Campus Network Design Workshop

Migrating a Campus Network: Flat to Routed
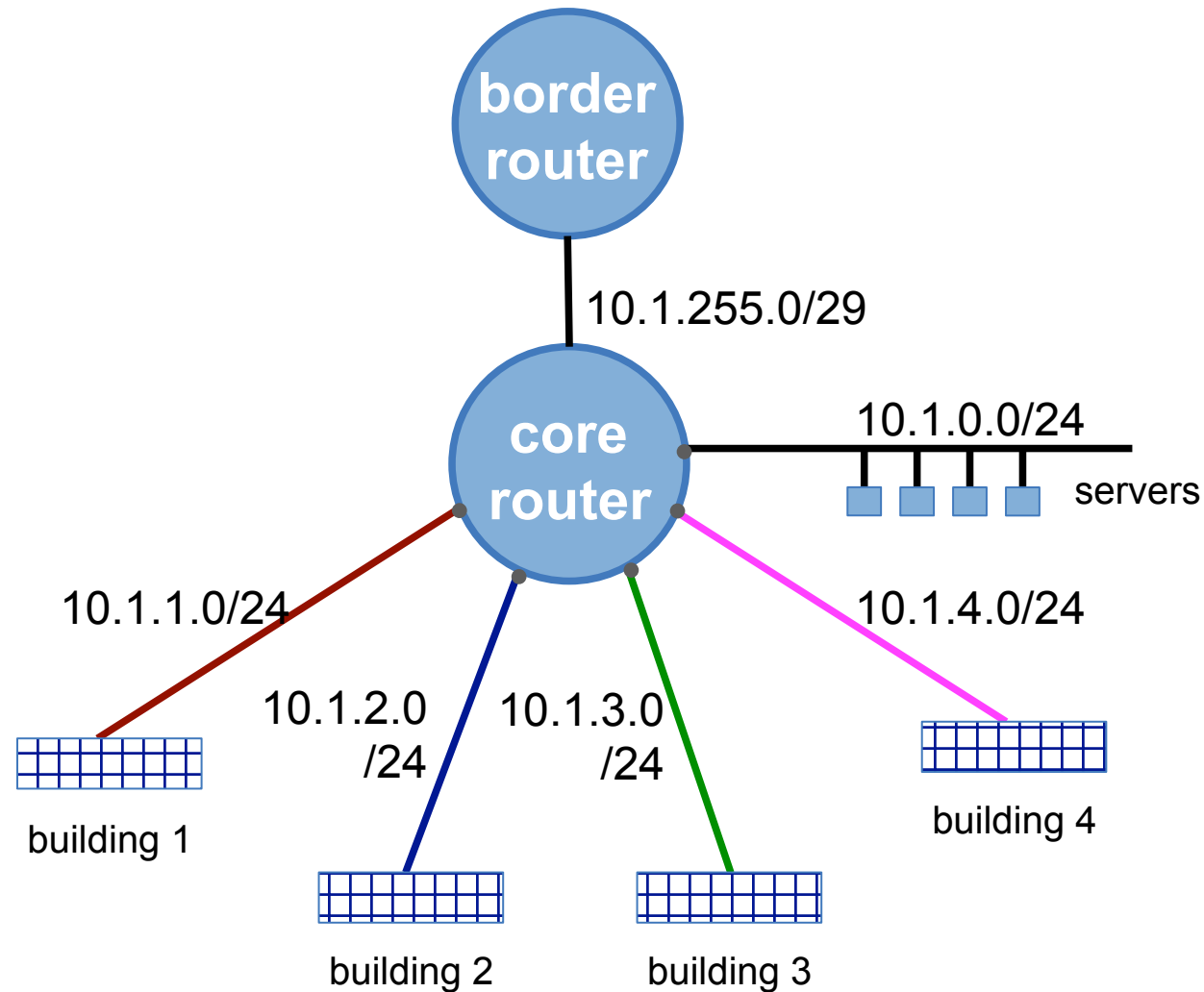
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Ideal routed campus network

Changing from flat network implies:

- Nearly everything needs renumbering!
  - Well, you can keep one subnet on its old addresses
  - What's hardest to renumber – servers perhaps?
- So, first get as much as possible onto DHCP
- This lets you renumber centrally

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Quick refresher: DHCP (RFC2131)

- A DHCP exchange is 4 UDP messages:
    - Client sends "Discover" (broadcast)
    - One or more servers replies with "Offer"
    - Client picks one offer and sends "Request"
    - Server responds with "Ack" to confirm
- Address is granted for a finite "lease time"
    - When this is nearly over, client must request again to continue using the address

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Lease time

- It's a good idea to reduce the lease time in advance of renumbering

  - e.g. say current lease time is 24 hours

  - Reduce this to 10 minutes then wait 24 hours

  - By this time you'll know every device is refreshing its address every 10 minutes

  - Minimises time for new addresses to be picked up

- Put back up after change tested and successful

DHCP options (RFC2132)

- DHCP response can also contain other settings to configure the client
  - Netmask, default gateway
  - DNS servers, default domain
  - SIP server (IP phones)
  - TFTP boot server (PXEboot / diskless clients)
- Centralises all client network configuration

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Managing Devices

- Highly recommended to use DHCP to configure even devices with "static" IP addresses like printers, phones, admin workstations

  - DHCP servers can be configured with a mapping of MAC address to fixed IP address

- DHCP logs are a useful source of availability information

DHCP Broadcasts

- You need to respond to the DHCP Discover broadcasts on every subnet

- Option 1: run DHCP service on the router itself
  - Can be awkward to manage if you have a lot of custom options or static MAC address mappings

- Option 2: use a feature on the router called "DHCP relay" or "DHCP helper"
  - Relays requests to one or more DHCP servers
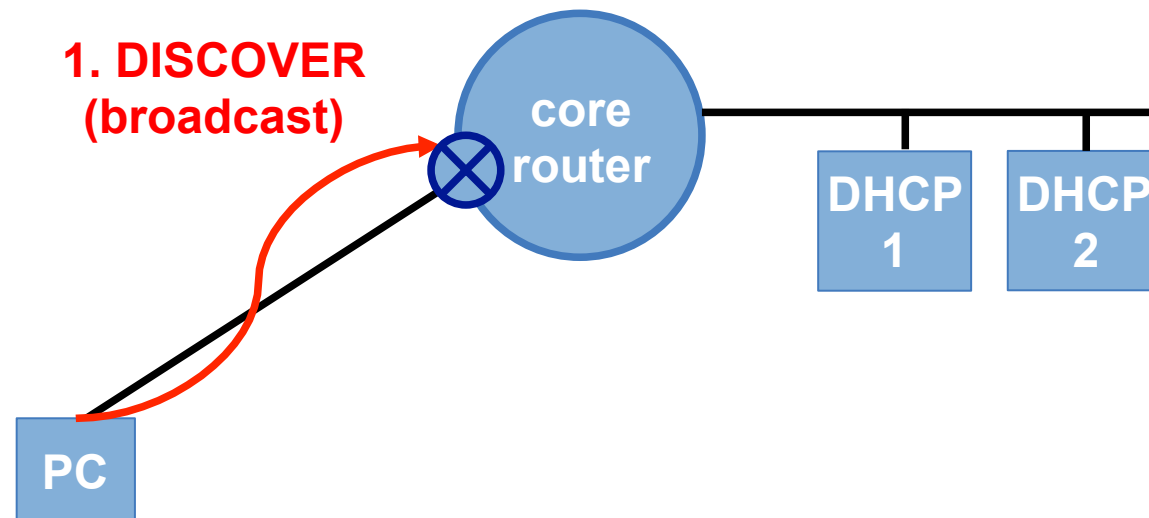
DHCP Relay

