2022-2023 学年第 1 学期《Linux 操作系统》期末综合实验

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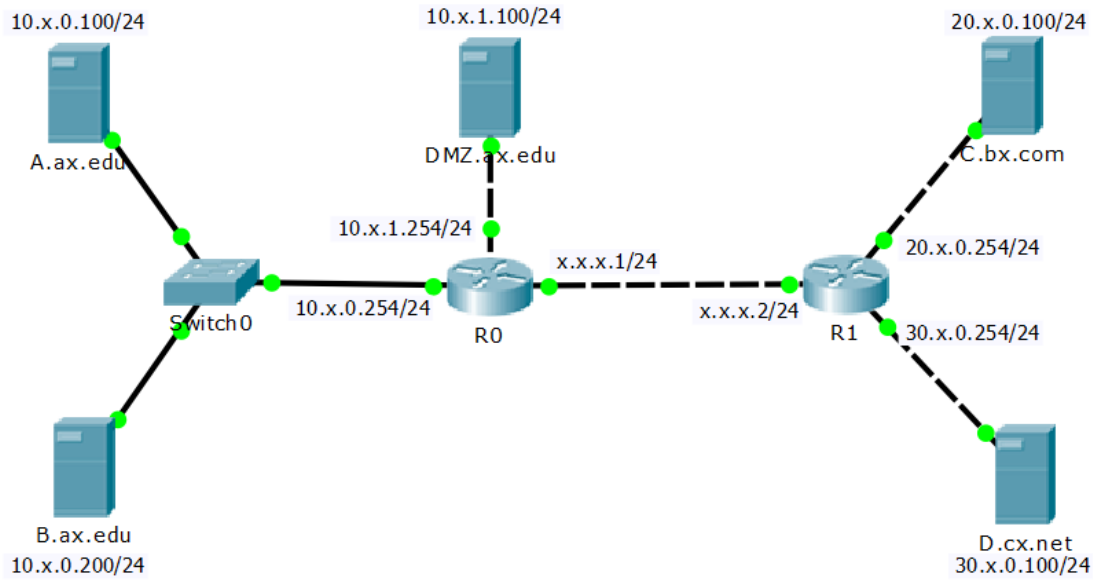
一、实验说明及要求

1. 请对关键的命令、配置、测试及运行结果进行截图(请确保截图中包含完整的命令行提示符，且文字字体足够大且清晰可见)；
2. 导出为 pdf 文件，文件名为用户名-姓名-final.pdf，在规定截止时间之前提交。
3. 所有配置均要求永久有效，所有相关服务均要求开机自动启动；
4. 虚拟机的普通用户名见附表，普通用户初始登录密码与用户名相同；
5. 实验步骤中只要出现 x 的地方必须替换成你自己的用户名序号，如你的用户名为 s23，则要求把 x 替换成 23。
6. 实验步骤后面出现的（备份 n）表示完成该步骤后，对所有虚拟机在关机状态（且卸载掉可能已挂载的光盘后）进行一次备份（请为该次备份添加好说明），以便将来恢复到该状态。期末成绩将根据每位同学做到的最后一个阶段进行打分。
7. 实验步骤中以 CentOS7 虚拟机为例，大家在实验中可以自行选择使用 CentOS7 或 Ubuntu20.04，也可以部分虚拟机使用 CentOS7，部分虚拟机使用 Ubuntu20.04。

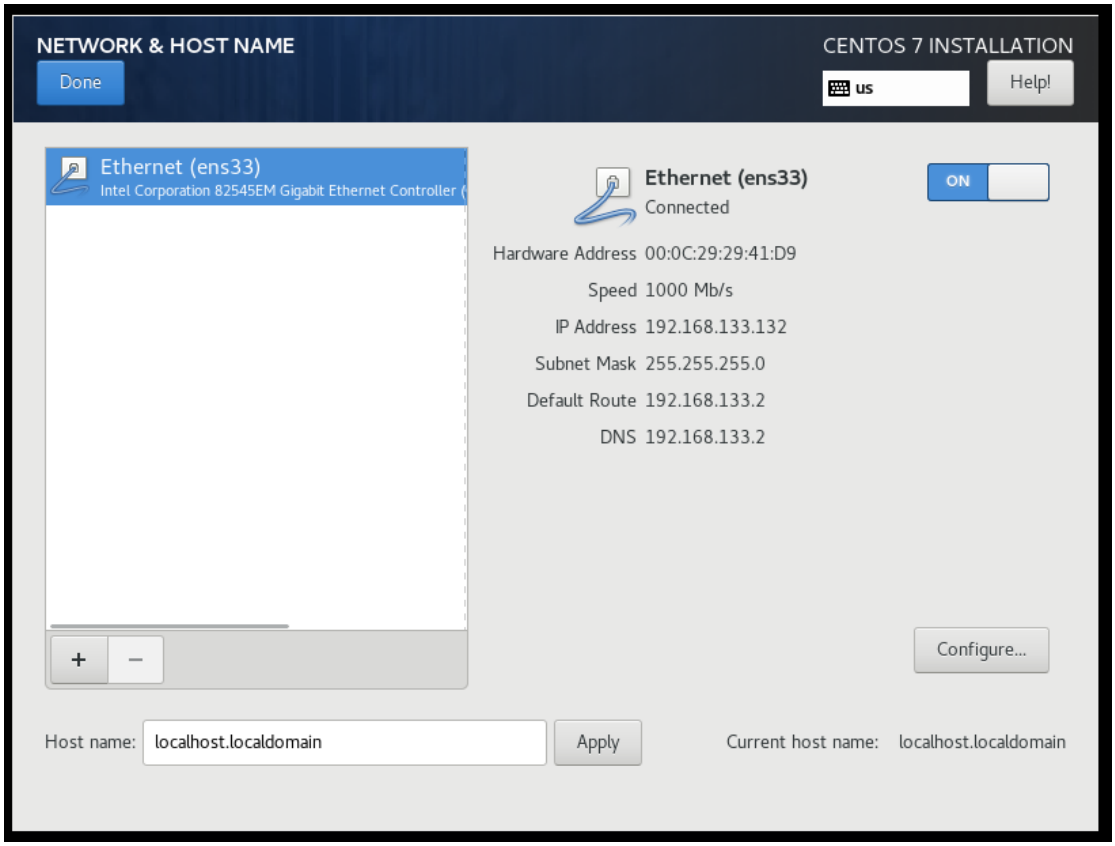
二、实验网络拓扑图（除交换机外，所有主机和路由器均用 Ubuntu 虚拟机模拟）

