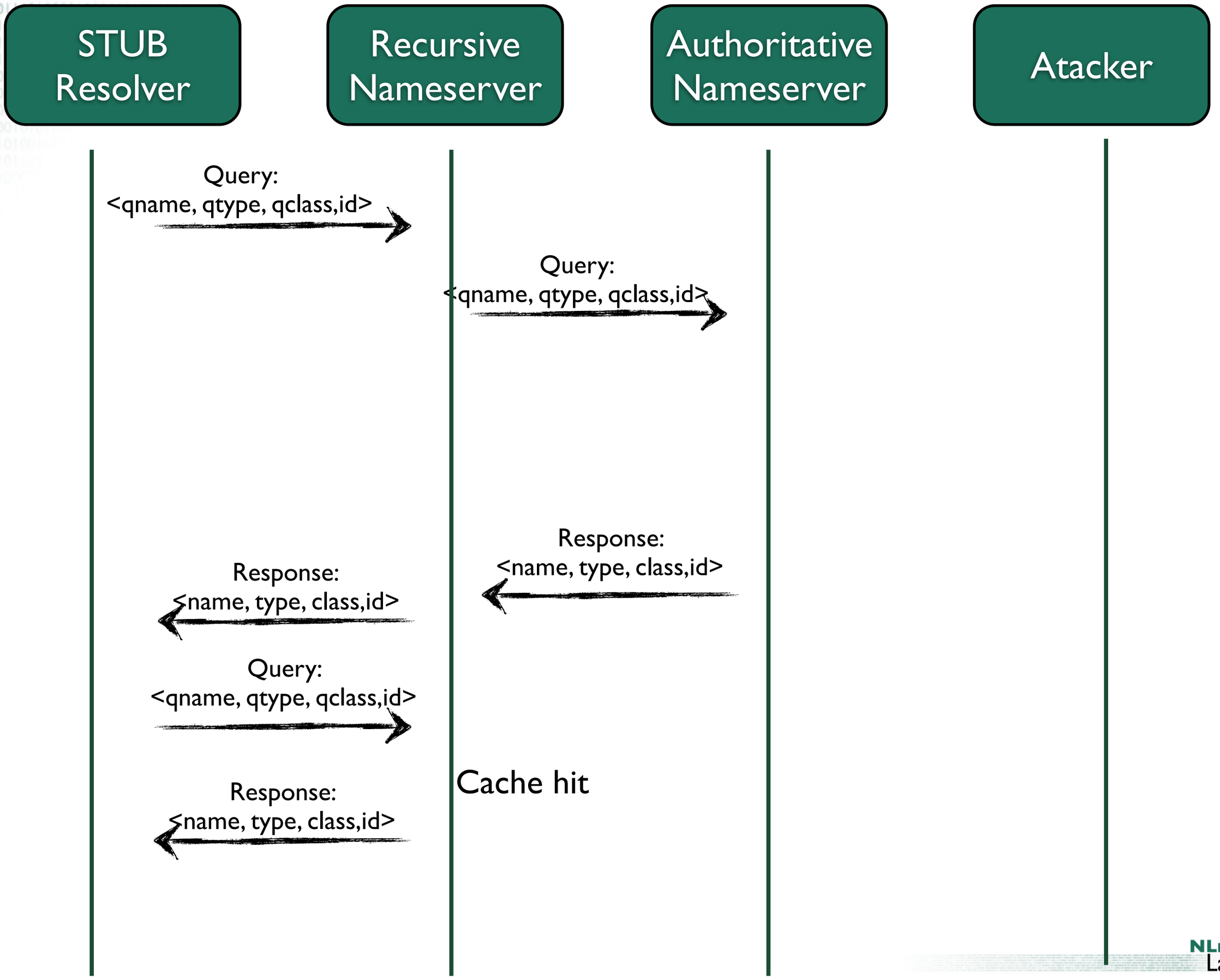
Recursive DNS

Mail server

Mail server

Internet

Labs


STUB Resolver
Recursive Nameserver
Authoritative Nameserver
Atacker
Query: <qname, qtype, qclass,id>
Query: <qname, qtype, qclass,id>
Response: <name, type, class,id>
Response: <name, type, class,id>
Query: <qname, qtype, qclass,id>
Cache hit
Response: <name, type, class,id>

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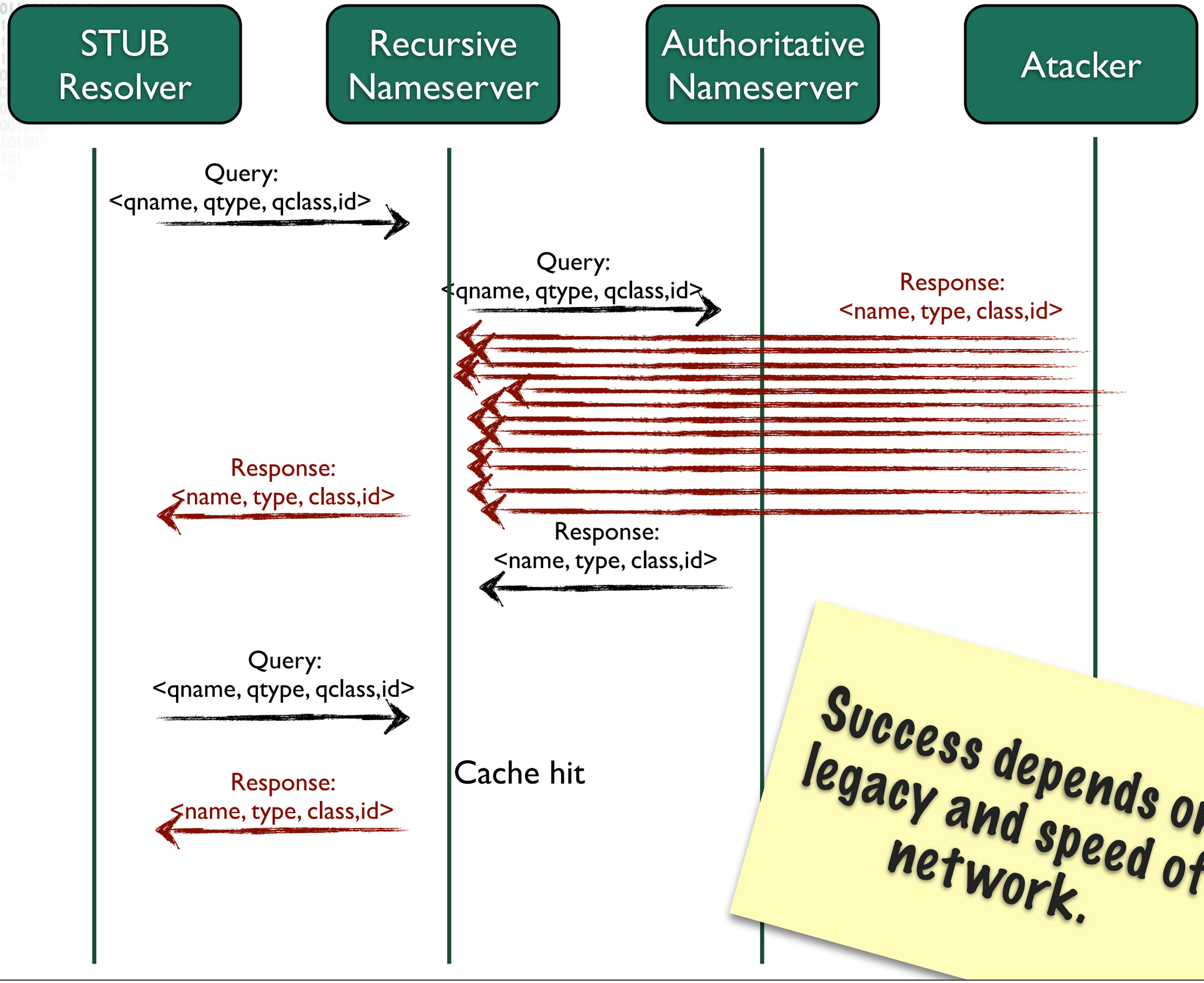
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Cache hit
Response: <name, type, class,id>
Success depends on legacy and speed of network.

STUB Resolver

Recursive N...rver

Authoritative Nameserver

Atacker

And on various properties that the attacher needs to match

Query:
qtype, qclass,id>

Response:
<name, type, class,id>

Response:
<name, type, class,id>

Response:
<name, type, class,id>

Query:
<qname, qtype, qclass,id>

Cache hit

Response:
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STUB Resolver

Recursive Nameserver

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Query ID

Query:
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Response:
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Query:
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Response:
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Cache hit

Success depends on legacy and speed of network.

STUB Resolver

Recursive N[illegible]rver

Authoritative Nameserver

Atacker

And on various properties that the attacher needs to match

Query ID

Source Port

Query:
qtype, qclass,id>

Response:
<name, type, class,id>

Response:
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Query:
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Response:
<name, type, class,id>

Cache hit

Success depends on legacy and speed of network.

