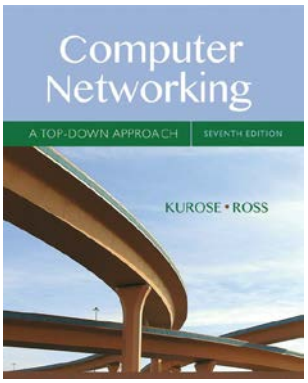
CS 447: Network and Data Communication

Wireshark Lab #01: DNS



As described in Section 2.4 of the text[1], the Domain Name System (DNS) translates hostnames to IP addresses, fulfilling a critical role in the Internet infrastructure. In this lab, we'll take a closer look at the client side of DNS. Recall that the client's role in the DNS is relatively simple – a client sends a *query* to its local DNS server, and receives a *response* back. As shown in Figures 2.19 and 2.20 in the textbook, much can go on "under the covers," invisible to the DNS clients, as the hierarchical DNS servers communicate with each other to either recursively or iteratively resolve the client's DNS query. From the DNS client's standpoint, however, the protocol is quite simple – a query is formulated to the local DNS server and a response is received from that server.

Before beginning this lab, you'll probably want to review DNS by reading Section 2.4 of the text. In particular, you may want to review the material on **local DNS servers**, **DNS caching**, **DNS records and messages**, and the **TYPE field** in the DNS record.

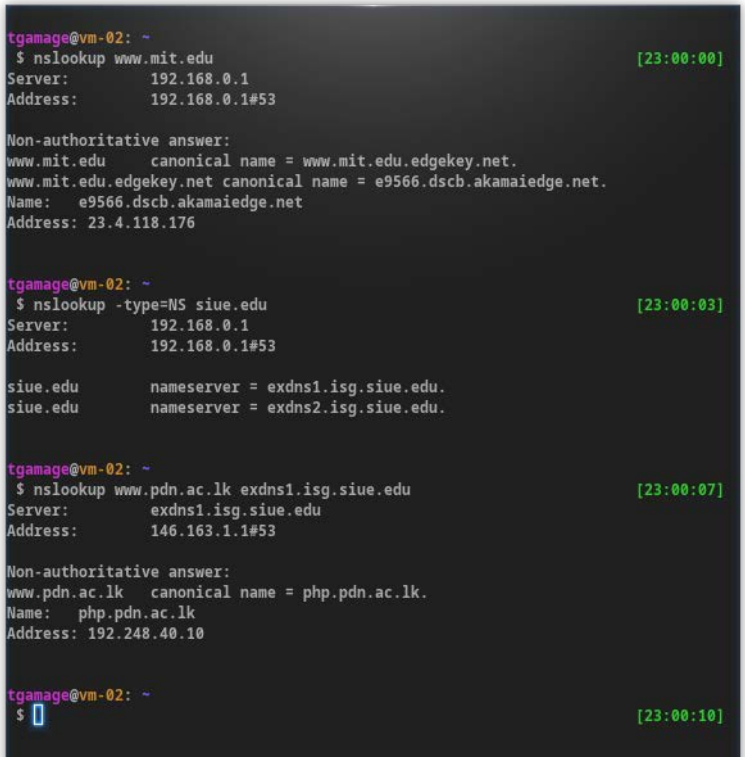
- nslookup

In this lab, we'll make extensive use of the *nslookup* tool, which is available in most Linux/Unix and Microsoft platforms today. To run *nslookup* in Linux/Unix, you just type the *nslookup* command on the command line. To run it in Windows, open the Command Prompt and run *nslookup* on the command line.

In it is most basic operation, *nslookup* tool allows the host running the tool to query any specified DNS server for a DNS record. The queried DNS server can be a root DNS server, a top-level-domain DNS server, an authoritative DNS server, or an intermediate DNS server (see the textbook for definitions of these terms). To accomplish this task, *nslookup* sends a DNS query to the specified DNS server, receives a DNS reply from that same DNS server, and displays the result.

The below screenshot shows the results of three independent *nslookup* commands (displayed in a Linux Terminal). In this example, the client host is the CS home server, which is a virtual machine behind a NAT box. For this virtual machine, DNS queries are answered by its default gateway – 192.168.0.1 – which will know the nearest local nameserver.

[1] References to figures and sections are for the 7th edition of our text, *Computer Networks, A Top-down Approach, 7th ed.,* J.F. Kurose and K.W. Ross, Addison-Wesley/Pearson, 2016.



Consider the first command:

```
nslookup www.mit.edu
```

When running *nslookup*, if no DNS server is specified, then *nslookup* sends the query to the default DNS server. This command is saying "*please send me the IP address for the host www.mit.edu*". As shown in the screenshot, the response from this command provides two pieces of information: (1) the name and IP address of the DNS server that provides the answer; and (2) the answer itself, which is the host name and IP address of www.mit.edu. Although the response came from the DNS server local to CS home server, it is most likely that this local DNS server iteratively contacted several other DNS servers to get the answer, as described in Section 2.4 of the textbook.

