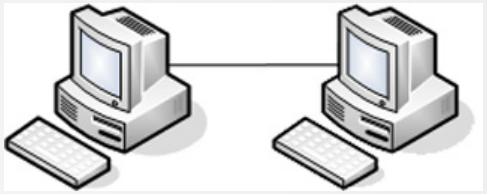
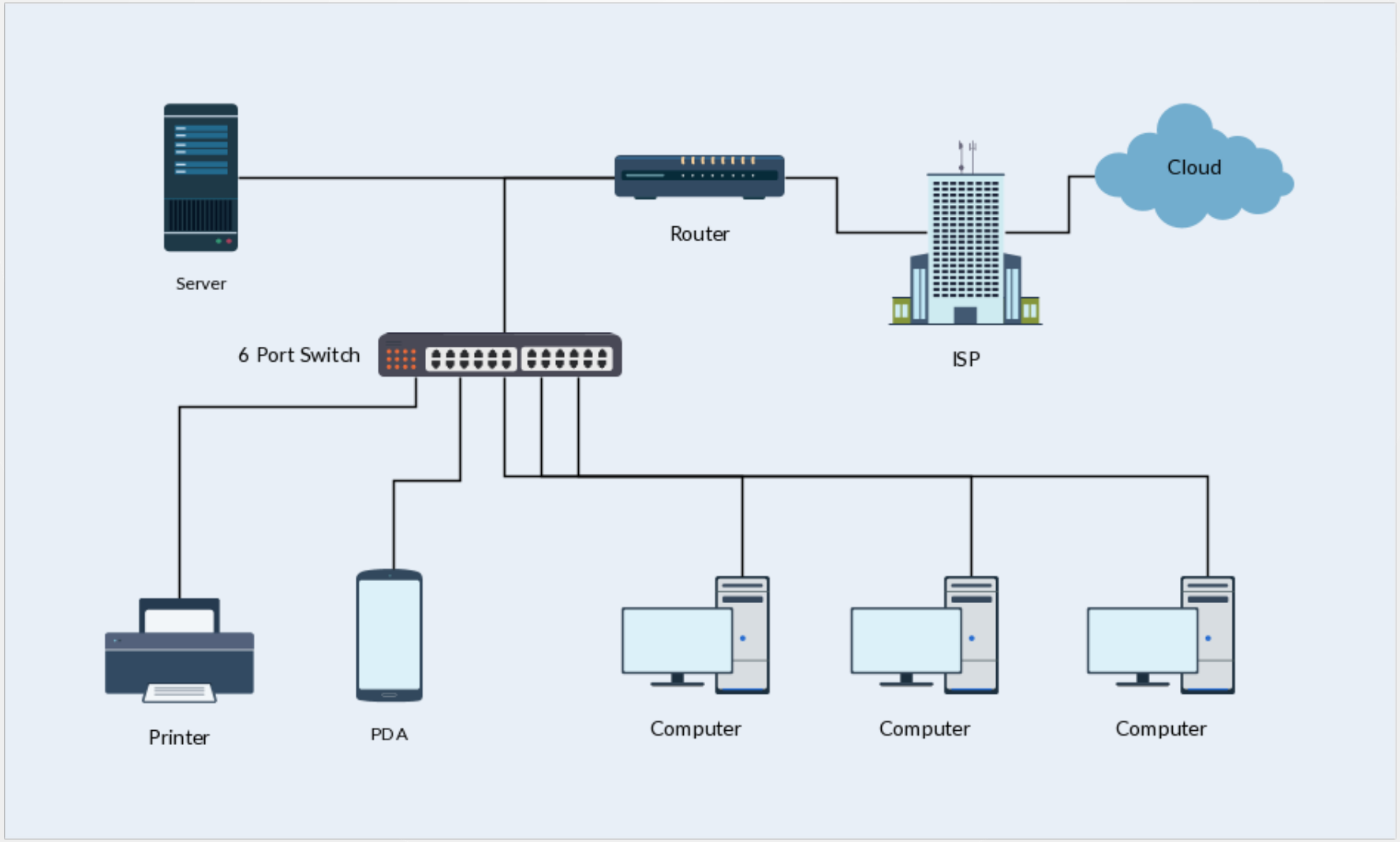
WWW & Internet