STUB Resolver

Recursive N[illegible]rver

Authoritative Nameserver

Atacker

And on various properties that the attacher needs to match

Query ID

Source Port

0X20

Query:
qtype, qclass,id>

Response:
<name, type, class,id>

Response:
<name, type, class,id>

<qname, qtype, qclass,id>

Response:
<name, type, class,id>

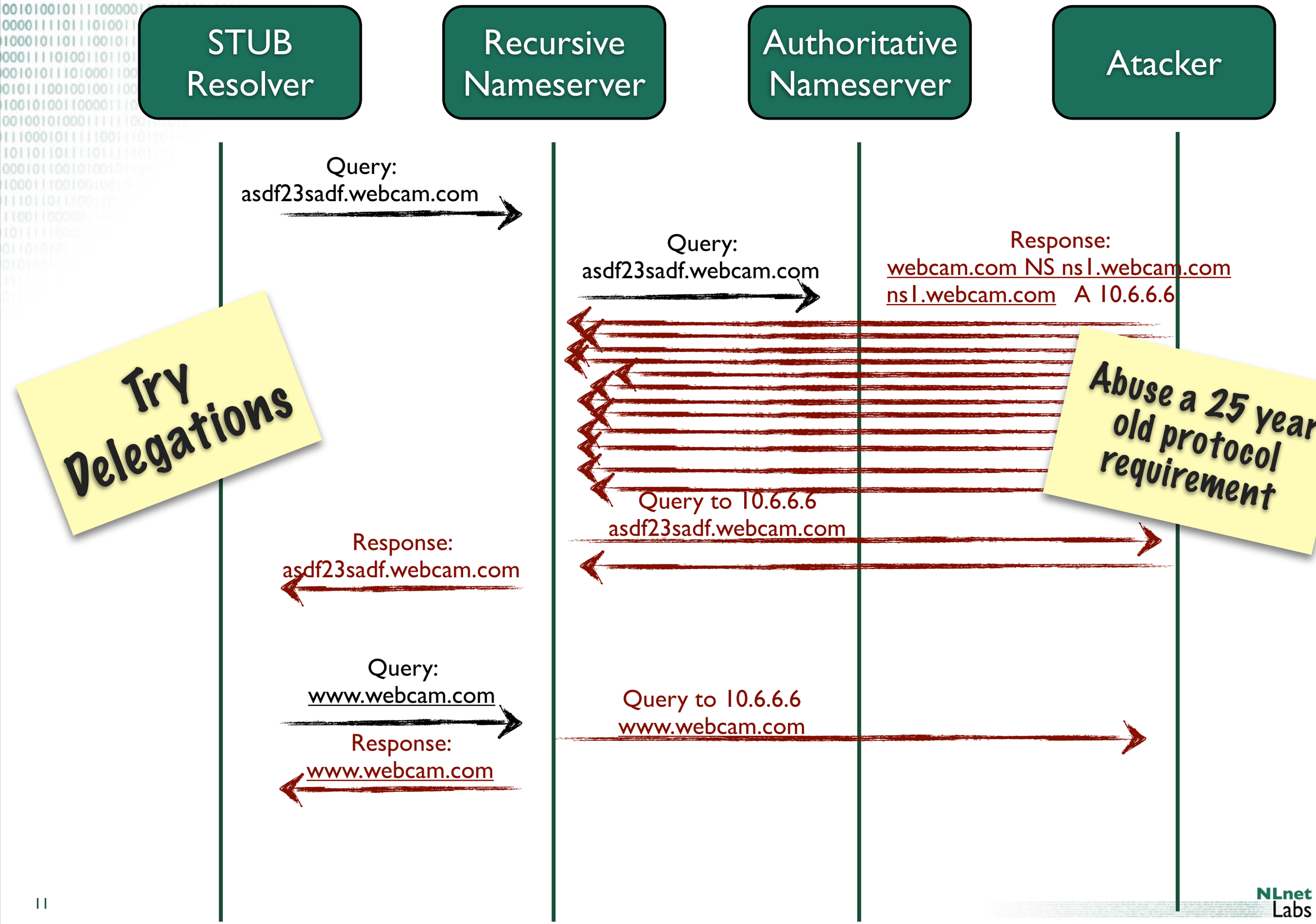
Cache hit

Success depends on legacy and speed of network.

TTL saves you?!?
I don't think so....

Dan Kaminsky's image from zdnet.com

Security Popstar


STUB Resolver
Recursive Nameserver
Authoritative Nameserver
Atacker
Query: asdf23sadf.webcam.com
Query: asdf23sadf.webcam.com
Response: webcam.com NS ns1.webcam.com
ns1.webcam.com A 10.6.6.6
Try Delegations
Abuse a 25 year old protocol requirement
Query to 10.6.6.6 asdf23sadf.webcam.com
Response: asdf23sadf.webcam.com
Query: www.webcam.com
Query to 10.6.6.6 www.webcam.com
Response: www.webcam.com

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Do attacks happen in practice?

Would you notice?

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Do attacks happen in practice?

Why would one attack the DNS?

While one could be doing other things

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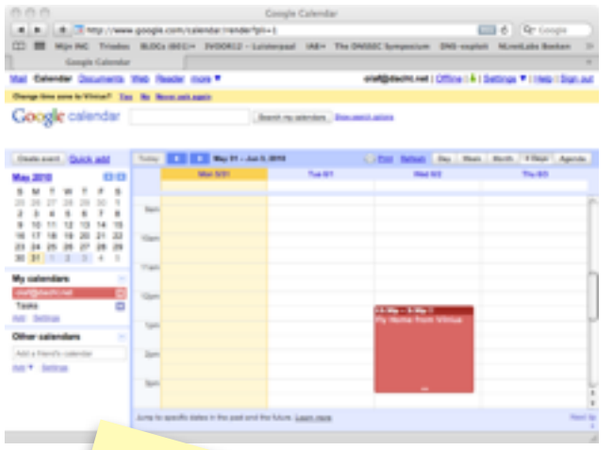
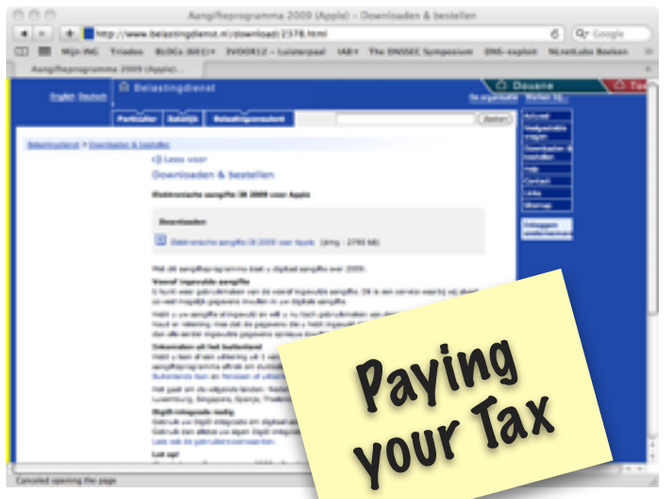
How to Protect?

Why would one attack the DNS?

Follow the Money





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Money

Don't all these transactions use SSL and Certificates?

The role of a CA

3rd party trust broker

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The role of a CA

3rd party trust broker

Subject Requests

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The role of a CA

3rd party trust broker

Subject Requests

RA performs checks

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The role of a CA

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Subject Requests

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RA tells CA to sign

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The role of a CA

3rd party trust broker

Subject Requests

RA performs checks

RA tells CA to sign

Browser trusts CA signed certificates

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The role of a CA

3rd party trust broker

EV Extended Validation

Subject Requests

RA performs checks

RA tells CA to sign

Browser trusts CA signed certificates

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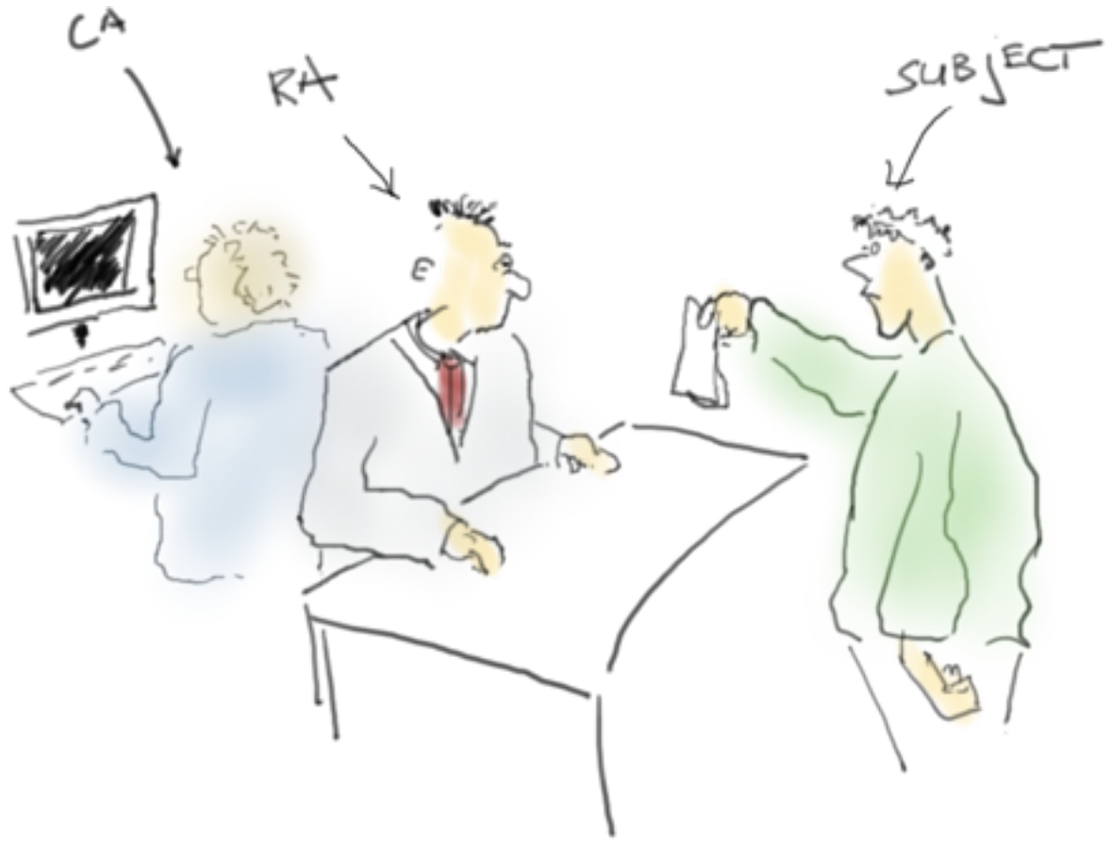

However all these little men are a wee bit expensive

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However all these little men are a wee bit expensive

AUTOMATE THE LOT

DV
Domain Validation

Subject: Please sign certificate for Example.com

RA sends a mail to well known address @example.com

When mail returned CA will sign

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DV
Domain Validation

All these checks are based on information fetched from the DNS

Hold that thought for Jakob's presentation

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Provisioning Vulnarabilities

DNS System Vulnerabilities

Registrars & Registrants

Server vulnarability

Man in the Middle

Secondary DNS

Registry

pri ry DNS

Secondary DNS

spoofing & Man in the Middle

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Taking Unbound as example

Other servers might make other choices, but any modern resolver takes similar approaches

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Security Choices in Unbound

- In general, a modern paranoid resolver
- DNSSEC support.
- RFC 2181 support completely
- Fine grained. Keeps track of where RRSets came from and won't upgrade them into answers.
- Does not allow RRSets to be overridden by lower level rrsets

Filtering

- Scrubber:
- Only in-bailiwick data is accepted in the answer
  - The answer section must contain only answer
  - CNAME, DNAME checked that chain is correct
    - CNAME cut off and only the first CNAME kept
      - Lookup rest yourself do not trust other server
    - DNAME synthesize CNAME by unbound do not trust other server. Also cut off like above.
    - DNAME from cache only used if DNSSEC-secure.