DHCP Relay
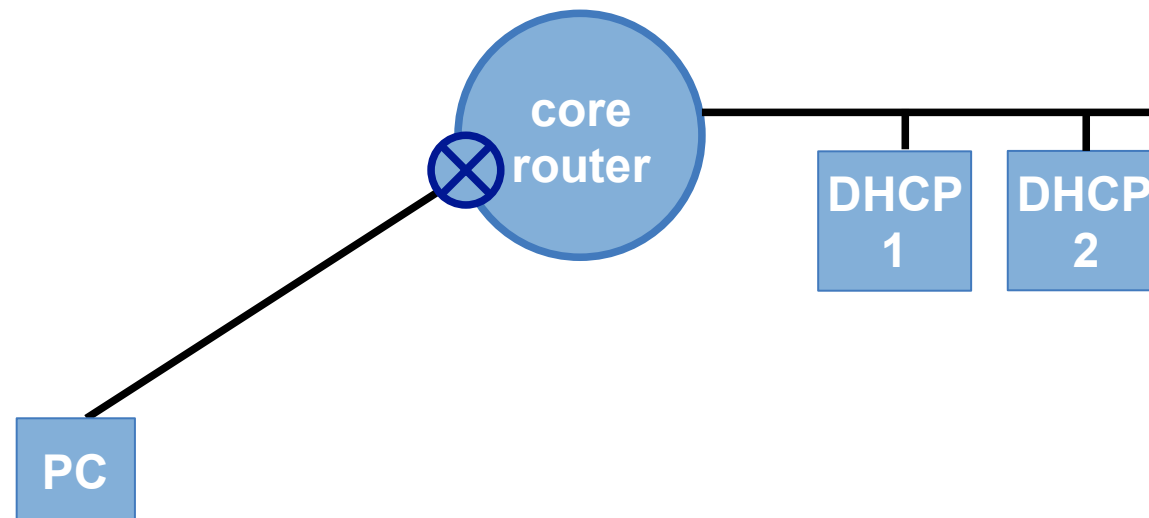
DHCP Relay

⊗ DHCP relay agent

2. DISCOVER (unicast)

1. DISCOVER (broadcast)

core router

PC

DHCP 1

DHCP 2

* Client can request broadcast response using the B flag

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DHCP Relay

⊗ DHCP relay agent

1. DISCOVER
(broadcast)

2. DISCOVER
(unicast)

core router

DHCP 1

DHCP 2

3. OFFER
(unicast)

PC

* Client can request broadcast response using the B flag

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DHCP Relay

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PC
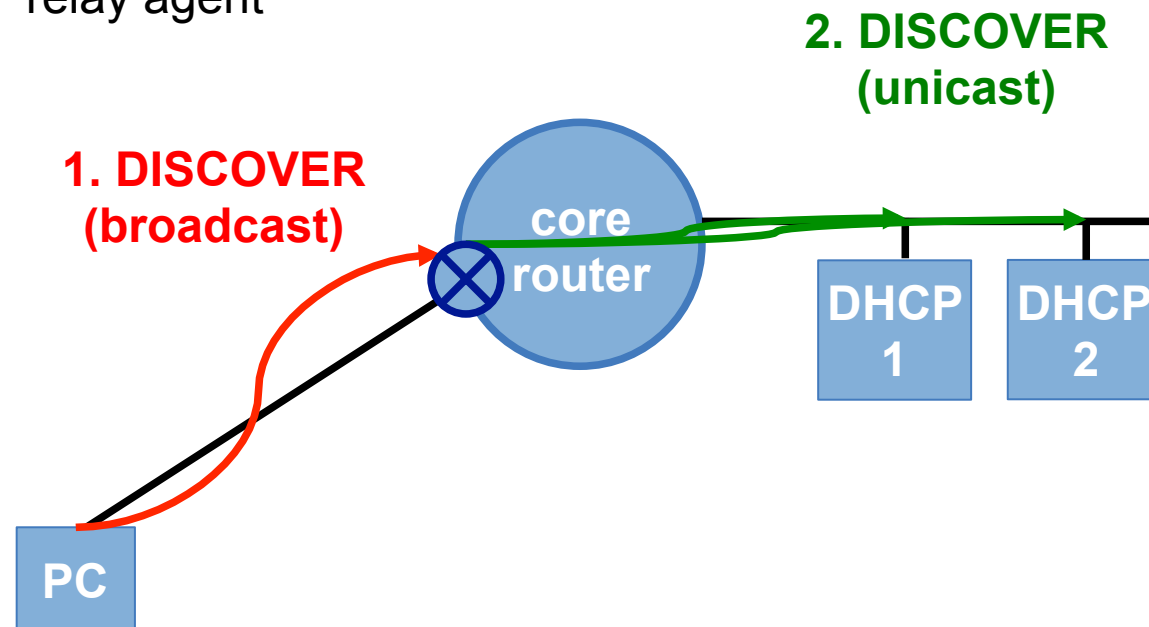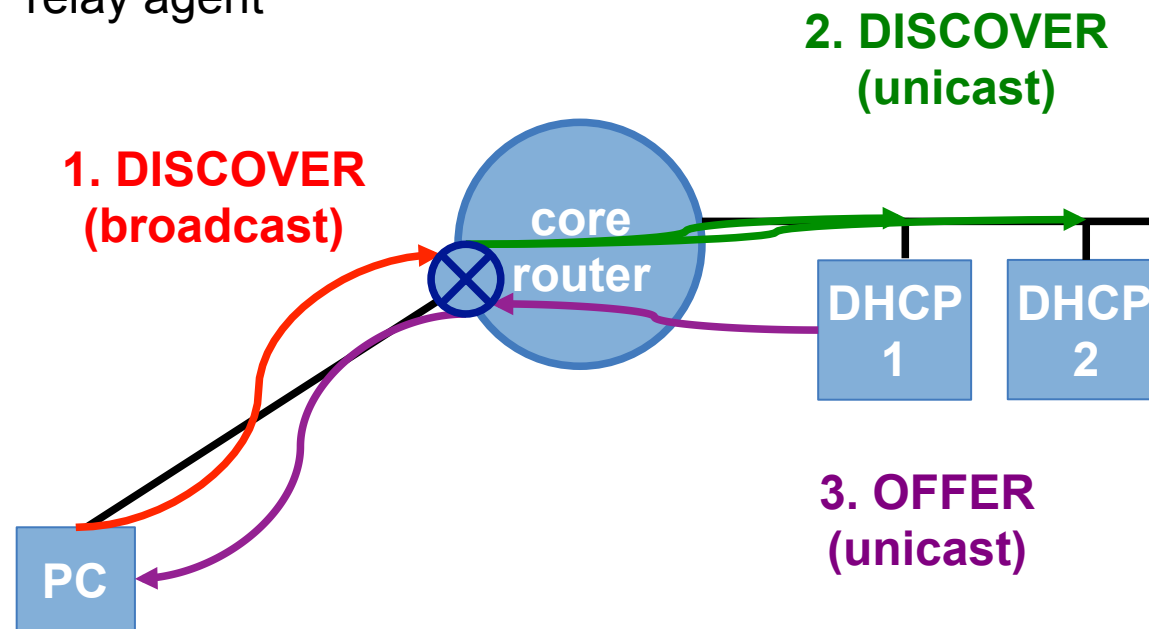
4. OFFER (broadcast or unicast) *

