



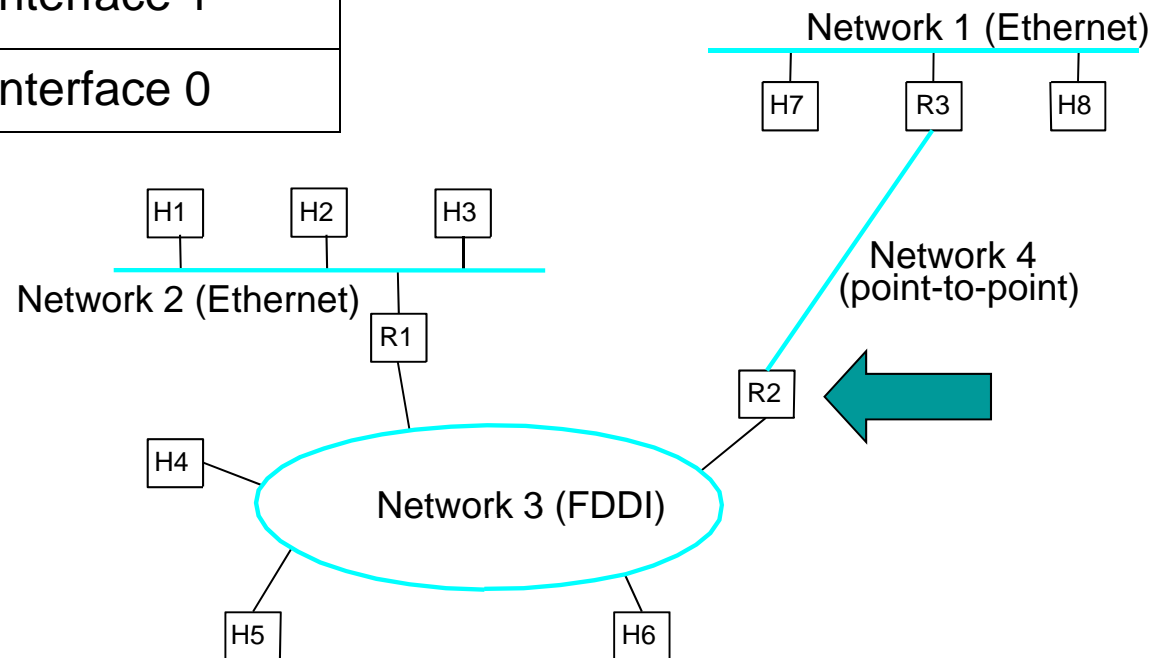
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# Computer Networks, Winter Term 2009/2010

## Sub- and Supernetting

# Recall: Sample Forwarding Table

Network Number	Next Hop
1	R3
2	R1
3	Interface 1
4	Interface 0

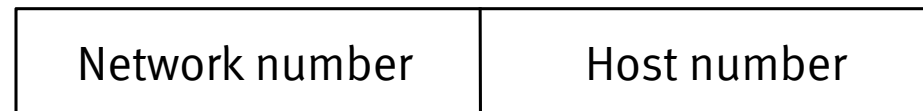


- What exactly is a network number?
  - Usage for routing?
  - How to minimize the number of network numbers that are carried around in routing protocols and get stored in routing tables?
- How to make sure the IP address space is not consumed too quickly?

- Subnetting
- Supernetting

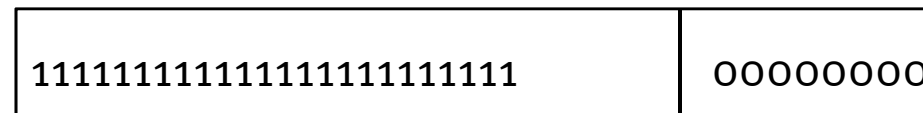
- Add another level to address/routing hierarchy: **subnet**
- Subnet **masks** define variable partition of host part
- Subnets visible only **within** site
  - Outside routers unaware of subnets
  - Several physical networks visible under **single** network number

(16b + 16b)



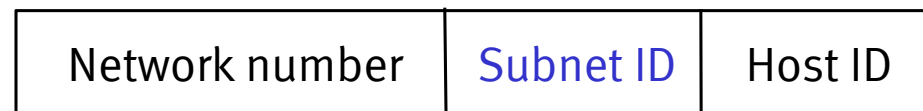
Class B address

(24b + 8b)



Subnet mask  
(255.255.255.0)

(16b + 8b + 8b)