Filtering II

- No address records in authority, additional section unless relevant – i.e. mentioned in a NS record in the authority section.
- Irrelevant data is removed
  - When the message only had preliminary parsing and has not yet been copied to the working region of memory

Entropy

- Randomness protects against spoof
  - Arc4random() (OpenBSD): crypto strong. May not be perfectly random, but predicting it is a cryptographical breakin.
    - Real entropy from OS as seed
- Query id – all 16 bits used.
- Port randomisation – uses all 16bits there, goes out of its way to make sure every query gets a fresh port number

Entropy II

- Destination address, and ipv4/ipv6. RTT band of 400msec (=everything).
  - Its not the timewindow but the randomness
- Query aggregation – same queries are not sent out – unless by different threads
- Qname strict match checked in reply
- 0x20 option
- Harden-referral-path (my draft) option
- Can use multiple source interfaces!
  - 4 outgoing IP address add +2 bits

Other measures

- Not for the wire itself
  - Heap function pointer protection (whitelisted)
  - Chroot() by default
  - User privileges are dropped (lots of code!)
  - ACL for recursion
  - No detection of attacks – assume always under attack
  - version.bind hostname.bind can be blocked or configured what to return (version hiding)
  - Disprefer recursion lame servers – they have a cache that can be poisoned

Arms Race...

Introducing DNSSEC

DNSSEC

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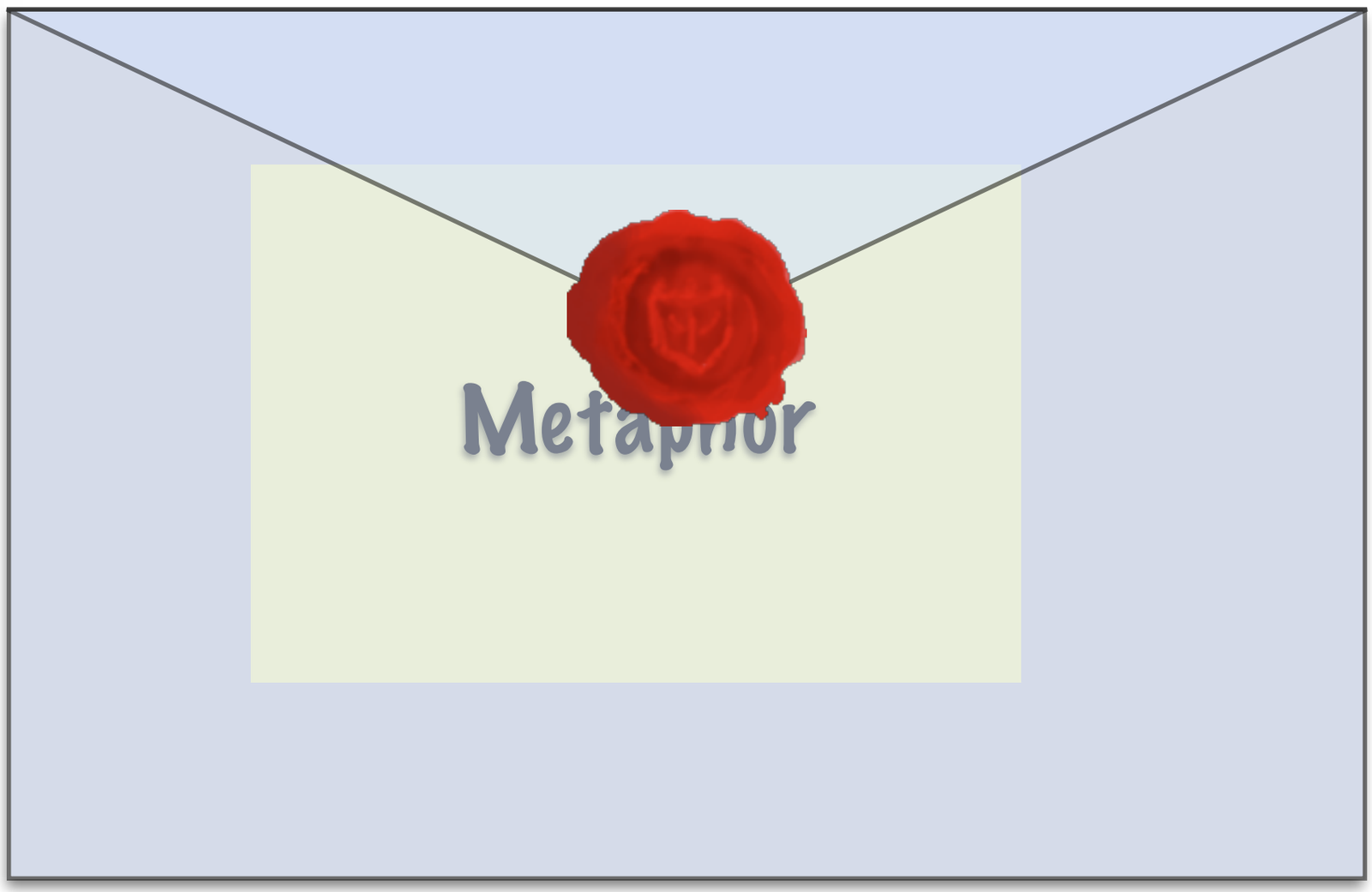
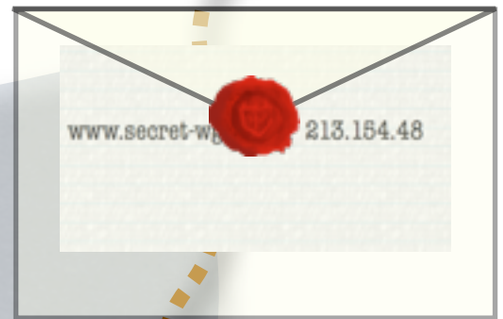
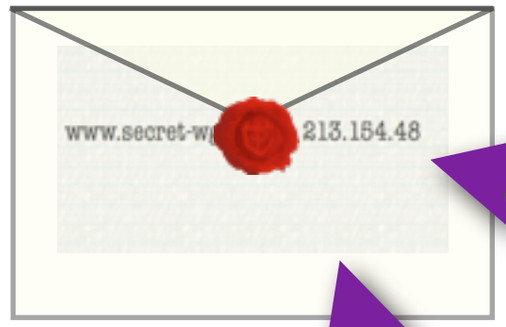

Metaphor


Metaphor

End to End Security

Registrars & Registrants





Secondary DNS

primary DNS

Registry

Secondary DNS

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All done using Public Key crypto

DNSKEY:
Public key from the keypair

RRSIG: Signatures made with a private key from the keypair

NSEC and NSEC3
For pre-calculated Denial of Existence

DS
For delegating Security

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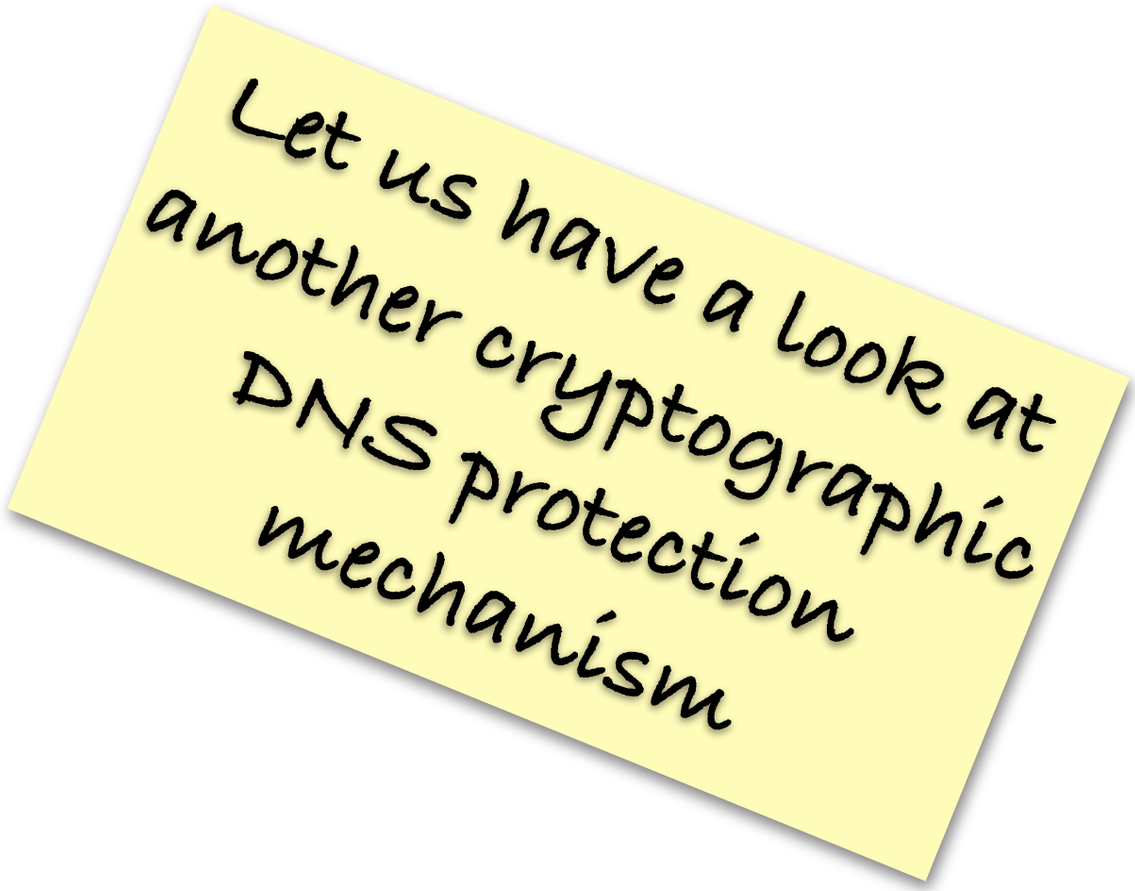
But more on that later



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Securing Host-Host Communication