* Client can request broadcast response using the B flag

DHCP relay configuration

- Repeat for every interface where DHCP service is required

```
interface Vlan100
   ip address 10.1.1.1 255.255.255.0
   ip helper-address 10.1.0.4
   ip helper-address 10.1.0.5
```

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DHCP server configuration

- Define each subnet where service is required
    - (Windows DHCP server: "DHCP scope")

```
subnet 10.1.1.0 netmask 255.255.255.0 {
    option routers 10.1.1.1;
    option subnet-mask 255.255.255.0;
    range 10.1.1.100 10.1.1.199;
}
```
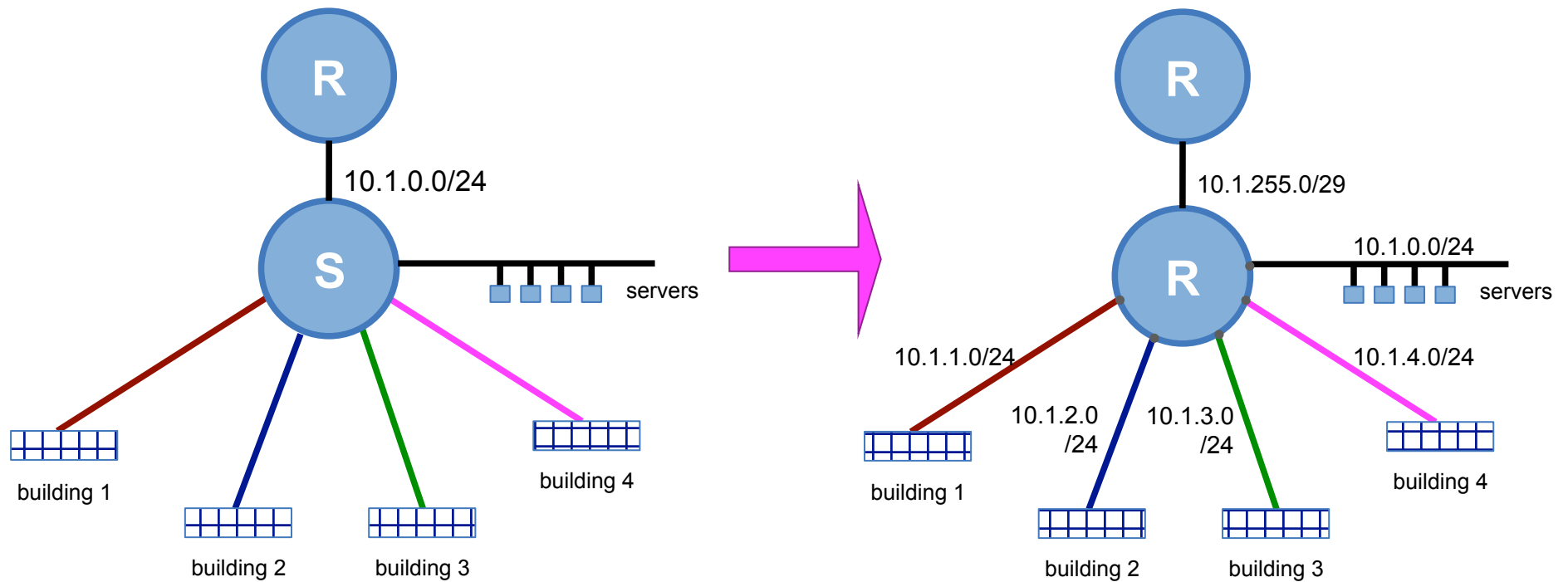
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Questions?

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Planning Migration

General Principles

- No "big bang"!
- Series of small, incremental changes
- Test at each stage
- Plan to rollback at each stage
  - You will discover things that break
  - Understand the problem, correct and try again
- Localize outages and give advance warning

Managing Complexity

- Incremental steps means you will be running parts of old and new configuration in parallel

- Remember to strip out old configuration when it is no longer needed
  - So it's understandable
  - So you are not left with any configuration which might be important but actually isn't

- It all gets easier with experience

Quick Example

- You want to replace an old switch with a new one
    - How would you go about it?

Old switch
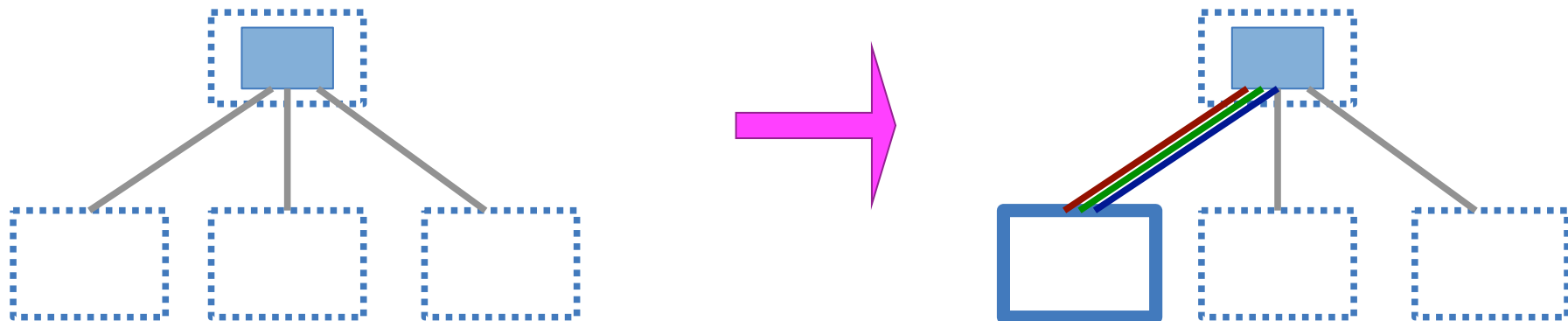
New switch
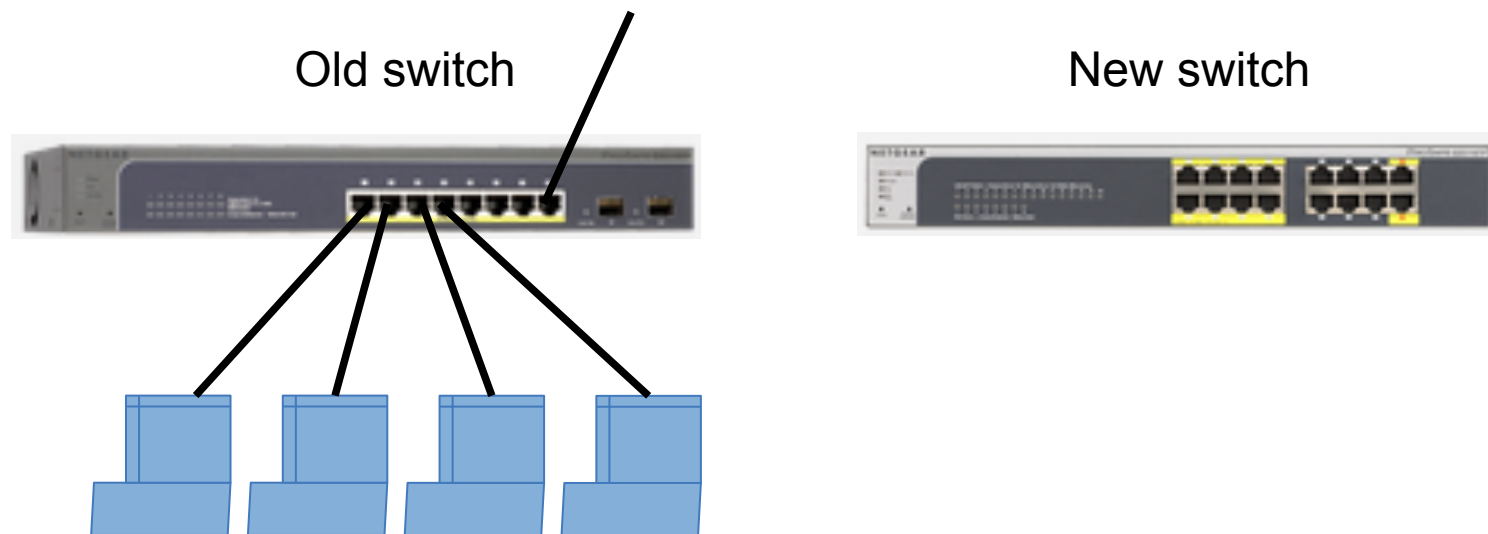
For discussion!

