# TCP/IP 通訊協定及應用

**Spring 2002**
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*http://wmlab.csie.ncu.edu.tw/course/tcp*

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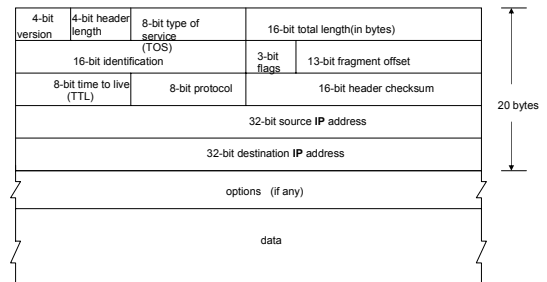
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# IP: INTERNET PROTOCOL

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## IP : INTERNET PROTOCOL

- Introduction
  - Unreliable
  - Connectionless
- IP header
- IP routing
- Cover subnetting

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## IP        Header

| 4-bit version | 4-bit header length | 8-bit type of service (TOS) | 16-bit total length(in bytes) | |
|---|---|---|---|---|
| 16-bit identification | | | 3-bit flags | 13-bit fragment offset |
| 8-bit time to live (TTL) | | 8-bit protocol | 16-bit header checksum | |
| 32-bit source **IP** address | | | | |
| 32-bit destination **IP** address | | | | |
| options   (if any) | | | | |
| data | | | | |

20 bytes

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## Recommended values for type-of-service field

| Application | Minimize delay | Maximize throughput | Maximize reliability | Minimize monetary cost | Hex value |
|---|---|---|---|---|---|
| Telnet/Rlogin | 1 | 0 | 0 | 0 | 0X10 |
| FTP control | 1 | 0 | 0 | 0 | 0X10 |
| data | 0 | 1 | 0 | 0 | 0X08 |
| any bulk data | 0 | 1 | 0 | 0 | 0X08 |
| TFTP | 1 | 0 | 0 | 0 | 0X10 |
| SMTP command phase | 1 | 0 | 0 | 0 | 0X10 |
| data phase | 0 | 1 | 0 | 0 | 0x08 |
| DNS UDP query | 1 | 0 | 0 | 0 | 0X10 |
| TCP query | 0 | 0 | 0 | 0 | 0X00 |
| zone transfer | 0 | 1 | 0 | 0 | 0X08 |
| ICMP error | 0 | 0 | 0 | 0 | 0X00 |
| query | 0 | 0 | 0 | 0 | 0X00 |
| any IGP | 0 | 0 | 0 | 0 | 0X04 |
| SMNP | 0 | 0 | 1 | 0 | 0X04 |
| BOOTP | 0 | 0 | 0 | 0 | 0X00 |
| NNTP | 0 | 0 | 0 | 1 | 0X02 |

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## Tos--precedence field

Precedence

111 - Network Control
110 - Internetwork Control
101 - CRITIC/ECP
100 - Flash Override
011 - Flash
010 - Immediate
001 - Priority
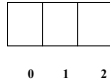000 - Routine

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## FLAGS

Various control flags

bit 0 : reserved ,must be zero

bit1 : 0=may fragment , 1= can't fragment

bit2 : 0=last fragment , 1= more fragment2

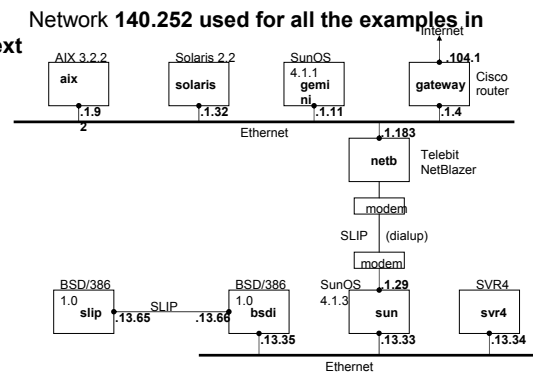|   |   |   |
|---|---|---|
|   |   |   |

