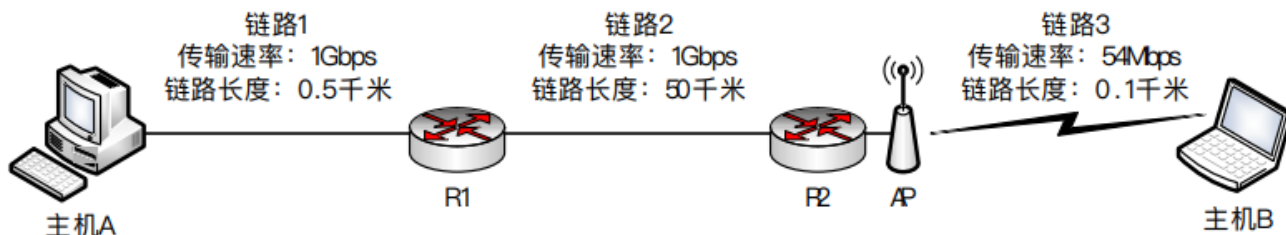


作业1

习题1-1 (50分)

网络的结构如下图所示，主机A与主机B之间通过3段链路和2台路由器（R1与R2）连接，每条链路的长度和传输速率在图中标出，R1与R2采用存储转发机制，主机B向主机A发送一个长度为9000字节的报文。设电磁波在有线链路与无线链路中的传播速度分别为 2×10^8 米/秒与 3×10^8 米/秒，忽略R2与AP之间连接使用的链路，忽略报文在R1与R2的路由决策与排队的延时。



请回答以下3个问题：

- (1) 如果采用报文交换模式，请计算报文传输的最小端到端延时（从主机B传输报文第一位开始，到主机A接收到报文最后一位所用的时间）（20分）
- (2) 如果将报文平均分成3个分组依次传输，请计算完成报文传输的最小端到端延时（忽略报文封装成分组的开销）（20分）
- (3) 如果考虑报文在路由器中的路由决策与排队过程，那么端到端延时不确定性的来源及影响最大的因素（10分）

解：1) $Latency = PROP + TRANS = \frac{L}{c} + \frac{P}{R}$

$$延时 t_1 = \frac{0.5 \times 10^3}{2 \times 10^8} + \frac{50 \times 10^3}{2 \times 10^8} + \frac{0.1 \times 10^3}{3 \times 10^8} + \frac{9 \times 10^3 \times 8}{1 \times 10^6 \times 10^6} \times 2 + \frac{9 \times 10^3 \times 8}{54 \times 10^6}$$

$$= \frac{1}{4} \times 10^{-5} + 25 \times 10^{-5} + \frac{1}{30} \times 10^{-5} + 14.4 \times 10^{-5} + \frac{4}{3} \times 10^{-3}$$

$$\approx 173.02 \times 10^{-5} s = 1.7302 ms$$

2) 每个分组的字节数 $9000 \div 3 = 3000 \text{ bytes}$

$$延时 t_2 = \frac{3000 \times 8}{54 \times 10^6} \times 3 + \frac{0.5 \times 10^3}{2 \times 10^8} + \frac{3000 \times 8}{1000 \times 10^6} + \frac{50 \times 10^3}{2 \times 10^8} + \frac{3000 \times 8}{1000 \times 10^6} + \frac{0.1 \times 10^3}{3 \times 10^8}$$

$$= 744 + 444 + 444 = 1632 \mu s \approx 1.63 ms$$

3) 最大的不确定因素是路由器的排队延迟

① 网络拥塞程度不同会导致排队时间变化

② 其他数据流的干扰

路由器的路由计算时间，路由器更新时间

链路负载的变化

① 共享链路的其他流量影响

② 网络拥塞控制机制的动态调整

习题1-2 (50分)

通过Windows命令行模式下的nslookup命令查询www.163.com，同时打开Wireshark软件捕获上述nslookup相关的DNS报文。

请回答以下3个问题：

- (1) 提供nslookup查询结果截图，并对查询结果进行全面分析 (20分)
- (2) 提供Wireshark捕获结果截图 (仅过滤出DNS报文)，并说明每条DNS报文的用途 (20分)
- (3) 提供某个DNS报文详细信息截图，说明DNS服务使用哪种传输层协议，以及哪些措施可提高DNS服务可靠性 (10分)

