EECS 325: Assignment 2

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EECS 325, Dr. WANG

Question 1

a.

$$T(\text{base file}) = \frac{10\text{KB}}{10\text{Mbps}} = \frac{10 \cdot 8\text{Kb}}{10,000\text{Kbps}} = 0.008\text{s}$$
$$T(\text{object}) = \frac{100\text{KB}}{10\text{Mbps}} = \frac{100 \cdot 8\text{Kb}}{10,000\text{Kbps}} = 0.08\text{s}$$

$$\begin{aligned} T(\text{non-persistent 1 TCP}) &= 2 \cdot \text{RTT} + T(\text{base file}) + 20 \cdot (2 \cdot \text{RTT} + T(\text{object})) \\ &= 2 \cdot 0.1s + 0.008s + 20(2 \cdot 0.1s + 0.008s) \\ &= 5.808s \end{aligned}$$

b.

$$C(\text{Bandwith per connection}) = \frac{10\text{Mbps}}{4} = \frac{10,000\text{Kbps}}{4} = 2,500\text{Kbps}$$
$$\implies T(\text{object per connection}) = \frac{100 \cdot 8\text{Kb}}{2,500\text{Kbps}} = 0.32\text{s}$$
$$T(\text{base file}) = \frac{10\text{KB}}{2,500\text{Kbps}} = \frac{10 \cdot 8\text{Kb}}{2,500\text{Kbps}} = 0.032\text{s}$$

$$\begin{aligned} T(\text{non-persistent 4 TCP}) &= 2 \cdot \text{RTT} + T(\text{base file}) + 20 \cdot \frac{1}{4} \cdot (2 \cdot \text{RTT} + T(\text{object per connection})) \\ &= 2 \cdot 0.1s + 0.032s + \frac{20}{4}(2 \cdot 0.1s + 0.32s) \\ &= 2.832s \end{aligned}$$

c.

$$\begin{aligned} T(\text{persistent pipelined}) &= 2 \cdot \text{RTT} + T(\text{base file}) + RTT(\text{request}) + 20 \cdot T(\text{object}) \\ &= 0.2s + 0.008s + 0.1s + 20(0.08s) \\ &= 1.908s \end{aligned}$$

d.

$$\begin{aligned} C(\text{Bandwith per connection}) &= \frac{10\text{Mbps}}{2} = \frac{10,000\text{Kbps}}{2} = 5,000\text{Kbps} \\ T(\text{object}) &= \frac{100\text{KB}}{5,000\text{Kbps}} = \frac{100 \cdot 8\text{Kb}}{5,000\text{Kbps}} = 0.16\text{s} \\ T(\text{base file}) &= \frac{10\text{KB}}{5,000\text{Kbps}} = \frac{10 \cdot 8\text{Kb}}{5,000\text{Kbps}} = 0.016\text{s} \end{aligned}$$

$$\begin{aligned} T(\text{persistent pipelined 2 TCP}) &= 2 \cdot \text{RTT} + T(\text{base file}) \\ &\quad + \frac{\text{number of objects}}{\text{number of connections}} \cdot (RTT(\text{request}) + T(\text{object})) \\ &= 0.2s + 0.016s + \frac{20}{2} \cdot (0.1s + 0.16s) \\ &= 2.816s \end{aligned}$$

Question 2

a.

$$D = \frac{\text{avergae object size}}{\text{access link capacity}} = \frac{S}{C} \quad \text{s}$$

$$\text{Average access delay} = \frac{D}{1 - DB} = \frac{\frac{S}{C}}{1 - \frac{S}{C} \cdot A} = \frac{S}{C - SA} \quad \text{s}$$

$$T_1 = \text{Average access delay} + T = \frac{S}{C - SA} + T \quad \text{s}$$

b.

$$\text{For } B = (1-p)\cdot A$$

$$\text{Average access delay} = \frac{D}{1-DB} = \frac{\frac{S}{C}}{1-(\frac{S}{C}\cdot(1-p)A)} = \frac{S}{C-(1-p)\cdot SA} \quad \text{s}$$

$$T_2 = \text{Average access delay} + T = \frac{S}{C-(1-p)\cdot SA} + T \quad \text{s}$$

c.

c.(i)

The total time will be 0 second if the requested information is cached in the local DNS server. Otherwise, it willl be $R_1 + R_2 + R_3$ as the DNS resolver will have to query from the root, TLD, and authoritative DNS server.

c.(ii)

If the DNS solver may query the requested information from its ISP, the additional R_0 will be added to the delay. If not, the ISP will again have to go through the process of query from root, TLD, and authoritative DNS server, thus cause a delay of $R_0 + R_1 + R_2 + R_3$.