Miroslav Hájek

Počítačová sieť

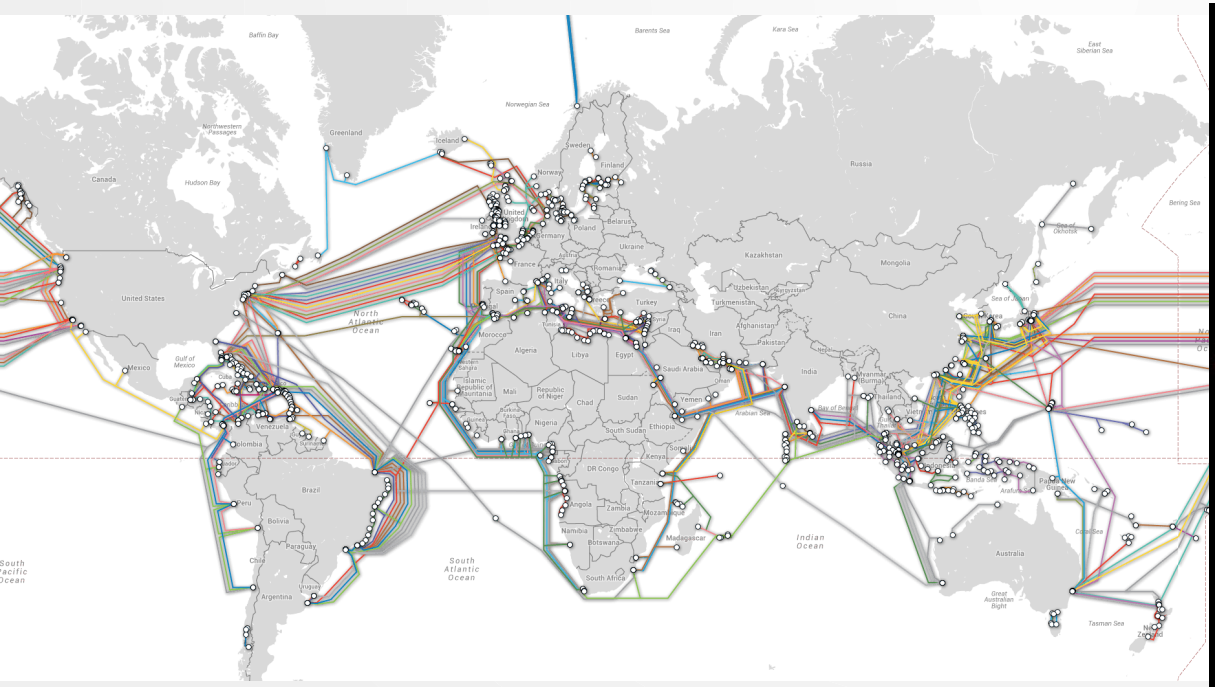


- Prepojenie počítačov za účelom komunikácie a zdieľania zdrojov

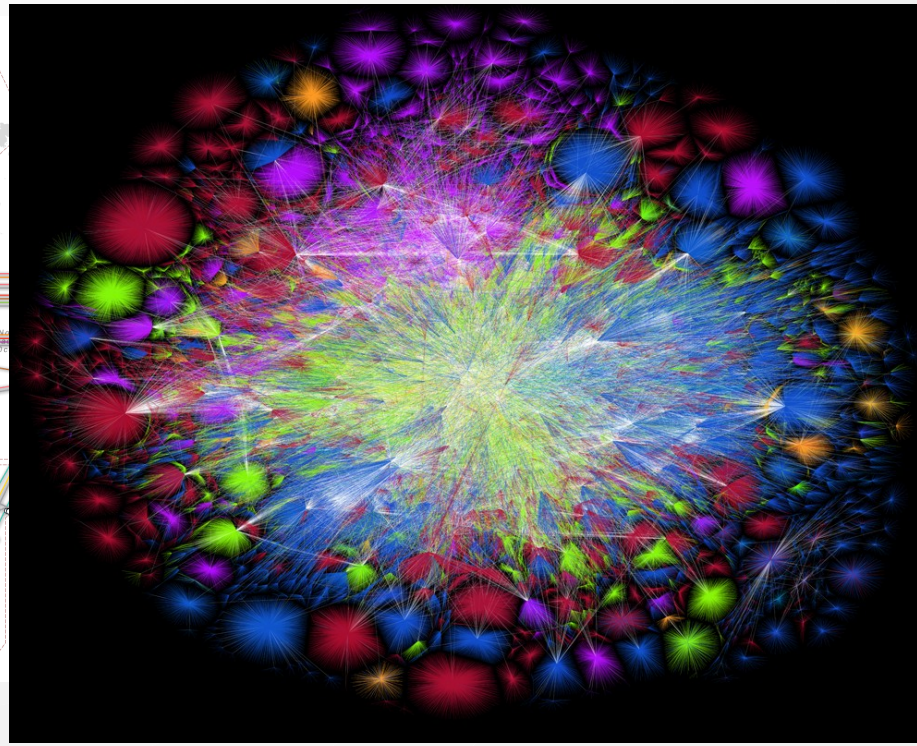


Internet

- ***interconnected networks*** - verejne dostupný celosvetový systém vzájomne prepojených počítačových sietí
- **Spoločné znaky:** prepínanie paketov, Internetový Protokol