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Longer Example
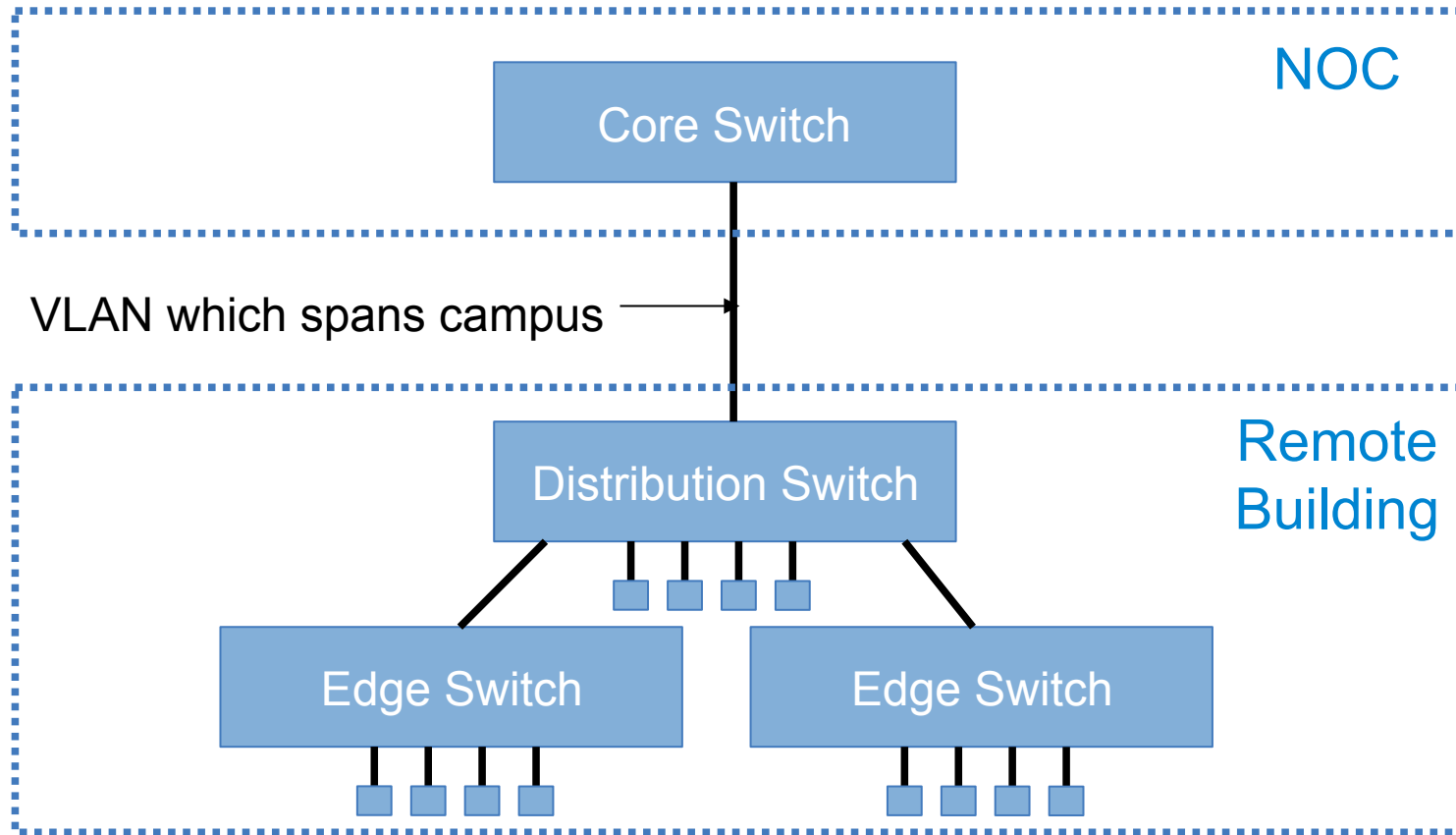
- Migrate one building from the flat network onto three new subnets (*e.g wired, wireless, guest*)

Before (detail)

