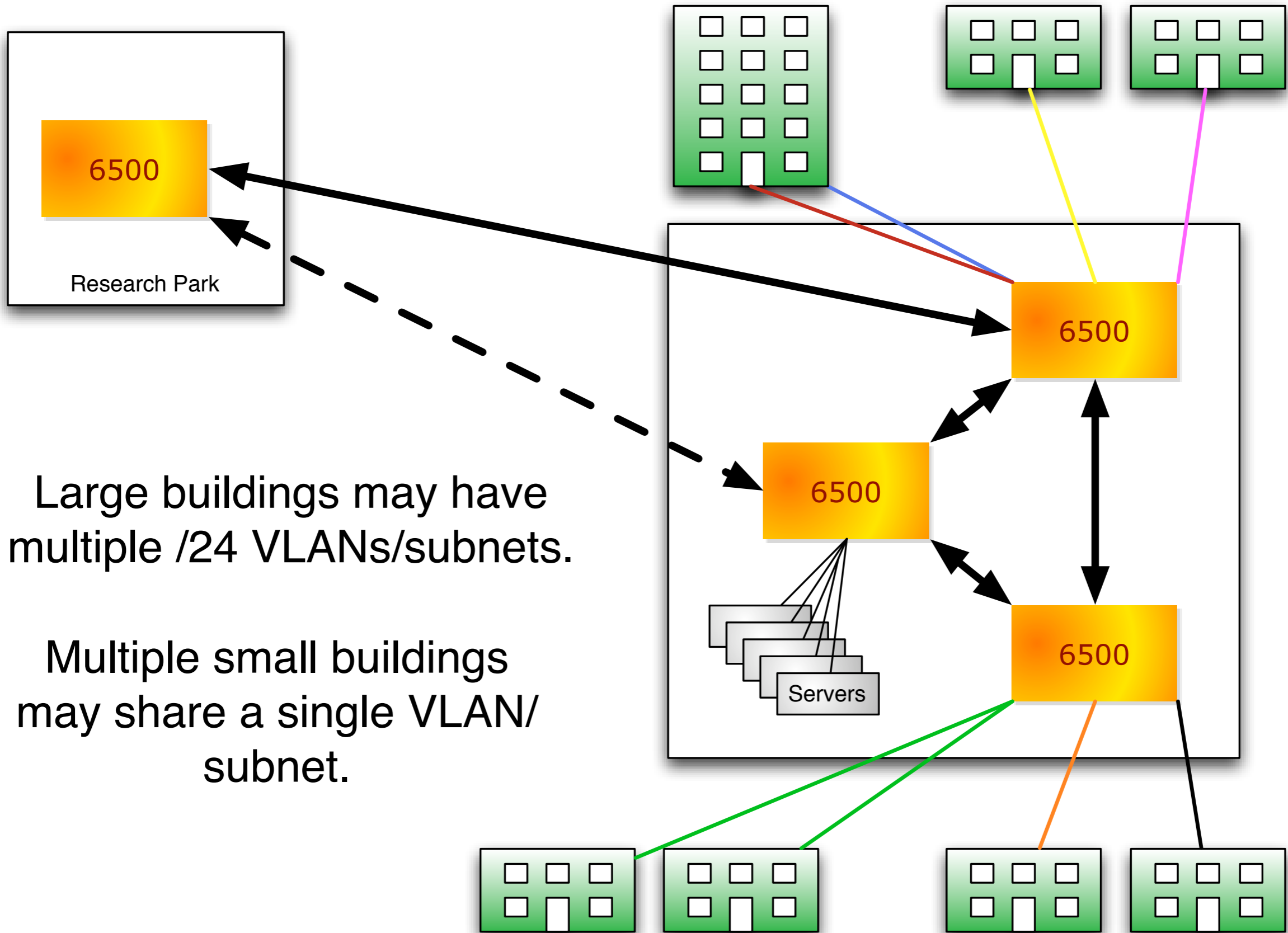


North Dakota State University

Bruce Curtis

NDSU Overview

- 12,000 Students
- Almost 100 Buildings
- 20,480 Public IPv4 numbers (1 /18 + 1 /20)
- Most VLANs/subnets are /24s (256 IPv4 IPs)
- $20,480 / 256 = \text{about } 80 \text{ VLANs/subnets}$



Large buildings may have multiple /24 VLANs/subnets.

Multiple small buildings may share a single VLAN/subnet.

