EECS 325: Assignment 2

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EECS 325, Dr. WANG

Question 1

a.

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

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

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

b.

$$C(\text{Bandwith per connection}) = \frac{10\text{Mbps}}{4} = \frac{10,000\text{Kbps}}{4} = 2,500\text{Kbps}$$

$$\Longrightarrow T(\text{object per connection}) = \frac{100 \cdot 8\text{Kb}}{2,500\text{Kbps}} = 0.32\text{s}$$

$$T(\text{non-persistent 4 TCP}) = 2 \cdot \text{RTT} + T(\text{base file}) + 20 \cdot \frac{1}{4} \cdot (2 \cdot \text{RTT} + T(\text{object per connection}))$$
$$= 2 \cdot 0.1s + 0.008s + \frac{20}{4}(2 \cdot 0.1s + 0.32s)$$
$$= 2.808s$$

c.

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

d.

$$C(\text{Bandwith per connection}) = \frac{10\text{Mbps}}{2} = \frac{10,000\text{Kbps}}{2} = 5,000\text{Kbps}$$

$$T(\text{persistent pipelined 2 TCP}) = 2 \cdot \text{RTT} + T(\text{base file})$$
$$+ \frac{\text{number of objects}}{number of connections} \cdot (RTT(\text{request}) + T(\text{object}))$$
$$= 0.2s + 0.008s + \frac{20}{2} \cdot (0.1s + 0.16s)$$
$$= 2.808s$$

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.