Компютърни Мрежи и GNU/Linux

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Кой съм аз

- Независим консултант

- За свободен софтуер, свобода на словото, достъпа до информация и т.н, както и Хуманизъм, Neurodiversity, Freedom of thought, etc.
- CCIE #8701 (Януари 2002)

Увод

- Какво са компютърните мрежи?

Лекцията

- Мрежови модели
- Често срещани протоколи
- Стандартни организации
- Инструменти и примери
- Хардуер
  - Дънни платки
  - Мрежови карти
- Ethernet, VLANs
- IP, UDP, TCP

Слоести ...

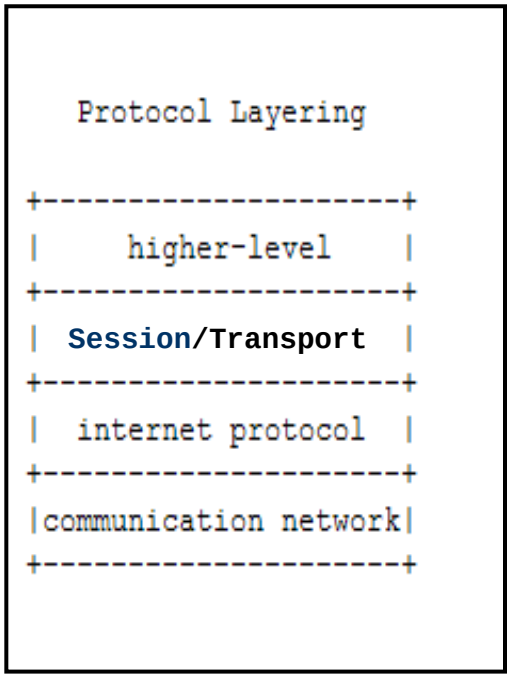
Слоести мрежови модели

OSI

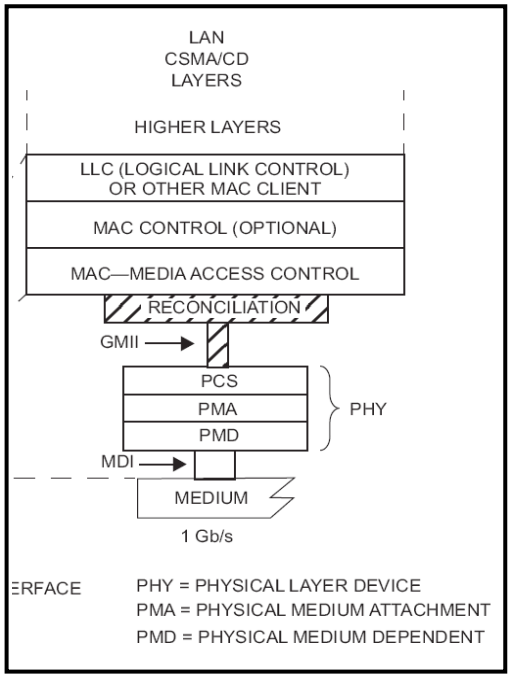
Моделите

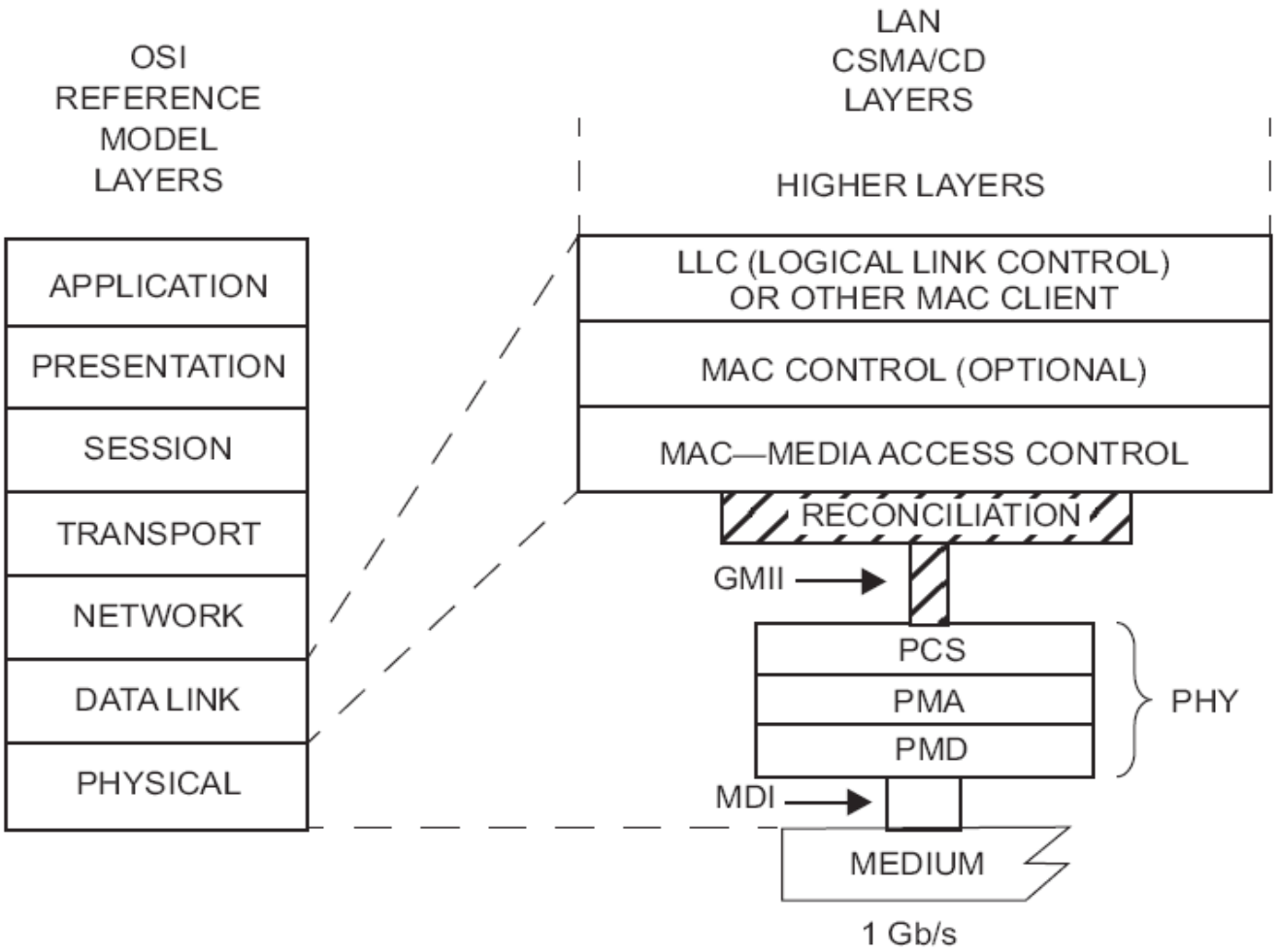
OSI

IETF



IEEE





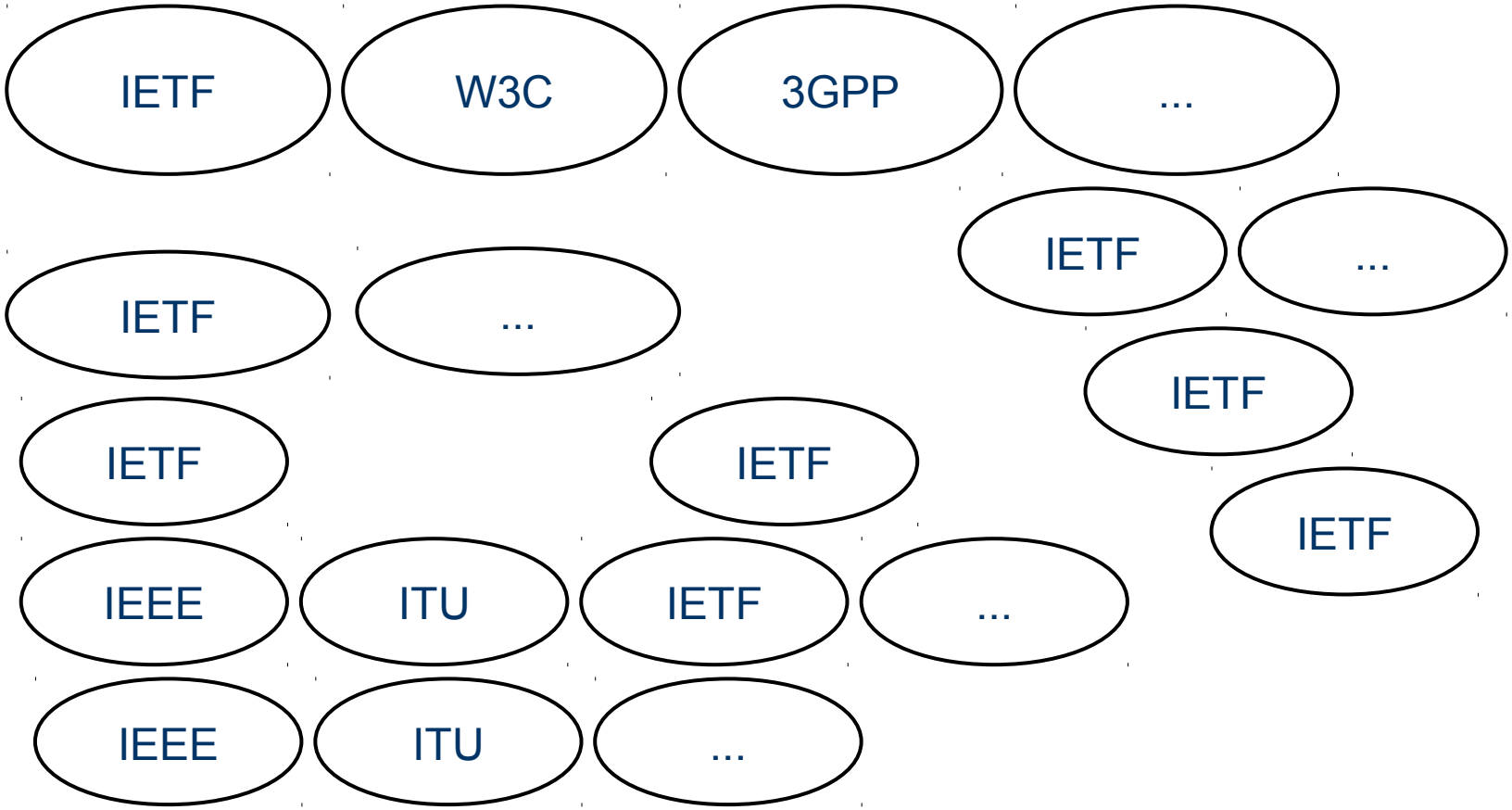
GMII = GIGABIT MEDIA INDEPENDENT INTERFACE
MDI = MEDIUM DEPENDENT INTERFACE
PCS = PHYSICAL CODING SUBLAYER