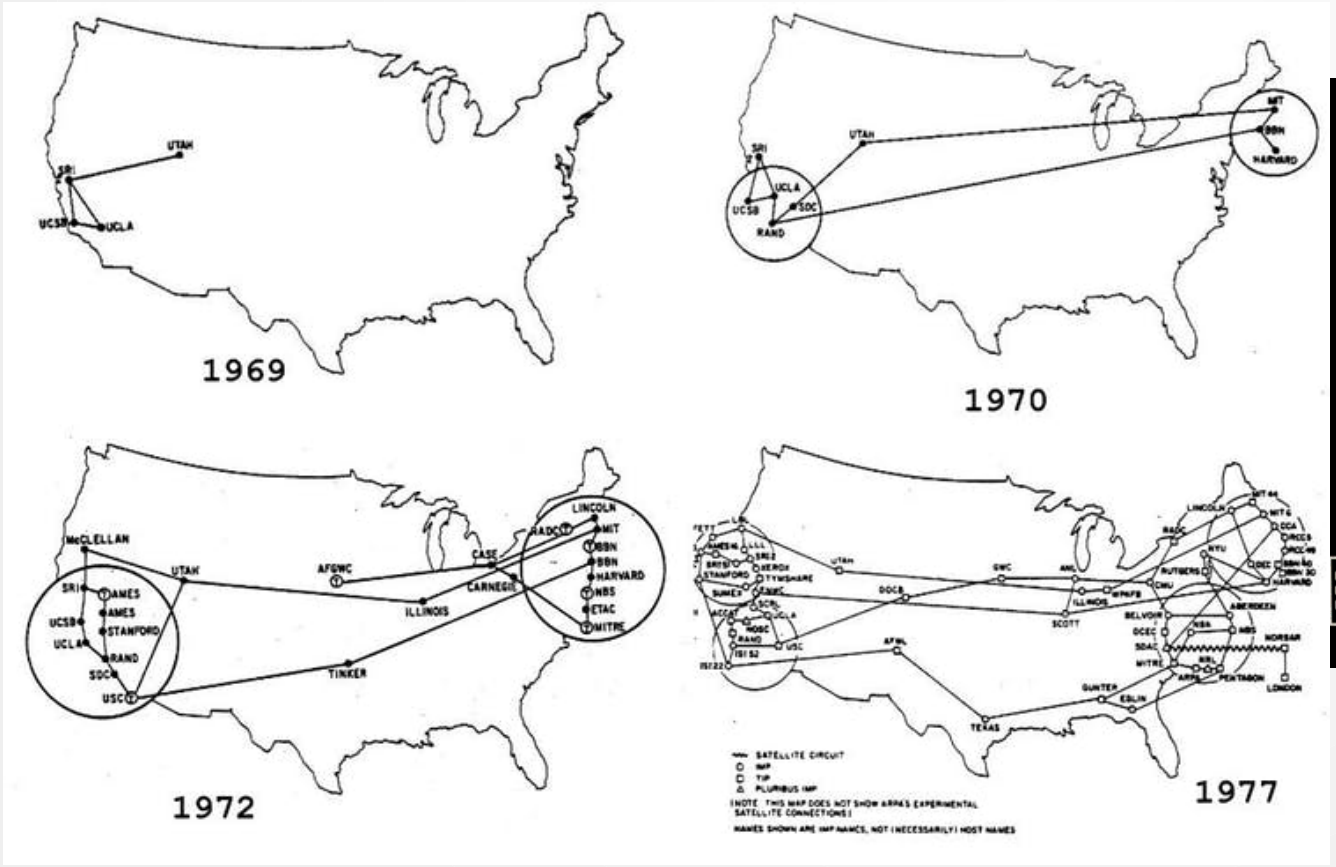
https://www.submarinecablemap.com/

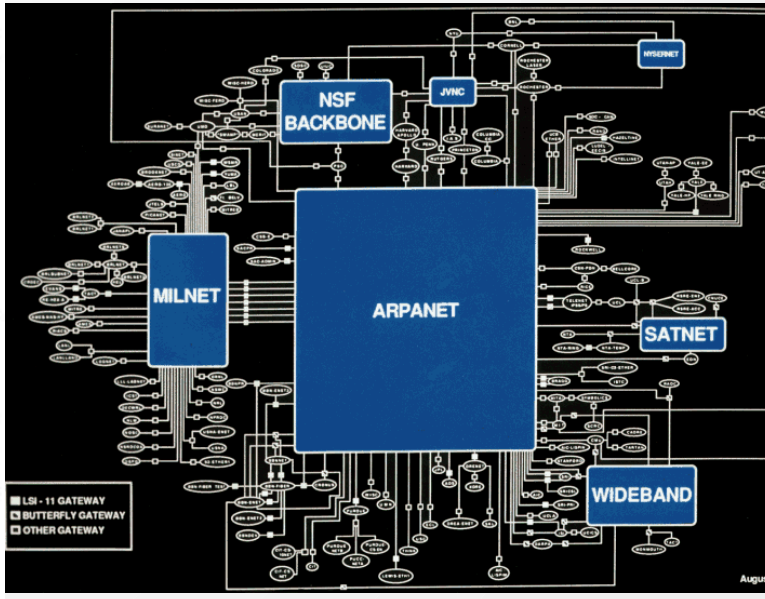


Barrett Lyon / The Opte Project (2015)
Visualization of the routing paths of the Internet.