DNSSEC

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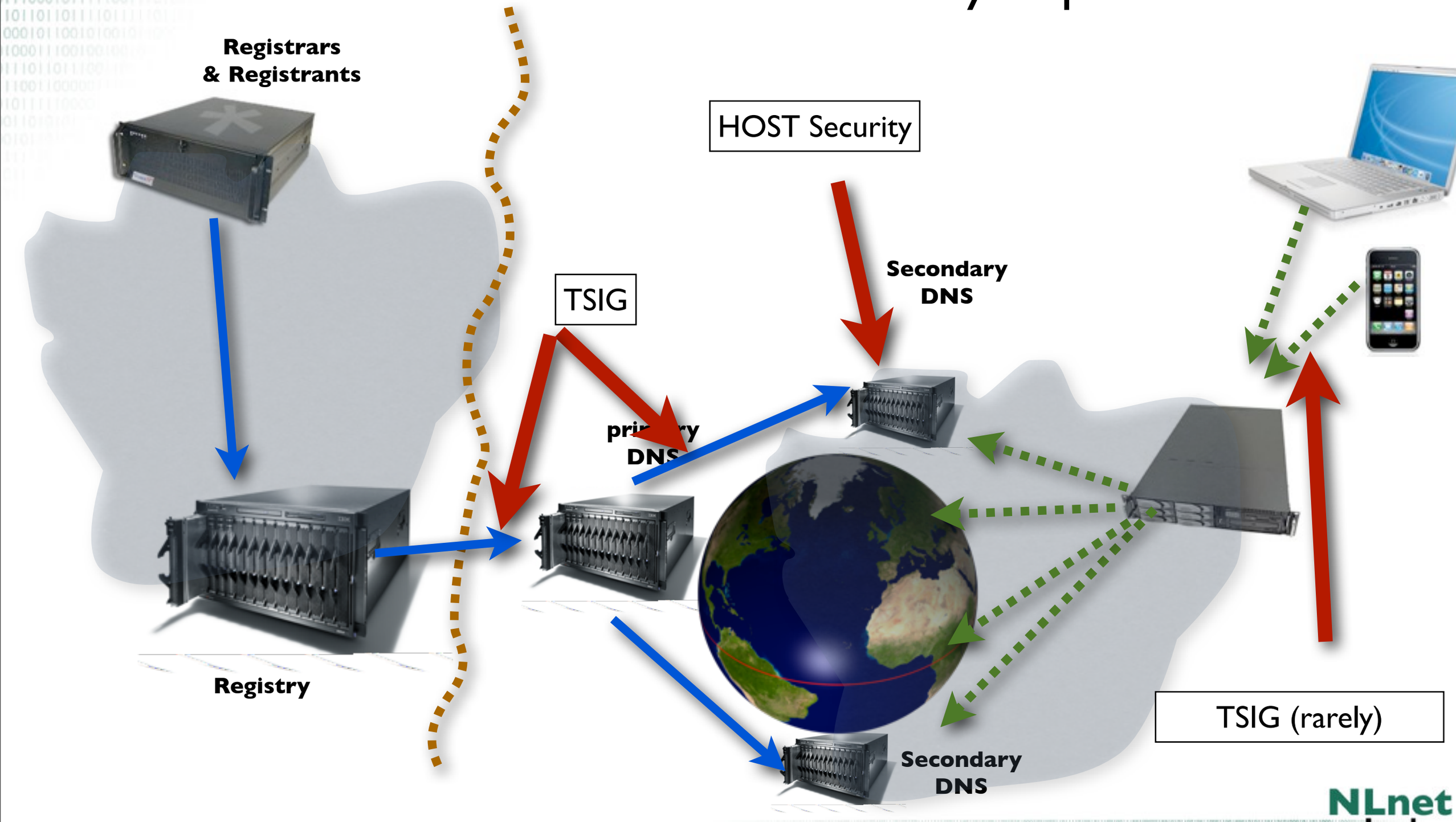
Data flow through the DNS

What should you protect...



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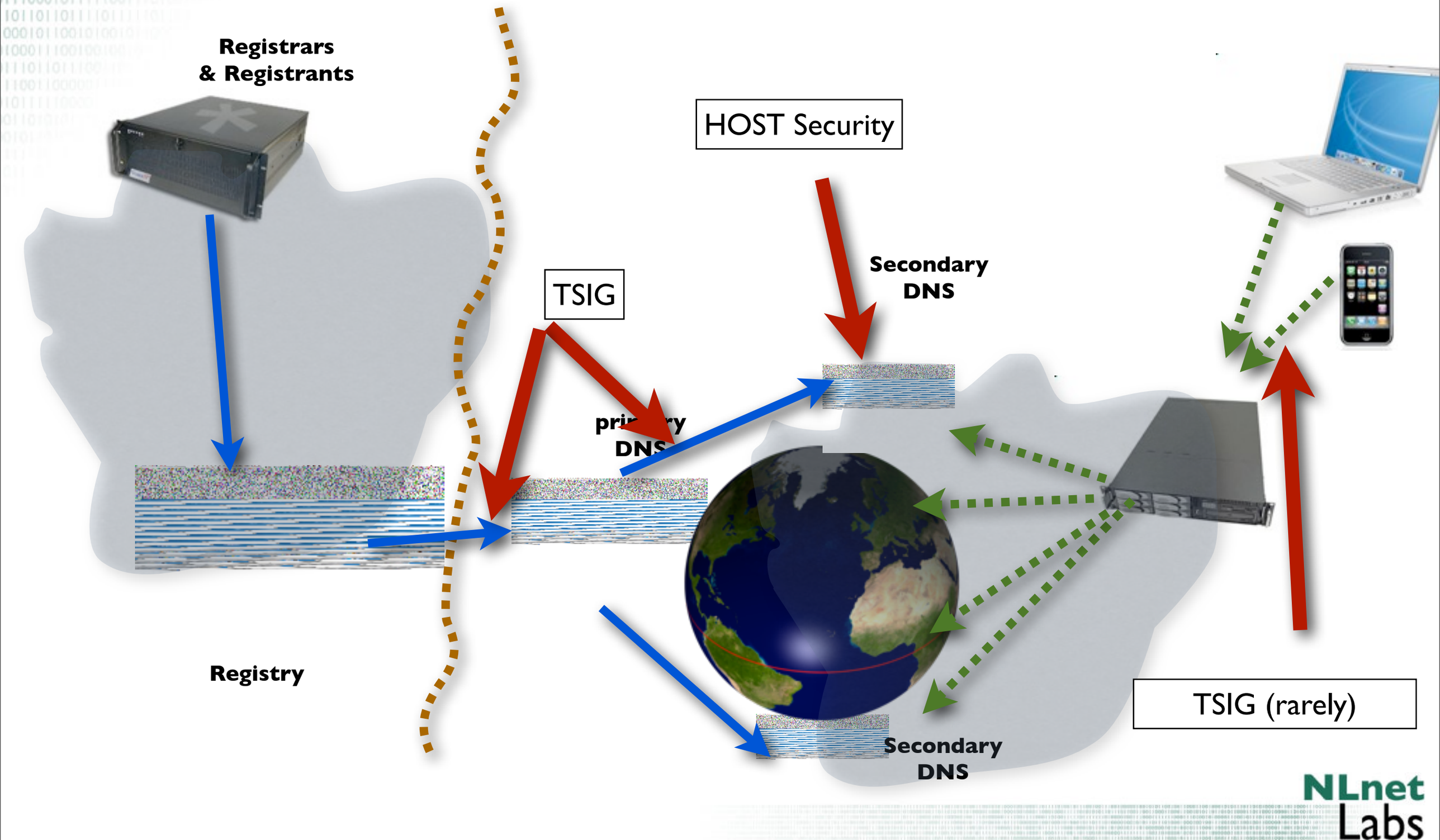

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Transaction Signature: TSIG

- TSIG (RFC 2845)
  - –Authorising dynamic updates and zone transfers
  - –Authentication of caching forwarders
  - –Independent from other features of DNSSEC
- One-way hash function
  - –DNS question or answer and timestamp
- Traffic signed with “shared secret” key
- Used in configuration, **NOT** in zone file