PHY = PHYSICAL LAYER DEVICE
PMA = PHYSICAL MEDIUM ATTACHMENT
PMD = PHYSICAL MEDIUM DEPENDENT

Протоколи

Протоколи

Стандартни организации



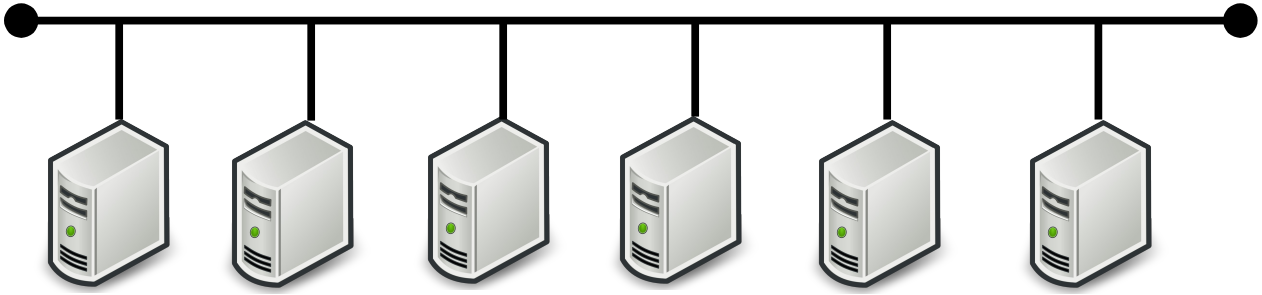
Стандартни организации

- Internet Engineering Task F (www.ietf.org)
- Institute of Electrical and Electronics Engineers - IEEE (www.ieee.org)
- International Telecommunication Union - ITU (www.itu.int)
- 3GPP (www.3gpp.org)
- x Forum, y Alliance, z Foundation (WiMax Forum, WiMedia Alliance, XMPP Standards Foundation, и т.н.)
- Повечето широко-използвани протоколи в мрежите са свободни