Let's try to find the authoritative DNS for siue.edu. Now consider the second command:

```
nslookup -type=NS siue.edu
```

In this example, we have provided the option "-type=NS" and the domain "siue.edu". This causes *nslookup* to send a query for a type-NS record to the default local DNS server. In words, the query is saying, "*please send me the host names of the authoritative DNS for siue.edu*". (When the –type option is not used, *nslookup* uses the default, which is to query for type A records.) The answer, displayed in the above screenshot, first indicates the DNS server that is providing the answer (which is the default local DNS server) along with two SIUE nameservers. Each of these servers is indeed an authoritative DNS server for the hosts on the SIUE campus.

At times, you may get "-type=NS" responses that indicate that the answer is "non-authoritative," meaning that this answer came from the cache of some server rather than from an authoritative DNS server. Also, you may also get the IP addresses of the hosts you are querying for, as in the

case with the first command. (Even though the type-NS query generated by *nslookup* did not explicitly ask for the IP addresses, the local DNS server returned these "for free" and *nslookup* displays the result.). This could include IP addresses of the authoritative DNS servers. Try the following command from your home computer for example and check the output.

```
nslookup -type=NS berkeley.edu
```

Now finally consider the third command:

```
nslookup www.pdn.ac.lk exdns1.isg.siue.edu
```

In this example, we indicate that we want to the query sent to the DNS server exdns1.isg.siue.edu rather than to the default DNS server (192.168.0.1). Thus, the query and reply transaction takes place directly between our querying host and exdns1.isg.siue.edu. In this example, the DNS server exdns1.isg.siue.edu provides the IP address of the host www.pdn.ac.lk, which is a web server at the University of Peradeniya (in Sri Lanka).

Now that we have gone through a few illustrative examples, you are perhaps wondering about the general syntax of *nslookup* commands. The syntax is:

```
nslookup –option1 –option2 host-to-find dns-server
```

In general, *nslookup* can be run with zero, one, two or more options. And as we have seen in the above examples, the dns-server is optional as well; if it is not supplied, the query is sent to the default local DNS server.

Now that we have provided an overview of *nslookup*, it is time for you to test drive it yourself. Do the following (and write down the results):

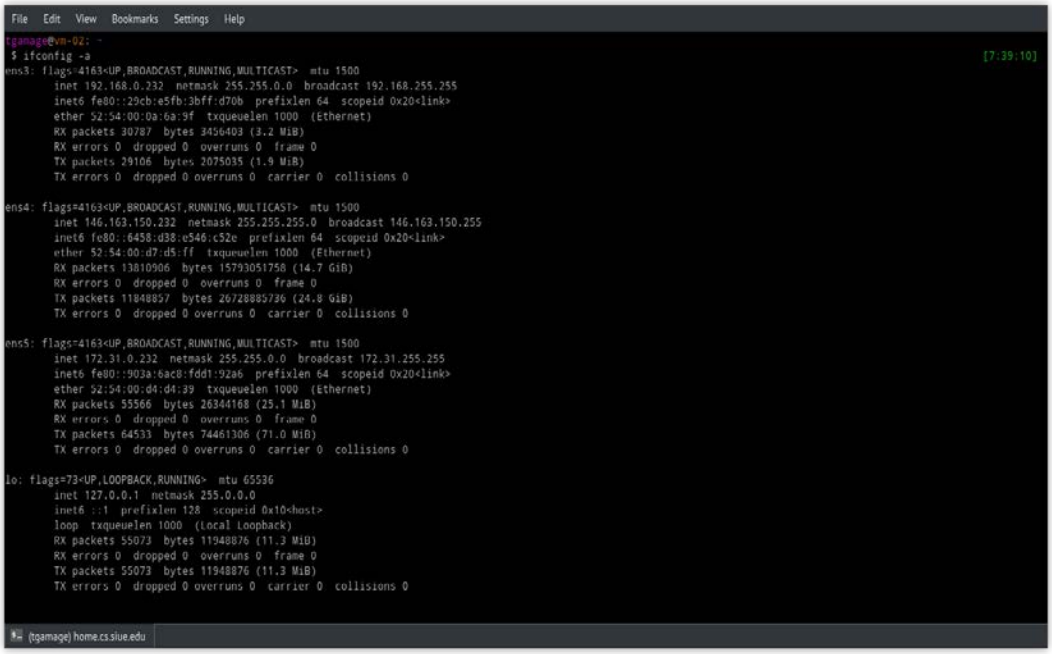
1. Run *nslookup* to obtain the IP address of a Web server in Europe. What is the IP address of that server?
2. Run *nslookup* to determine the authoritative DNS servers for a university in Australia.
3. Run *nslookup* so that one of the DNS servers obtained in Question 2 is queried for the mail servers for Google Mail (Gmail). What is its IP address?