TSIG Example

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TSIG Example

Slave

KEY:
$h@r3dS3cr3t

Master

DNSSEC

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TSIG Example

Slave

KEY:
$h@r3dS3cr3t

Master

KEY:
$h@r3dS3cr3t

DNSSEC

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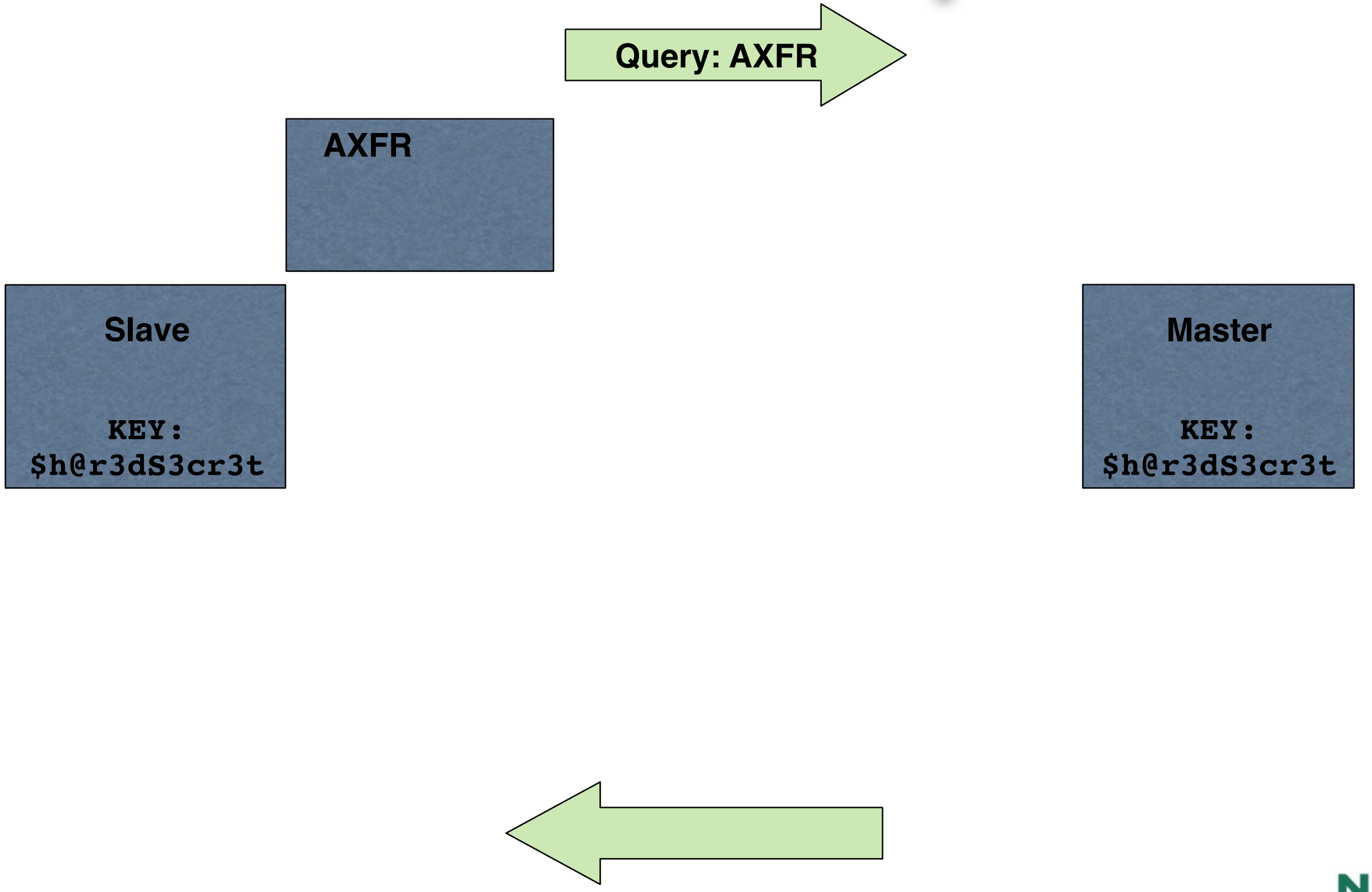
TSIG Example



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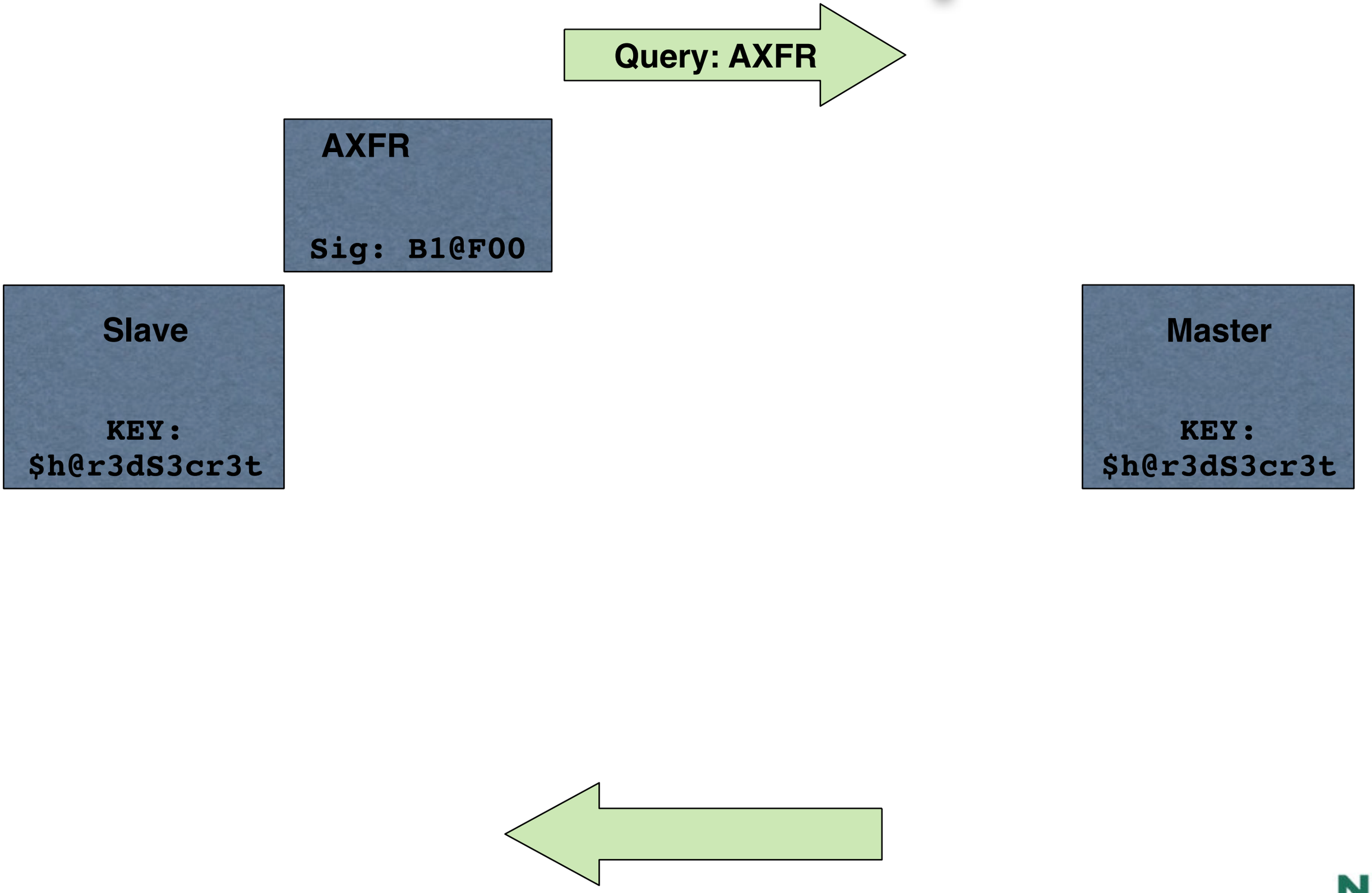

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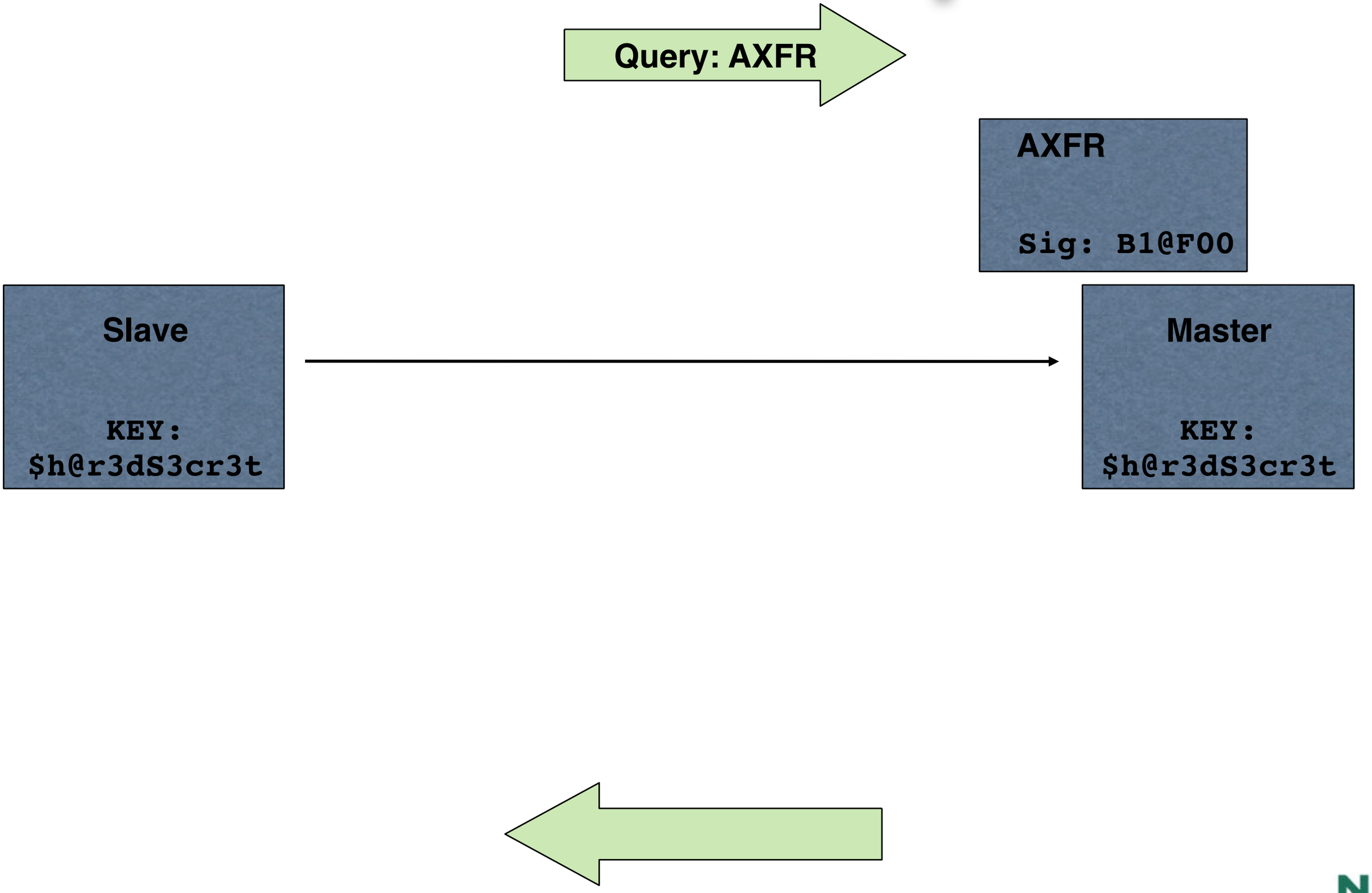