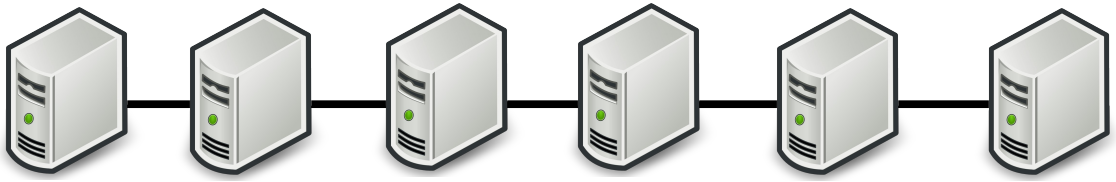
Мрежова топология

Мрежова топология

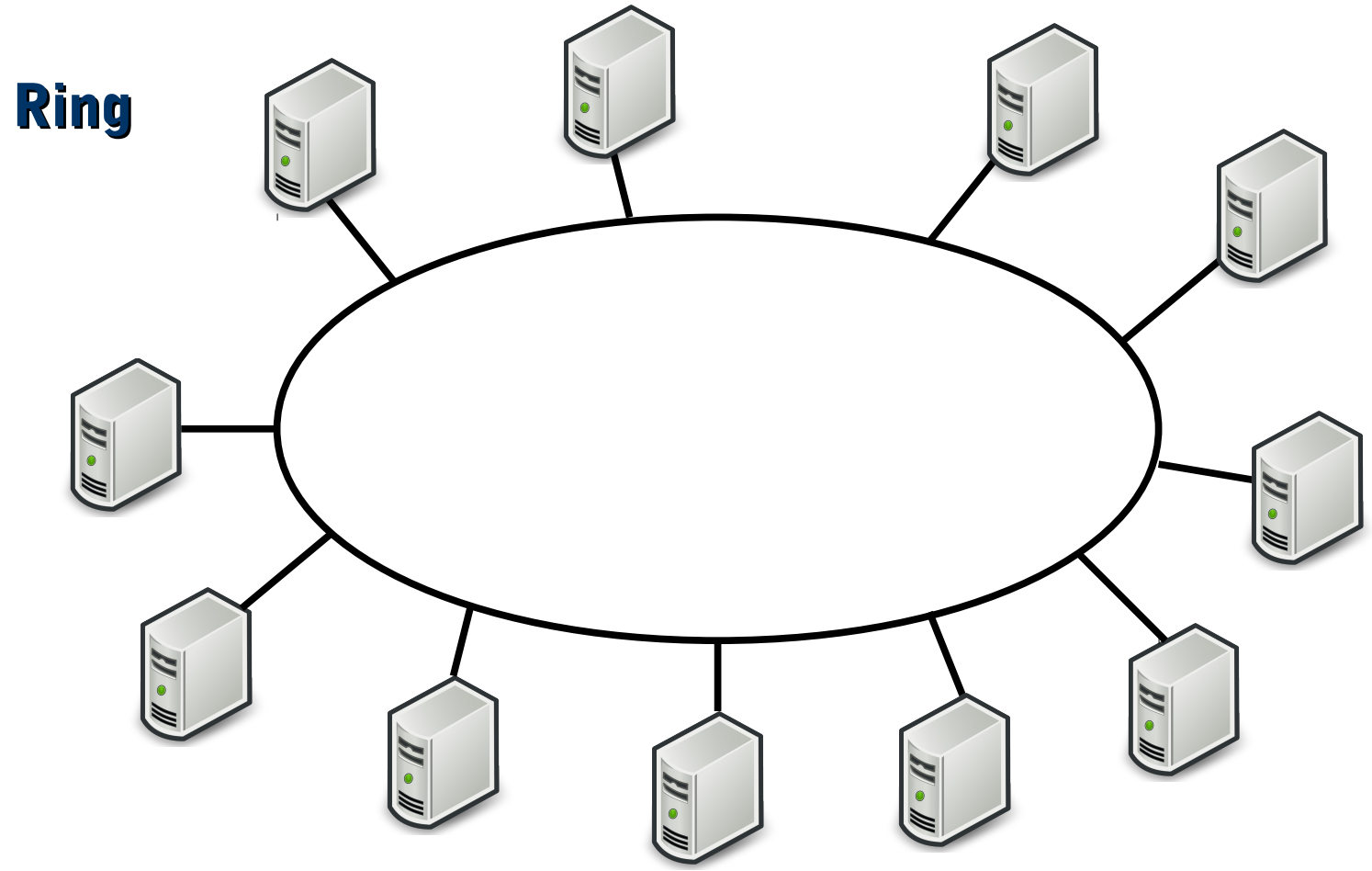
Bus



Line

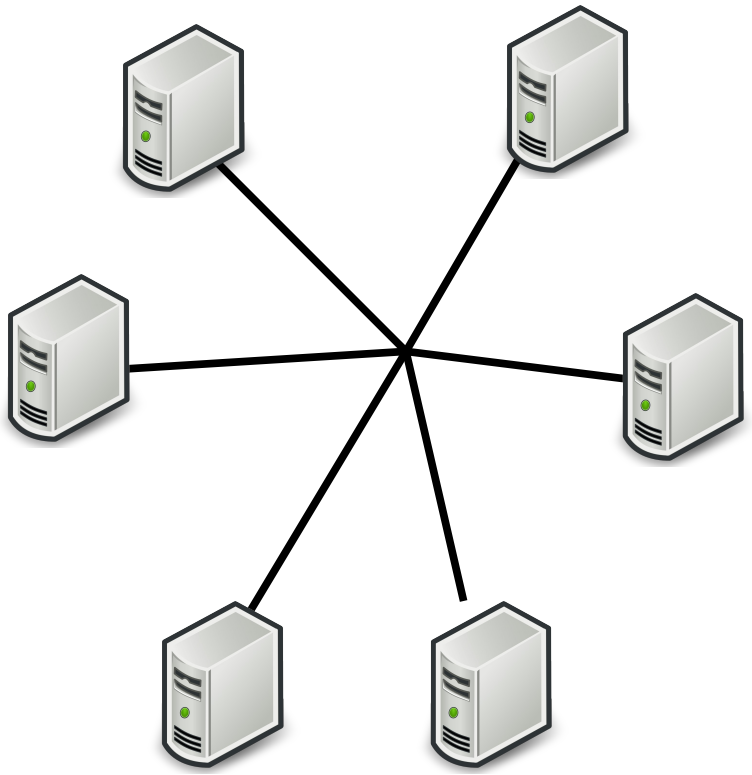


Мрежова топология



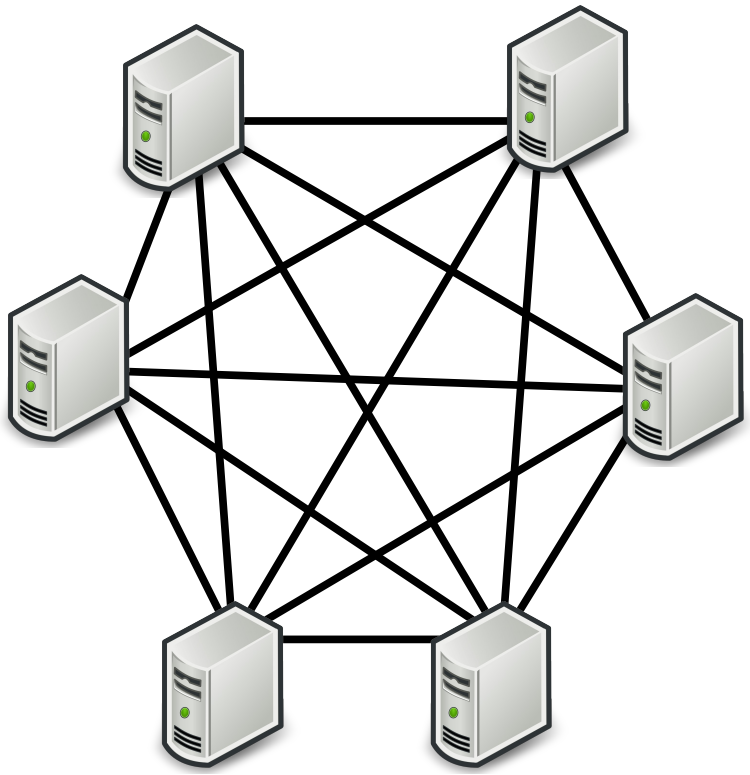
Мрежова топология

Star



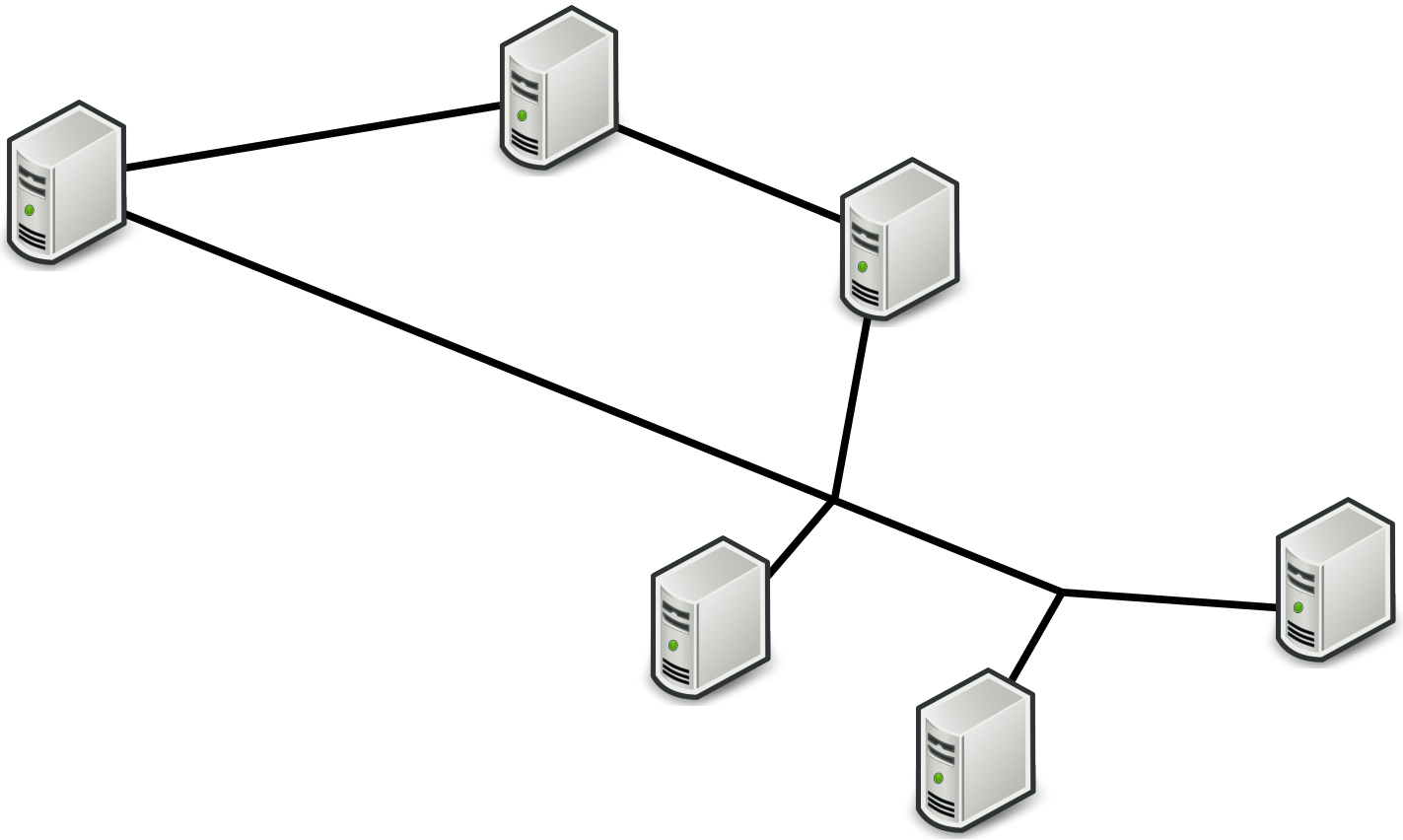
Мрежова топология

Fully connected star



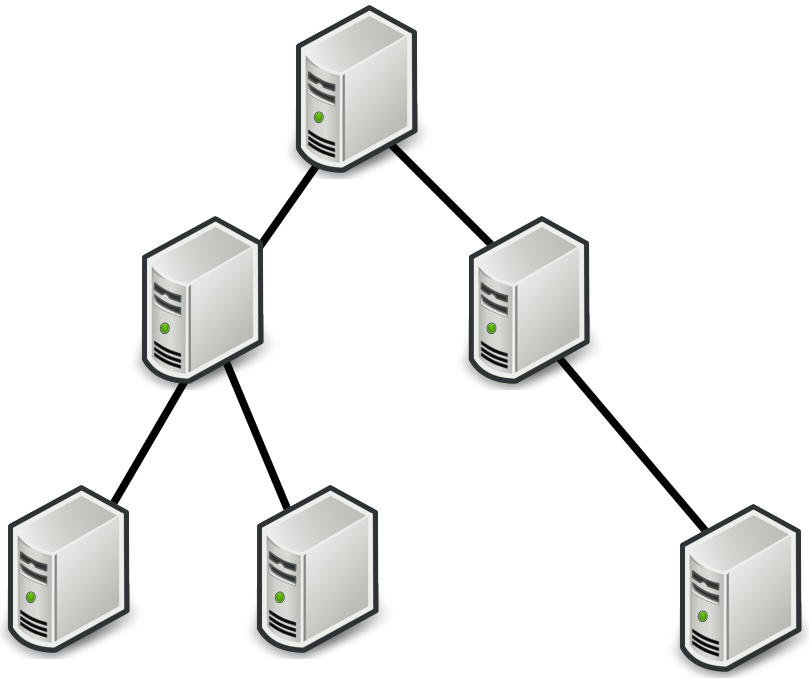
Мрежова топология

Mesh

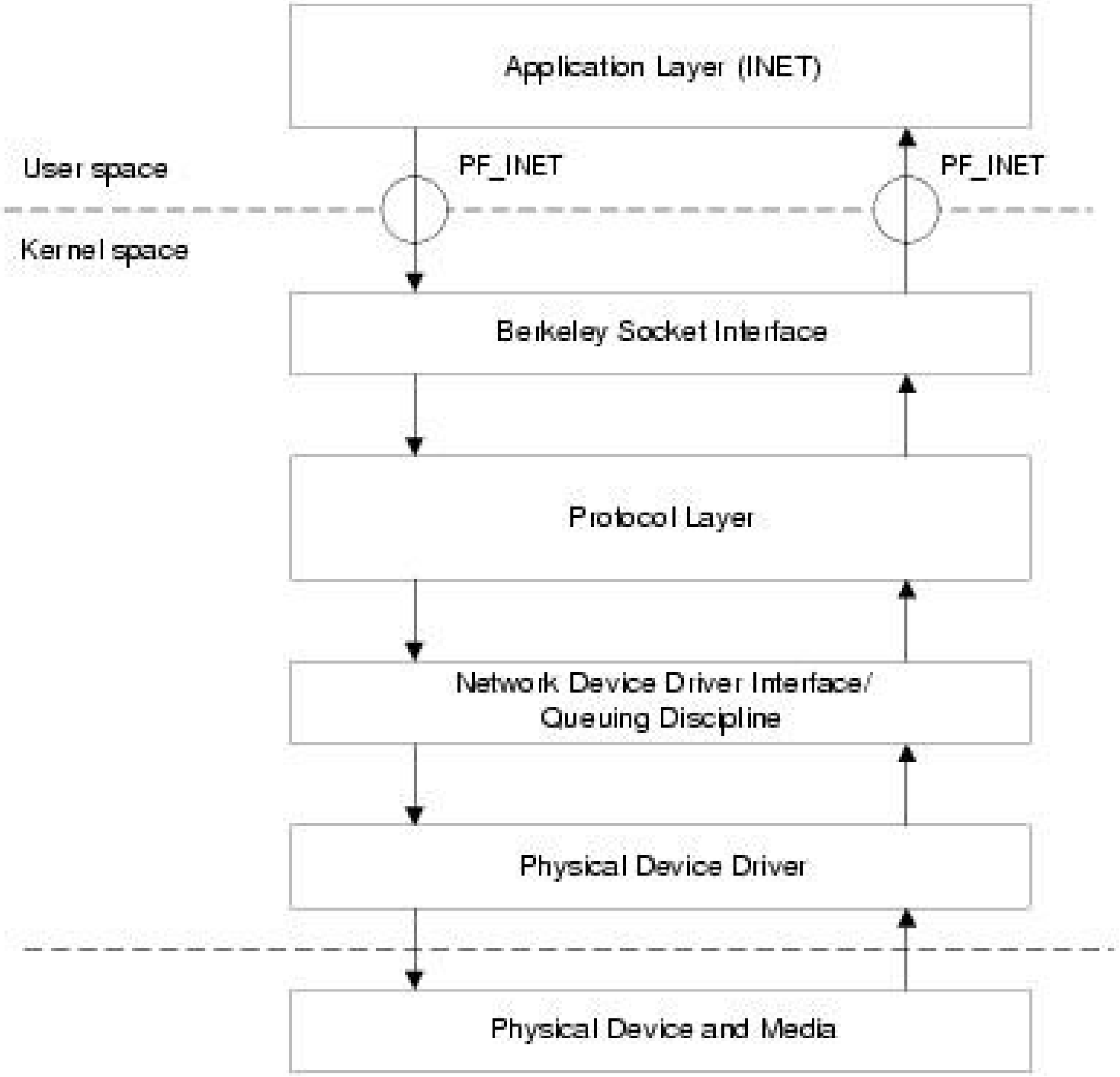


Мрежова топология

Tree

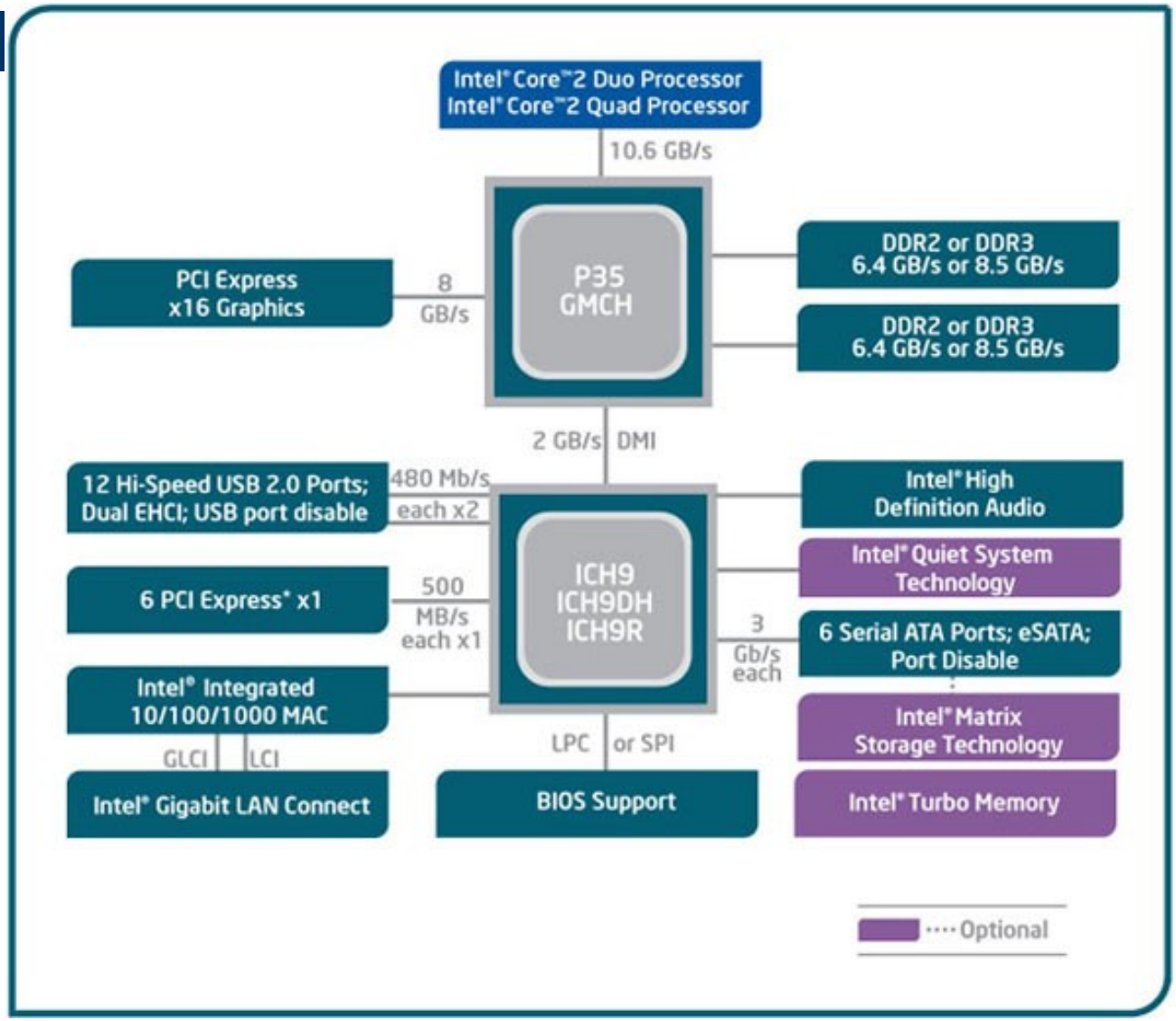


Инструменти


Application Layer (INET)
User space
PF_INET
PF_INET
Kernel space
Berkeley Socket Interface
Protocol Layer
Network Device Driver Interface/
Queuing Discipline
Physical Device Driver
Physical Device and Media