Question 3

a.

dig com @198.41.0.4 A norecursive

```
HenryZsMacMR932:~ zhonghenry$ dig com @198.41.0.4 A norecursive

; <<>> DiG 9.10.6 <<>> com @198.41.0.4 A norecursive
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 54149
;; flags: qr rd; QUERY: 1, ANSWER: 0, AUTHORITY: 13, ADDITIONAL: 27
;; WARNING: recursion requested but not available

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 1472
;; QUESTION SECTION:
;com. IN A

;; AUTHORITY SECTION:
com. 172800 IN NS a.gtld-servers.net.
com. 172800 IN NS b.gtld-servers.net.
```

```
com. 172800 IN NS c.gtld-servers.net.
com. 172800 IN NS d.gtld-servers.net.
com. 172800 IN NS e.gtld-servers.net.
com. 172800 IN NS f.gtld-servers.net.
com. 172800 IN NS g.gtld-servers.net.
com. 172800 IN NS h.gtld-servers.net.
com. 172800 IN NS i.gtld-servers.net.
com. 172800 IN NS j.gtld-servers.net.
com. 172800 IN NS k.gtld-servers.net.
com. 172800 IN NS l.gtld-servers.net.
com. 172800 IN NS m.gtld-servers.net.

;; ADDITIONAL SECTION:
a.gtld-servers.net. 172800 IN A 192.5.6.30
b.gtld-servers.net. 172800 IN A 192.33.14.30
c.gtld-servers.net. 172800 IN A 192.26.92.30
d.gtld-servers.net. 172800 IN A 192.31.80.30
e.gtld-servers.net. 172800 IN A 192.12.94.30
f.gtld-servers.net. 172800 IN A 192.35.51.30
g.gtld-servers.net. 172800 IN A 192.42.93.30
h.gtld-servers.net. 172800 IN A 192.54.112.30
i.gtld-servers.net. 172800 IN A 192.43.172.30
j.gtld-servers.net. 172800 IN A 192.48.79.30
k.gtld-servers.net. 172800 IN A 192.52.178.30
l.gtld-servers.net. 172800 IN A 192.41.162.30
m.gtld-servers.net. 172800 IN A 192.55.83.30
a.gtld-servers.net. 172800 IN AAAA 2001:503:a83e::2:30
b.gtld-servers.net. 172800 IN AAAA 2001:503:231d::2:30
c.gtld-servers.net. 172800 IN AAAA 2001:503:83eb::30
d.gtld-servers.net. 172800 IN AAAA 2001:500:856e::30
e.gtld-servers.net. 172800 IN AAAA 2001:502:1ca1::30
f.gtld-servers.net. 172800 IN AAAA 2001:503:d414::30
g.gtld-servers.net. 172800 IN AAAA 2001:503:eea3::30
h.gtld-servers.net. 172800 IN AAAA 2001:502:8cc::30
i.gtld-servers.net. 172800 IN AAAA 2001:503:39c1::30
j.gtld-servers.net. 172800 IN AAAA 2001:502:7094::30
k.gtld-servers.net. 172800 IN AAAA 2001:503:d2d::30
l.gtld-servers.net. 172800 IN AAAA 2001:500:d937::30
m.gtld-servers.net. 172800 IN AAAA 2001:501:b1f9::30

;; Query time: 40 msec
;; SERVER: 198.41.0.4#53(198.41.0.4)
;; WHEN: Thu Feb 20 02:16:13 EST 2020
;; MSG SIZE  rcvd: 828
```

```
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NXDOMAIN, id: 62890
;; flags: qr rd ra; QUERY: 1, ANSWER: 0, AUTHORITY: 1, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 512
;; QUESTION SECTION:
;norecursive. IN A

;; AUTHORITY SECTION:
. 86383 IN SOA a.root-servers.net. nstld.verisign-grs.com. 2020022001 1800 900 604800 86400

;; Query time: 27 msec
;; SERVER: 192.168.1.1#53(192.168.1.1)
;; WHEN: Thu Feb 20 02:16:13 EST 2020
;; MSG SIZE  rcvd: 115
```

