Domain Name Service Security
CS 239
Advanced Topics in Network Security
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The Problem

- The Domain Name Service (DNS) translates human-readable names to IP addresses
  - E.g., thesiger.cs.ucla.edu translates to 131.179.192.144
  - DNS also provides other similar services
- It wasn't designed with security in mind

DNS Threats

- Threats to name lookup secrecy
  - Definition of DNS system says this data isn't secret
- Threats to DNS information integrity
  - Very important, since everything trusts that this translation is correct
- Threats to DNS availability
  - Potential to disrupt Internet service

What Could Really Go Wrong?

- DNS lookups could be faked
  - Meaning packets go to the wrong place
- The DNS service could be subject to a DoS attack
  - Or could be used to amplify one
- Attackers could "bug" a DNS server to learn what users are looking up

Where Does the Threat Occur?

- Unlike routing, threat can occur in several places
  - At DNS servers
  - But also at DNS clients
    - Which is almost everyone
- Core problem is that DNS responses aren't authenticated

The DNS Lookup Process

`lookup thesiger.cs.ucla.edu`

`ping thesiger.cs.ucla.edu`

Should result in a ping packet being sent to 131.179.191.144

`answer 131.179.191.144`

If the answer is wrong, in standard DNS the client is screwed

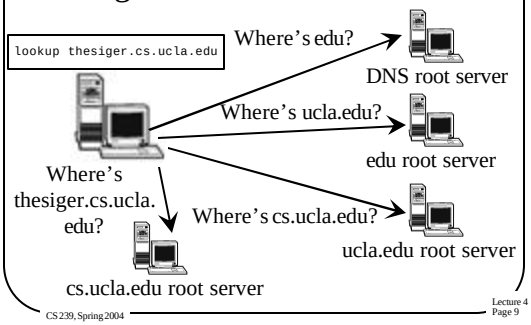
How Did the DNS Server Perform the Lookup?

- Leaving aside details, it has a table of translations between names and addresses
- It looked up thesiger.cs.ucla.edu in the table
- And replied with whatever the address was

Where Did That Table Come From?

- Ultimately, the table entries are created by those owning the domains
  - On a good day . . .
- And stored at servers that are authoratative for that domain
- In this case, the UCLA Computer Science Department DNS server ultimately stored it
- Other servers use a hierarchical lookup method to find the translation when needed

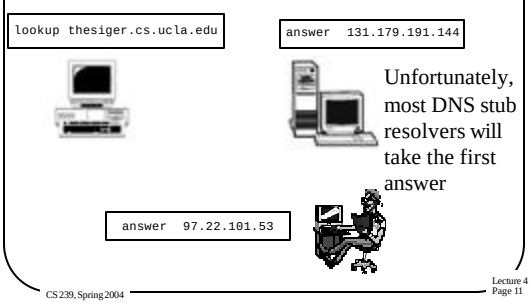
Doing Hierarchical Translation



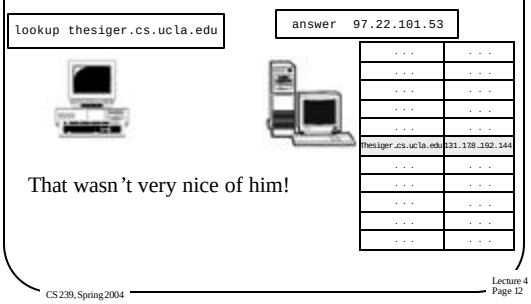
Where Can This Go Wrong?

- Someone can spoof the answer from a DNS server
  - Relatively easy, since UDP is used
- One of the DNS servers can lie
- Someone can corrupt the database of one of the DNS servers

The Spoofing Problem

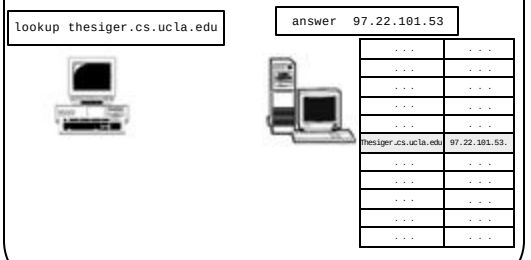


DNS Servers Lying



That wasn't very nice of him!

DNS Database Corruption



The DNSSEC Solution

- Sign the translations
- Who does the signing?
  - The server doing the response?
  - Or the server that "owns" the namespace in question?
- DNSSEC uses the latter solution

Implications of the DNSSEC Solution

- DNS databases must store signatures of resource records
- There must be a way of checking the signatures
- The protocol must allow signatures to be returned

Checking the Signature

- Basically, use certificates to validate public keys for namespaces
- Who signs the certificates?
  - The entity controlling the higher level namespace
- This implies a hierarchical solution

An Example

- Who signs the translation for thesiger.cs.ucla.edu to 131.179.192.144?
- The UCLA CS DNS server
- How does someone know that 's the right server to sign?
- Because the UCLA server says so
  - Securely, with signatures
- Where do you keep that information?
  - In DNS databases
- Ultimately, hierarchical signatures leading up to ICANN's attestation of who controls the edu namespace

Implications for Use

- To be really secure, you must check signatures yourself
- Next best is to have a really trusted authority check the signatures
  - And to have secure, authenticated communications between trusted authority and you

Some Questions for Discussion

- Partial deployment and interoperability?
- Costs?
- Susceptibility to denial of service?
- Handling negative answers?
- Need also for authenticated communications with server?