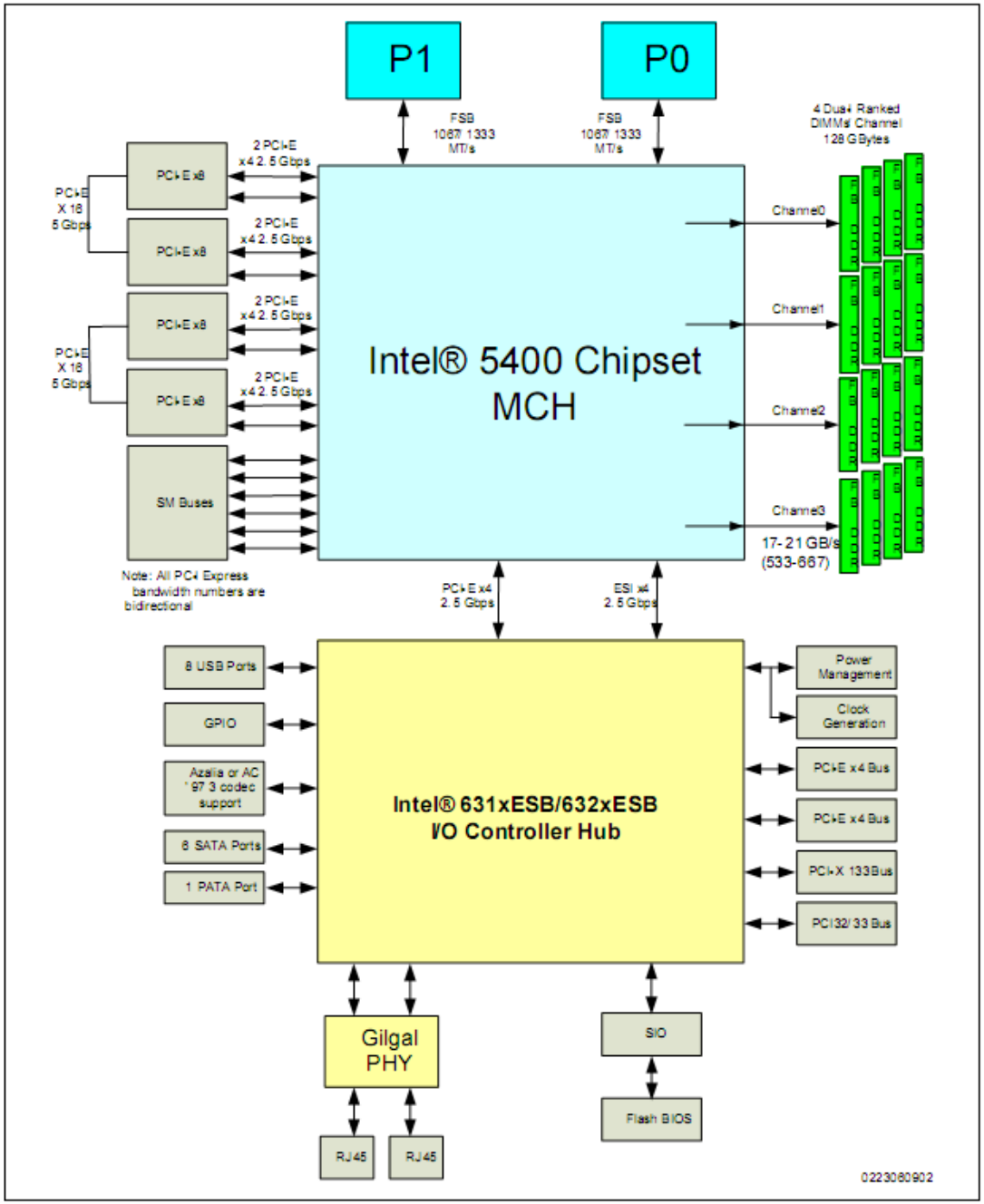
Q&A

Desktop Hardware



Server

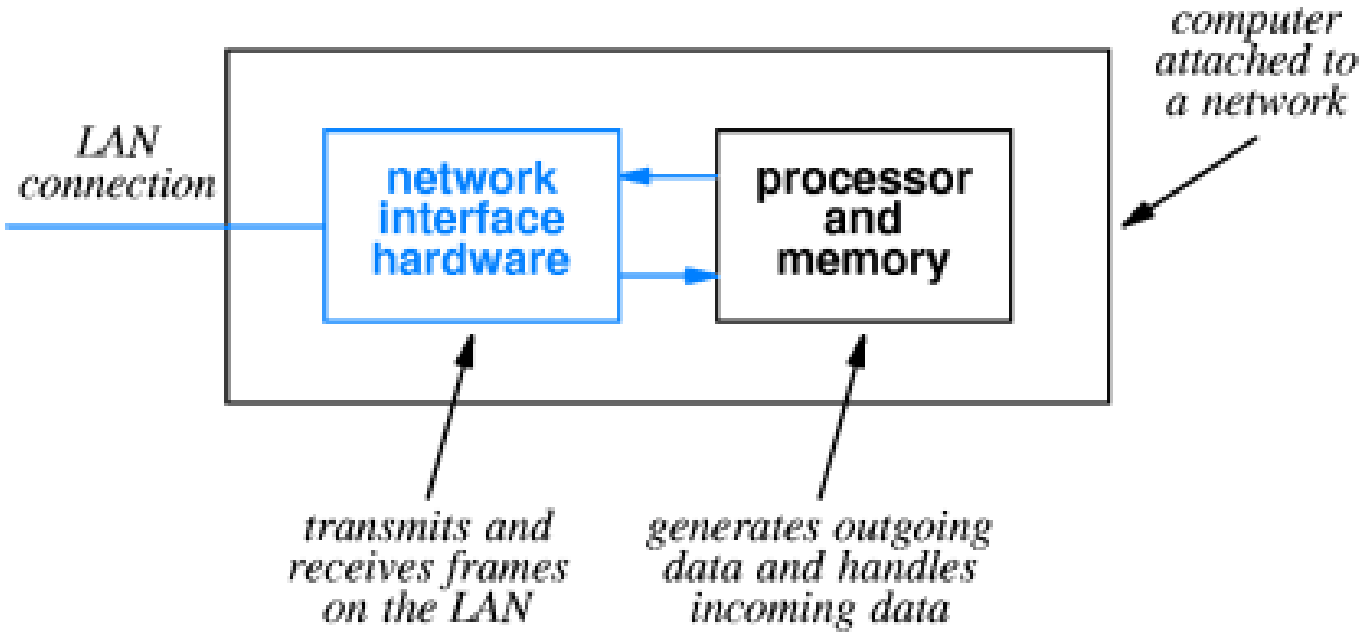
Figure 1-1. Intel® 5400 Chipset System Block Diagram



lspci

```
gaia:~# lspci
00:00.0 Host bridge: Intel Corporation E7320 Memory Controller Hub (rev 0c)
00:00.1 Class ff00: Intel Corporation E7320 Error Reporting Registers (rev 0c)
00:02.0 PCI bridge: Intel Corporation E7525/E7520/E7320 PCI Express Port A (rev 0c)
00:03.0 PCI bridge: Intel Corporation E7525/E7520/E7320 PCI Express Port A1 (rev 0c)
00:1c.0 PCI bridge: Intel Corporation 6300ESB 64-bit PCI-X Bridge (rev 02)
00:1d.0 USB Controller: Intel Corporation 6300ESB USB Universal Host Controller (rev
    02)
00:1d.1 USB Controller: Intel Corporation 6300ESB USB Universal Host Controller (rev
    02)
00:1d.4 System peripheral: Intel Corporation 6300ESB Watchdog Timer (rev 02)
00:1d.5 PIC: Intel Corporation 6300ESB I/O Advanced Programmable Interrupt
    Controller (rev 02)
00:1d.7 USB Controller: Intel Corporation 6300ESB USB2 Enhanced Host Controller (rev
    02)
00:1e.0 PCI bridge: Intel Corporation 82801 PCI Bridge (rev 0a)
00:1f.0 ISA bridge: Intel Corporation 6300ESB LPC Interface Controller (rev 02)
00:1f.1 IDE interface: Intel Corporation 6300ESB PATA Storage Controller (rev 02)
00:1f.3 SMBus: Intel Corporation 6300ESB SMBus Controller (rev 02)
03:01.0 RAID bus controller: 3ware Inc 9550SX SATA-RAID
04:03.0 VGA compatible controller: ATI Technologies Inc Rage XL (rev 27)
04:04.0 Ethernet controller: Broadcom Corporation NetXtreme BCM5705 Gigabit Ethernet
    (rev 03)
```

NIC

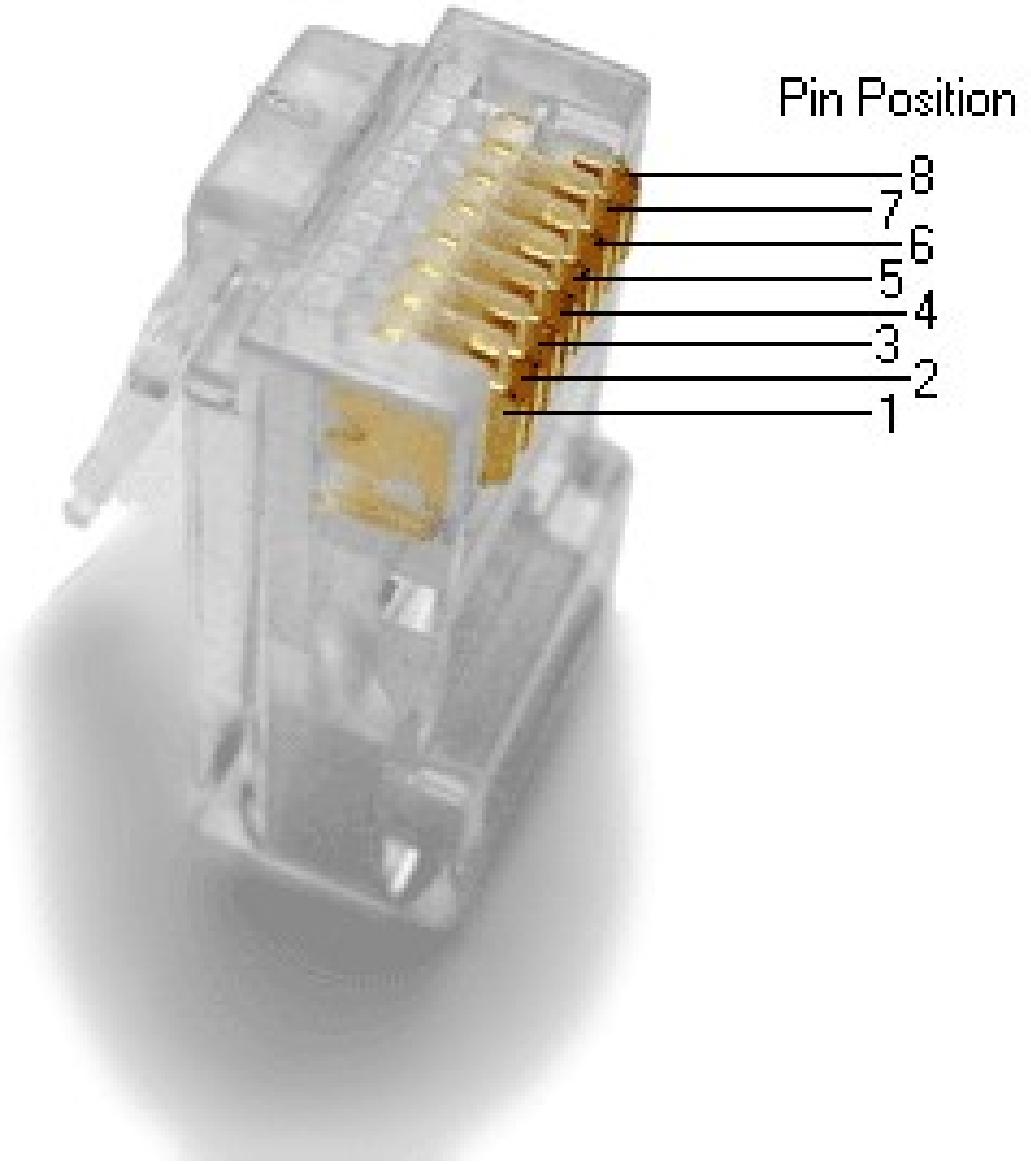

computer attached to a network
LAN connection
network interface hardware
processor and memory
transmits and receives frames on the LAN
generates outgoing data and handles incoming data