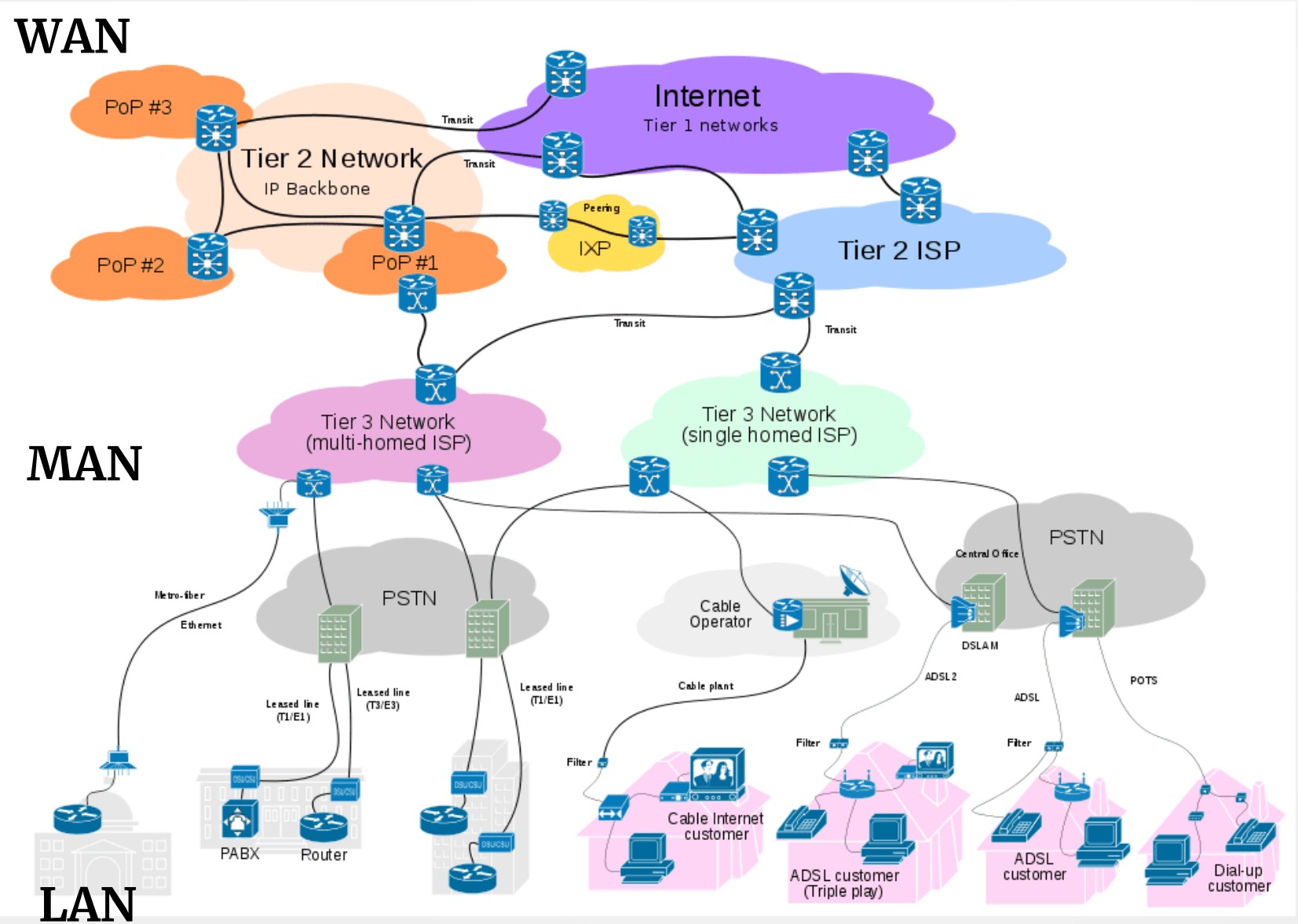
ARPANET Advanced Research Projects Agency Network

- Prvá správa – UCLA a SRI (29.10.1969, 22:30) - 50 kbit/s
- Interface Message Processor (IMP) – uzly pre pripojenie
- Inšpiratívne výskumné siete: NPL (UK), CYCLADES (Fr.)





Internet dneška



ÚRAD PRE REGULÁCIU ELEKTRONICKÝCH KOMUNIKÁCIÍ A POŠTOVÝCH SLUŽIEB

The Slovak Internet eXchange

NIX·SK

Slovak Telekom
Orange
UPC
Antik
Slovanet
Swan
RadioLan
DSi Data
Satro
Benestra
VNET
...

