实验报告

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1.实验题目： 路由转发实验

2.实验内容：

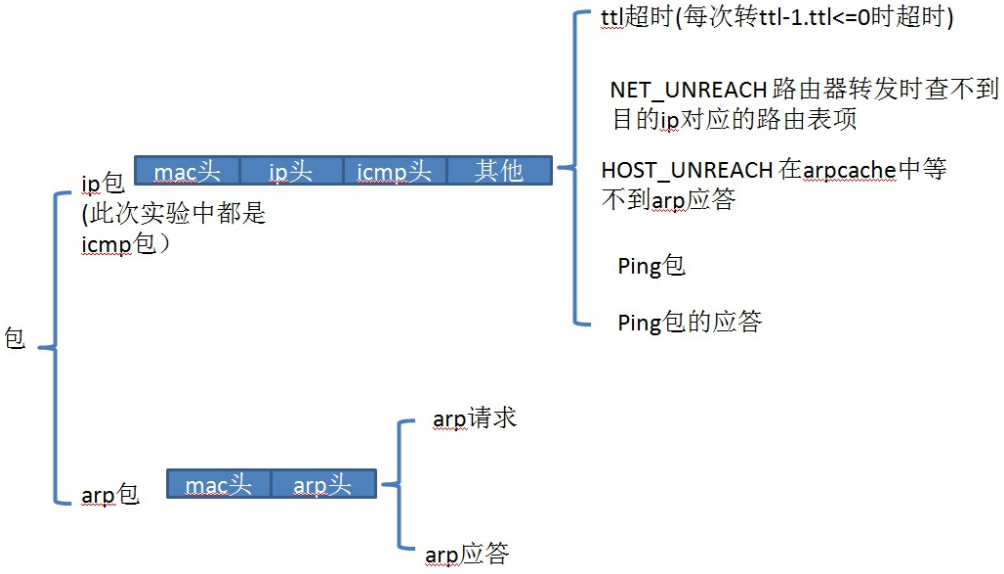
- arp:发送、接收arp request，arp reply
- arpcache:
  - arpcache_lookup：查询arpcache中是否有需要的ip->mac映射
  - arp_insert：收到arp reply后，把对应的ip->mac插入到arpcache的ip->mac映射表中，并查找缓存packet序列把这个ip下的缓存packet都发送出
  - arp_append_packet：需要转发packet但是没有对应的ip->mac映射项，则先把此packet缓存到对应的ip下面。如果之前没有此ip的缓存序列则需要创建
  - arp_sweep：一个单独的线程，每一秒启动一次，将arpcache缓存的ip序列下的每一个ip发一个arp请求。如果有某个ip超过了发arp request的上限，则删除此ip的packet缓存序列，并对每个packet发icmp HOST_UNREACH错误
- icmp:组织icmp包(有ping的reply，路由表查不到表项的NET_UNREACH,在arpcache中发送超过arp request数量上限而未收到arp reply的HOST_UNEACH,转发次数超过上限TTL<0)并发送出去
- ip:
  - longest_prefix_match:在ip表中进行最长匹配找到对应的网络
  - handle_ip_packet:收到ip包后，如果是ping包则返回icmp的ping应答，否则转发
  - ip_forward_packet:处理收到的ip包。如果路由表能最长匹配到对应的端口则转发出去，否则丢弃packet并发回icmp NET_UNREACH
- 学会手动配置路由表