Ethernet PHY

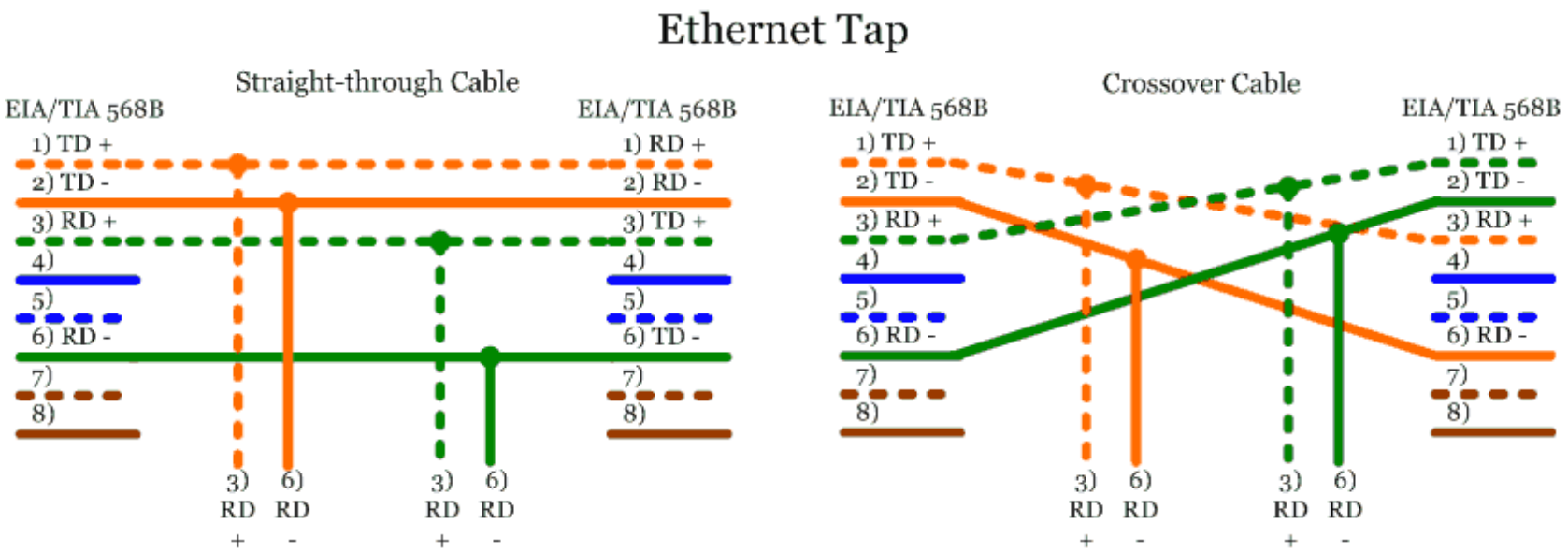
- Диференциални сигнали
- Усукани двойки

- Категории кабели
  - 5/5e (100MHz)
  - 6/6a (250/500 MHz)

8P8C (RJ-45)



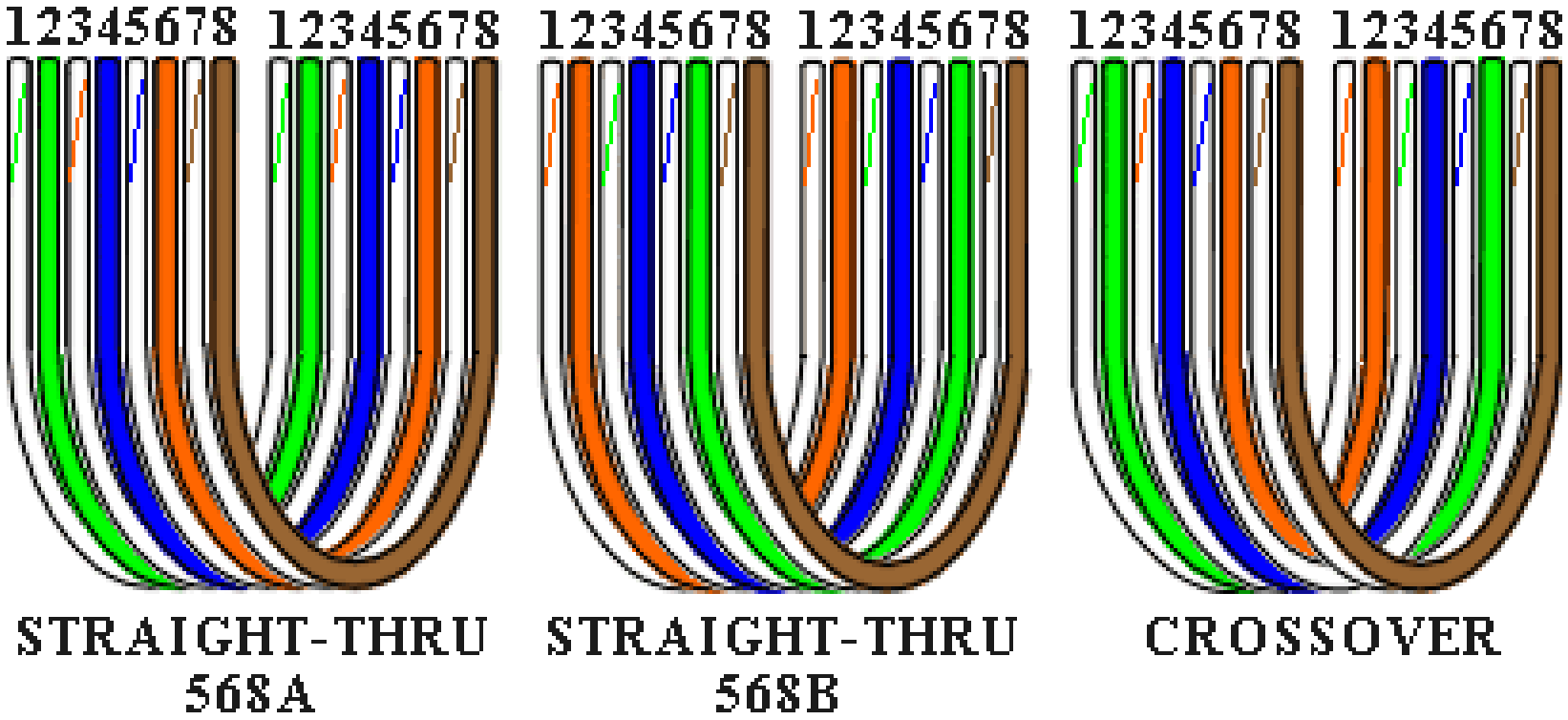
Ethernet PHY

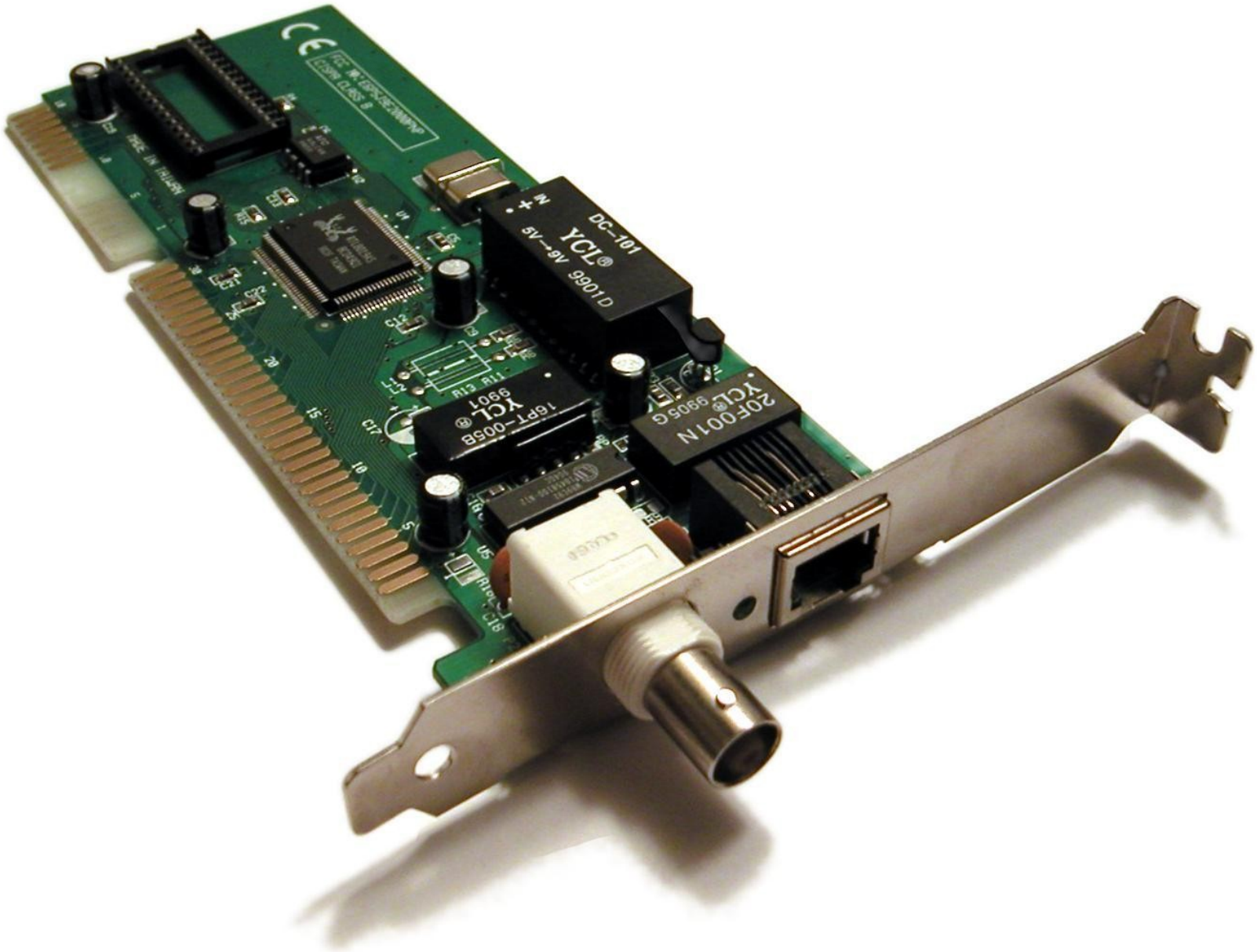


100BASE-TX

Crossed cable

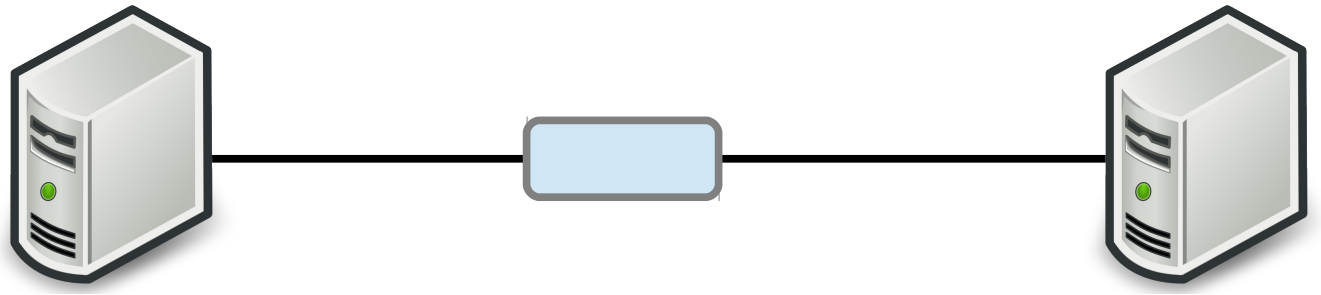
- бо,о,бз,с,бс,з,бк,к – тип B
- 1,2 <-> 3,6 и обратно