NDSU Overview

- NDSU IPv6 committee representation
 - Network
 - Servers
 - Desktop
 - Security
 - Help Desk
 - Research Computing (HPC clusters etc)
 - Department early adopters
 - EDUTECH (K12)

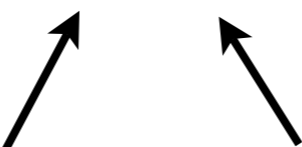
NDSU IPv6 Addressing Scheme

- For administrative convenience IPv4 numbers already contain the VLAN number as a component (**48 - 127**), and IPv6 numbers will also.
- VLAN **95**
- 134.129.**95**.x/24
- 10.248.**95**.x/24 IP phones, APs etc
- 2001:4930:**95**::x/64

NDSU IPv6 Addressing Scheme

- Where possible the last octet of the IPv4 number will be the same as the last field of the IPv6 number
- VLAN **95**
- 134.129.**95**.**122**/24
- 2001:4930:**95**::**122**/64

Larger Subnets

- VLAN **52**
 - 134.129.**52**.0/23 (512 numbers)
 - 134.129.**52**.116
 - 2001:4930:**52**::116/64
 - 134.129.**53**.116
 - 2001:4930:**52**::1116/64
- 

Smaller Subnets

- 134.129.**112**.0/25 (128 numbers)
 - 2001:4930:**112a**::/64
 - 2001:4930:**112:a**::/64
- 134.129.**112**.129/25 (128 numbers)
 - 2001:4930:**112b**::/64
 - 2001:4930:**112:b**::/64

Other examples

- DHCP
- Virtual Machines
- IP phones
- Printers, etc

IPv6 Numbering Scheme

- In general we want to encode classification info in the first 48 bits of the host portion of the IPv6 address, or bits 64 through 112. Or in other words the 3 fields before the last field in the IPv6 number, as indicated by the **x**s below.
- 2001:4930:95::**x:x:x**:120

IPv6 Numbering Scheme

- More specifically, to preserve bits for future classification, to begin with we will only use bits 96 through 112 which is the field before the last field. (The second to last field) as indicated by the **x** in the example below.
- 2001:4930:95::**x**:120 which is short for 2001:4930:95:0:0:0:**x**:120

DHCP

- Include a "d" as the first digit in the second to last field to indicate a DHCP number
- 2001:4930:95::dxxx:120
 - 2001:4930:95::d001:1
 - 2001:4930:95::d001:2
 - 2001:4930:95::d001:9999

DHCP

- 2001:4930:95::dddd:1
- 2001:4930:95::dddd:2
- 2001:4930:95::dddd:9999
- 2001:4930:95::dddd:1
- 2001:4930:95::d999:1
- 2001:4930:95::dfff:1

Virtual Machines

- Virtual Machines will have a 0 for the first digit in the second to last field. In the format indicated below.
- 2001:4930:95::0xxx:120

Virtual Machines

- VM examples, long and short form
 - 2001:4930:95::0001:120 2001:4930:95::1:120
 - 2001:4930:95::0002:120 2001:4930:95::2:120
 - 2001:4930:95::0999:120 2001:4930:95::999:120
 - 2001:4930:95::0fff:120 2001:4930:95::fff:120

Virtual Machines

- Two Categories of Server VMs (static IP)
 - Dual Stack VMs
 - IPv6 Only VMs

Virtual Machines

- Chose a numbering scheme that makes it easy to determine from the VM IPv6 number either
 - The IPv4 number of the VM
 - The IPv6 and/or IPv4 number(s) of the physical server

Dual Stack VMs

- IPv6 number of the VM will be based upon the IPv4 number of the VM
- Base machine IPv4 address: 134.129.95.10
- Base machine IPv6 address: 2001:4930:95::10
- VM1 IPv4 address: 134.129.95.20
 - VM1 IPv6 address: 2001:4930:95::1:20
- VM2 IPv4 address: 134.129.95.50
 - VM2 IPv6 address: 2001:4930:95::1:50

Dual Stack VMs

- Note that the VM IPv6 addresses are based on the IPv4 addresses of the VM machine but have some form of 0xxx in the second to last field. (In the examples below it is always 0001 which is shortened to 1).
- VM1 IPv4 address: 134.129.95.20
- VM1 IPv6 address: 2001:4930:95::1:20
- VM2 IPv4 address: 134.129.95.50
- VM2 IPv6 address: 2001:4930:95::1:50

IPv6 Only VMs

- The policy for VMs with no IPv4 numbers (IPv6 only) is that the VM will be based on the IPv6 number of the base machine
 - Base machine IPv4 address: 134.129.95.10
 - Base machine IPv6 address: 2001:4930:95::10
 - VM1 IPv6 address: 2001:4930:95::1:10
 - VM2 IPv6 address: 2001:4930:95::2:10
 - VM3 IPv6 address: 2001:4930:95::3:10
 - VM4 IPv6 address: 2001:4930:95::4:10
 - VM999 IPv6 address: 2001:4930:95::999:10
 - VMbad IPv6 address: 2001:4930:95::bad:10

IPv6 Only VMs

- Base machine IPv6 address: 2001:4930:95::333 (no IPv4 address)
- VM1 IPv6 address: 2001:4930:95::1:333
- VM2 IPv6 address: 2001:4930:95::2:333
- VM3 IPv6 address: 2001:4930:95::3:333
- VM4 IPv6 address: 2001:4930:95::4:333
- VM999 IPv6 address: 2001:4930:95::999:333
- VMbad IPv6 address: 2001:4930:95::bad:333

Portable IPv6 only VMs

- It is possible that in the future we could define a third class of VMs, which are VMs used in the server subnet and have no IPv4 number and are meant to be easily moved between physical hosts