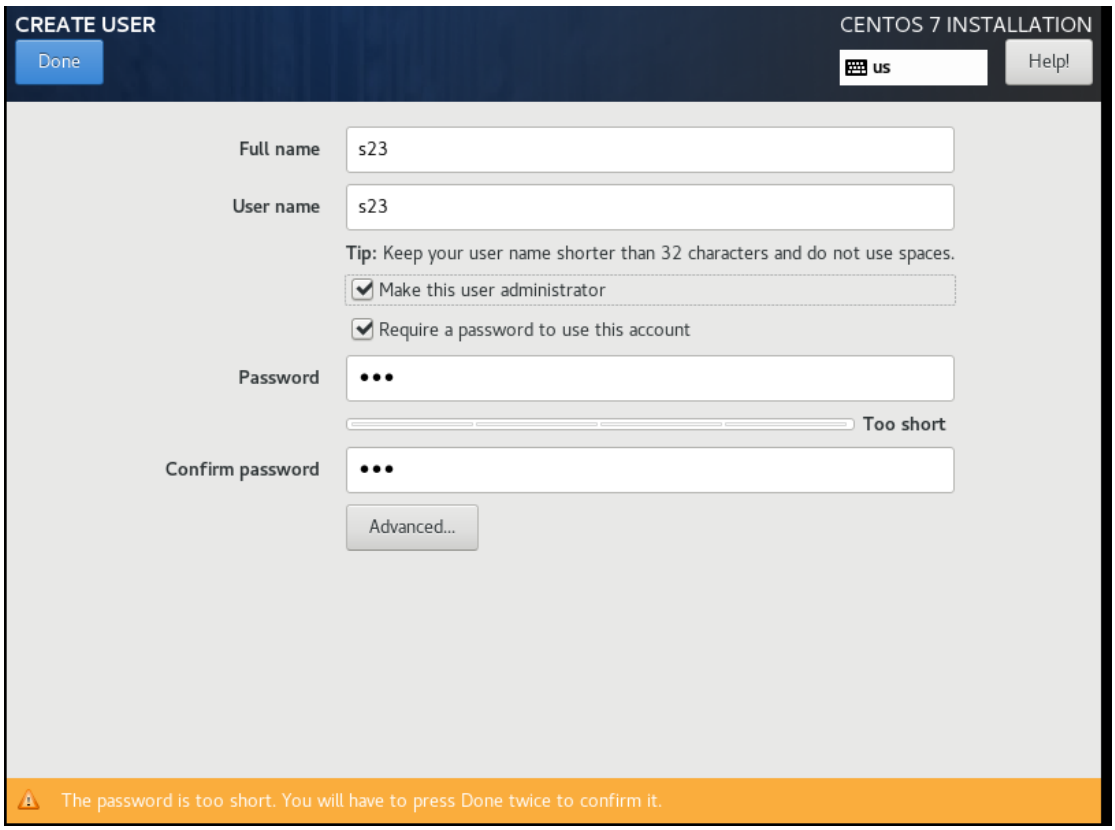


三、实验步骤（共 25 分）

阶段一：静态路由配置（10 分）

1 .新建一台虚拟机 ax-mini，虚拟机去掉软驱，然后最小化安装 CentOS7，语言选英文，并配置好 yum 光盘源，利用光盘源安装配置好 autofs 实现自动挂载光盘，并设置 autofs 服务开机自动启动，以方便利用光盘安装软件包，卸载光盘，stop 并 disable 防火墙 firewalld，禁用 selinux，关机后设置其内存为 512M，然后对虚拟机进行备份。


NETWORK & HOST NAME
Done
CENTOS 7 INSTALLATION
us
Help!
Ethernet (ens33)
Intel Corporation 82545EM Gigabit Ethernet Controller
Ethernet (ens33)
Connected
ON
Hardware Address 00:0C:29:29:41:D9
Speed 1000 Mb/s
IP Address 192.168.133.132
Subnet Mask 255.255.255.0
Default Route 192.168.133.2
DNS 192.168.133.2
Configure...
Host name: localhost.localdomain
Apply
Current host name: localhost.localdomain

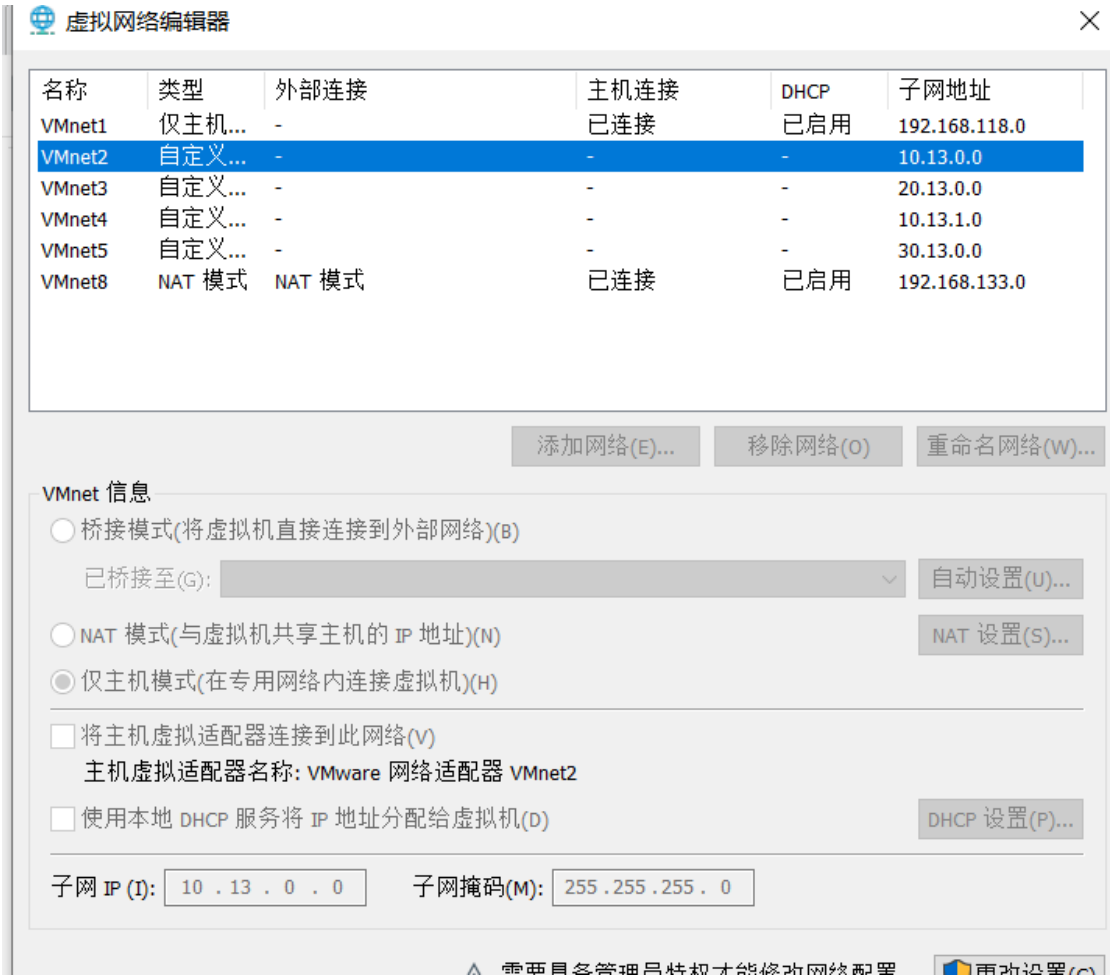

CREATE USER
Done
CENTOS 7 INSTALLATION
us
Help!
Full name
s23
User name
s23
Tip: Keep your user name shorter than 32 characters and do not use spaces.
Make this user administrator
Require a password to use this account
Password
Too short
Confirm password
Advanced...
The password is too short. You will have to press Done twice to confirm it.

```
# CentOS-Media.repo
#
#  This repo can be used with mounted DVD media, verify the mount point for
#  CentOS-7.  You can use this repo and yum to install items directly off the
#  DVD ISO that we release.
#
# To use this repo, put in your DVD and use it with the other repos too:
#  yum --enablerepo=c7-media [command]
#
# or for ONLY the media repo, do this:
#
#  yum --disablerepo=\* --enablerepo=c7-media [command]

[c7-media]
name=CentOS-$releasever - Media
baseurl=file:///media/cdrom/
gpgcheck=1
enabled=1
gpgkey=file:///etc/pki/rpm-gpg/RPM-GPG-KEY-CentOS-7
~
~
~
~
~
~
~
~
~
~
```