3.实验过程

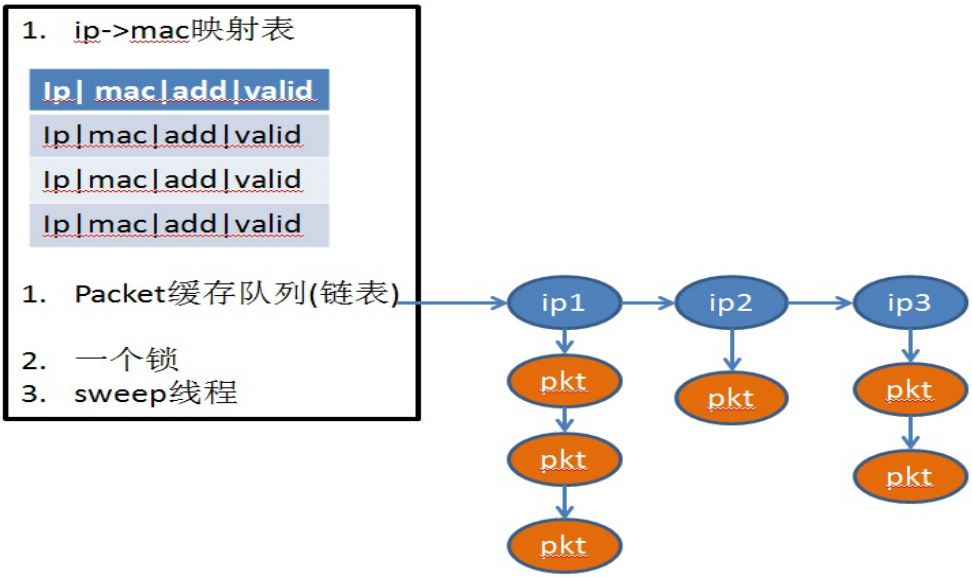
这次的代码太长了，就不把源码贴在这里了，code文件夹里都有。分析一下实验的代码流程和数据结构，并结合几次实验理解一下理论课的一些知识

3.1 不同包的结构和功能

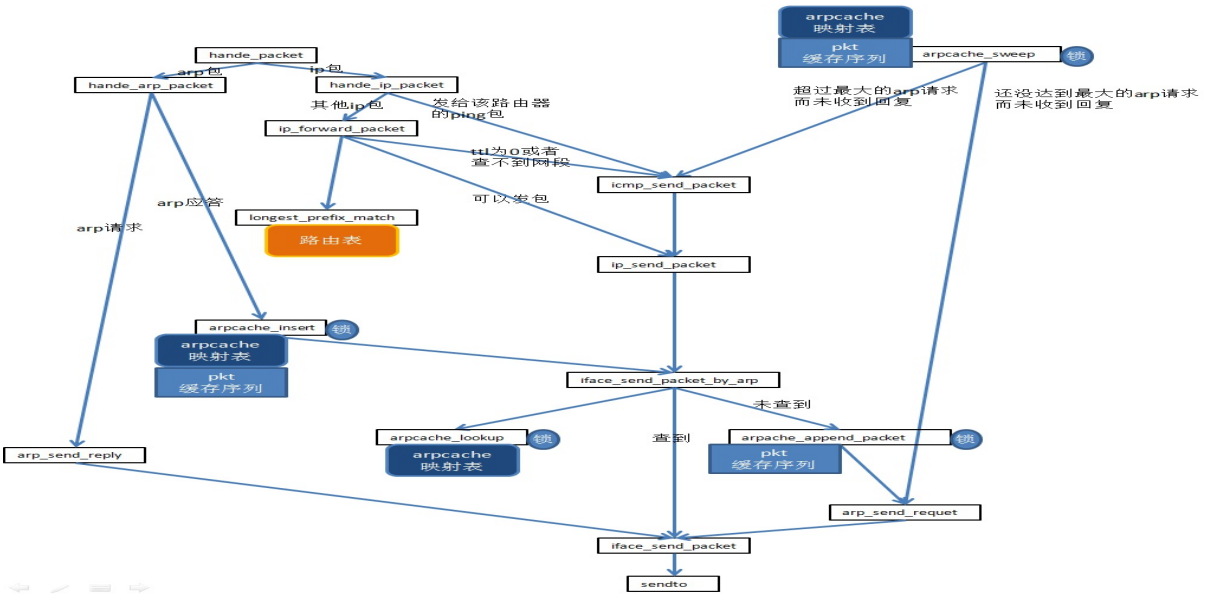
收到ip包可以转发、回应；收到arp包可以回应或丢弃，而不会转发arp包



3.2 arpcache



3.3 线程-函数-包-数据结构之间的包含、调用、操作关系



3.4 三种表的对比：转发表、路由表、arpcache表

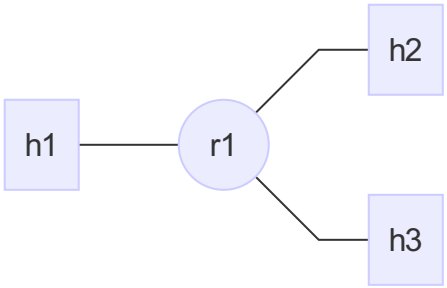
对比	转发表	路由表	arpcache表
拥有者	交换机	路由器	路由器
数据结构	hash表(用链表解决冲突)	链表	数组
表项的映射	目的mac->发包iface	目的ip->发包iface	目的ip->下一跳mac
表项获取方式	学习	手动配置	arp请求、应答
表项是否老化	老化	固定	老化
表的网络层级	链路	ip	链路-ip两层的媒介