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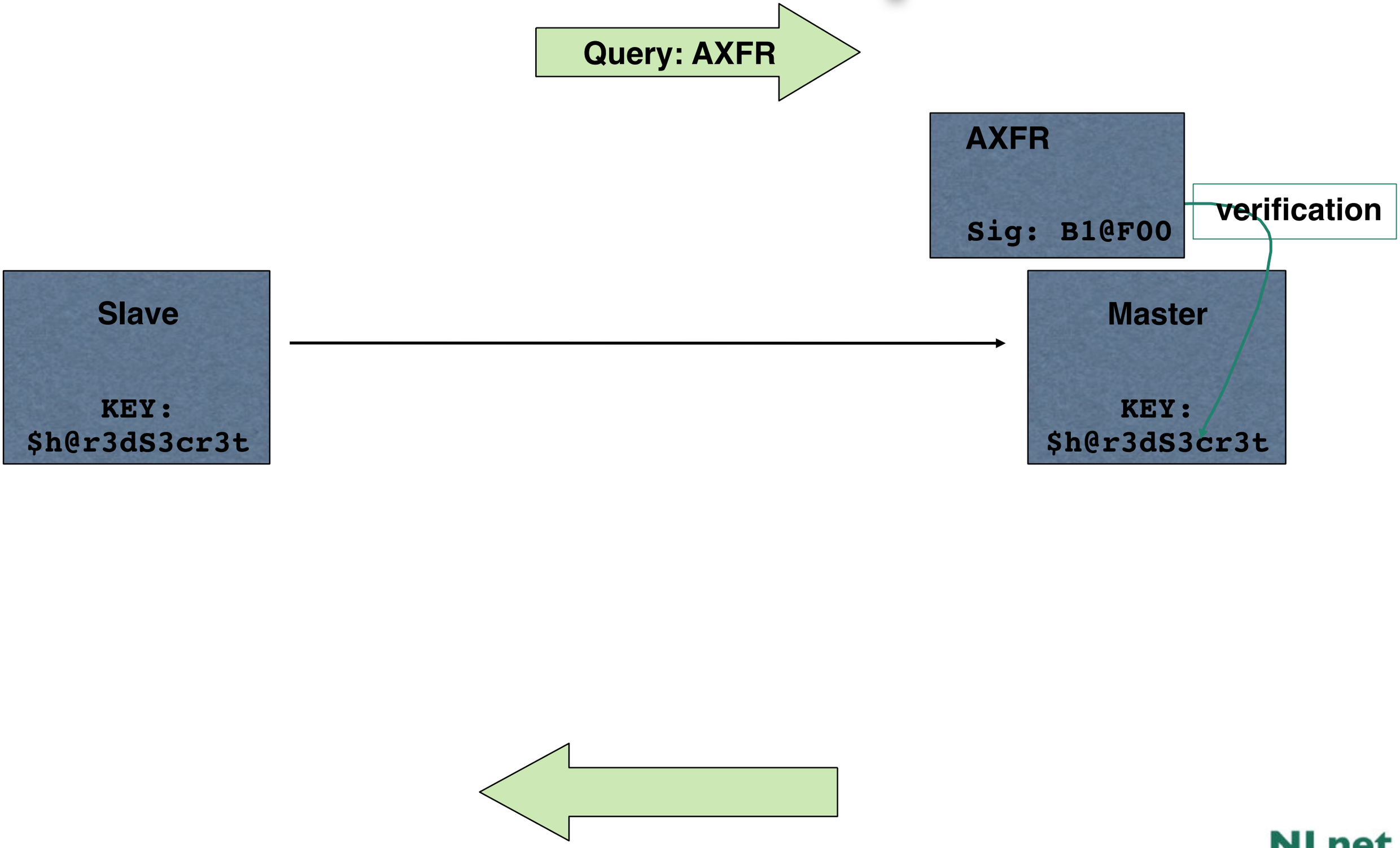

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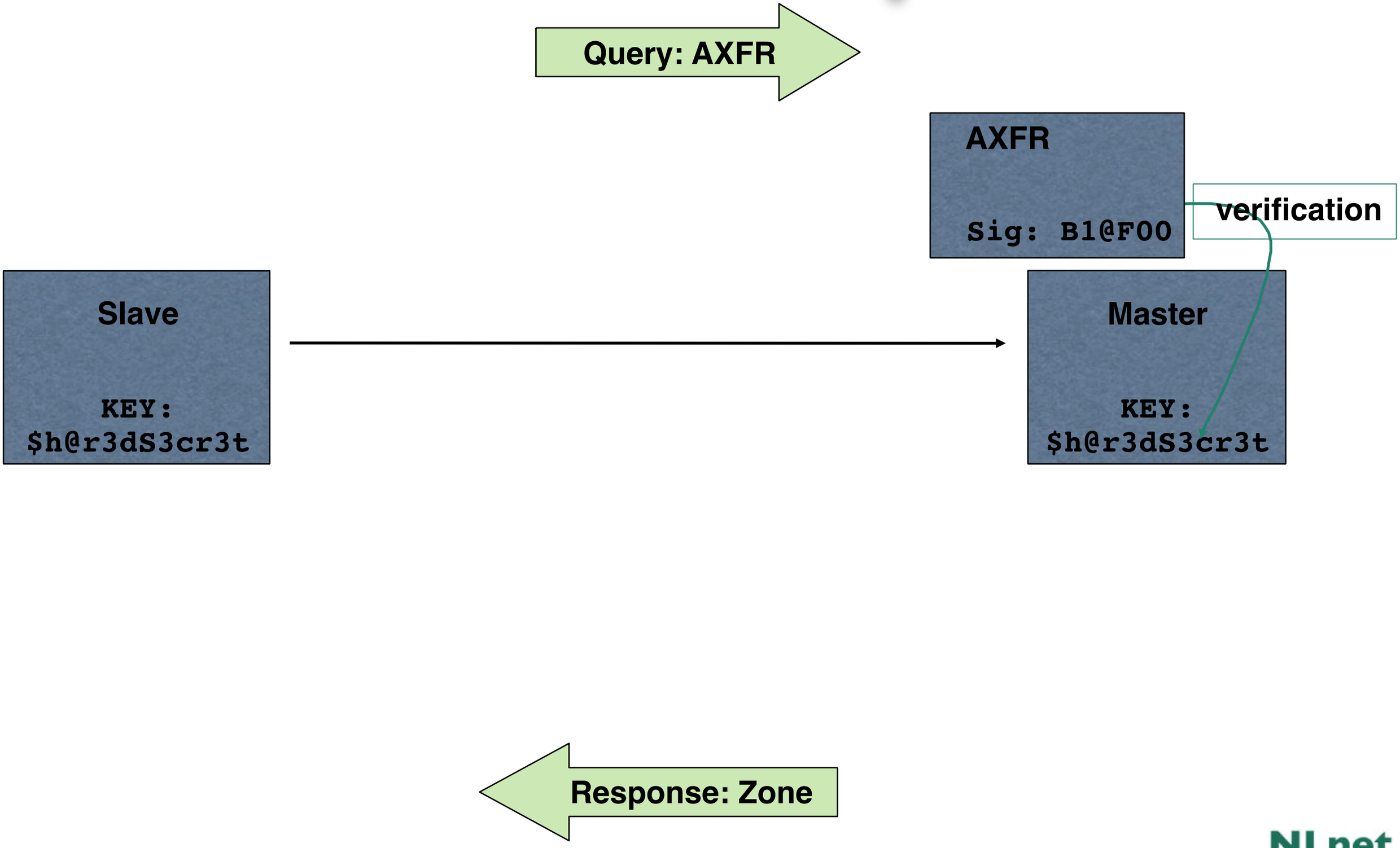
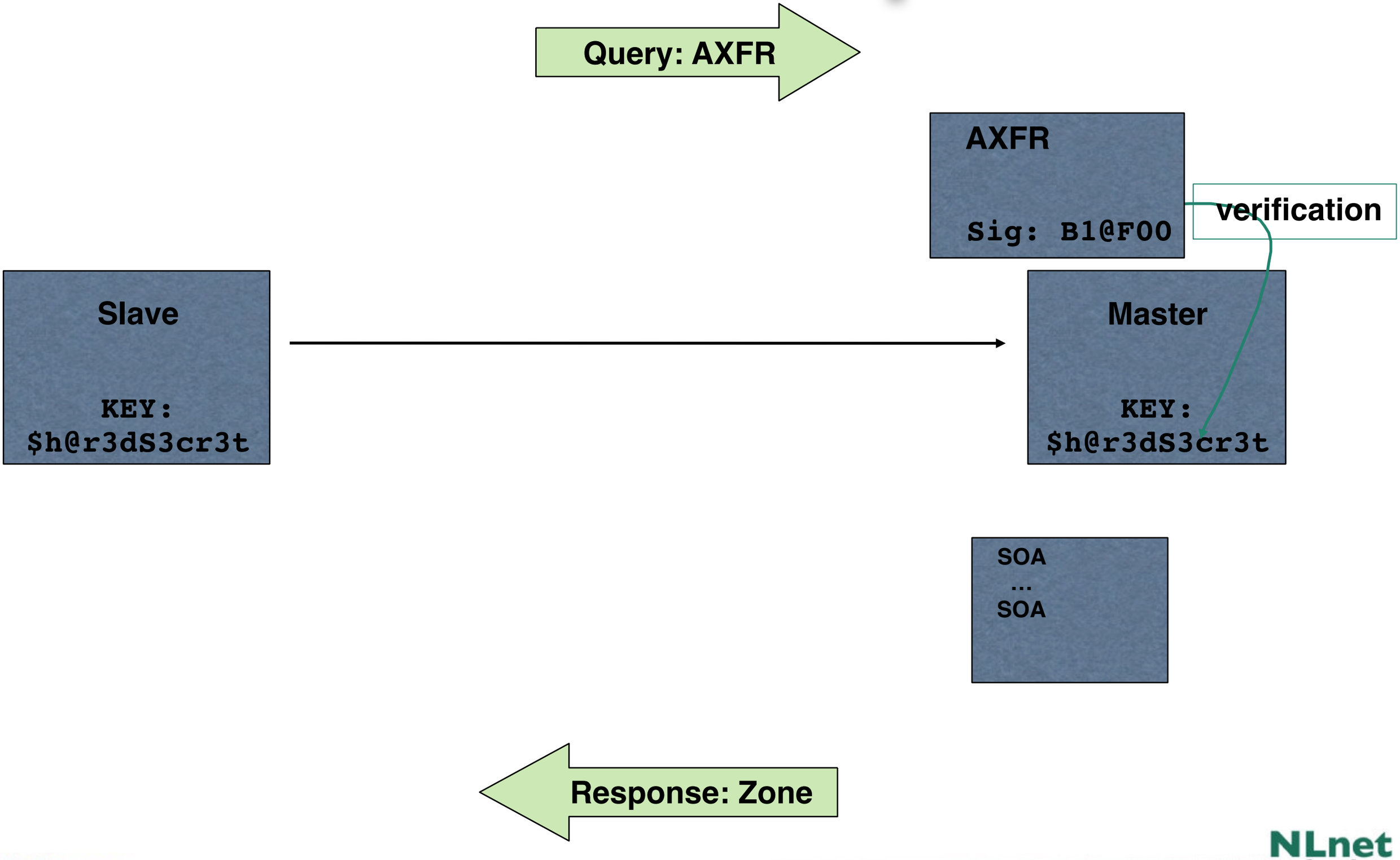