1. Create new vLANs in core

New VLAN subinterfaces

Core Switch

Spare access port
Test vlan 11, 12, 13 in turn

Distribution Switch

Edge Switch

Edge Switch
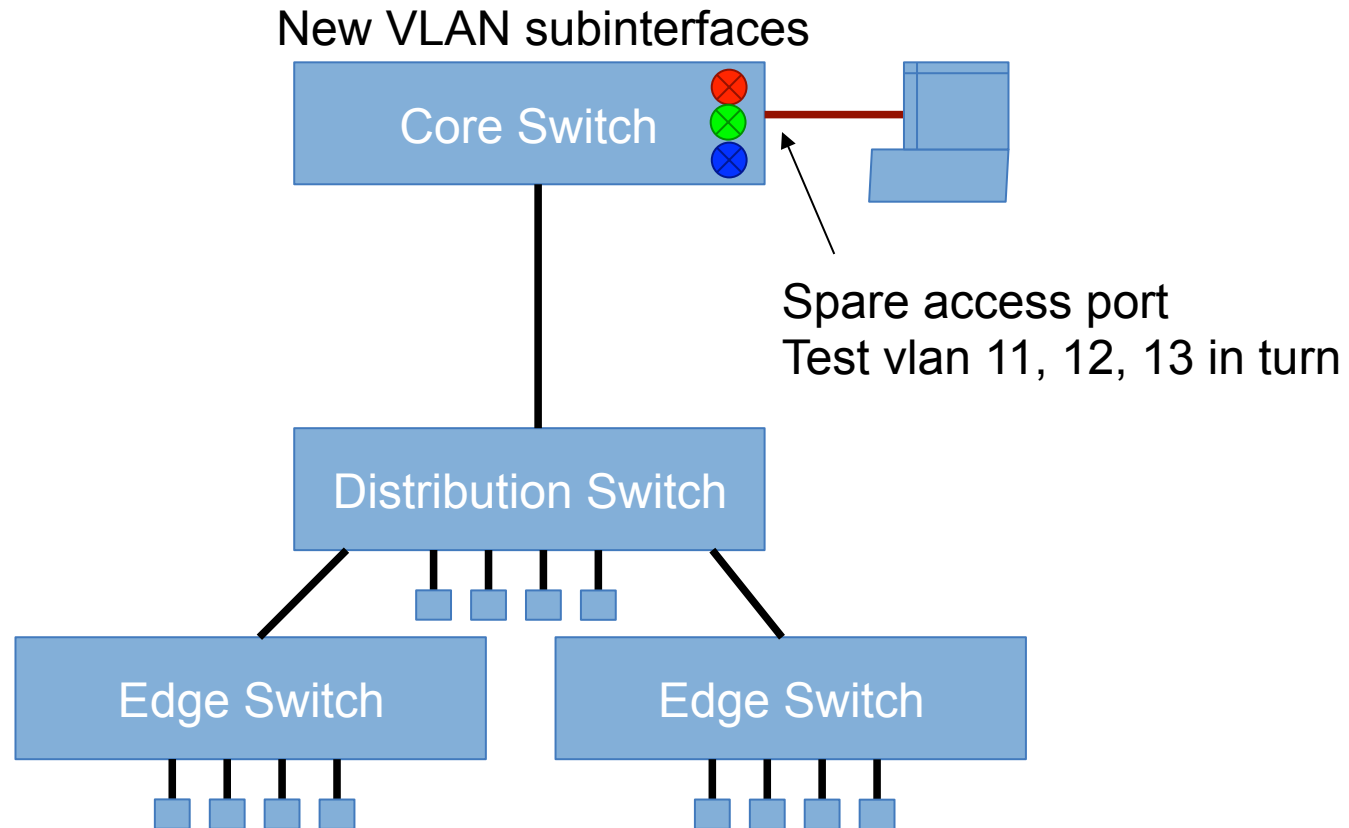
Test all client functionality, e.g. DHCP, routing
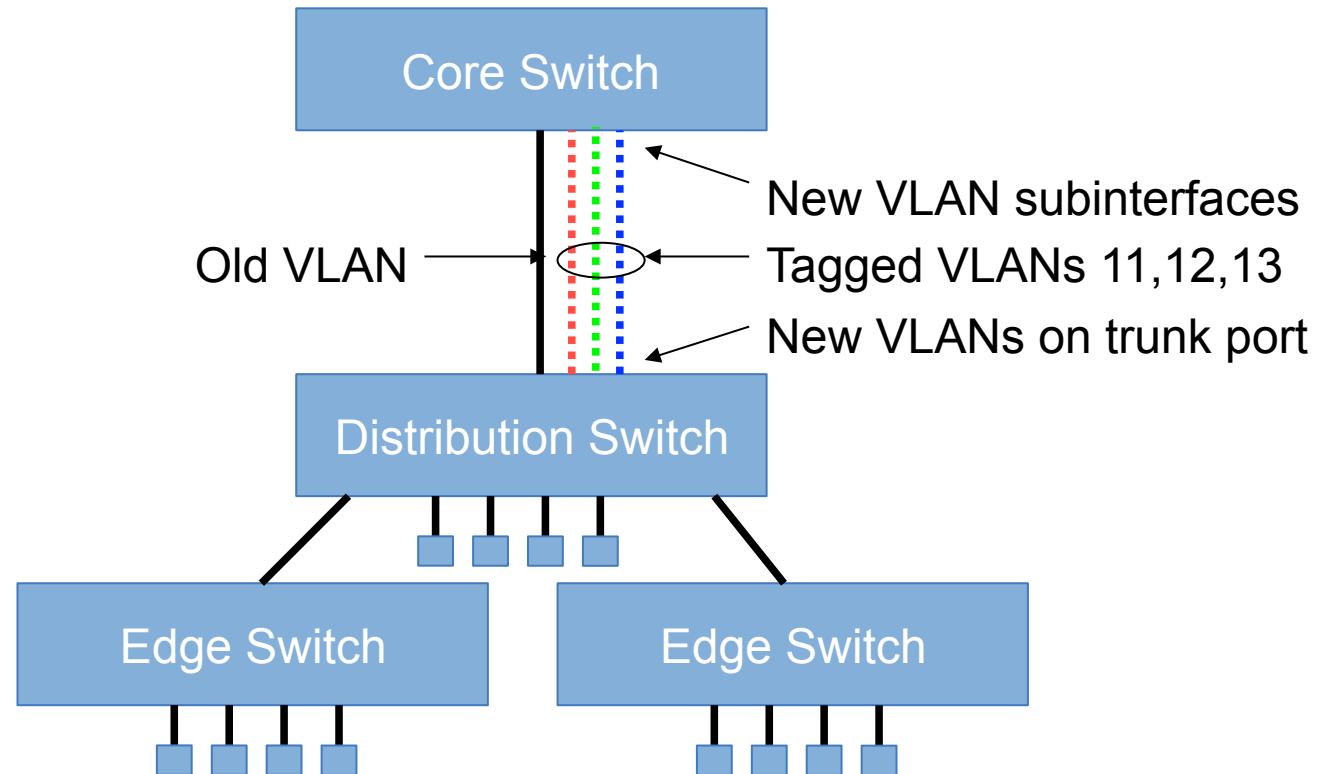
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Rollback plan

- Undo changes to core switch
- Take a copy of the configuration before you start making any changes, so you have a reliable reference

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2. Add new vLANs to trunk

Should not break anything! (But check anyway)

Choice to make

- Run the old VLAN untagged, together with the new VLANs tagged; OR

- Change the old VLAN to tagged at both ends
  - Bigger change, but may be easier to understand