解: (1)

```

C:\WINDOWS\system32\cmd. x + v
Microsoft Windows [版本 10.0.22631.4602]
(c) Microsoft Corporation。保留所有权利。

C:\Users\lenovo>nslookup www.163.com
服务器: 41.45.30.222.in-addr.arpa -> 域名
Address: 222.30.45.41 -> IPv4地址

非权威应答:
名称: www.163.com.w.kunluncan.com -> 非权威DNS服务器或本地
Addresses: 2400:a980:ff:7:3::3fa -> IPv6 缓存中检索
           2400:a980:ff:7:3::3f9
           58.205.221.108 -> IPv4
           58.205.221.111
           58.205.221.80
           58.205.221.109
           58.205.221.79
           58.205.221.107
           58.205.221.112
           58.205.221.110
Aliases: www.163.com 目标域名
          www.163.com.163jiasu.com

C:\Users\lenovo>
  
```

(2)

No.	Time	Source	Destination	Protocol	Length	Info
1269	34.143384	222.30.45.41	10.136.94.89	DNS	99	Standard query response 0x0001 PTR 41.45.30.222.in-addr.arpa PTR 41.45.30.222.in-addr.arpa
1270	34.145670	10.136.94.89	222.30.45.41	DNS	71	Standard query 0x0002 A www.163.com
1271	34.148723	222.30.45.41	10.136.94.89	DNS	272	Standard query response 0x0002 A www.163.com CNAME www.163.com.163jiasu.com CNAME www.163.com.w.kunl
1272	34.154639	10.136.94.89	222.30.45.41	DNS	71	Standard query 0x0003 AAAA www.163.com
1273	34.158024	222.30.45.41	10.136.94.89	DNS	200	Standard query response 0x0003 AAAA www.163.com CNAME www.163.com.163jiasu.com CNAME www.163.com.w.k
1277	34.728175	10.136.94.89	222.30.45.41	DNS	88	Standard query 0x7170 A api3-eeft-mixed-h1.feishu.cn
1278	34.730054	222.30.45.41	10.136.94.89	DNS	324	Standard query response 0x7170 A api3-eeft-mixed-h1.feishu.cn CNAME api3-eeft-mixed-h1.feishu.cn.w.c
1279	34.730533	10.136.94.89	222.30.45.41	DNS	88	Standard query 0x9e28 AAAA api3-eeft-mixed-h1.feishu.cn
1280	34.732332	222.30.45.41	10.136.94.89	DNS	254	Standard query response 0x9e28 AAAA api3-eeft-mixed-h1.feishu.cn CNAME api3-eeft-mixed-h1.feishu.cn.
1347	39.383432	10.136.94.89	222.30.45.41	DNS	90	Standard query 0xb64d A self.events.data.microsoft.com
1348	39.384876	222.30.45.41	10.136.94.89	DNS	211	Standard query response 0xb64d A self.events.data.microsoft.com CNAME self-events-data.trafficmanage
1349	39.385084	10.136.94.89	222.30.45.41	DNS	90	Standard query 0xdf49 AAAA self.events.data.microsoft.com
1350	39.386505	222.30.45.41	10.136.94.89	DNS	256	Standard query response 0xdf49 AAAA self.events.data.microsoft.com CNAME self-events-data.trafficman

本机IP: 10.136.94.89
目的IP: 222.30.45.41

1270和1272 query是查询报文
1271和1273 query response是应答报文
A是对IPv4地址查询
AAAA是IPv6地址查询

(3)

DNS使用UDP上层协议

提高可靠性

① 部署DNS冗余服务器

② 缓存优化

③ 安全防护措施

④ 保护监控和保护

- (1) 部署多台DNS主服务器
- (2) 不同地理位置 避免单点故障
- (3) 使用Any cast 就近解析
- (1) 合理设置TTL
- (2) 递归查询缓存
- (1) 实施DNSSEC 确保域名解析安全
- (2) 启用DNS Cookie验证
- (3) 防范反射和放大攻击

以1271号报文为例↓

Frame 1271: 272 bytes on wire (2176 bits), 272 bytes captured (2176 bits) on interface \Device\NPF_{8EFB813B-166E-4299-B387-295D784D25A5}, id 0

Section number: 1

> Interface id: 0 (\Device\NPF_{8EFB813B-166E-4299-B387-295D784D25A5})

Encapsulation type: Ethernet (1)

Arrival Time: Dec 20, 2024 20:29:49.560934000 中国标准时间

UTC Arrival Time: Dec 20, 2024 12:29:49.560934000 UTC

Epoch Arrival Time: 1734697789.560934000

[Time shift for this packet: 0.000000000 seconds]

[Time delta from previous captured frame: 0.003053000 seconds]

[Time delta from previous displayed frame: 0.003053000 seconds]

[Time since reference or first frame: 34.148723000 seconds]

Frame Number: 1271

Frame Length: 272 bytes (2176 bits)

Capture Length: 272 bytes (2176 bits)

[Frame is marked: False]

[Frame is ignored: False]