TSIG Example



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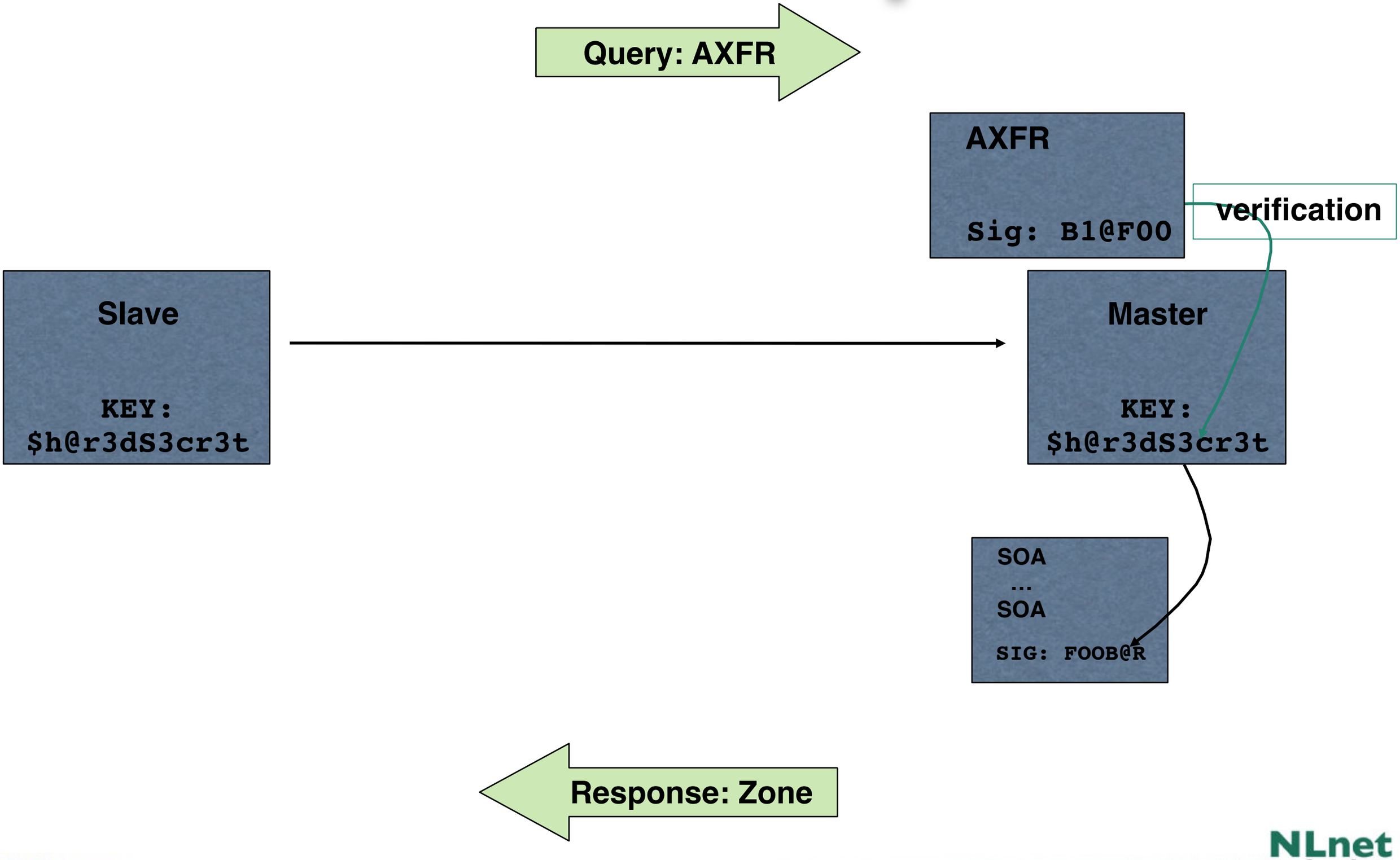

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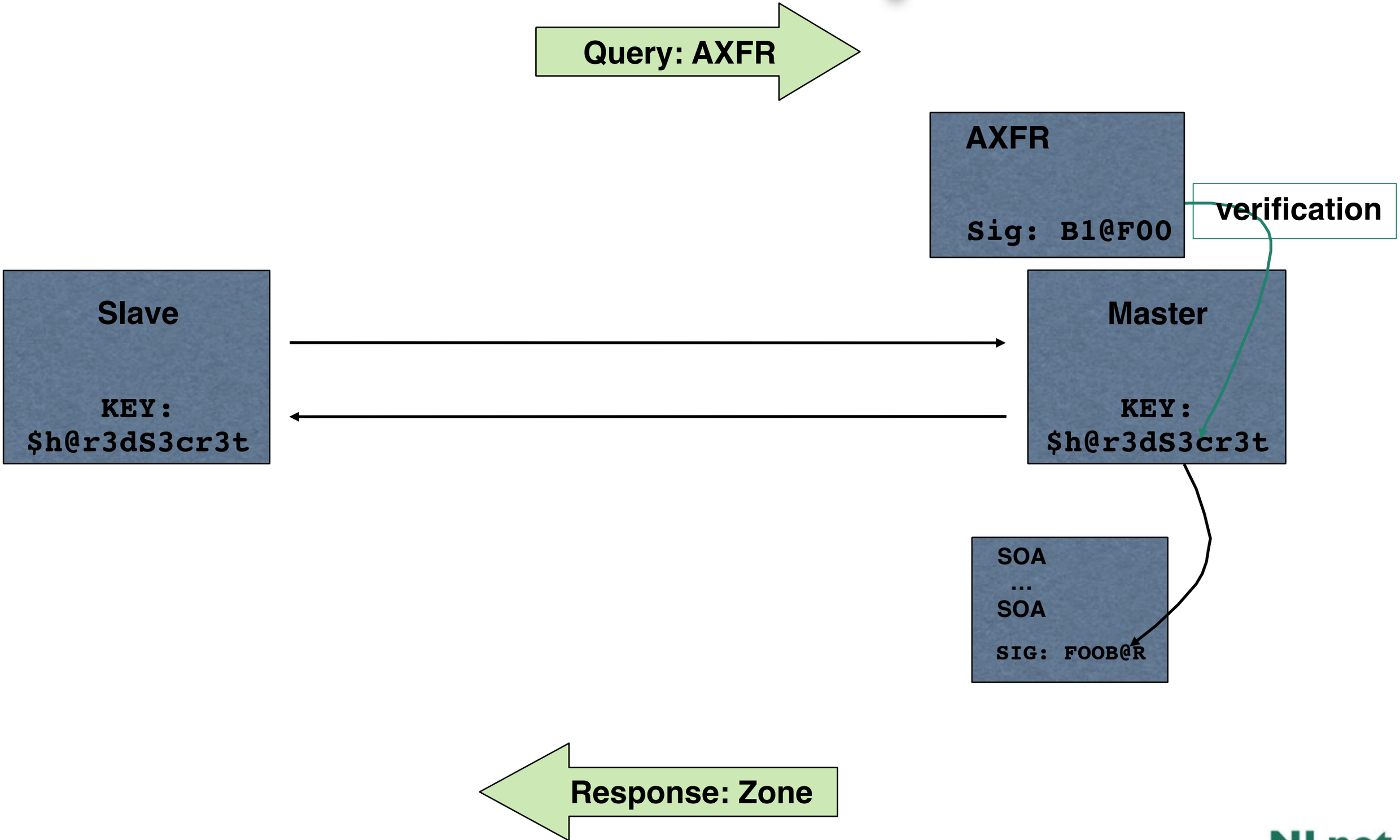
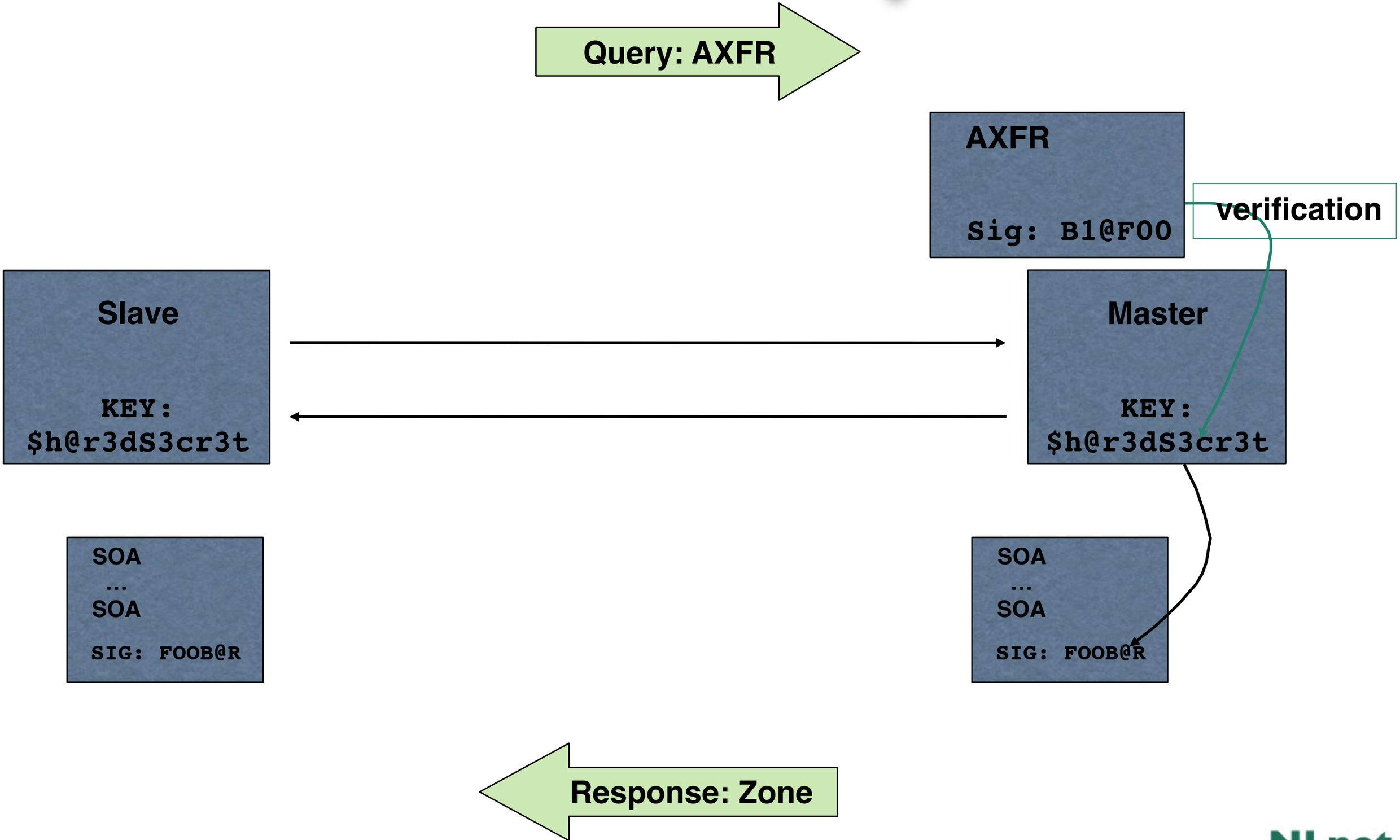