DC-101
YCL
5V~9V 9901D
16PT-005B
YCL
9901
20F001N
YCL 9905G

Hub, Switch, Router

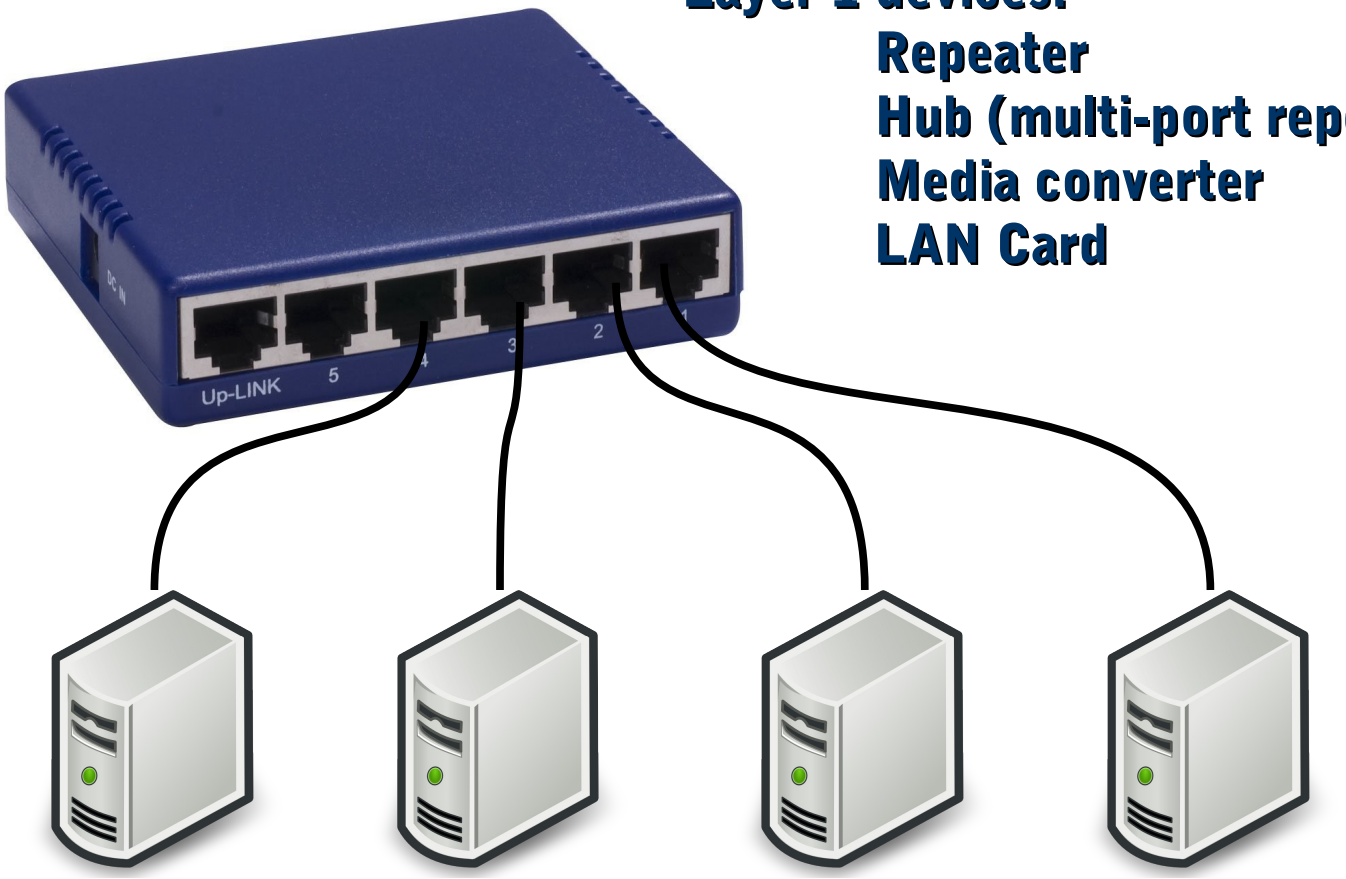
Repeater



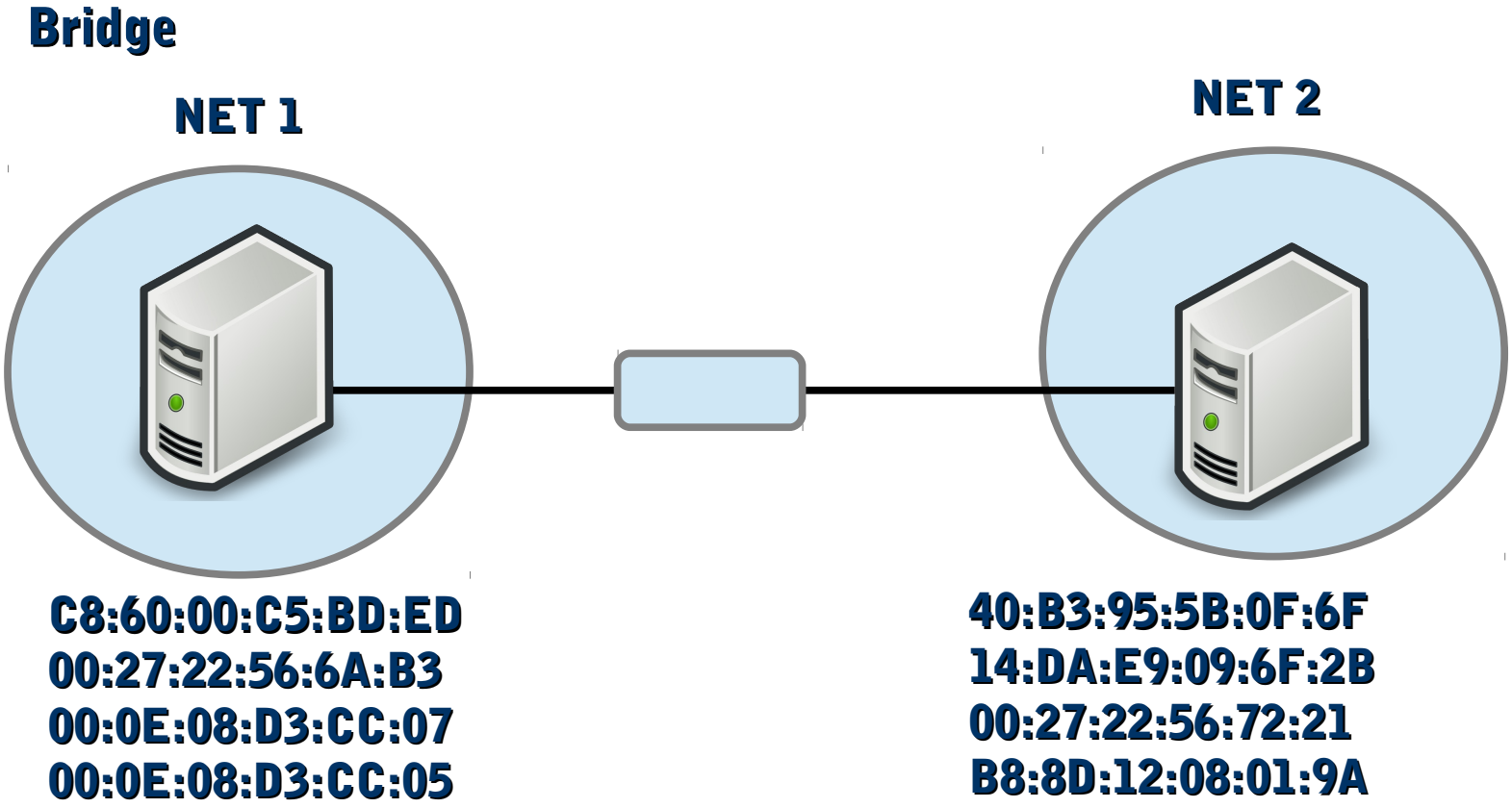
Hub, Switch, Router

Layer 1 devices:

- **Repeater**
- **Hub (multi-port repeater)**
- **Media converter**
- **LAN Card**



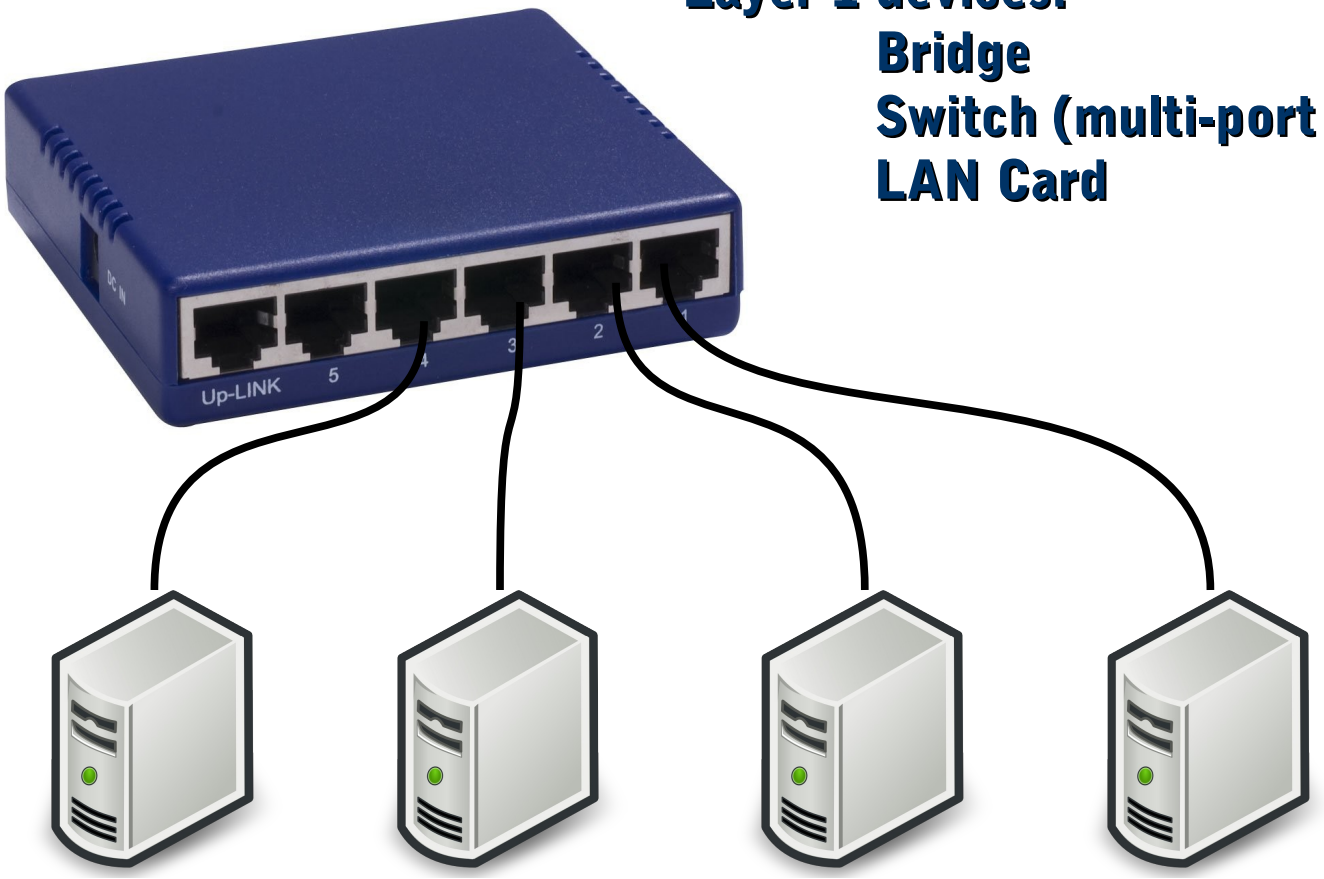
Hub, Switch, Router



Hub, Switch, Router

Layer 1 devices:

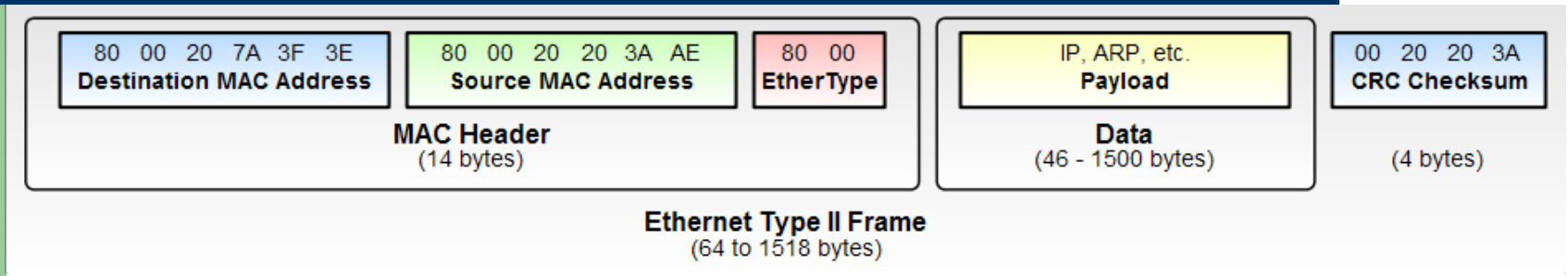
- **Bridge**
- **Switch (multi-port bridge)**
- **LAN Card**



Рамки, пакети, сегменти

Рамки, пакети, сегменти

Ethernet рамка



- Network order / Machine order ...
- битове 6 и 7 от MAC адреса ...

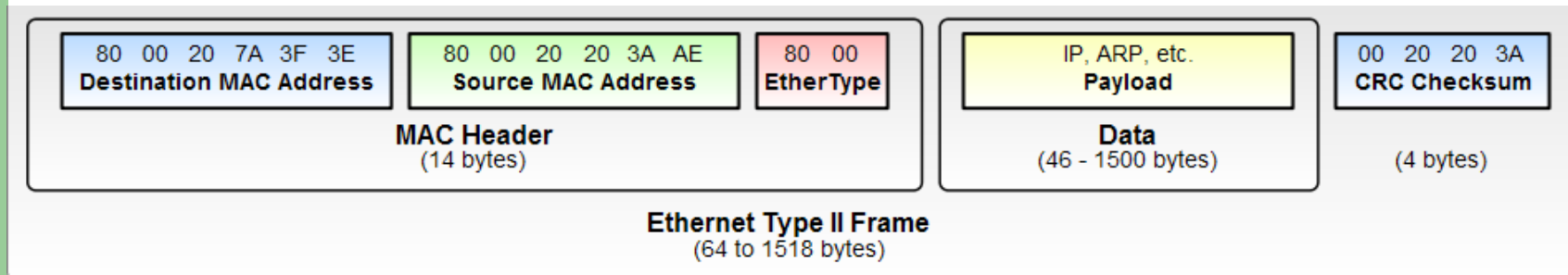
- max 150 Kpps @ 100Mbps

Hub, Switch, Router

Switch

- Принцип на работа

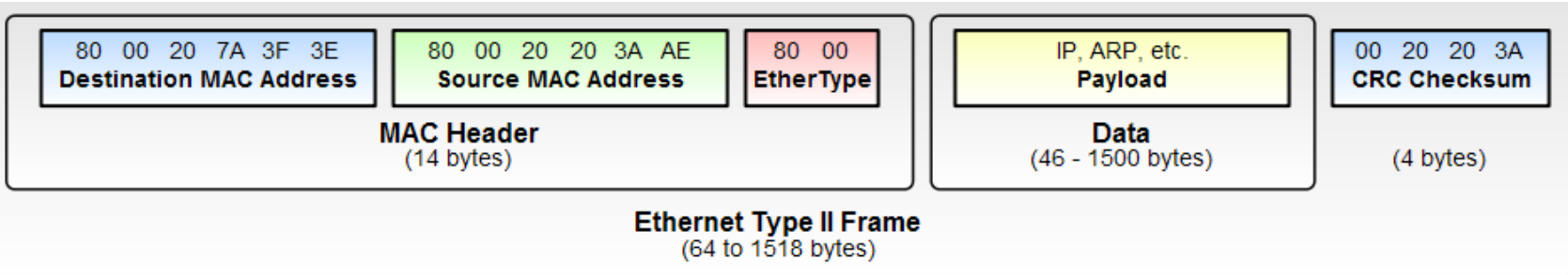
- Broadcast/Multicast/Unicast
- Unknown Unicast



VLANs and Trunking

- IEEE 802.1q / 802.1p
- Принцип на работа
- Native(untagged) VLAN

- Tag Protocol ID (TPID) 0x8100
- 3-bit priority, 12-bit VLAN ID

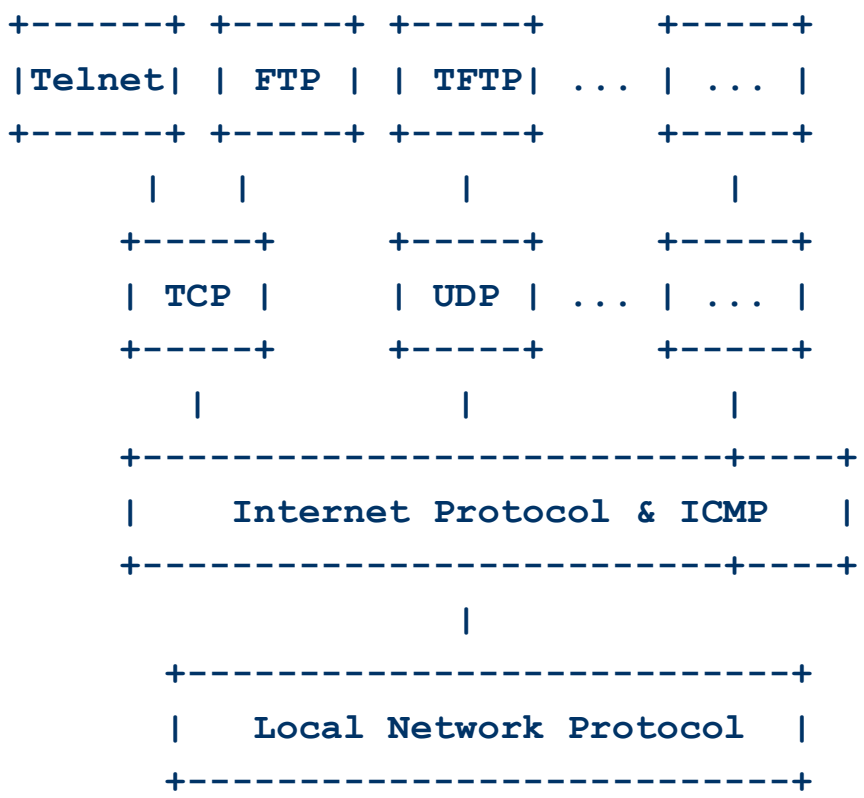


Ethernet

Q&A

IP (RFC 791)

Relation to other protocols



Protocol Relationships

Figure 1.

Model of operation

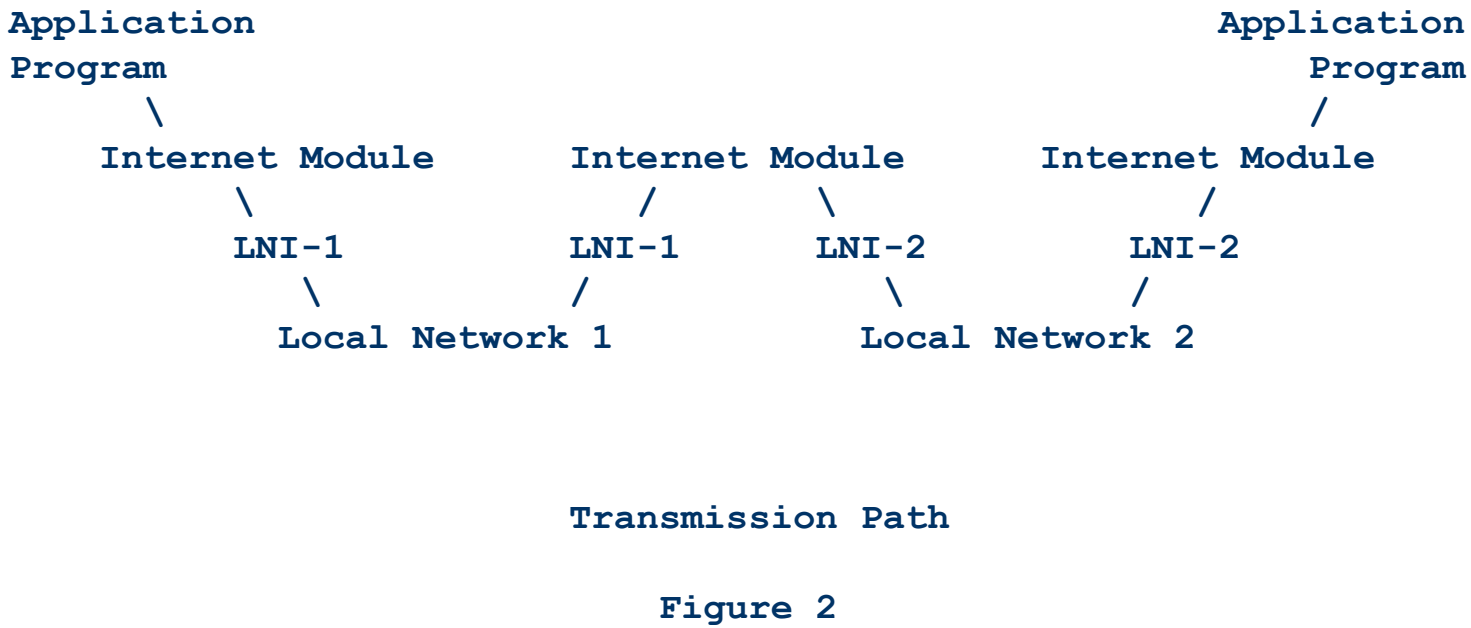
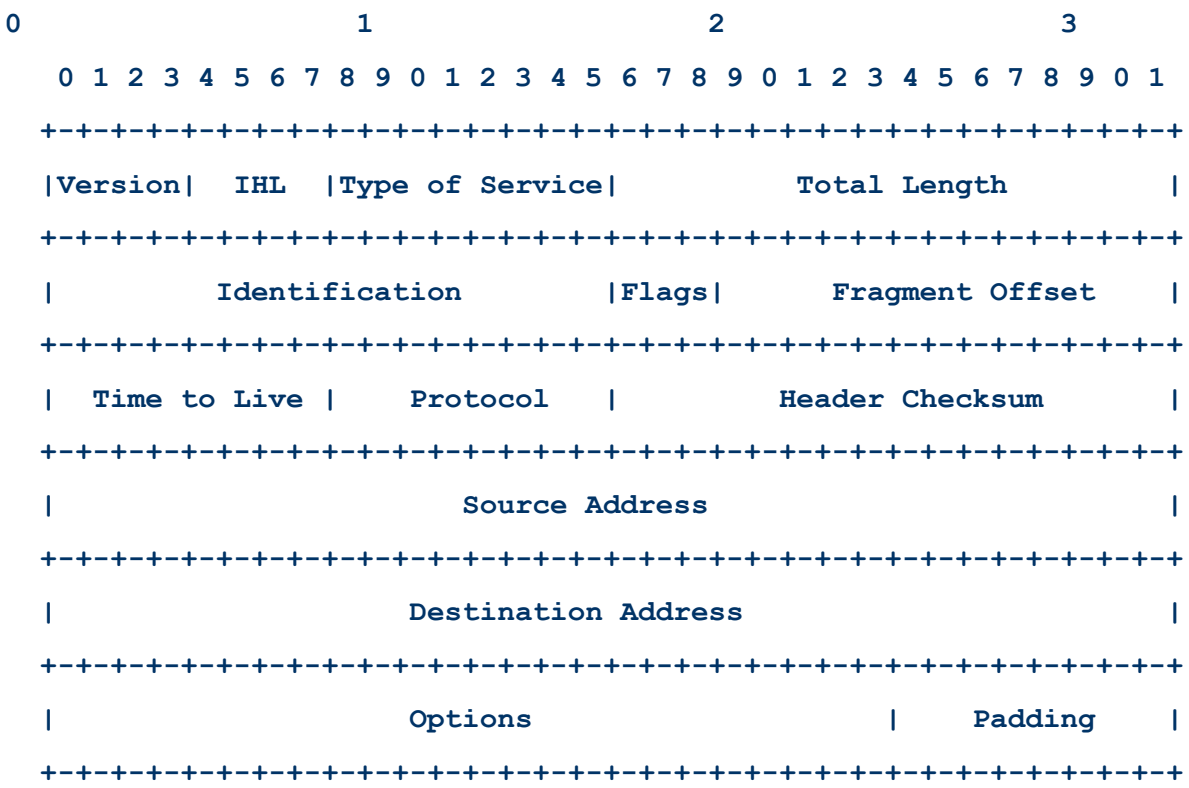