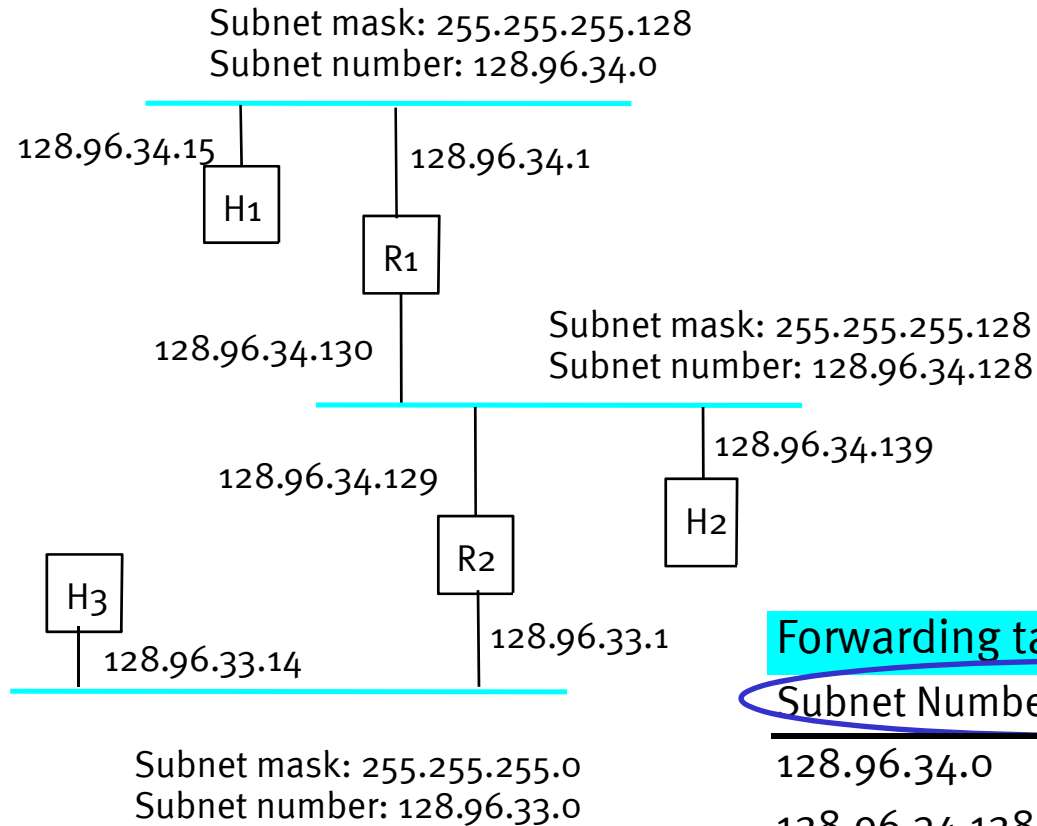
**Subnetted  
address**

Slide based on: Instructor's Manual for Peterson and Davie:  
Computer Networks (2<sup>nd</sup> ed.), © Morgan-Kaufmann Publishers 2000

- Host IP address 128.176.159.102  
and subnet mask 255.255.254.0
  - Binary  
10000000 10110000 10011111 01100110,  
11111111 11111111 11111110 00000000
  - Logical AND returns  
10000000 10110000 10011110 00000000  
or  
128.176.158.0

# Subnet Example

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- IP address ranges?
- Where is interface 0?

Network number

Forwarding table at router R1

Subnet Number	Subnet Mask	Next Hop
128.96.34.0	255.255.255.128	interface 0
128.96.34.128	255.255.255.128	interface 1
128.96.33.0	255.255.255.0	R2

```
D = destination IP address
for each entry (SubnetNum, SubnetMask, NextHop)
  D1 = SubnetMask & D
  if D1 = SubnetNum
    if NextHop is an interface
      deliver datagram directly to D
    else
      deliver datagram to NextHop
```