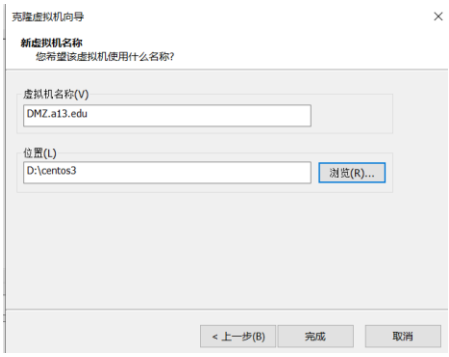
```
~
~
~
~
"/etc/auto.misc" 15L, 527C written
[root@192 yum.repos.d]# umount /dev/cdrom
[root@192 yum.repos.d]# rmdir /media/cdrom/
[root@192 yum.repos.d]# cd
```

```
"/etc/selinux/config" 14L, 542C written
[root@192 ~]# eject
[root@192 ~]# ls /media
[root@192 ~]# ls /media/cdrom
CentOS_BuildTag  EFI  EULA  GPL  images  isolinux  LiveOS  Packages  repodata  RPM-GPG-KEY-CentOS-7  RPM-GPG-KEY-CentO
[root@192 ~]# eject
[root@192 ~]#
```

2. 为 VirtualBox 添加 4 个仅主机网络（10.x.0.0/24、10.x.1.0/24、20.x.0.0/24、30.x.0.0/24），且不要启用这些仅主机网络的 DHCP 服务。



3. 从 ax-mini 的备份复制出 7 台虚拟机，虚拟机名称分别为主机 A.ax.edu、B.ax.edu、DMZ.ax.edu、C.bx.com、D.cx.net 和路由器 R0.ax.edu、R1.ispx.com。根据网络拓扑图为各台虚拟机修改网络连接并根据需要添加网卡并设置好网卡所连接的网络，其中 R0.ax.edu 和 R1.ispx.com 之间的 x.x.x.0/30 为内部网络，将这 7 台虚拟机编组成一个组。




A.a13.edu
开启此虚拟机
编辑虚拟机设置
设备
内存 512 MB
处理器 1
硬盘 (SCSI) 10 GB
CD/DVD (IDE) 正在使用文件 C:...
网络适配器 自定义 (VMnet2)
USB 控制器 存在
声卡 自动检测
打印机 存在
显示器 自动检测
描述
在此处键入对该虚拟机的描述。


B.a13.edu
开启此虚拟机
编辑虚拟机设置
设备
内存 512 MB
处理器 1
硬盘 (SCSI) 10 GB
CD/DVD (IDE) 正在使用文件 C:...
网络适配器 自定义 (VMnet2)
USB 控制器 存在
声卡 自动检测
打印机 存在
显示器 自动检测
描述
在此处键入对该虚拟机的描述。


DMZ.a13.edu
开启此虚拟机
编辑虚拟机设置
设备
内存 512 MB
处理器 1
硬盘 (SCSI) 10 GB
CD/DVD (IDE) 正在使用文件 C:...
网络适配器 自定义 (VMnet4)
USB 控制器 存在
声卡 自动检测
打印机 存在
显示器 自动检测
描述


C.b13.com
开启此虚拟机
编辑虚拟机设置
设备
内存 512 MB
处理器 1
硬盘 (SCSI) 10 GB
CD/DVD (IDE) 正在使用文件 C:...
网络适配器 自定义 (VMnet3)
USB 控制器 存在
声卡 自动检测
打印机 存在
显示器 自动检测
描述
在此处键入对该虚拟机的描述。

4．启动所有虚拟机，根据虚拟机名称永久设置所有虚拟机的主机名，并永久设置好所有虚拟机的接口 IP 地址（**注意：请在配置网卡 IP 地址前先检查网卡的 mac 地址和网卡名称的对应关系，一定不要弄错!!!**），要求所有路由器上停止并禁用 NetworkManager 服务。并为所有主机配置好永久默认网关，为所有路由器永久启用路由转发功能。

设置主机名：

```
[root@localhost ~]# hostnamectl set-hostname B
[root@localhost ~]# bash
[root@b ~]#
```

其余同理

设置虚拟机 IP 地址：

主机：

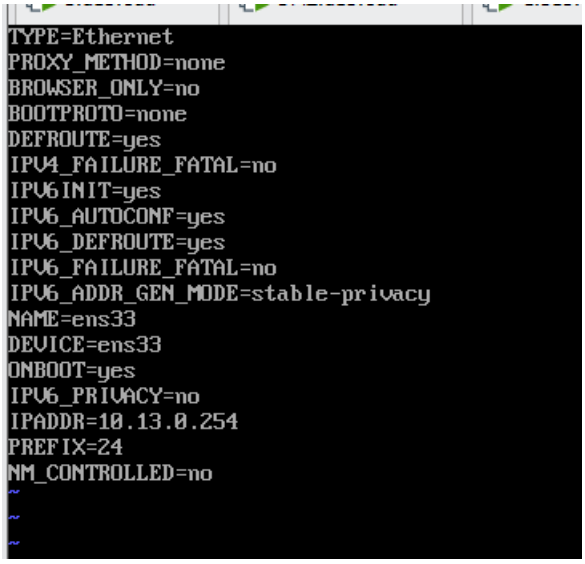
```
PROXY_METHOD=none
BROWSER_ONLY=no
BOOTPROTO=none
DEFROUTE=yes
IPV4_FAILURE_FATAL=no
IPV6INIT=yes
IPV6_AUTOCONF=yes
IPV6_DEFROUTE=yes
IPV6_FAILURE_FATAL=no
IPV6_ADDR_GEN_MODE=stable-privacy
NAME=ens33
DEVICE=ens33
ONBOOT=yes
IPV6_PRIVACY=no
IPADDR=10.13.0.100
PREFIX=24
GATEWAY=10.13.0.254
~
```

使配置文件生效：

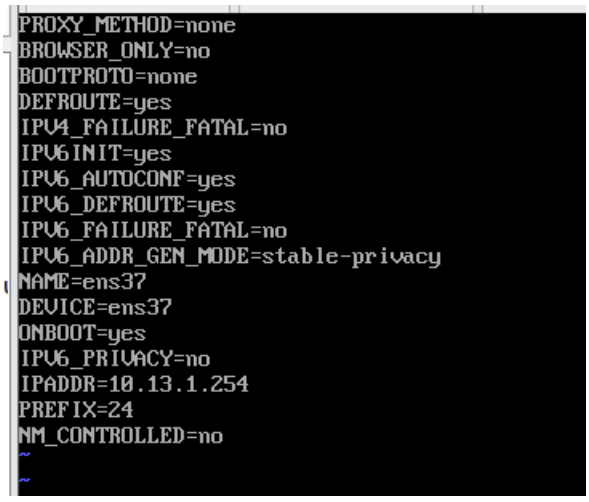
```
[root@a network-scripts]# nmcli conn reload
[root@a network-scripts]# nmcli con down enps33
Error: 'enps33' is not an active connection.
Error: no active connection provided.
[root@a network-scripts]# nmcli con down ens33
Connection 'ens33' successfully deactivated (D-Bus active path: /org/freedesktop/NetworkManager/Acti
veConnection/18)
[root@a network-scripts]# nmcli con up ens33
Connection successfully activated (D-Bus active path: /org/freedesktop/NetworkManager/ActiveConnecti
on/19)
[root@a network-scripts]# ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
2: ens33: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 10
00
    link/ether 00:0c:29:a1:e1:76 brd ff:ff:ff:ff:ff:ff
    inet 10.13.0.100/24 brd 10.13.0.255 scope global noprefixroute ens33
       valid_lft forever preferred_lft forever
    inet6 fe80::fb34:4353:4907:292/64 scope link noprefixroute
       valid_lft forever preferred_lft forever
[root@a network-scripts]#
```