Figure 2

Мрежова топология

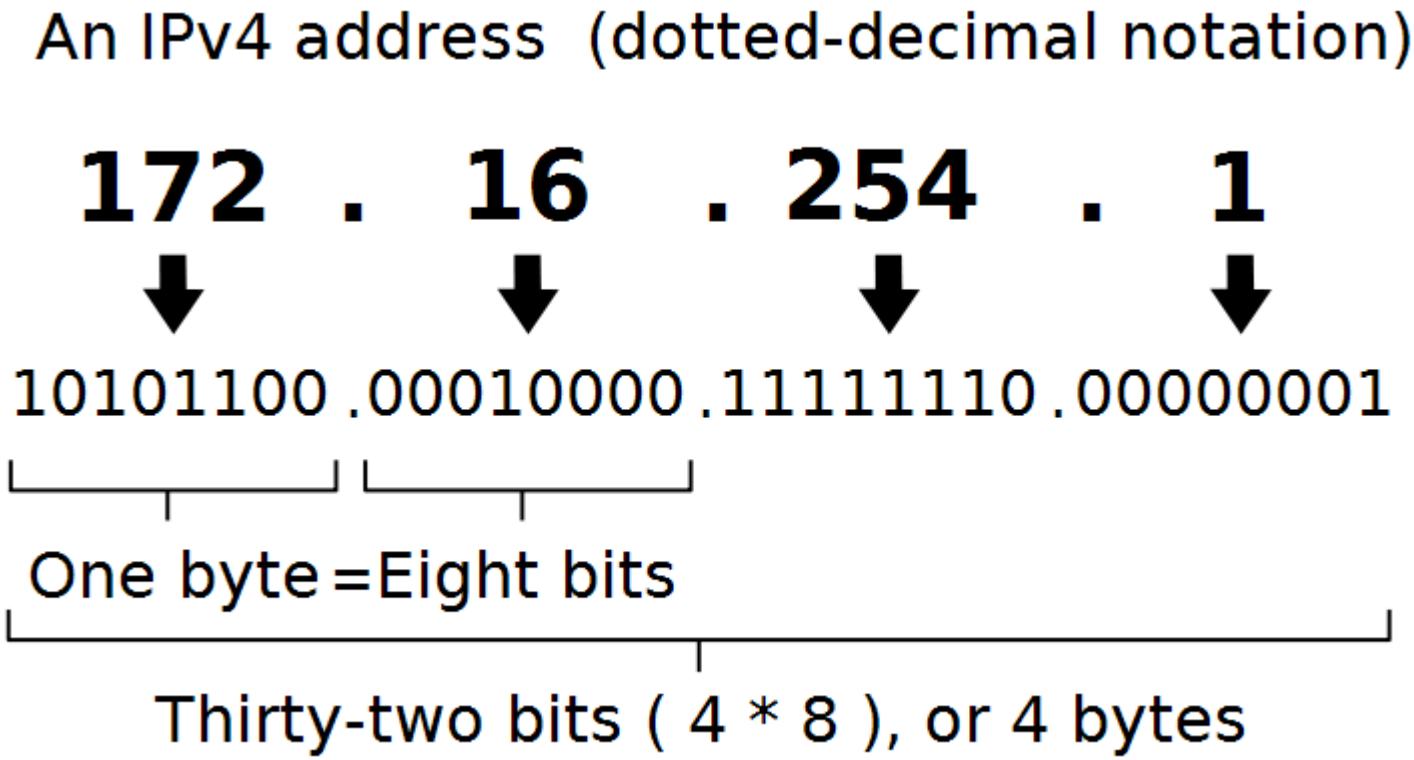
IP Header



Example Internet Datagram Header

Figure 4.

IP Address


An IPv4 address (dotted-decimal notation)
172 . 16 . 254 . 1
10101100.00010000.11111110.00000001
One byte=Eight bits
Thirty-two bits (4 * 8), or 4 bytes

IP Subnetting

- CIDR (RFC1519 ’93 -> RFC4632)

notation	addrs/block	# blocks	
n.n.n.n/32	1	4294967296	"host route"
n.n.n.x/31	2	2147483648	"p2p link"
n.n.n.x/30	4	1073741824	
n.n.n.x/29	8	536870912	
n.n.n.x/28	16	268435456	
n.n.n.x/27	32	134217728	
n.n.n.x/26	64	67108864	
n.n.n.x/25	128	33554432	
n.n.n.0/24	256	16777216	legacy "Class C"
n.n.x.0/23	512	8388608	
n.n.x.0/22	1024	4194304	
n.n.x.0/21	2048	2097152	
n.n.x.0/20	4096	1048576	

IP Subnetting

n.n.x.0/19	8192	524288	
n.n.x.0/18	16384	262144	
n.n.x.0/17	32768	131072	
n.n.0.0/16	65536	65536	legacy "Class B"
n.x.0.0/15	131072	32768	
n.x.0.0/14	262144	16384	
n.x.0.0/13	524288	8192	
n.x.0.0/12	1048576	4096	
n.x.0.0/11	2097152	2048	
n.x.0.0/10	4194304	1024	
n.x.0.0/9	8388608	512	
n.0.0.0/8	16777216	256	legacy "Class A"
x.0.0.0/7	33554432	128	
x.0.0.0/6	67108864	64	
x.0.0.0/5	134217728	32	
x.0.0.0/4	268435456	16	
x.0.0.0/3	536870912	8	
x.0.0.0/2	1073741824	4	
x.0.0.0/1	2147483648	2	
0.0.0.0/0	4294967296	1	"default route"

ipcalc

```
boyan@luna:~$ ipcalc 192.168.1.3/24 20
Address:   192.168.1.3          11000000.10101000.00000001. 00000011
Netmask:   255.255.255.0 = 24   11111111.11111111.11111111. 00000000
Wildcard:  0.0.0.255            00000000.00000000.00000000. 11111111
=>
Network:   192.168.1.0/24       11000000.10101000.00000001. 00000000
HostMin:   192.168.1.1          11000000.10101000.00000001. 00000001
HostMax:   192.168.1.254        11000000.10101000.00000001. 11111110
Broadcast: 192.168.1.255        11000000.10101000.00000001. 11111111
Hosts/Net: 254                   Class C, Private Internet

Supernet

Netmask:   255.255.240.0 = 20   11111111.11111111.1111 0000.00000000
Wildcard:  0.0.15.255           00000000.00000000.0000 1111.11111111

Network:   192.168.0.0/20       11000000.10101000.0000 0000.00000000
HostMin:   192.168.0.1          11000000.10101000.0000 0000.00000001
HostMax:   192.168.15.254       11000000.10101000.0000 1111.11111110
Broadcast: 192.168.15.255       11000000.10101000.0000 1111.11111111
Hosts/Net: 4094                  Class C, Private Internet

boyan@luna:~$
```

```
boyan@luna:~$ ipcalc 192.168.1.3/24 26
Address:   192.168.1.3          11000000.10101000.00000001. 00000011
Netmask:   255.255.255.0 = 24   11111111.11111111.11111111. 00000000
Wildcard:  0.0.0.255            00000000.00000000.00000000. 11111111
=>
Network:   192.168.1.0/24       11000000.10101000.00000001. 00000000
HostMin:   192.168.1.1          11000000.10101000.00000001. 00000001
HostMax:   192.168.1.254        11000000.10101000.00000001. 11111110
Broadcast: 192.168.1.255        11000000.10101000.00000001. 11111111
Hosts/Net: 254                   Class C, Private Internet

Subnets after transition from /24 to /26

Netmask:   255.255.255.192 = 26 11111111.11111111.11111111.11 000000
Wildcard:  0.0.0.63             00000000.00000000.00000000.00 111111

 1.
Network:   192.168.1.0/26       11000000.10101000.00000001.00 000000
HostMin:   192.168.1.1          11000000.10101000.00000001.00 000001
HostMax:   192.168.1.62         11000000.10101000.00000001.00 111110
Broadcast: 192.168.1.63         11000000.10101000.00000001.00 111111
Hosts/Net: 62                    Class C, Private Internet

 2.
Network:   192.168.1.64/26      11000000.10101000.00000001.01 000000
HostMin:   192.168.1.65         11000000.10101000.00000001.01 000001
HostMax:   192.168.1.126        11000000.10101000.00000001.01 111110
Broadcast: 192.168.1.127        11000000.10101000.00000001.01 111111
Hosts/Net: 62                    Class C, Private Internet

 3.
Network:   192.168.1.128/26     11000000.10101000.00000001.10 000000
HostMin:   192.168.1.129        11000000.10101000.00000001.10 000001
HostMax:   192.168.1.190        11000000.10101000.00000001.10 111110
Broadcast: 192.168.1.191        11000000.10101000.00000001.10 111111
Hosts/Net: 62                    Class C, Private Internet

 4.
Network:   192.168.1.192/26     11000000.10101000.00000001.11 000000
HostMin:   192.168.1.193        11000000.10101000.00000001.11 000001
HostMax:   192.168.1.254        11000000.10101000.00000001.11 111110
Broadcast: 192.168.1.255        11000000.10101000.00000001.11 111111
Hosts/Net: 62                    Class C, Private Internet


Subnets:   4
Hosts:     248
boyan@luna:~$
```

Special adresses

- 0.0.0.0 – uninitialized endpoint
- 0.0.0.0/8 – local network (not 0/0)
- 127.0.0.0/8 – loopback
- 169.254.0.0/16 – link-local adresses
- 224.0.0.0/4 – Multicast (Class D)
- 240.0.0.0/4 – Experimental (Class E)
- 255.255.255.255 – Local Broadcast

Special adresses

- RFC1918
- 10.0.0.0/8
- 172.16.0.0/12
- 192.168.0.0/16