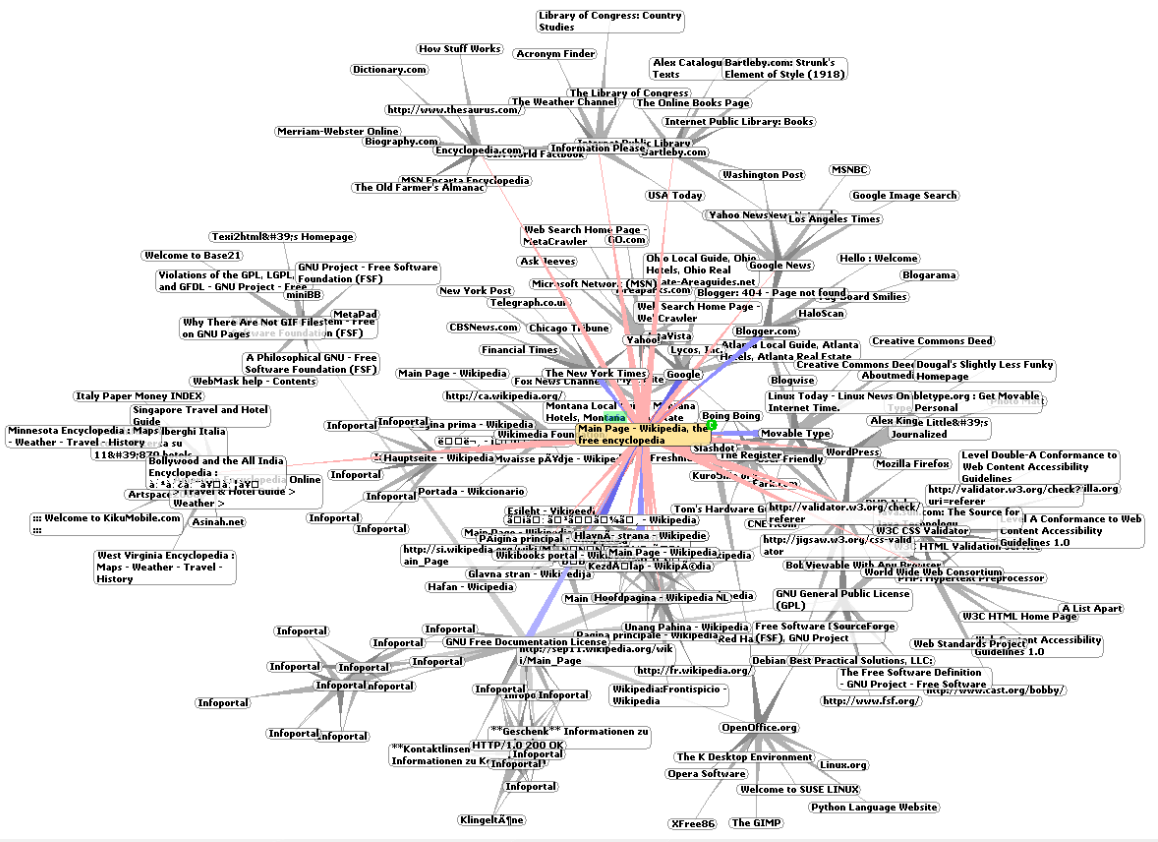
Pripojenie k internetu:
https://www.ezd.sk/pcpi/index.php

World Wide Web

- Hypertextový systém pre prehliadanie dokumentov (webstránka) na Internete – „celosvetová pavučina hypertextu“
- Tim Berners-Lee (CERN, 1991) - http://info.cern.ch/

- Moderný Web:
  - uživateľ tvorcom obsahu
  - personalizácia
  - intuitívna interakcia

- Služby:
  - Wiki, Blogy, E-mail
  - Sociálne siete a četovanie
  - Zdieľanie súborov, fotografií a videí