0   1   2

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## routing table

- Destination IP address
- IP address of a *next-hop router ,* or the IP address of a directly connected network
- flags
- Specification of which network interface the datagram should be passed to for transmission
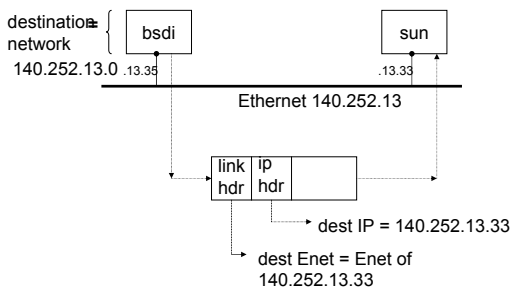
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## IP routing performs

tions

- Search the routing table for an entry that matches the complete destination IP address
- Search the routing table for an entry that matches just the destination network ID
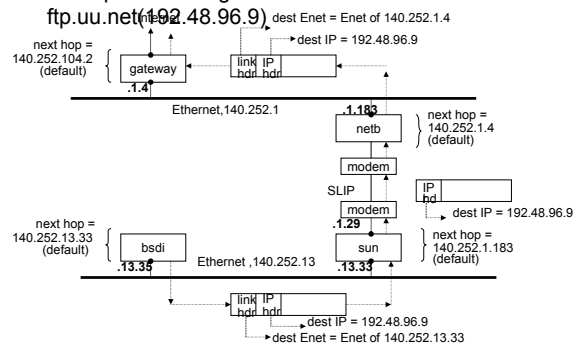- Search the routing table for an entry labeled " default"

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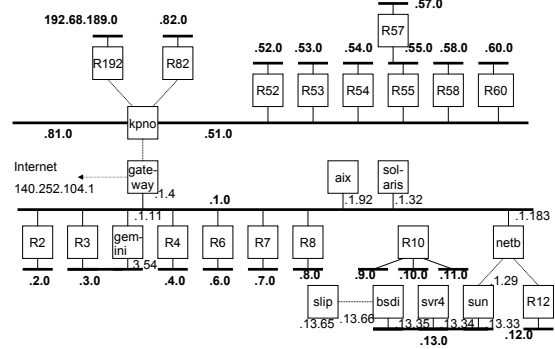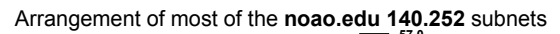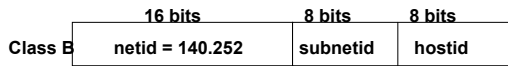## Network **140.252** used for all the examples in the text
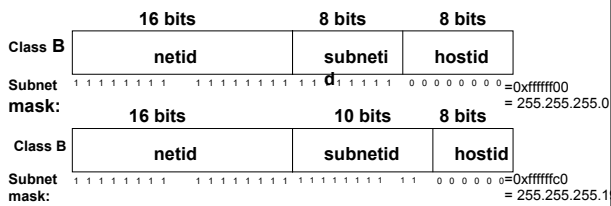
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## Delivery of IP datagram from bsdi to sun

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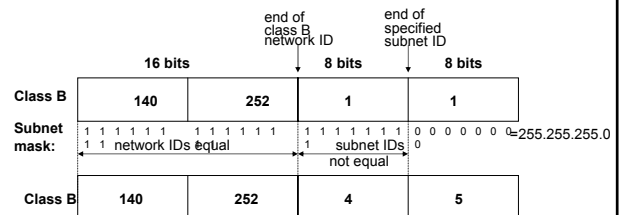## Initial path of datagram from bsdi to ftp.uu.net(192.48.96.9)

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## Subnetting a class B address

| 16 bits | 8 bits | 8 bits |
|---|---|---|
| **netid = 140.252** | **subnetid** | **hostid** |

Class B

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## Arrangement of most of the **noao.edu 140.252** subnets