3.5 四种设备的对比：集线器、网桥/交换机、路由器

对比	集线器	网桥/交换机	路由器
层级	物理	链路	ip
各端口是否处于相同碰撞域	是	否	否
各端口是否处于相同广播域		是	否
*备注	共享一根线的带宽	网桥双端口，交换机多端口	

4.实验结果

拓扑1



结果：

```
#################### h1 ping 10.0.2.22 ####################
PING 10.0.2.22 (10.0.2.22) 56(84) bytes of data.
64 bytes from 10.0.2.22: icmp_seq=1 ttl=63 time=173 ms
64 bytes from 10.0.2.22: icmp_seq=2 ttl=63 time=0.515 ms
64 bytes from 10.0.2.22: icmp_seq=3 ttl=63 time=0.472 ms
64 bytes from 10.0.2.22: icmp_seq=4 ttl=63 time=0.478 ms
64 bytes from 10.0.2.22: icmp_seq=5 ttl=63 time=0.478 ms

--- 10.0.2.22 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4068ms
rtt min/avg/max/mdev = 0.472/35.039/173.256/69.108 ms



#################### h1 ping 10.0.3.33 ####################
PING 10.0.3.33 (10.0.3.33) 56(84) bytes of data.
64 bytes from 10.0.3.33: icmp_seq=1 ttl=63 time=1.59 ms
64 bytes from 10.0.3.33: icmp_seq=2 ttl=63 time=0.284 ms
64 bytes from 10.0.3.33: icmp_seq=3 ttl=63 time=0.528 ms
64 bytes from 10.0.3.33: icmp_seq=4 ttl=63 time=0.524 ms
64 bytes from 10.0.3.33: icmp_seq=5 ttl=63 time=0.531 ms

--- 10.0.3.33 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4051ms
rtt min/avg/max/mdev = 0.284/0.692/1.595/0.461 ms
```

```
#################### h1 ping 10.0.1.1 ####################
PING 10.0.1.1 (10.0.1.1) 56(84) bytes of data.
64 bytes from 10.0.1.1: icmp_seq=1 ttl=64 time=1.92 ms
64 bytes from 10.0.1.1: icmp_seq=2 ttl=64 time=0.369 ms
64 bytes from 10.0.1.1: icmp_seq=3 ttl=64 time=0.339 ms
64 bytes from 10.0.1.1: icmp_seq=4 ttl=64 time=1.72 ms
64 bytes from 10.0.1.1: icmp_seq=5 ttl=64 time=0.368 ms

--- 10.0.1.1 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4032ms
rtt min/avg/max/mdev = 0.339/0.944/1.920/0.719 ms



#################### h1 ping 10.0.4.1 ####################
PING 10.0.4.1 (10.0.4.1) 56(84) bytes of data.
From 10.0.1.1 icmp_seq=1 Destination Net Unreachable
From 10.0.1.1 icmp_seq=2 Destination Net Unreachable
From 10.0.1.1 icmp_seq=3 Destination Net Unreachable
From 10.0.1.1 icmp_seq=4 Destination Net Unreachable
From 10.0.1.1 icmp_seq=5 Destination Net Unreachable

--- 10.0.4.1 ping statistics ---
5 packets transmitted, 0 received, +5 errors, 100% packet loss, time 4066ms
```

```
###################### h1 ping 10.0.2.5 ######################
PING 10.0.2.5 (10.0.2.5) 56(84) bytes of data.
From 10.0.1.1 icmp_seq=1 Destination Host Unreachable
From 10.0.1.1 icmp_seq=2 Destination Host Unreachable
From 10.0.1.1 icmp_seq=3 Destination Host Unreachable
From 10.0.1.1 icmp_seq=4 Destination Host Unreachable
From 10.0.1.1 icmp_seq=5 Destination Host Unreachable

--- 10.0.2.5 ping statistics ---
5 packets transmitted, 0 received, +5 errors, 100% packet loss, time 4047ms
pipe 3
```