- Whichever you are most comfortable with

- No clients should be affected yet

- Rollback plan: revert these small config changes

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3. Extend vLANs to edge
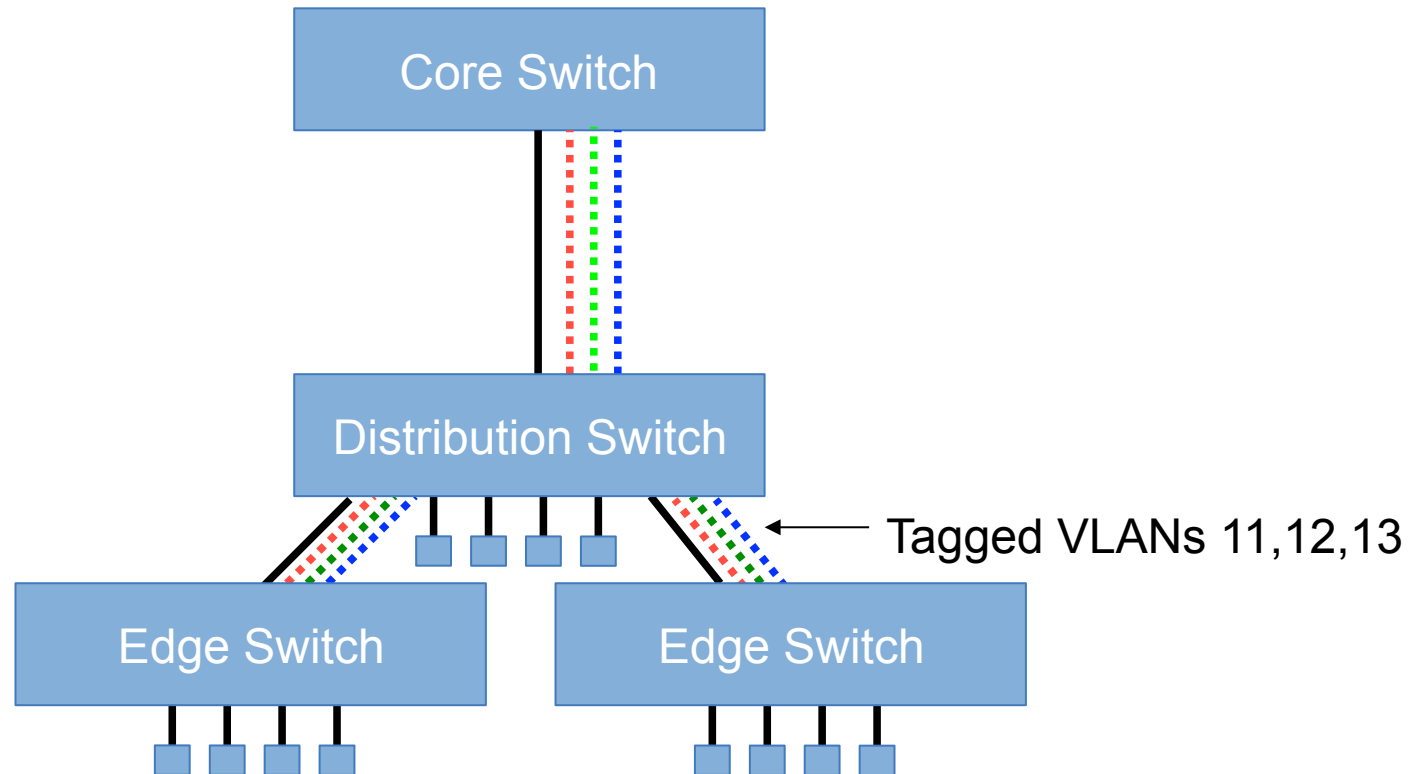
Again, nothing should break

4. Test with spare access ports

Re-test all client functionality, DHCP, routing

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5. Re-assign edge ports individually
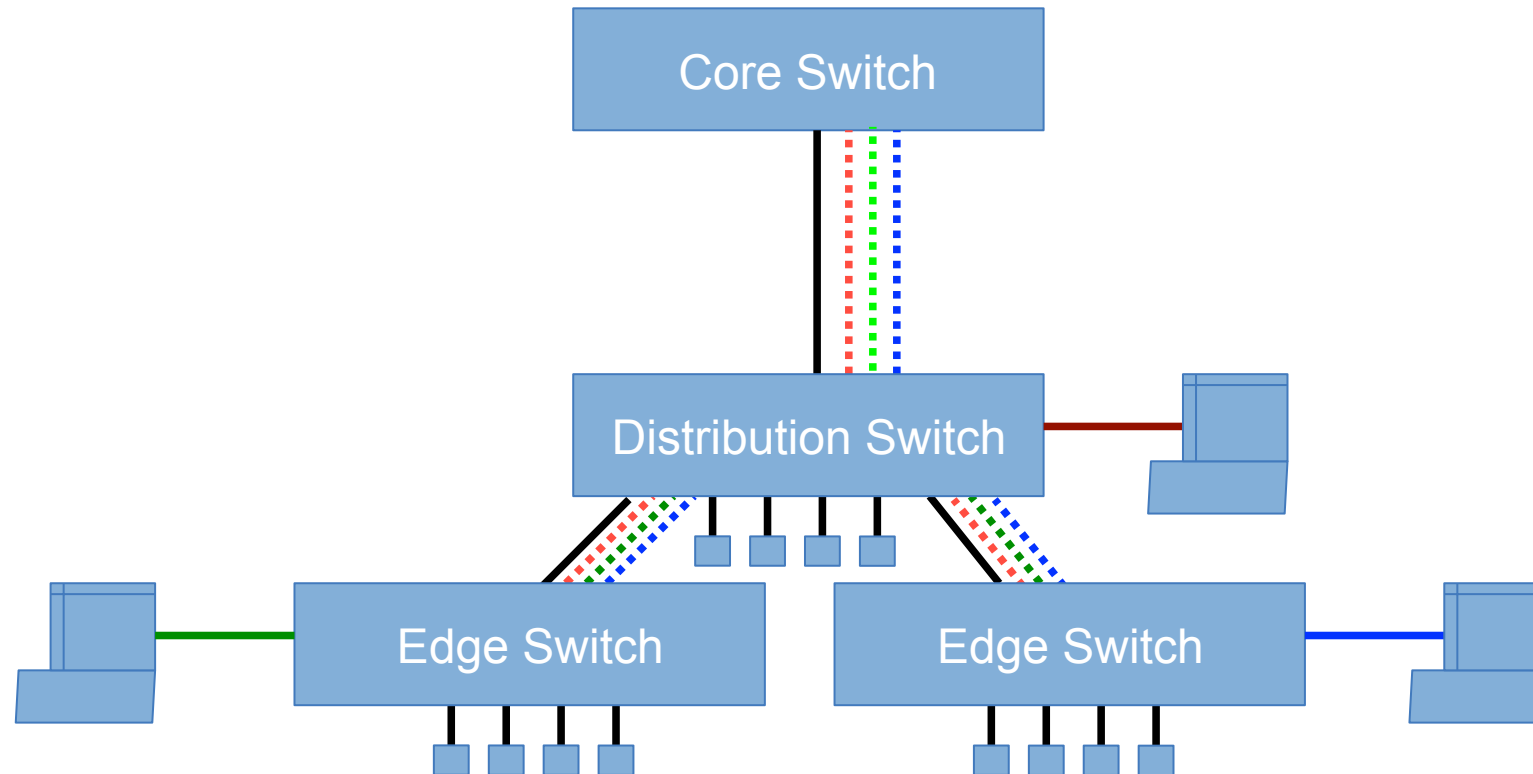