- ipconfig/ifconfig

ipconfig (for Windows) and *ifconfig* (for Linux/Unix) are among the most useful little utilities in your host, especially for debugging network issues. On Windows, *ipconfig* can be used to show your current TCP/IP information, including your address, DNS server addresses, adapter type and so on. Most Linux distributions does not cache DNS entries in this manner, unless a dedicated DNS reslover, such as nsd, dnsmasq, etc, is installed. Linux machines depend on the entries in the *etc/resolve.conf* to resolve DNS queries. However, *ifconfig* on Linux can be used for various other useful functions such as enabling promiscous mode, setting net masks, tunnelling, etc. See the man page for ifconfig by typing *man ifconfig* on a Linux terminal for more information.
The following screenshot was taken by typing

```
ipconfig -a
```

into a Linux terminal.



On windows machines, *ipconfig* is also very useful for managing the DNS information stored in your host. In Section 2.5 we learned that a host can cache DNS records it recently obtained. To see these cached records, after the prompt C:\> provide the following command:

```
ipconfig /displaydns
```

Each entry shows the remaining Time to Live (TTL) in seconds. To clear the cache, enter

```
ipconfig /flushdns
```

Flushing the DNS cache clears all entries and reloads the entries from the hosts file.

- 3. Tracing DNS with Wireshark

Now that we are familiar with *nslookup* and *ipconfig*, we're ready to get down to some serious business. Let's first capture the DNS packets that are generated by ordinary Web-surfing activity.

- Use *ipconfig* to empty the DNS cache in your host.
  - On Windows this can be accomplished using `ipconfig /flushdns`
  - On Linux first install `nscd` using your package manager. For a Debian-based machine, this would be done via:
    `sudo apt-get install nscd` (if not installed by default)
    `sudo nscd restart or sudo nscd –i hosts`
- Open your browser and empty your browser cache. (With Internet Explorer, go to Tools menu and select Internet Options; then in the General tab select Delete Files.)
- Open Wireshark and enter "`ip.addr == your_IP_address`" into the filter, where you obtain your_IP_address with `ifconfig`. This filter removes all packets that neither originate nor are destined to your host.
- Start packet capture in Wireshark.
- With your browser, visit the Web page: https://www.iana.org/

- Stop packet capture.

If you are unable to run Wireshark on a live network connection, you can download a packet trace file that was captured while following the steps above on one of the author's computers[2]. Answer the following questions. Whenever possible, when answering a question below, you should hand in a printout of the packet(s) within the trace that you used to answer the question asked. Annotate the printout[3] to explain your answer. To print a packet, use *File->Print*, choose *Selected packet only*, choose *Packet summary line,* and select the minimum amount of packet detail that you need to answer the question.

4. Locate the DNS query and response messages. Are they sent over UDP or TCP?
5. What is the destination port for the DNS query message? What is the source port of DNS response message?
6. To what IP address is the DNS query message sent? Use ipconfig to determine the IP address of your local DNS server. Are these two IP addresses the same?
7. Examine the DNS query message. What "Type" of DNS query is it? Does the query message contain any "answers"?
8. Examine the DNS response message. How many "answers" are provided? What do each of these answers contain?
9. Consider the subsequent TCP SYN packet sent by your host. Does the destination IP address of the SYN packet correspond to any of the IP addresses provided in the DNS response message?
10. This web page contains images. Before retrieving each image, does your host issue new DNS queries?

Now let's play with *nslookup*[4].

- Start packet capture.
- Do an *nslookup* on eng.pdn.ac.lk
- Stop packet capture.

You should get a trace that looks something like the following:

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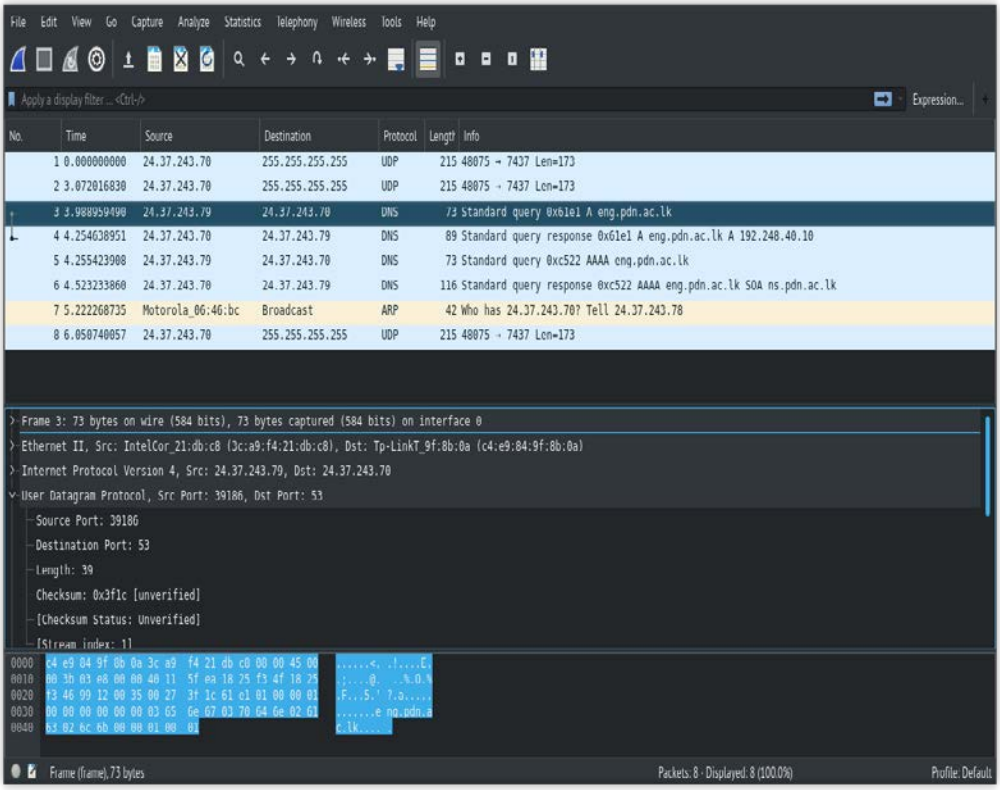
[2] Download the zip file http://gaia.cs.umass.edu/wireshark-labs/wireshark-traces.zipand extract the file dns-ethereal-trace-1. The traces in this zip file were collected by Wireshark running on one of the author's computers, while performing the steps indicated in the Wireshark lab. Once you have downloaded the trace, you can load it into Wireshark and view the trace using the *File* pull down menu, choosing *Open*, and then selecting the dns-ethereal-trace-1 trace file.

[3] What do we mean by "annotate"? If you hand in a paper copy, please highlight where in the printout you've found the answer and add some text (preferably with a colored pen) noting what you found in what you 've highlight. If you hand in an electronic copy, it would be great if you could also highlight and annotate.

[4] If you are unable to run Wireshark and capture a trace file, use the trace file dns-ethereal-trace-2 in the zip file http://gaia.cs.umass.edu/wireshark-labs/wireshark-traces.zip



We see from the above screenshot that *nslookup* actually sent three DNS queries and received three DNS responses. For the purpose of this assignment, in answering the following questions, ignore the first two sets of queries/responses, as they are specific to *nslookup* and are not normally generated by standard Internet applications. You should instead focus on the last query and response messages.

What is the destination port for the DNS query message? What is the source port of DNS response message?

11. To what IP address is the DNS query message sent? Is this the IP address of your default local DNS server?
12. Examine the DNS query message. What "Type" of DNS query is it? Does the query message contain any "answers"?
13. Examine the DNS response message. How many "answers" are provided? What do each of these answers contain?
14. Provide a screenshot.

Now repeat the previous experiment, but instead issue the command:

```
nslookup -type=NS siue.edu
```

Answer the following questions[5] :

15. To what IP address is the DNS query message sent? Is this the IP address of your default local DNS server?

[5] If you are unable to run Wireshark and capture a trace file, use the trace file dns-ethereal-trace-3 in the zip file http://gaia.cs.umass.edu/wireshark-labs/wireshark-traces.zip

16. Examine the DNS query message. What "Type" of DNS query is it? Does the query message contain any "answers"?
17. Examine the DNS response message. What MIT nameservers does the response message provide? Does this response message also provide the IP addresses of the MIT namesers?
18. Provide a screenshot.

Now repeat the previous experiment, but instead issue the command:

```
nslookup www.pdn.ac.lk exdns1.isg.siue.edu
```

Answer the following questions[6]:

19. To what IP address is the DNS query message sent? Is this the IP address of your default local DNS server? If not, what does the IP address correspond to?
20. Examine the DNS query message. What "Type" of DNS query is it? Does the query message contain any "answers"?
21. Examine the DNS response message. How many "answers" are provided? What does each of these answers contain?
22. Provide a screenshot.

[6] If you are unable to run Wireshark and capture a trace file, use the trace file dns-ethereal-trace-4 in the zip file http://gaia.cs.umass.edu/wireshark-labs/wireshark-traces.zip