路由器：

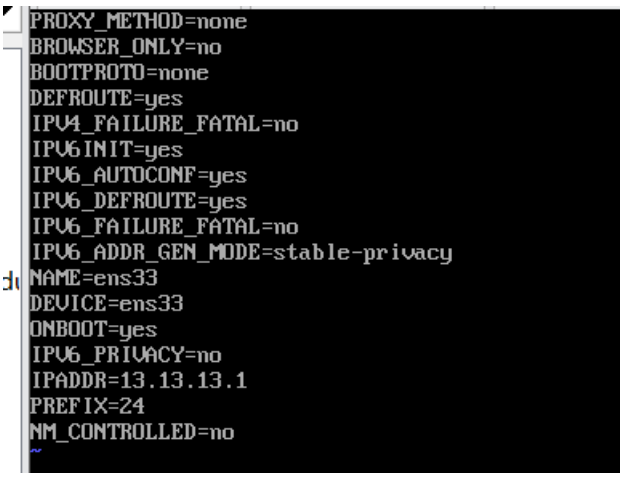
```
[root@r0 ~]# systemctl stop NetworkManager
[root@r0 ~]# systemctl is-enabled NetworkManager
disabled
[root@r0 ~]#
```



```
TYPE=Ethernet
PROXY_METHOD=none
BROWSER_ONLY=no
BOOTPROTO=none
DEFROUTE=yes
IPV4_FAILURE_FATAL=no
IPV6INIT=yes
IPV6_AUTOCONF=yes
IPV6_DEFROUTE=yes
IPV6_FAILURE_FATAL=no
IPV6_ADDR_GEN_MODE=stable-privacy
NAME=ens33
DEVICE=ens33
ONBOOT=yes
IPV6_PRIVACY=no
IPADDR=10.13.0.254
PREFIX=24
NM_CONTROLLED=no
~
~
~
```



```
PROXY_METHOD=none
BROWSER_ONLY=no
BOOTPROTO=none
DEFROUTE=yes
IPV4_FAILURE_FATAL=no
IPV6INIT=yes
IPV6_AUTOCONF=yes
IPV6_DEFROUTE=yes
IPV6_FAILURE_FATAL=no
IPV6_ADDR_GEN_MODE=stable-privacy
NAME=ens37
DEVICE=ens37
ONBOOT=yes
IPV6_PRIVACY=no
IPADDR=10.13.1.254
PREFIX=24
NM_CONTROLLED=no
~
~
```



```
PROXY_METHOD=none
BROWSER_ONLY=no
BOOTPROTO=none
DEFROUTE=yes
IPV4_FAILURE_FATAL=no
IPV6INIT=yes
IPV6_AUTOCONF=yes
IPV6_DEFROUTE=yes
IPV6_FAILURE_FATAL=no
IPV6_ADDR_GEN_MODE=stable-privacy
NAME=ens33
DEVICE=ens33
ONBOOT=yes
IPV6_PRIVACY=no
IPADDR=13.13.13.1
PREFIX=24
NM_CONTROLLED=no
~
```

```
[root@r0 network-scripts]# systemctl restart network
[root@r0 network-scripts]# ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
2: ens33: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default
00
    link/ether 00:0c:29:79:40:f8 brd ff:ff:ff:ff:ff:ff
    inet 10.13.0.254/24 brd 10.13.0.255 scope global ens33
       valid_lft forever preferred_lft forever
    inet6 fe80::20c:29ff:fe79:40f8/64 scope link
       valid_lft forever preferred_lft forever
3: ens37: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UNKNOWN group def
en 1000
    link/ether 00:0c:29:79:40:02 brd ff:ff:ff:ff:ff:ff
    inet 10.13.1.254/24 brd 10.13.1.255 scope global ens37
       valid_lft forever preferred_lft forever
    inet6 fe80::20c:29ff:fe79:4002/64 scope link
       valid_lft forever preferred_lft forever
4: ens38: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UNKNOWN group def
en 1000
    link/ether 00:0c:29:79:40:0c brd ff:ff:ff:ff:ff:ff
    inet 13.13.13.1/24 brd 13.13.13.255 scope global ens38
       valid_lft forever preferred_lft forever
    inet6 fe80::20c:29ff:fe79:400c/64 scope link
       valid_lft forever preferred_lft forever
[root@r0 network-scripts]#
```

启用路有转发：

```
#
# For more information, see sysctl.conf(5) and sysctl.d(5).
net.ipv4.ip_forward=1
~
~
```

5. 启动所有虚拟机，为 R0 添加默认路由，为 R1 添加静态路由，测试验证 5 台主机 A.ax.edu、B.ax.edu、DMZ.ax.edu、C.bx.com、D.cx.net 之间能两两 ping 通。（备份 1：5 分）

为 r0 添加默认：

```
PROXY_METHOD=none
BROWSER_ONLY=no
BOOTPROTO=none
DEFROUTE=yes
IPV4_FAILURE_FATAL=no
IPV6INIT=yes
IPV6_AUTOCONF=yes
IPV6_DEFROUTE=yes
IPV6_FAILURE_FATAL=no
IPV6_ADDR_GEN_MODE=stable-privacy
NAME=ens38
DEVICE=ens38
ONBOOT=yes
IPV6_PRIVACY=no
IPADDR=13.13.13.1
PREFIX=24
GATEWAY=13.13.13.2
NM_CONTROLLED=no
```

为 R1 添加静态：

```
PROXY_METHOD=none
BROWSER_ONLY=no
BOOTPROTO=none
DEFROUTE=yes
IPV4_FAILURE_FATAL=no
IPV6INIT=yes
IPV6_AUTOCONF=yes
IPV6_DEFROUTE=yes
IPV6_FAILURE_FATAL=no
IPV6_ADDR_GEN_MODE=stable-privacy
NAME=ens38
DEVICE=ens38
ONBOOT=yes
IPV6_PRIVACY=no
IPADDR=13.13.13.2
PREFIX=24
NM_CONTROLLED=no
10.13.0.0/24 via 13.13.13.1
10.13.1.0/24 via 13.13.13.1
~
```

测试：

a- C

```
[root@a network-scripts]# ping 20.13.0.100
PING 20.13.0.100 (20.13.0.100) 56(84) bytes of data.
64 bytes from 20.13.0.100: icmp_seq=1 ttl=62 time=1.93 ms
64 bytes from 20.13.0.100: icmp_seq=2 ttl=62 time=1.59 ms
64 bytes from 20.13.0.100: icmp_seq=3 ttl=62 time=0.769 ms
^C
--- 20.13.0.100 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2006ms
rtt min/avg/max/mdev = 0.769/1.433/1.937/0.492 ms
[root@a network-scripts]#
```

b- C

```
[root@b network-scripts]# ping 20.13.0.100
PING 20.13.0.100 (20.13.0.100) 56(84) bytes of data.
64 bytes from 20.13.0.100: icmp_seq=764 ttl=62 time=2.15 ms
64 bytes from 20.13.0.100: icmp_seq=765 ttl=62 time=0.926 ms
64 bytes from 20.13.0.100: icmp_seq=766 ttl=62 time=0.860 ms
64 bytes from 20.13.0.100: icmp_seq=767 ttl=62 time=0.725 ms
64 bytes from 20.13.0.100: icmp_seq=768 ttl=62 time=0.838 ms
64 bytes from 20.13.0.100: icmp_seq=769 ttl=62 time=0.657 ms
64 bytes from 20.13.0.100: icmp_seq=770 ttl=62 time=0.658 ms
64 bytes from 20.13.0.100: icmp_seq=771 ttl=62 time=1.07 ms
64 bytes from 20.13.0.100: icmp_seq=772 ttl=62 time=1.14 ms
64 bytes from 20.13.0.100: icmp_seq=773 ttl=62 time=0.905 ms
^C
--- 20.13.0.100 ping statistics ---
773 packets transmitted, 10 received, 98% packet loss, time 773173ms
rtt min/avg/max/mdev = 0.657/0.994/2.151/0.415 ms
```