Prehliadanie webstránok

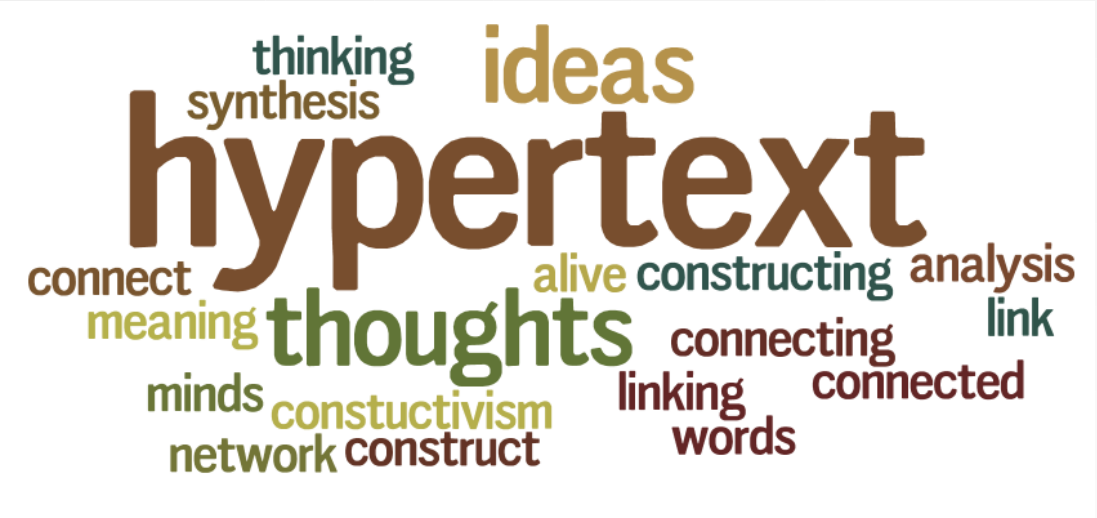
Prehliadač

Vyhľadávač