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## Example subnet masks for two different class B subnet arrangements

| 16 bits | 8 bits | 8 bits |
|---|---|---|
| **netid** | **subnetid** | **hostid** |

Class B

Subnet mask:  1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1  0 0 0 0 0 0 0 0 = 0xffffff00 = 255.255.255.0

| 16 bits | 10 bits | 8 bits |
|---|---|---|
| **netid** | **subnetid** | **hostid** |

Class B

Subnet mask:  1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1  1 1 1 1 1 1 1 1  1 1  0 0 0 0 0 0 = 0xffffffc0 = 255.255.255.19

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## Comparison of two class B addresses using a subnet mask

end of class B network ID

end of specified subnet ID

| | 16 bits | | 8 bits | 8 bits |
|---|---|---|---|---|
| Class B | 140 | 252 | 1 | 1 |
| Subnet mask: | 1 1 1 1 1 1  1 1 1 1 1 1 | 1 1 1 1 1 1 1 1 | 0 0 0 0 0 0 0 0 | = 255.255.255.0 |
| | 1 1  network IDs equal | 1 | subnet IDs not equal | |
| Class B | 140 | 252 | 4 | 5 |

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## Special class IP addresses

| IP address | | | Can appears as | | |
|---|---|---|---|---|---|
| net ID | subnet ID | host ID | source ? | destination? | Description |
| 0 | | 0 | OK | never | this host on this net (see restrictions below) |
| 0 | | hostid | OK | never | specified host on this net (see restrictions below) |
| 127 | | anything | OK | OK | loopback address (Section 2.7) |
| -1 | | -1 | never | OK | limited broadcast (never forwarded) |
| netid | | -1 | never | OK | net-directed broadcast to netid |
| netid | subnetid | -1 | never | OK | subnet-directed broadcast to netid,subnetid |
| netid | -1 | -1 | never | OK | all-subnets-directed broadcast to netid |

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## Arrangement of hosts and networks for author's subnet



author's subnet:140.252.13

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## Slide 1

Using variable-length subnets

| | 16 bits | 11 bits | 5 bits |
|---|---|---|---|

**Class B**: net ID = 140.252 | subnet ID | host ID

8 bits = 13        128 64 32 16 8 4 2 1

**Subnet mask:** 1 1 1 1 1 1 1 1    1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0
1 1 1

=0xfffffffe0
= 255.255.192.224

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## Slide 2

IP addresses on author's subnet

| Host | IP address | Subnet mask | Net ID / Subnet ID | Host ID | Comment |
|---|---|---|---|---|---|
| sun | 140.252.1.29 | 255.255.255.0 | 140.252.1 | 29 | on subnet 1 |
| | 140.252.13.33 | 255.255.255.254 | 140.252.13.32 | 1 | on author's Ethernet |
| svr4 | 140.252.13.3 | 255.255.255.224 | 140.252.13.32 | 2 | |
| bsdi | 140.252.13.35 | 255.255.255.224 | 140.252.13.32 | 3 | on Ethernet |
| | 140.252.13.66 | 255.255.255.224 | 140.252.13.64 | 2 | point-to-point |
| slip | 140.252.13.65 | 255.255.255.224 | 140.252.13.64 | 1 | point-to-point |
| | 140.252.13.63 | 255.255.255.224 | 140.252.13.32 | 32 | broadcast addr on Ethernet |

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## Slide 3

### IP futures

- Over half of all class B addresses have already been allocated.
- 32-bit IP addresses in general are inadequate for the predicted long-term growth of the Internet.
- The current routing structure is not hierarchical , but flat,requiring one routing table entry per network.

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## Slide 4

### Solution

- SIP, the Simple Internet Protocol.
- PIP
- TUBA,which stands for "TCP and  UDP with Bigger Address " is based on the

  OSI CLNP(Connectionless Network Protocol) , an OSI protocol similar to IP
- TP/IX

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