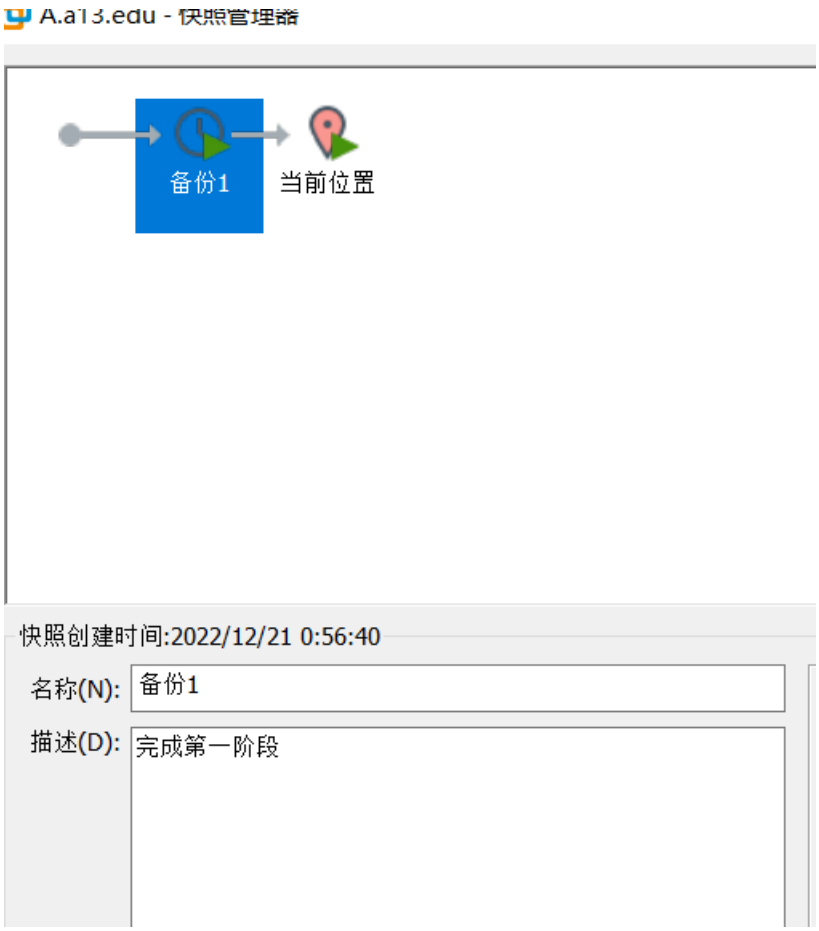
c- A

```
[root@c network-scripts]# ping 10.13.0.100
PING 10.13.0.100 (10.13.0.100) 56(84) bytes of data.
64 bytes from 10.13.0.100: icmp_seq=1 ttl=62 time=1.08 ms
64 bytes from 10.13.0.100: icmp_seq=2 ttl=62 time=0.762 ms
64 bytes from 10.13.0.100: icmp_seq=3 ttl=62 time=1.08 ms
^C
--- 10.13.0.100 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2007ms
rtt min/avg/max/mdev = 0.762/0.978/1.088/0.155 ms
[root@c network-scripts]#
```

d- a

```
       valid_lft forever preferred_lft forever
[root@d network-scripts]# ping 10.13.0.100
PING 10.13.0.100 (10.13.0.100) 56(84) bytes of data.
64 bytes from 10.13.0.100: icmp_seq=1 ttl=62 time=1.03 ms
64 bytes from 10.13.0.100: icmp_seq=2 ttl=62 time=1.25 ms
64 bytes from 10.13.0.100: icmp_seq=3 ttl=62 time=0.822 ms
^C
--- 10.13.0.100 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2006ms
rtt min/avg/max/mdev = 0.822/1.035/1.252/0.179 ms
[root@d network-scripts]# _
```

备份：



阶段二：DNS 服务配置（10 分）

1. 启动所有虚拟机，即所有主机能通过静态路由互相 ping 通的状态。

2. 配置 A 为 ax.edu 域的主域名服务器并进行测试。

安装 bind

```
Installed:
  bind.x86_64 32:9.11.4-26.P2.el7              bind-utils.x86_64 32:9.11.4-26.P2.el7

Dependency Installed:
  GeoIP.x86_64 0:1.5.0-14.el7                    audit-libs-python.x86_64 0:2.8.5-4.el7
  bind-libs.x86_64 32:9.11.4-26.P2.el7           bind-libs-lite.x86_64 32:9.11.4-26.P2.el7
  bind-license.noarch 32:9.11.4-26.P2.el7        checkpolicy.x86_64 0:2.5-8.el7
  geoipupdate.x86_64 0:2.5.0-1.el7               libcgroup.x86_64 0:0.41-21.el7
  libsemanage-python.x86_64 0:2.5-14.el7         policycoreutils-python.x86_64 0:2.5-34.el7
  python-IPy.noarch 0:0.75-6.el7                 python-ply.noarch 0:3.4-11.el7
  setools-libs.x86_64 0:3.3.8-4.el7

Complete!
[root@a network-scripts]# _
```

配置 named.conf

```
options {
        listen-on port 53 { any; };
        listen-on-v6 port 53 { none; };
        directory       "/var/named";
        dump-file       "/var/named/data/cache_dump.db";
        statistics-file "/var/named/data/named_stats.txt";
        memstatistics-file "/var/named/data/named_mem_stats.txt";
        recursing-file  "/var/named/data/named.recursing";
        secroots-file   "/var/named/data/named.secroots";
        allow-query     { any; };
```

```
};

zone "." IN {
        type hint;
        file "named.ca";
};
zone "a13.edu" IN {
        type master;
        file "a13.edu.zone";
}
zone "0.13.10.in-addr-arpa" IN {
        type master;
        file "10.13.0.apra";
};
include "/etc/named.rfc1912.zones";
include "/etc/named.root.key";
```

配置正向域：

```
@       IN SOA  ns1.a13.edu. admin.a13.edu. (
                                        0       ; serial
                                        1D      ; refresh
                                        1H      ; retry
                                        1W      ; expire
                                        3H )    ; minimum

        NS      ns1
        NS      ns2
ns1     A       10.13.0.100
ns2     A       10.13.0.200
www     A       10.13.0.100
ftp     CNAME   c1
c1      A       10.13.0.100
~
~
~
```

配置反向域：

```
@       IN SOA  ns1.a13.edu. admin.a13.edu. (
                                        0       ; serial
                                        1D      ; refresh
                                        1H      ; retry
                                        1W      ; expire
                                        3H )    ; minimum
        NS      ns1.a13.edu.
100     PTR     c1.a13.edu.
100     PTR     ns1.a13.edu.
200     PTR     c2.a13.edu.
200     PTR     ns2.a13.edu.
~
~
~
~
~
```

测试：

```
[root@a named]# host A.a13.edu
A.a13.edu has address 10.13.0.100
```

3．配置 B 为 ax.edu 域的从域名服务器并进行测试。

```
};

zone "a13.edu" IN {
        type slave;
        file "slaves/a13.edu.zone";
        masters { 10.13.0.100; };
};

zone "0.13.10.in-addr.arpa" IN {
        type slave;
        file "slaves/10.13.0.arpa";
        masters { 10.13.0.100; };
};
```

```
};
zone "a13.edu" IN {
        type master;
        file "a13.edu.zone";
        allow-transfer { 10.13.0.200; };
};
zone "0.13.10.in-addr-arpa" IN {
        type master;
        file "10.13.0.arpa";
        allow-transfer { 10.13.0.200; };
};
```

```
[root@b slaves]# ll
total 8
-rw-r--r-- 1 named named 287 Dec 22 01:11 10.13.0.arpa
-rw-r--r-- 1 named named 354 Dec 22 01:04 a13.edu.zone
[root@b slaves]# _
```

```
www.a13.edu has address 10.13.0.100
[root@b slaves]# host www.a13.edu 10.13.0.200
Using domain server:
Name: 10.13.0.200
Address: 10.13.0.200#53
Aliases:

www.a13.edu has address 10.13.0.100
[root@b slaves]# _
```