[Protocols in frame: eth:ethertype:ip:udp:dns]

[Coloring Rule Name: UDP]

[Coloring Rule String: udp]

Wireshark 捕获的帧序号

帧长度

帧中使用的协议: 以太网, UDP, DNS

Ethernet II, Src: IETF-VRRP-VRID_08 (00:00:5e:00:01:08), Dst: Intel_b0:77:a0 (70:a8:d3:b0:77:a0)

> Destination: Intel_b0:77:a0 (70:a8:d3:b0:77:a0)

> Source: IETF-VRRP-VRID_08 (00:00:5e:00:01:08)

Type: IPv4 (0x0800)

Internet Protocol Version 4, Src: 222.30.45.41, Dst: 10.136.94.89

0100 = Version: 4

.... 0101 = Header Length: 20 bytes (5)

> Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)

Total Length: 258

Identification: 0x2323 (8995)

> 000. = Flags: 0x0

...0 0000 0000 0000 = Fragment Offset: 0

Time to Live: 61

Protocol: UDP (17)

Header Checksum: 0xe59f [validation disabled]

[Header checksum status: Unverified]

> Source Address: 222.30.45.41

> Destination Address: 10.136.94.89

User Datagram Protocol, Src Port: 53, Dst Port: 62918

Source Port: 53

Destination Port: 62918

Length: 238

Checksum: 0x4c5e [unverified]

[Checksum Status: Unverified]

[Stream index: 51]

> [Timestamps]

UDP payload (230 bytes)

> Domain Name System (response)

Domain Name System (response)

Transaction ID: 0x0002

> Flags: 0x8180 Standard query response, No error

1... .. = Response: Message is a response

.000 0... .. = Opcode: Standard query (0)

.... 0... .. = Authoritative: Server is not an authority for domain

.... ..0... .. = Truncated: Message is not truncated

.... ..1... .. = Recursion desired: Do query recursively

.... ..1... .. = Recursion available: Server can do recursive queries

.... ..0... .. = Z: reserved (0)

.... ..0... .. = Answer authenticated: Answer/authority portion was not authenticated by the server

.... ..0... .. = Non-authenticated data: Unacceptable

..... ..0000 = Reply code: No error (0)

Questions: 1

Answer RRs: 10

Authority RRs: 0

Additional RRs: 0

> Queries

> www.163.com: type A, class IN

> Answers

> www.163.com: type CNAME, class IN, cname www.163.com.163jiasu.com

> www.163.com.163jiasu.com: type CNAME, class IN, cname www.163.com.w.kunluncan.com

> www.163.com.w.kunluncan.com: type A, class IN, addr 58.205.221.108

> www.163.com.w.kunluncan.com: type A, class IN, addr 58.205.221.111

> www.163.com.w.kunluncan.com: type A, class IN, addr 58.205.221.80

> www.163.com.w.kunluncan.com: type A, class IN, addr 58.205.221.109

> www.163.com.w.kunluncan.com: type A, class IN, addr 58.205.221.79

> www.163.com.w.kunluncan.com: type A, class IN, addr 58.205.221.107

> www.163.com.w.kunluncan.com: type A, class IN, addr 58.205.221.112

> www.163.com.w.kunluncan.com: type A, class IN, addr 58.205.221.110

[Request In: 1270]

[Time: 0.003053000 seconds]

Answers

> www.163.com: type CNAME, class IN, cname www.163.com.163jiasu.com

> www.163.com.163jiasu.com: type CNAME, class IN, cname www.163.com.w.kunluncan.com

> Name: www.163.com.163jiasu.com

Type: CNAME (5) (Canonical NAME for an alias)

Class: IN (0x0001)

Time to live: 915 (15 minutes, 15 seconds)

Data length: 26

CNAME: www.163.com.w.kunluncan.com

> www.163.com.w.kunluncan.com: type A, class IN, addr 58.205.221.108

> www.163.com.w.kunluncan.com: type A, class IN, addr 58.205.221.111

> www.163.com.w.kunluncan.com: type A, class IN, addr 58.205.221.80

> www.163.com.w.kunluncan.com: type A, class IN, addr 58.205.221.109

> www.163.com.w.kunluncan.com: type A, class IN, addr 58.205.221.79

> www.163.com.w.kunluncan.com: type A, class IN, addr 58.205.221.107

> www.163.com.w.kunluncan.com: type A, class IN, addr 58.205.221.112

> www.163.com.w.kunluncan.com: type A, class IN, addr 58.205.221.110

[Request In: 1270]

[Time: 0.003053000 seconds]

标准查询(0)

表示只有1个查询报文

类型为 CNAME: 别名记录

因在 1270 号查询报文

名称
类型
时间
数据长度
数据