Clients moved
to new VLANs

Controlled interruption to service

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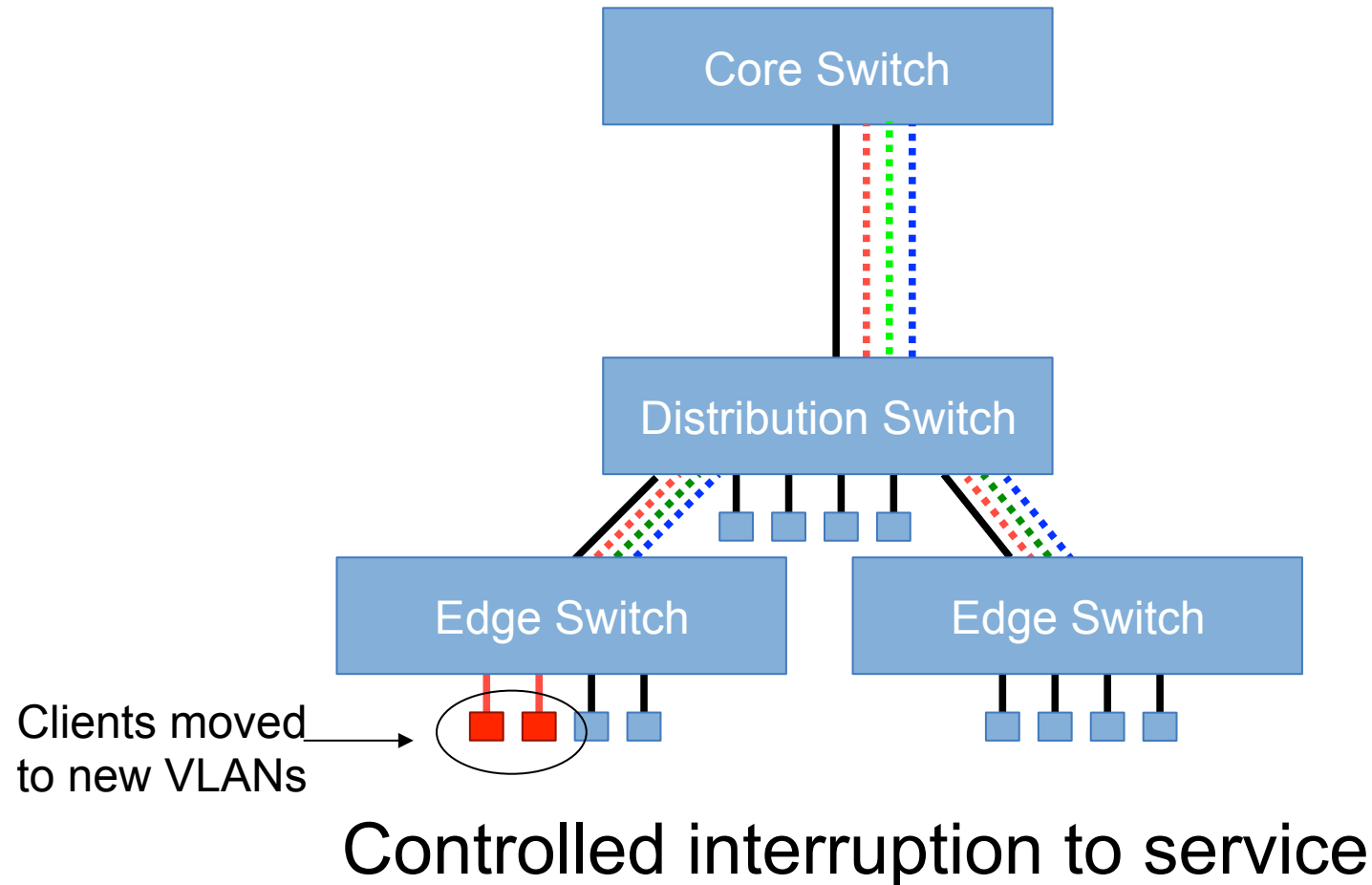
6. Move all the remaining clients

- Hint: a 5-second shutdown on the port can help force clients to re-DHCP

```
interface GigabitEthernet 0/3
  shutdown
  no shutdown
```

- Problematic clients can be rolled back to the old vLAN while you work out how to fix them

- For important devices, check in DHCP logs that they have come back

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7. Renumber the switches

- Give the switches new management IP addresses on the appropriate new VLAN
  - Remember the default gateway will change
  - Try not to lock yourself out!
  - Serial console is safest way to do this
- Might choose to do this earlier (before moving clients)

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8. Check nothing on old VLAN IPs

- wireshark / nmap / angry IP scanner are useful tools for this
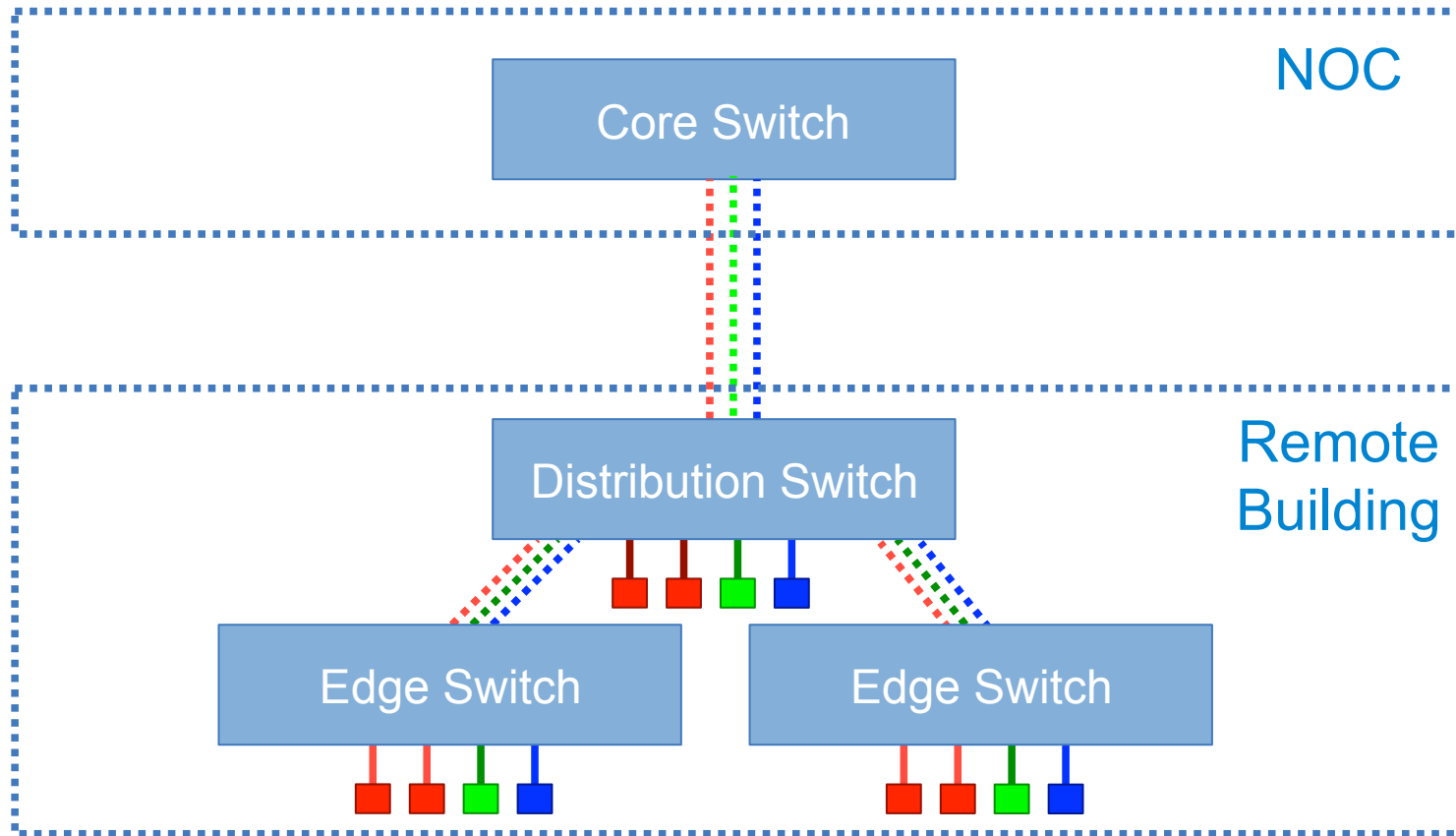
  - Connect a laptop to each new VLAN, but configured statically with an IP address on the old VLAN range

  ```
  nmap -sP -n x.x.x.x/x  # old range
  ```