4．配置 C 为 bx.com 域的主域名服务器并进行测试。

编辑/etc/named.conf

```
zone "." IN {
        type hint;
        file "named.ca";
};

zone "b13.com" IN {
        type master;
        file "b13.com.zone";
};

zone "0.13.20.in-addr.arpa" IN {
        type master;
        file "20.13.0.arpa";
};
"/etc/named.conf" 71L, 1926C written
[root@c ~]#
```

编辑域名服务器：b13.com.zone 和 20.13.0.arpa

```
@       IN SOA  C.b13.com. admin.b13.com. (
                                        0       ; serial
                                        1D      ; refresh
                                        1H      ; retry
                                        1W      ; expire
                                        3H )    ; minimum
        NS      C
C       A       20.13.0.100
WWW     A       20.13.0.100
~
~
~
```

```
$TTL 1D
@       IN SOA  C.b13.com. admin.b13.com. (
                                        0       ; serial
                                        1D      ; refresh
                                        1H      ; retry
                                        1W      ; expire
                                        3H )    ; minimum
        NS      C.b13.com
100     PTR     20.13.0.100
~
~
~
~
~
~
```

测试：

```
[root@c named]# systemctl enable named
Created symlink from /etc/systemd/system/multi-user.target.wants/named.service
ystem/named.service.
[root@c named]# host www.b13.com
www.b13.com has address 20.13.0.100
[root@c named]#
```

5. 配置 D 为 cx.net 域的主域名服务器并进行测试。

编辑/etc/named.conf

```
zone "." IN {
        type hint;
        file "named.ca";
};

zone "c13.net" IN {
        type master;
        file "c13.net.zone";
};

zone "0.13.30.in-addr.arpa" IN {
        type master;
        file "30.13.0.arpa";
};
"/etc/named.conf" 71L, 1926C written
[root@d ~]# named-checkconf
[root@d ~]# cd
```

编辑域名服务器：c13.net.zone 和 30.13.0.arpa

```
$TTL 3H
@       IN SOA  D.c13.net. admin.c13.net. (
                                        0       ; serial
                                        1D      ; refresh
                                        1H      ; retry
                                        1W      ; expire
                                        3H )    ; minimum
        NS      D
D       A       30.13.0.100
WWW     A       30.13.0.100
~
~
~
~
~
```

```
$TTL 1D
@       IN SOA  D.c13.net. admin.c13.net. (
                                        0       ; serial
                                        1D      ; refresh
                                        1H      ; retry
                                        1W      ; expire
                                        3H )    ; minimum
        NS      D.c13.net.
100     PTR     D.c13.net.
~
~
~
~
~
~
~
```

测试：

```
[root@d named]# systemctl start named
[root@d named]# systemctl enable named
Created symlink from /etc/systemd/system/multi-user.tar
ystem/named.service.
[root@d named]# host www.c13.net
www.c13.net has address 30.13.0.100
[root@d named]#
```

6．配置 R1 为 com 域和 net 域的主域名服务器，并委派 bx.com 域给 C，委派 cx.net 域给 D，然后对委派进行测试。

修改/etc/named.cong 配置文件：

```
zone "." IN {
        type hint;
        file "named.ca";
};

zone "com" IN {
        type master;
        file "com.zone";
};

zone "net" IN {
        type master;
        file "net.zone";
};
```

B.a13.edu | DMZ.a13.edu | C.b13.com | D.c13.net

```
$TTL 3H
@       IN SOA  com. admin.com. (
                                        0       ; serial
                                        1D      ; refresh
                                        1H      ; retry
                                        1W      ; expire
                                        3H )    ; minimum
        NS      com.
        A       13.13.13.2
b13     A       20.13.0.100
c13     A       20.13.0.100
```

```
$TTL 3H
@       IN SOA  net. admin.net. (
                                        0       ; serial
                                        1D      ; refresh
                                        1H      ; retry
                                        1W      ; expire
                                        3H )    ; minimum
        NS      net.
        A       30.13.0.254
c13     A       30.13.0.100
d.c13   A       30.13.0.100
```

```
[root@r1 named]# host C.b13.com
C.b13.com has address 20.13.0.100
[root@r1 named]# host D.c13.bet
^C[root@r1 named]# host D.c13.net
d.c13.net has address 30.13.0.100
[root@r1 named]# _
```

7．配置 DMZ 为本地域名服务器，设置其将所有查询转发给 R1，并进行测试。

配置/etc/named.conf

```
dump-file       "/var/named/data/cache_dump.db";
statistics-file "/var/named/data/named_stats.txt";
memstatistics-file "/var/named/data/named_mem_stats.txt";
recursing-file  "/var/named/data/named.recursing";
secroots-file   "/var/named/data/named.secroots";
allow-query     { any; };
forward only;
forwarders { 13.13.13.2; };

/*
```

测试：

```
/etc/named.conf  64L, 1858C written
[root@dmz ~]# systemctl start named
[root@dmz ~]# systemctl ebable named
Unknown operation 'ebable'.
[root@dmz ~]# systemctl enable named
Created symlink from /etc/systemd/system/multi-user.target.wants/named.service t
ystem/named.service.
[root@dmz ~]# host www.c13.net
www.c13.net has address 30.13.0.100
[root@dmz ~]# host www.b13.com
www.b13.com has address 20.13.0.100
[root@dmz ~]# host www.a13.edu
^C[root@dmz ~]#
```

8．配置 R1 将对 ax.edu 域的请求转发给 A，并进行测试。

在/etc/named.conf 新增：

```
        file "com.zone";
};

zone "net" IN {
        type master;
        file "net.zone";
};

zone "a13.edu" IN {
        type fprward;
        forwarders { 10.13.0.100; };
};
:wq
```

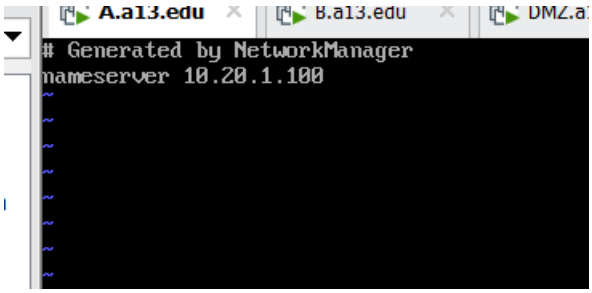
测试：

```
include "/etc/named.root.key";
"/etc/named.conf" 75L, 1965C written
[root@r1 named]# systemctl reload named
[root@r1 named]# host www.a13.edu
www.a13.edu has address 10.13.0.100
[root@r1 named]#
```

9．配置 A、B、C、D 的本地域名服务器为 DMZ，并进行域名解析测试。**（备份 2：10 分）**

设置 ABCD 主机的本地域名服务器：

```
"/etc/resolv.conf" 2L, 52C written
[root@b ~]# vi /etc/resolv.conf
```


A.a13.edu
B.a13.edu
Generated by NetworkManager
nameserver 10.20.1.100

测试：

A：


"/etc/resolv.conf" 2L, 53C written
[root@a ~]# host www.a13.edu
www.a13.edu has address 10.13.0.100
[root@a ~]# host www.b13.com
www.b13.com has address 20.13.0.100
[root@a ~]# host www.c13.net
www.c13.net has address 30.13.0.100
[root@a ~]#

B：


"/etc/resolv.conf" 2L, 53C written
[root@b ~]# host www.a13.edu
www.a13.edu has address 10.13.0.100
[root@b ~]# host www.b13.com
www.b13.com has address 20.13.0.100
[root@b ~]# host www.c13.net
www.c13.net has address 30.13.0.100
[root@b ~]#