dig facebook.com @192.5.6.30 A norecursive

```
HenryZsMacMR932:~ zhonghenry$ dig facebook.com @192.5.6.30 A norecursive

; <<>> DiG 9.10.6 <<>> facebook.com @192.5.6.30 A norecursive
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 19057
;; flags: qr rd; QUERY: 1, ANSWER: 0, AUTHORITY: 4, ADDITIONAL: 9
;; WARNING: recursion requested but not available

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 4096
;; QUESTION SECTION:
;facebook.com. IN A

;; AUTHORITY SECTION:
facebook.com. 172800 IN NS a.ns.facebook.com.
facebook.com. 172800 IN NS b.ns.facebook.com.
facebook.com. 172800 IN NS c.ns.facebook.com.
facebook.com. 172800 IN NS d.ns.facebook.com.

;; ADDITIONAL SECTION:
a.ns.facebook.com. 172800 IN AAAA 2a03:2880:fffe:c:face:b00c::35
a.ns.facebook.com. 172800 IN A 69.171.239.12
b.ns.facebook.com. 172800 IN AAAA 2a03:2880:ffff:c:face:b00c::35
b.ns.facebook.com. 172800 IN A 69.171.255.12
c.ns.facebook.com. 172800 IN A 185.89.218.12
c.ns.facebook.com. 172800 IN AAAA 2a03:2880:f1fc:c:face:b00c::35
```

```
d.ns.facebook.com. 172800 IN A 185.89.219.12
d.ns.facebook.com. 172800 IN AAAA 2a03:2880:f1fd:c:face:b00c::35

;; Query time: 47 msec
;; SERVER: 192.5.6.30#53(192.5.6.30)
;; WHEN: Thu Feb 20 02:17:08 EST 2020
;; MSG SIZE  rcvd: 284

;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NXDOMAIN, id: 6067
;; flags: qr rd ra; QUERY: 1, ANSWER: 0, AUTHORITY: 1, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 512
;; QUESTION SECTION:
;norecursive. IN A

;; AUTHORITY SECTION:
. 86391 IN SOA a.root-servers.net. nstld.verisign-grs.com. 2020022001 1800 900 604800 86400

;; Query time: 24 msec
;; SERVER: 192.168.1.1#53(192.168.1.1)
;; WHEN: Thu Feb 20 02:17:08 EST 2020
;; MSG SIZE  rcvd: 115
```

dig www.facebook.com @69.171.239.12 A norecursive

```
HenryZsMacMR932:~ zhonghenry$ dig www.facebook.com @69.171.239.12 A norecursive

; <<>> DiG 9.10.6 <<>> www.facebook.com @69.171.239.12 A norecursive
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 49087
;; flags: qr aa rd; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 1
;; WARNING: recursion requested but not available

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 4096
;; QUESTION SECTION:
;www.facebook.com. IN A

;; ANSWER SECTION:
www.facebook.com. 3600 IN CNAME star-mini.c10r.facebook.com.

;; Query time: 14 msec
;; SERVER: 69.171.239.12#53(69.171.239.12)
```

```
;; WHEN: Thu Feb 20 02:18:38 EST 2020
;; MSG SIZE  rcvd: 102

;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NXDOMAIN, id: 20239
;; flags: qr rd ra; QUERY: 1, ANSWER: 0, AUTHORITY: 1, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 512
;; QUESTION SECTION:
;norecursive. IN A

;; AUTHORITY SECTION:
. 86367 IN SOA a.root-servers.net. nstld.verisign-grs.com. 2020022001 1800 900 604800 86400

;; Query time: 24 msec
;; SERVER: 192.168.1.1#53(192.168.1.1)
;; WHEN: Thu Feb 20 02:18:38 EST 2020
;; MSG SIZE  rcvd: 115
```