拓扑2

结果：

```
test2.txt

#################### traceroute 10.0.2.22 ####################
traceroute to 10.0.2.22 (10.0.2.22), 30 hops max, 60 byte packets
 1  10.0.1.1 (10.0.1.1)  7.899 ms  9.341 ms  9.295 ms
 2  10.0.3.2 (10.0.3.2)  19.819 ms  19.952 ms  19.961 ms
 3  10.0.4.2 (10.0.4.2)  57.863 ms  57.890 ms  57.881 ms
 4  10.0.2.22 (10.0.2.22)  57.867 ms  57.862 ms  57.846 ms



#################### h1 ping 10.0.1.1 ####################
PING 10.0.1.1 (10.0.1.1) 56(84) bytes of data.
64 bytes from 10.0.1.1: icmp_seq=1 ttl=64 time=0.298 ms
64 bytes from 10.0.1.1: icmp_seq=2 ttl=64 time=0.416 ms
64 bytes from 10.0.1.1: icmp_seq=3 ttl=64 time=0.334 ms
64 bytes from 10.0.1.1: icmp_seq=4 ttl=64 time=0.355 ms
64 bytes from 10.0.1.1: icmp_seq=5 ttl=64 time=0.561 ms

--- 10.0.1.1 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4040ms
rtt min/avg/max/mdev = 0.298/0.392/0.561/0.095 ms
```

```
################### h1 ping 10.0.3.2 ###################
PING 10.0.3.2 (10.0.3.2) 56(84) bytes of data.
64 bytes from 10.0.3.2: icmp_seq=1 ttl=63 time=2.82 ms
64 bytes from 10.0.3.2: icmp_seq=2 ttl=63 time=0.887 ms
64 bytes from 10.0.3.2: icmp_seq=3 ttl=63 time=0.665 ms
64 bytes from 10.0.3.2: icmp_seq=4 ttl=63 time=0.919 ms
64 bytes from 10.0.3.2: icmp_seq=5 ttl=63 time=1.50 ms

--- 10.0.3.2 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4037ms
rtt min/avg/max/mdev = 0.665/1.360/2.826/0.785 ms



################### h1 ping 10.0.4.2 ###################
PING 10.0.4.2 (10.0.4.2) 56(84) bytes of data.
64 bytes from 10.0.4.2: icmp_seq=1 ttl=62 time=6.18 ms
64 bytes from 10.0.4.2: icmp_seq=2 ttl=62 time=1.33 ms
64 bytes from 10.0.4.2: icmp_seq=3 ttl=62 time=3.02 ms
64 bytes from 10.0.4.2: icmp_seq=4 ttl=62 time=1.76 ms
64 bytes from 10.0.4.2: icmp_seq=5 ttl=62 time=1.40 ms

--- 10.0.4.2 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4007ms
rtt min/avg/max/mdev = 1.330/2.741/6.183/1.825 ms
```

```
###################### h1 ping 10.0.2.22 ######################
PING 10.0.2.22 (10.0.2.22) 56(84) bytes of data.
64 bytes from 10.0.2.22: icmp_seq=1 ttl=61 time=1.65 ms
64 bytes from 10.0.2.22: icmp_seq=2 ttl=61 time=1.66 ms
64 bytes from 10.0.2.22: icmp_seq=3 ttl=61 time=1.04 ms
64 bytes from 10.0.2.22: icmp_seq=4 ttl=61 time=1.02 ms
64 bytes from 10.0.2.22: icmp_seq=5 ttl=61 time=1.17 ms

--- 10.0.2.22 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4007ms
rtt min/avg/max/mdev = 1.025/1.314/1.664/0.288 ms
```

5.结果分析

实验一

h1 ping 10.0.2.22,10.0.3.33可以ping通，说明路由器正确连通了多个局域网
h1 ping 10.0.4.1 回复net unreach，说明路由器里没有此网段的路由表项，目的网段不可达
h1 ping 10.0.2.5，回复host unreach，说明路由器有此网段的路由表项，但是发出arp请求后一直无法收到arp回应，目的主机不可达

实验二

h1 traceroute h2，正确显示了沿途的ip端口。
h1 ping traceroute显示的沿途端口能够ping通。
说明路由器ip配置正确，并且多跳路由器正确连通了两个局域网