TSIG Example



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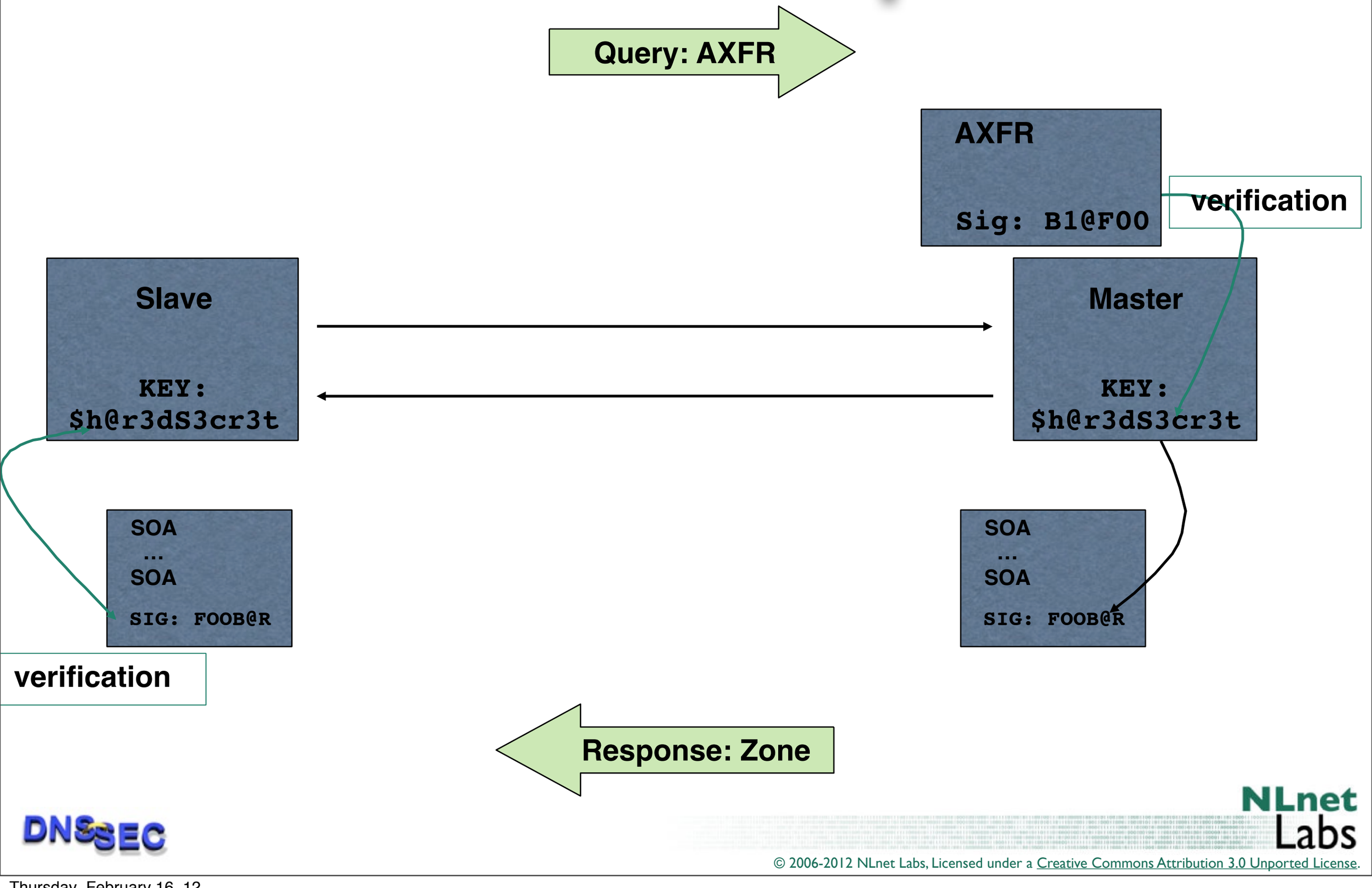
TSIG Example



TSIG for Zone Transfers

1. Generate secret
2. Communicate secret
3. Configure servers
4. Test

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Importance of the Time Stamp

- TSIG/SIG(0) signs a complete DNS request / response with time stamp
  - To prevent replay attacks
  - Currently hardcoded at five minutes

- Operational problems when comparing times
  - Make sure your local time zone is properly defined
  - **`date -u`** will give UTC time, easy to compare between the two systems
  - Use NTP synchronisation!

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Authenticating Servers Using SIG(0)

- Alternatively, it is possible to use SIG(0)
  - –Not yet widely used
  - –Works well in dynamic update environment
- Public key algorithm
  - –Authentication against a public key published in the DNS
- SIG(0) specified in RFC 2931

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Cool Application

- Use TSIG-ed dynamic updates to configure configure your laptops name

- My laptop is know by the name of aagje.secret-wg.org
  - http://ops.ietf.org/dns/dynupd/secure-ddns-howto.html
  - Mac OS users: there is a bonjour based tool.
    - www.dns-sd.org

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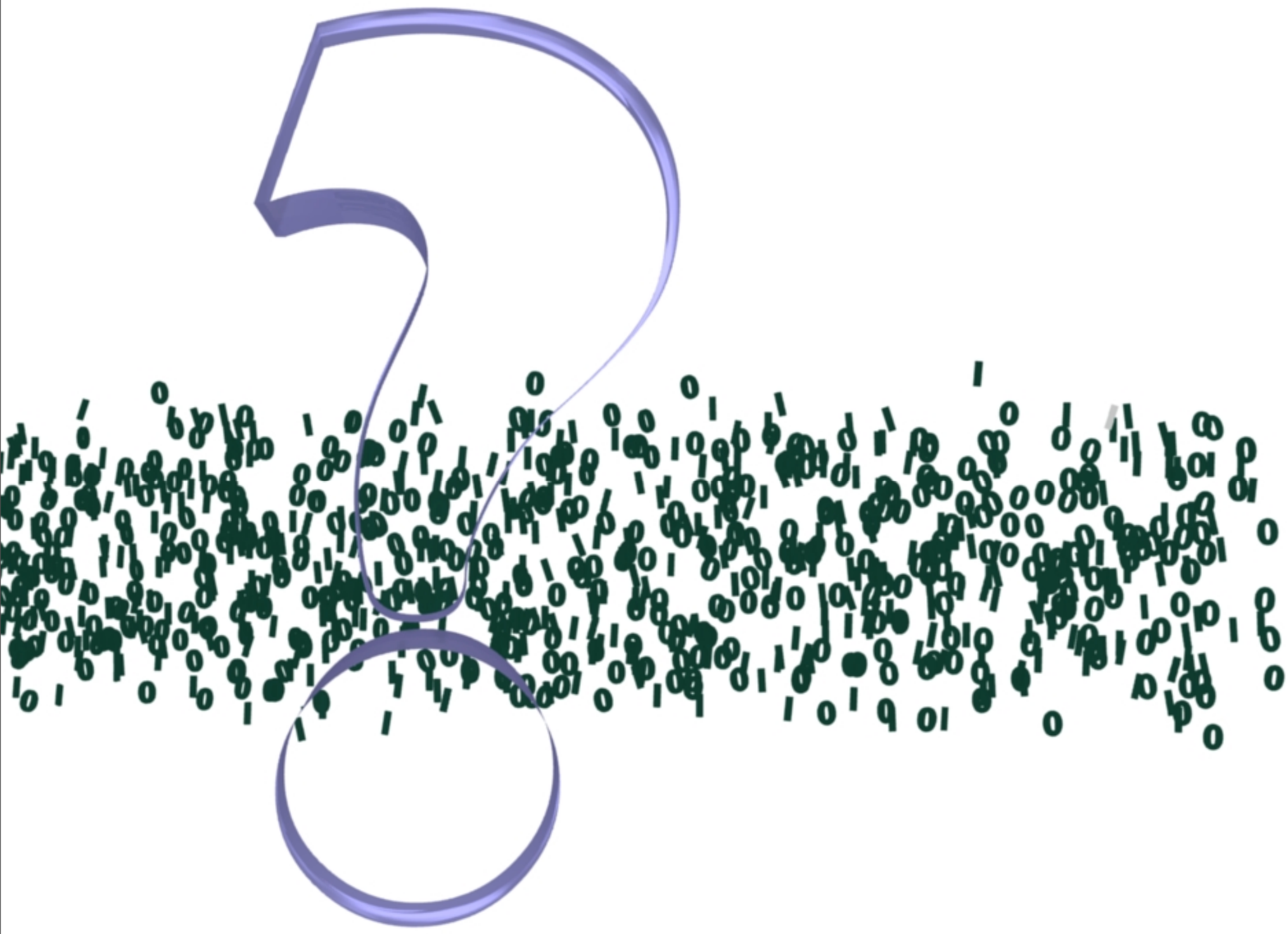

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