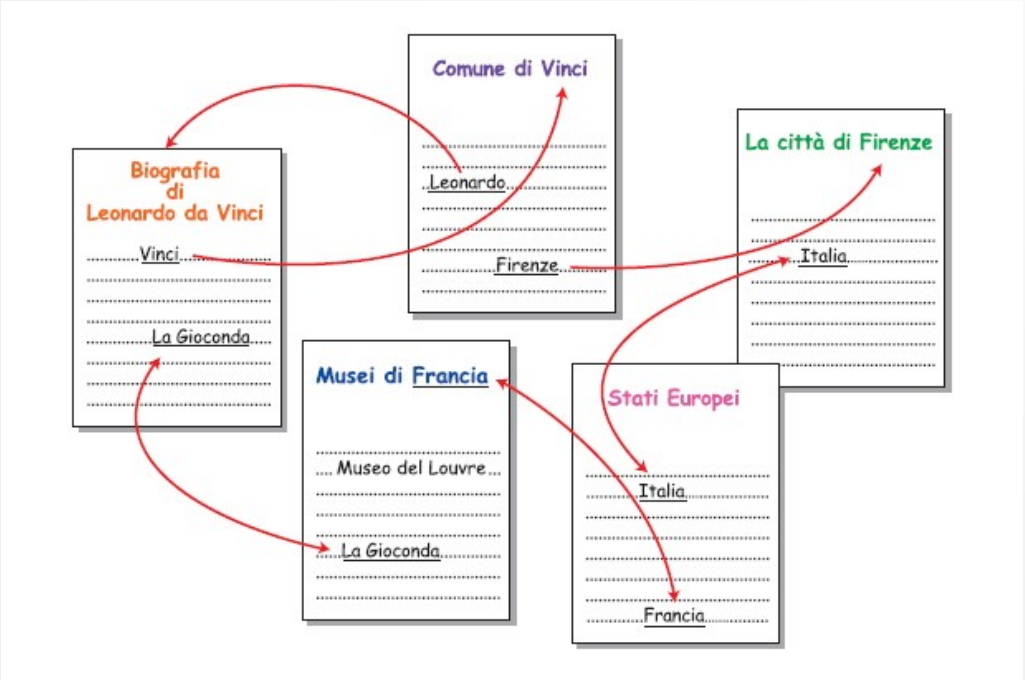
Google

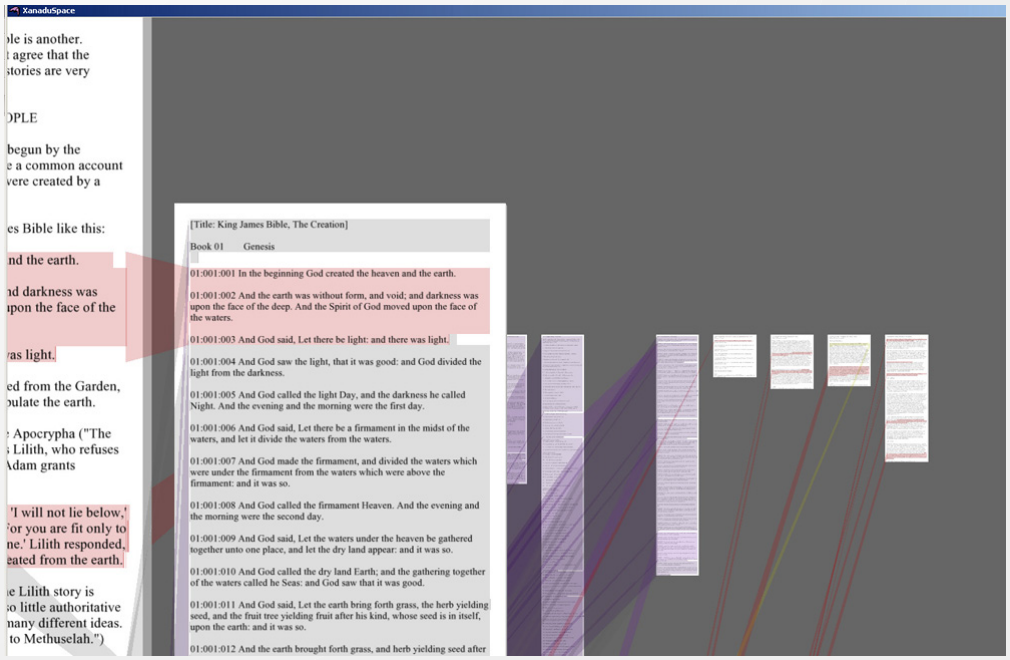
YAHOO!