- Use default router if nothing matches



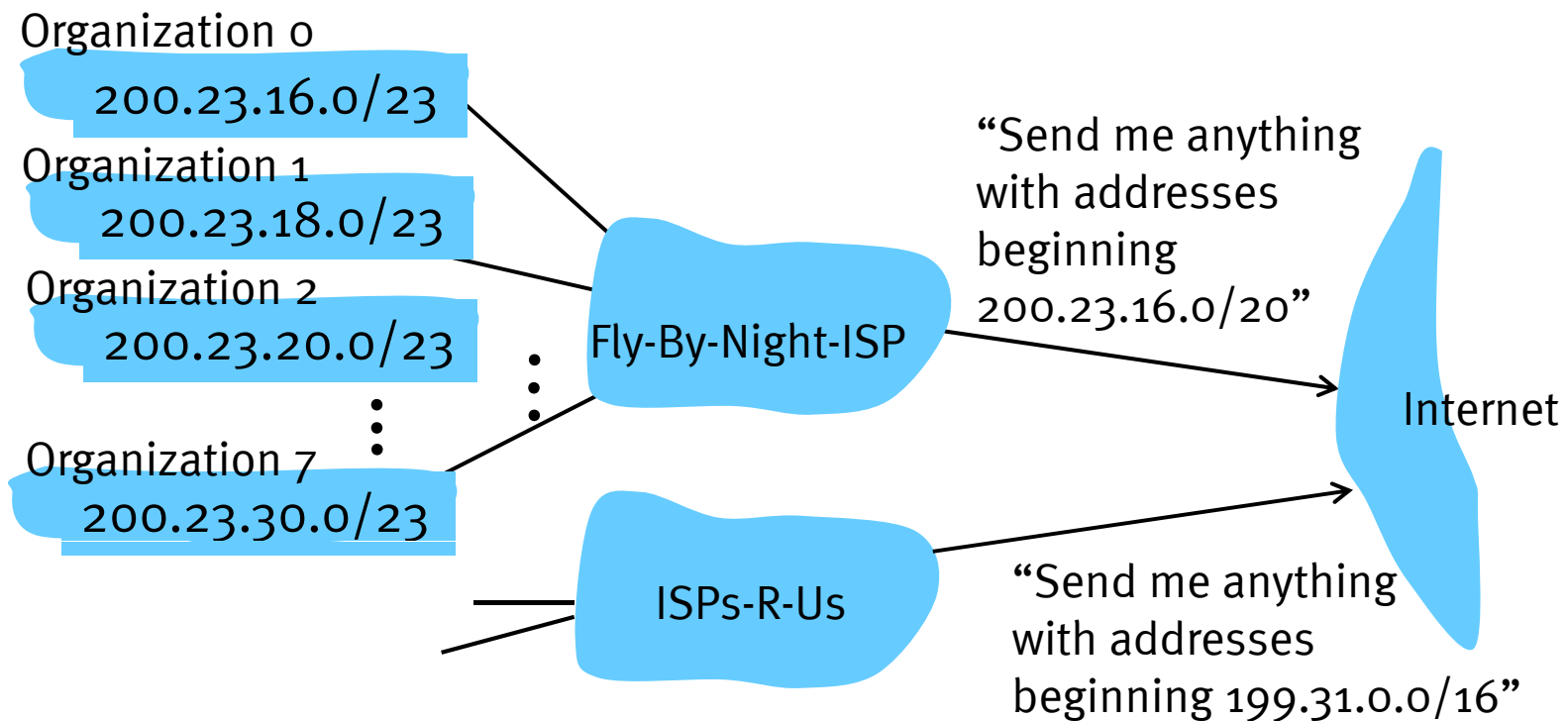
- Explain forwarding of a datagram from H3 (128.96.33.14) to H1 (128.96.34.15).

- Subnetting
- **Supernetting**

- Aggregate “nearby” networks under single network number
  - Called **CIDR**: Classless Inter-Domain Routing
  - All IPv4 Internet routers understand CIDR
- Represent aggregate network with a single pair
  - (first\_network\_address, count)
  - **CIDR prefixes** are network numbers
    - 128.176.158.0/23
    - 128.176.0.0/16
  - Restrict block sizes to powers of 2