  - You will discover any devices which are still statically configured with old IP addresses
  - Find them and correct them

9. Strip out the old vLAN

Final test to sign-off

Summary

- Lots of steps, but each one is easy to rollback
- Plan in advance what the final configuration will look like, and the steps to get there
- Make sure you know how to rollback any step
- Test before and after each change
  - Monitoring key devices with e.g. LibreNMS can give you extra confidence nothing has broken

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Plan within your constraints

- Some of your switches are dumb?
- Some parts of your network must be in service at particular times?
- Make a plan which best fits your situation

Other hints and tips

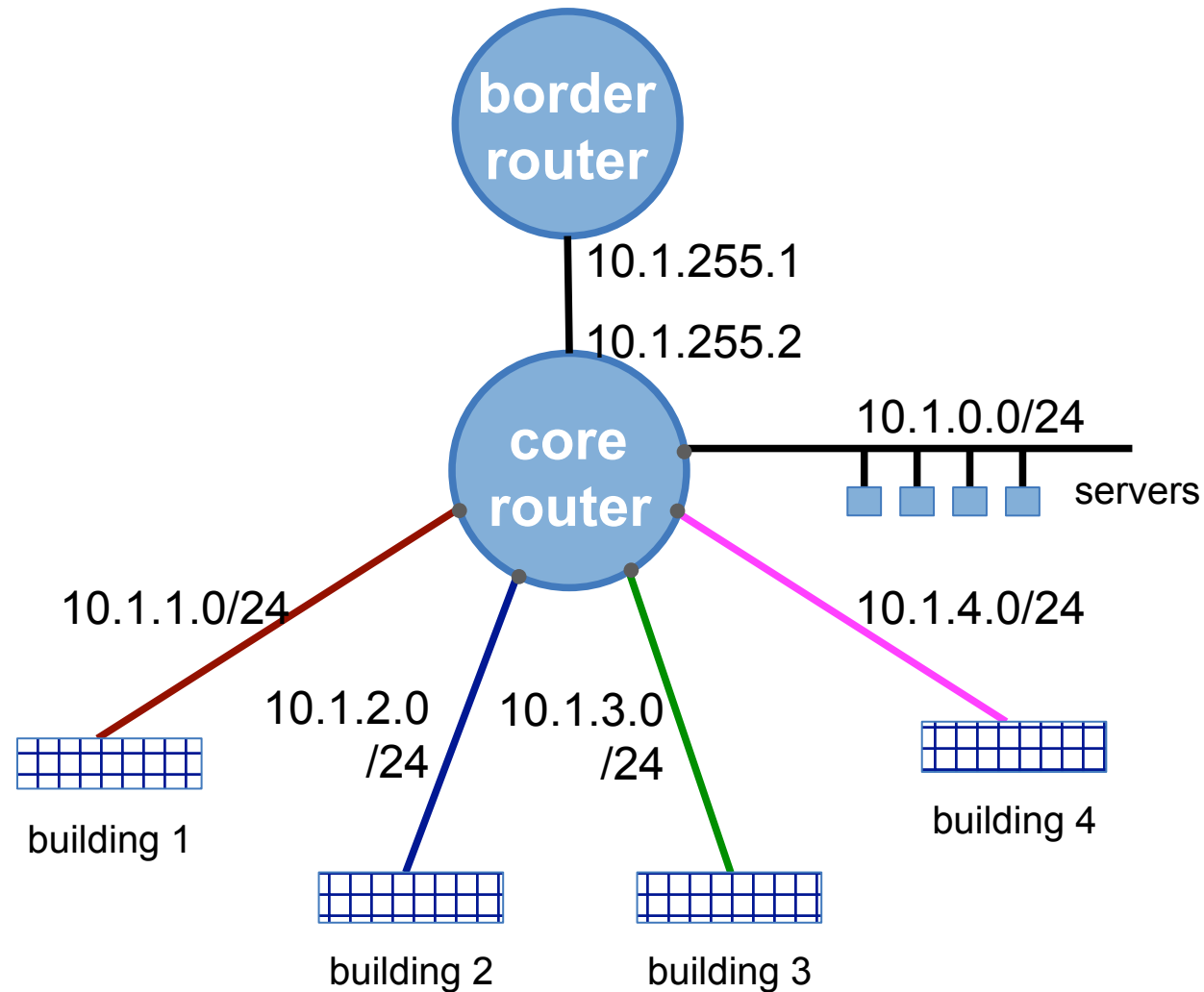- If your core switch has only SFP ports, a copper gigabit SFP is useful for testing

- If you move an IP address from one device to another, other devices may have the old MAC address cached in their ARP table for a while
  - Cisco routers are worst: 4 hour ARP timeout!
  - "clear arp-cache" may be required

- "write memory" as each change completed and tested

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Renumbering servers

- If you are renumbering servers, remember to reduce the DNS TTL in advance of changes
  - Allow enough time for all caches to expire records with the old TTL
  - Put it back up afterwards
- "Secondary IP addresses" can be useful when renumbering servers on the same VLAN
  - Both old and new IP addresses are active at the same time

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Don't forget (static) routes

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10.1.0.0/24 via 10.1.255.2
10.1.1.0/24 via 10.1.255.2
10.1.2.0/24 via 10.1.255.2
10.1.3.0/24 via 10.1.255.2
10.1.4.0/24 via 10.1.255.2
OR:
10.1.0.0/16 via 10.1.255.2

border router

10.1.255.1

10.1.255.2

core router

10.1.0.0/24

servers

10.1.1.0/24

10.1.2.0 /24

10.1.3.0 /24

10.1.4.0/24

building 1

building 2

building 3

building 4

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Don't forget (static) routes

10.1.0.0/24 via 10.1.255.2
10.1.1.0/24 via 10.1.255.2
10.1.2.0/24 via 10.1.255.2
10.1.3.0/24 via 10.1.255.2
10.1.4.0/24 via 10.1.255.2
OR:
10.1.0.0/16 via 10.1.255.2

border router

10.1.255.1

10.1.255.2

core router

10.1.0.0/24

servers

10.1.1.0/24

10.1.2.0 /24

10.1.3.0 /24

10.1.4.0/24

building 1

building 2

building 3

building 4

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Don't forget (static) routes

border router

10.1.0.0/24 via 10.1.255.2
10.1.1.0/24 via 10.1.255.2
10.1.2.0/24 via 10.1.255.2
10.1.3.0/24 via 10.1.255.2
10.1.4.0/24 via 10.1.255.2
OR:
10.1.0.0/16 via 10.1.255.2

0.0.0.0/0 via 10.1.255.1
10.1.0.0/16 via Null0 (why?)

10.1.255.1

10.1.255.2

core router

10.1.0.0/24

servers

10.1.1.0/24

10.1.2.0 /24

10.1.3.0 /24

10.1.4.0/24

building 1

building 2

building 3

building 4

Questions?

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