dig star-mini.c10r.facebook.com @69.171.239.12 A nonrecursive

```
HenryZsMacMR932:~ zhonghenry$ dig star-mini.c10r.facebook.com @69.171.239.12 A nonrecursive

; <<>> DiG 9.10.6 <<>> star-mini.c10r.facebook.com @69.171.239.12 A nonrecursive
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 28428
;; flags: qr rd; QUERY: 1, ANSWER: 0, AUTHORITY: 4, ADDITIONAL: 9
;; WARNING: recursion requested but not available

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 4096
;; QUESTION SECTION:
;star-mini.c10r.facebook.com. IN A

;; AUTHORITY SECTION:
c10r.facebook.com. 3600 IN NS a.ns.c10r.facebook.com.
c10r.facebook.com. 3600 IN NS c.ns.c10r.facebook.com.
c10r.facebook.com. 3600 IN NS b.ns.c10r.facebook.com.
c10r.facebook.com. 3600 IN NS d.ns.c10r.facebook.com.

;; ADDITIONAL SECTION:
a.ns.c10r.facebook.com. 3600 IN AAAA 2a03:2880:f0fc:b:face:b00c::99
a.ns.c10r.facebook.com. 3600 IN A 129.134.30.11
c.ns.c10r.facebook.com. 3600 IN AAAA 2a03:2880:f1fc:b:face:b00c::99
```

```
c.ns.c10r.facebook.com. 3600 IN A 185.89.218.11
b.ns.c10r.facebook.com. 3600 IN AAAA 2a03:2880:f0fd:b:face:b00c::99
b.ns.c10r.facebook.com. 3600 IN A 129.134.31.11
d.ns.c10r.facebook.com. 3600 IN AAAA 2a03:2880:f1fd:b:face:b00c::99
d.ns.c10r.facebook.com. 3600 IN A 185.89.219.11

;; Query time: 22 msec
;; SERVER: 69.171.239.12#53(69.171.239.12)
;; WHEN: Thu Feb 20 02:19:30 EST 2020
;; MSG SIZE  rcvd: 620

;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NXDOMAIN, id: 58013
;; flags: qr rd ra; QUERY: 1, ANSWER: 0, AUTHORITY: 1, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 512
;; QUESTION SECTION:
;nonrecursive. IN A

;; AUTHORITY SECTION:
. 86382 IN SOA a.root-servers.net. nstld.verisign-grs.com. 2020022001 1800 900 604800 86400

;; Query time: 24 msec
;; SERVER: 192.168.1.1#53(192.168.1.1)
;; WHEN: Thu Feb 20 02:19:30 EST 2020
;; MSG SIZE  rcvd: 116
```

b.

I worked with Yuhui ZHANG, and consulted TA regarding the following questions.

b.(i)

We need to insert the following records to the TLD server due to change from `.net` to `.com`

1. `(foo.com, dns.foo.com, NS, TTL)`
2. `(dns.foo.com, dns.foo.com's IP address, A, TTL)`

We will also need to insert the following record to the ADNS of `www.foo.com`:
`(www.foo.com, dns.foo.com's IP address, A, TTL)`

b.(ii)

We need to insert the following records to the DNS of `foo.net`:

1. (web.foo.net, dns.web.foo.net, NS, TTL)

2. (dns.web.foo.net, dns.web.foo.net's IP address, A, TTL)

We will also need to insert the following record to the ADNS of web.foo.net:
(web.foo.net, web.foo.net's IP address, A, TTL)

b.(iii)

We need to change the IP record in the ADNS of www.foo.net:
(www.foo.net, www.foo.net's new IP address, A, TTL)

c.

When an open DSN resolver does query, CDN will likely to allocate CDN servers which are close to the (open) DNS resolver, which might be far away from you – the client. On the other hand, the by utilizing LDNS resolver, the CDN serves will allocate CDN servers which are physically close to you, and thus provide a better experience.