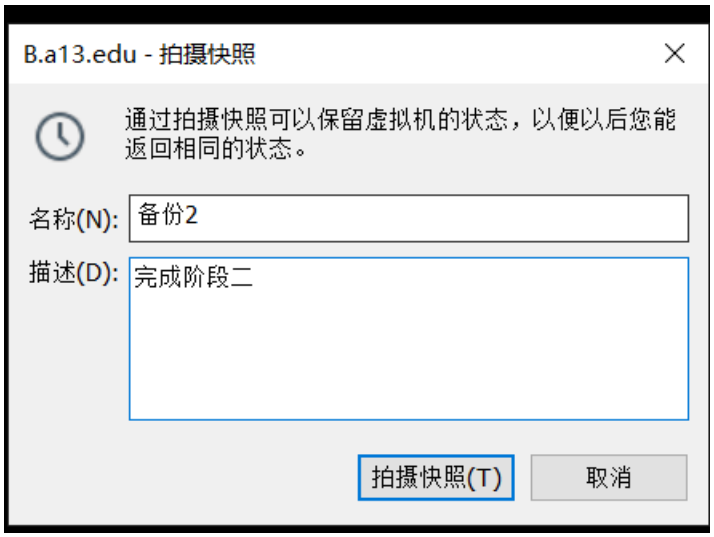
C：


"/etc/resolv.conf" 2L, 53C written
[root@c named]# host www.a13.edu
www.a13.edu has address 10.13.0.100
[root@c named]# host www.b13.com
www.b13.com has address 20.13.0.100
[root@c named]# host www.c13.net
www.c13.net has address 30.13.0.100
[root@c named]# _

D：


"/etc/resolv.conf" 2L, 53C written
[root@d named]# host www.a13.edu
www.a13.edu has address 10.13.0.100
[root@d named]# host www.b13.com
www.b13.com has address 20.13.0.100
[root@d named]# host www.c13.net
www.c13.net has address 30.13.0.100
[root@d named]# _

备份：



阶段三：DHCP 服务配置（5 分）

1. 在 R0 上配置 DHCP 服务，为 10.x.0.0/24 网段的主机分配 10.x.0.50~59 的 IP 地址、默认网关及 DNS 服务器(R0 相应接口上的 IP 地址)，为 30.x.0.0/24 网段的主机分配 30.x.0.70~79 的 IP 地址、默认网关及 DNS 服务器(R0 相应接口上的 IP 地址)。

下载 dhcp 并修改配置文件：

```
default-lease-time 600;
max-lease-time 7200;
log-facility local7;



# A slightly different configuration for an internal subnet.
subnet 10.13.0.0 netmask 255.255.255.0 {
  range 10.13.0.50 10.13.0.59;
  option domain-name-servers 10.13.1.100;
  option domain-name "a13.edu";
  option routers 10.13.0.254;
  option broadcast-address 10.13.0.255;
}

subnet 30.13.0.0 netmask 255.255.255.0 {
        range 30.13.0.70 30.13.0.79;
        option domain-name-server 10.13.1.100;
        option domain-name "c19.net";
        option routers 30.13.0.254;
        option broadcast-address 30.13.0.255;
}

subnet 13.13.13.0 netmask 255.255.255.0 {
}
~
```

```
Failed to start dhcp.service: Unit not found.
[root@r0 dhcp]# systemctl start dhcpd
[root@r0 dhcp]# systemctl enable dhcpd
Created symlink from /etc/systemd/system/multi-user.target.want
ystem/dhcpd.service.
[root@r0 dhcp]#
```

2. 在 R1 上配置并启动 DHCP 中继代理服务。

```
Complete!
[root@r1 ~]# cp /usr/lib/systemd/system/dhcrelay.service  /etc/systemd/system
[root@r1 ~]# vi /etc/systemd/system/dhcrelay.service a_
```

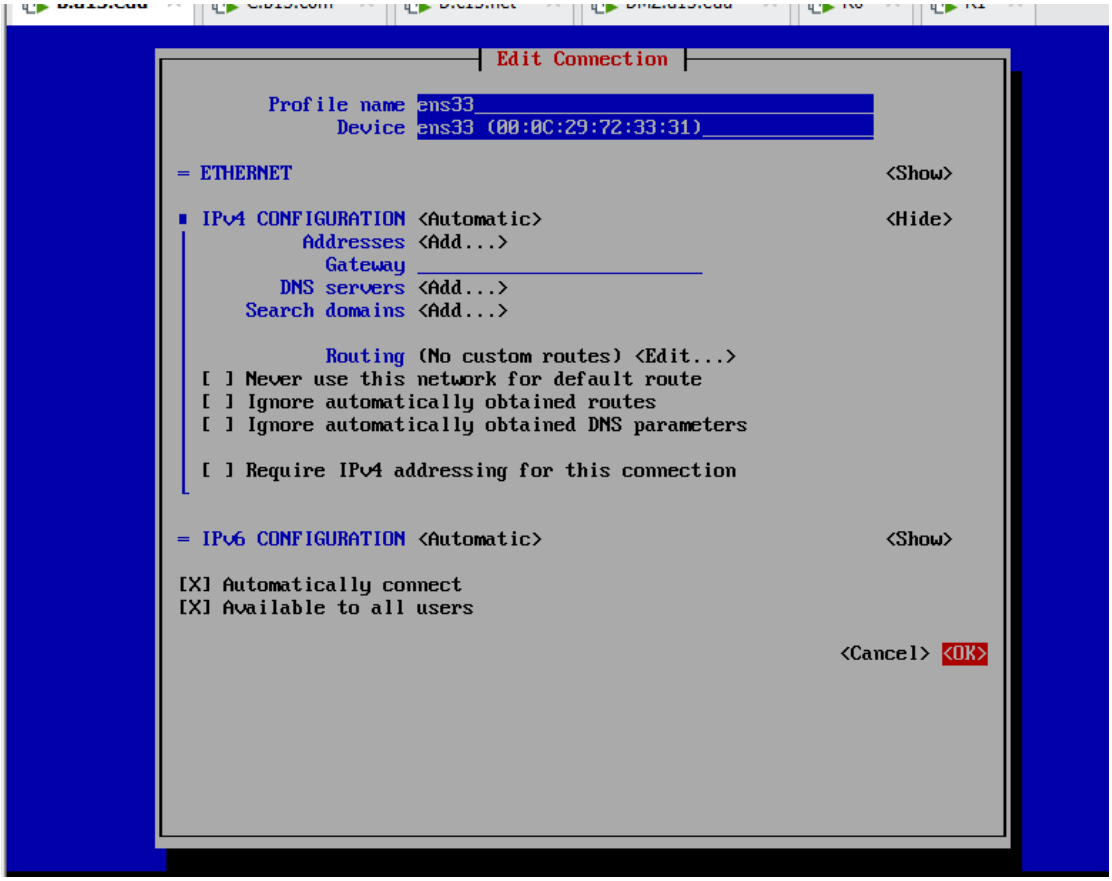
```
Description=DHCP Relay Agent Daemon
Documentation=man:dhcrelay(8)
Wants=network-online.target
After=network-online.target

[Service]
Type=notify
ExecStart=/usr/sbin/dhcrelay -d --no-pid 13.13.13.1

[Install]
WantedBy=multi-user.target
~
~
~
~
~
~
~
~
```

```
~
"/etc/systemd/system/dhcrelay.service" 12L, 242C written
[root@r1 ~]# systemctl --system daemon-reload
[root@r1 ~]# systemctl start dhcrelay.service
[root@r1 ~]# _
```

3. 将 B 和 D 配置为通过 DHCP 自动获取 IP 地址。

B:

```
Last login: Tue Dec 20 23:42:27 on tty1
[root@b ~]# systemctl stop named
[root@b ~]# systemctl disable named
Removed symlink /etc/systemd/system/multi-user.target.wants/named.service.
[root@b ~]# nmcil conn down ens33
-bash: nmcil: command not found
[root@b ~]# nmcli conn down ens33
Connection 'ens33' successfully deactivated (D-Bus active path: /org/freedes
veConnection/1)
[root@b ~]# _
```