# Route Aggregation with CIDR

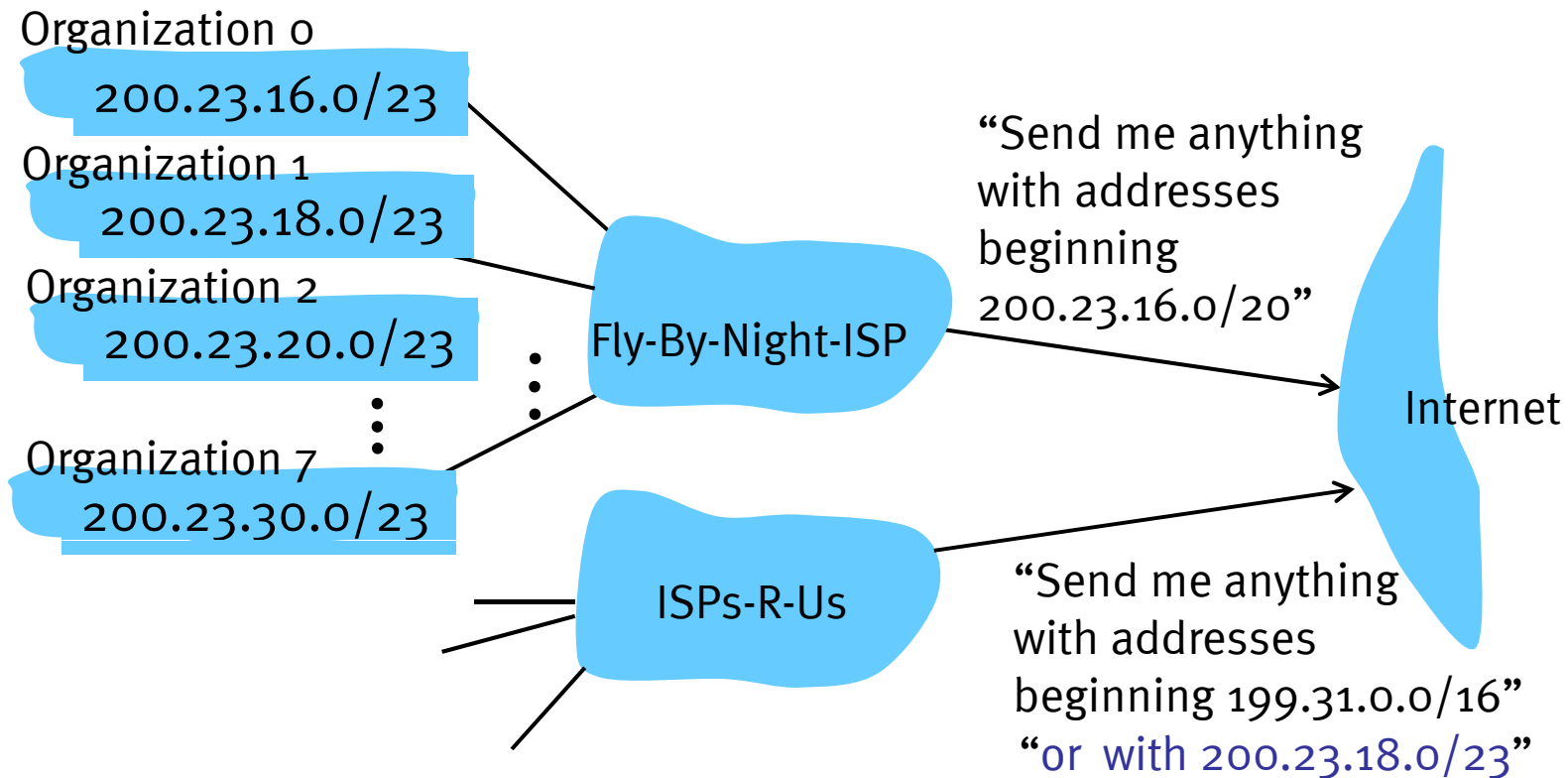
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Slide based on Kurose, Ross: Computer Networking:  
A Top Down Approach (4<sup>th</sup> ed.). Addison-Wesley, 2007.

# More Specific Routes with CIDR

Organization 1 changes ISP. What now?



Slide based on Kurose, Ross: Computer Networking:  
A Top Down Approach (4<sup>th</sup> ed.). Addison-Wesley, 2007.

- IP **lookup** problem
  - For details see, e.g., lectures by Prof. Ottmann
- Forwarding tables with entries (CIDR prefix, Next hop)
  - Destination IP address matched against “every” CIDR prefix
  - **Longest match wins**
  - E.g., 200.23.18.42 matches 200.23.16.0/20 and 200.23.18.0/23
    - 200.23.18.0/23 is longer (more specific) and wins
- View CIDR prefix as **interval**, destination IP address as **point**
  - Easy to see: Intervals either contained or disjoint
  - Find smallest interval containing point
  - Use tree structures for efficient retrieval
    - Concurrent querying and updating
    - Efficient rotation for interval trees
  - Lots of research!

- Subnetting

- Splitting of single network number into multiple subnets
  - Single number for several physical networks
- Invisible for global routing

- Supernetting/CIDR

- Variable-sized networks (in contrast to classes)
  - Aggregation of multiple networks into single network number
  - More efficient assignment of IP address space
- Basis for global routing

- Explain forwarding with sub- and supernetting
- Apply route aggregation for CIDR scenarios