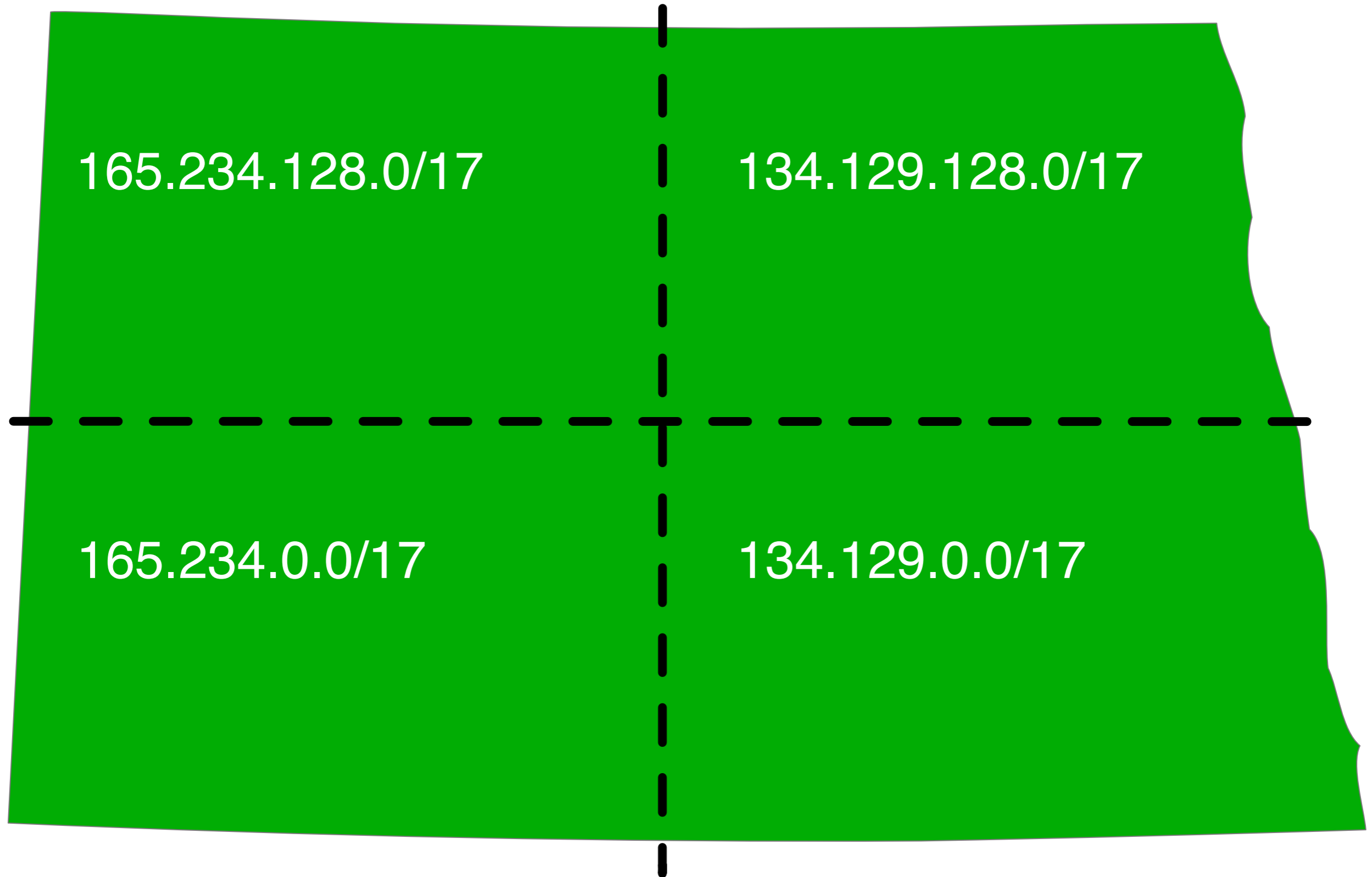
Portable IPv6 only VMs

- It has not been discussed in full so this is just an example, not policy, but we could use a format of **1xxx** in the second to last field to classify a portable IPv6 only VM.
 - VM1 IPv6 address: 2001:4930::1000:1
 - VM2 IPv6 address: 2001:4930::1000:2
 - VM3 IPv6 address: 2001:4930::1000:3
 - VM4 IPv6 address: 2001:4930::1000:4

Something to consider

- There are a lot of numbers in the last 64 bits of the IPv6 address. They could be used for things beyond administrative convenience.
- You could use patterns in the last 64 bits to group devices rather than using VLANs. That could allow access lists at your border to apply to only certain devices.
- For example set all IP phones to have **f000** in the second to last field
 - 2003:4930:95::**f000**:100

Geographical



Geographical

165.234.128.0/17

2001:4930:9000::/36

134.129.128.0/17

2001:4930:1000::/36

165.234.0.0/17

2001:4930:8000::/36

134.129.0.0/17

2001:4930::/36

Geographical

- We briefly considered dividing our campus IPv6 numbers geographically

Geographical

- But we quickly decided that it was more useful to have the IPv6 address be based on the existing VLANs and IPv4 addresses.