D 同理

4. 测试并查看 B 和 D 自动获取 IP 地址的情况。（备份 3：5 分）

B:

```
    link/ether 00:0c:29:72:33:31 brd ff:ff:ff:ff:ff:ff
[root@b ~]# nmcli conn up ens33
Connection successfully activated (D-Bus active path: /org/freedesktop/NetworkManager/Active
on/7)
[root@b ~]# ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
2: ens33: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default
00
    link/ether 00:0c:29:72:33:31 brd ff:ff:ff:ff:ff:ff
    inet 10.13.0.50/24 brd 10.13.0.255 scope global noprefixroute dynamic ens33
       valid_lft 598sec preferred_lft 598sec
    inet6 fe80::fb34:4353:4907:292/64 scope link tentative noprefixroute dadfailed
       valid_lft forever preferred_lft forever
    inet6 fe80::78af:d305:643f:eb3b/64 scope link noprefixroute
       valid_lft forever preferred_lft forever
[root@b ~]#
```

D:

```
[root@d ~]# nmcli conn up ens33
Connection successfully activated (D-Bus active path: /org/freedesktop/NetworkMa
on/2)
[root@d ~]# ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group defaul
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
2: ens33: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP g
00
    link/ether 00:0c:29:a2:3f:69 brd ff:ff:ff:ff:ff:ff
    inet 30.13.0.70/24 brd 30.13.0.255 scope global noprefixroute dynamic ens33
       valid_lft 596sec preferred_lft 596sec
    inet6 fe80::fb34:4353:4907:292/64 scope link noprefixroute
       valid_lft forever preferred_lft forever
[root@d ~]# _
```

阶段四：Web 服务配置（5 分）

1. 在 A.ax.edu 上配置 3 个 Web 网站。

①主网站（www.ax.edu）：运行于 10.x.0.100，网站根目录为/websites/www.ax.edu；

安装 apache

```
[root@a network-scripts]# yum install httpd httpd-manual_
```

```
[root@a network-scripts]# yum install elinks lynx
```

```
[root@a network-scripts]# yum -y install tree
```

```
# it explicitly to prevent problems during startup.
#
# If your host doesn't have a registered DNS name, ente
#
#ServerName www.example.com:80
ServerName www.a13.edu:80
#
# Deny access to the entirety of your server's filesys
# explicitly permit access to web content directories
```

修改网站根目录为/websites/www.a13.edu

```
ServerRoot "/etc/httpd"
Listen 80
Include conf.modules.d/*.conf
User apache
Group apache
ServerAdmin root@localhost
ServerName www.a13.edu:80
<Directory />
    AllowOverride none
    Require all denied
</Directory>
DocumentRoot "/websites/www.a13.edu"
<Directory "/websites">
    AllowOverride None
    Require all granted
</Directory>
<Directory "/websites/www.a13.edu">
    Options Indexes FollowSymLinks
    AllowOverride None
    Require all granted
</Directory>
<IfModule dir_module>
    DirectoryIndex index.html
</IfModule>
<Files ".ht*">
    Require all denied
</Files>
ErrorLog "logs/error_log"
```

②基于主机名的虚拟网站（ocw.ax.edu）：也运行于 10.x.0.100，网站根目录为/websites/ocw.ax.edu；

创建虚拟主机配置文件：

```
[root@a conf.d]# vi ip-hosts.conf
```

```
<VirtualHost 10.13.0.100>
DocumentRoot /websites/ocw.a13.edu
ServerName ocw.a13.edu
</VirtualHost>
<VirtualHost 10.13.0.100>
DocuMentRoot /websites/oa.a13.edu
ServerName oa.a13.edu
</VirtualHost>
~
~
~
```

```
[root@a conf.d]# mkdir -p /websites/ocw.a20.edu
[root@a conf.d]# mkdir -p /websites/oa.a20.edu
```

③基于 IP 的内部虚拟网站（oa.ax.edu）：运行于 10.x.0.101（需要添加永久 IP 地址），网站根目录为/websites/oa.ax.edu；

```
<VirtualHost 10.13.0.100>
DocumentRoot /websites/ocw.a13.edu
ServerName ocw.a13.edu
</VirtualHost>
<VirtualHost 10.13.0.100>
DocuMentRoot /websites/oa.a13.edu
ServerName oa.a13.edu
</VirtualHost>
~
~
~
```

```
[root@a conf.d]# nmcli conn modify ens33 +ipv4.addr 10.13.0.101/24
```

2. 在 A.ax.edu 上让每个系统用户（root 用户除外）可以建立自己的个人网站，请为你自己创建个人网站 www.ax.edu/~ax。

```
    #UserDir disabled

    #
    # To enable requests to /~user/ to serve the user's public_html
    # directory, remove the "UserDir disabled" line above, and uncomment
    # the following line instead:
    #
    UserDir public_html
</IfModule>
```

```
"userdir.conf" 36L, 1252C written
[root@a conf.d]# su - a13
su: user a13 does not exist
[root@a conf.d]# su - s13
su: user s13 does not exist
[root@a conf.d]# su - a13
su: user a13 does not exist
[root@a conf.d]# ll /home
total 0
drwx------. 2 s23 s23 62 Dec 20 16:28 s23
[root@a conf.d]# useradd a13
[root@a conf.d]# su - a13
[a13@a ~]$ mkdir public_html
[a13@a ~]$ chmod 711 /home/a13/
[a13@a ~]$ chmod 755 public_html/
[a13@a ~]$ echo '<h1>this a13.com</h1>'>public_html/index.html
[a13@a ~]$ _
```

3. 在 D.cx.net 上配置主网站 www.cx.net。

```
#
# ServerName gives the name and port that the server uses to i
# This can often be determined automatically, but we recommend
# it explicitly to prevent problems during startup.
#
# If your host doesn't have a registered DNS name, enter its I
#
#ServerName www.example.com:80
ServerName www.c13.net:80

#
# Deny access to the entirety of your server's filesystem. You
# explicitly permit access to web content directories in other
# <Directory> blocks below.
"httpd.conf" 354L, 11229C written
```

```
"httpd.conf" 354L, 11779C written
[root@d conf]# cp -p httpd.conf{,.bak}
[root@d conf]# grep '^[^#]' httpd.conf.bak | grep -v '^ \+#' >httpd.conf
[root@d conf]# vi
```

4. 启动 httpd 服务，并设置 httpd 服务开机自动启动，为每个网站创建好首页 index.html，根据需要调整 DNS 服务器的设置，然后从各客户端测试访问所有网站。**（备份 4：5 分）**

A:


```
[root@a conf.d]# curl 10.13.0.100
<h1>weclome ocw.a13.edu<h1>
[root@a conf.d]# curl 10.13.0.101
<h1>weclome aa.a13.edu<h1>
[root@a conf.d]# curl www.a13.edu
<h1>weclome ocw.a13.edu<h1>
[root@a conf.d]# curl 30.13.0.70
hahahah
[root@a conf.d]#
```

B:

```
[root@b ~]# curl 10.13.0.100
<h1>weclome ocw.a13.edu<h1>
[root@b ~]# curl 10.13.0.101
<h1>weclome aa.a13.edu<h1>
[root@b ~]# curl 30.13.0.70
hahahah
```

C:

```
Complete!
[root@c ~]# curl 10.13.0.100
<h1>weclome ocw.a13.edu<h1>
[root@c ~]# curl 10.13.0.101
<h1>weclome aa.a13.edu<h1>
[root@c ~]# curl 30.13.0.100
^C
[root@c ~]# curl 30.13.0.70
hahahah
```

D:

```
Complete!
[root@d conf]# curl 10.13.0.100
<h1>weclome ocw.a13.edu<h1>
[root@d conf]# curl 10.13.0.101
<h1>weclome aa.a13.edu<h1>
[root@d conf]# curl 30.13.0.70
hahahah
[root@d conf]#
```