bing



- Počítačové využitie **odkazov** na prepájanie častí textov alebo navzájom súvisiacich prvkov textu – hypermédia
- Nelineárne myslenie, prepojenia navždy všetkého, vzájomné vzťahy
- Vaneever Bush (Memex, 1945), Ted Nelson (Xanadu, 1965)

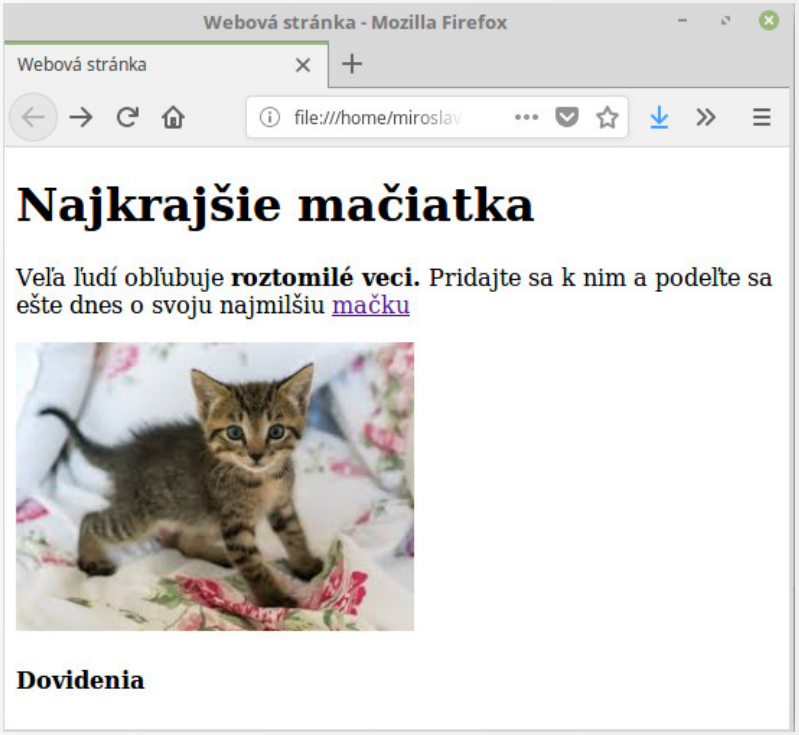


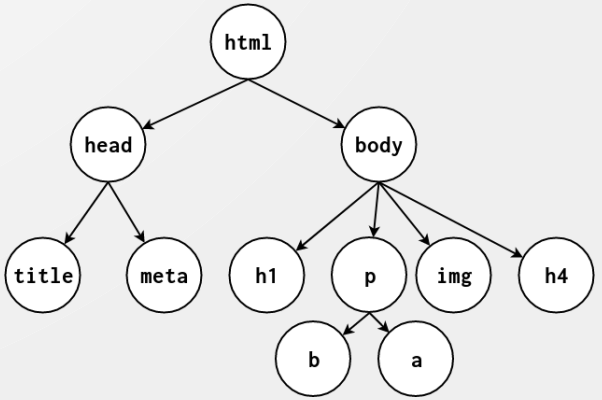


HyperText Markup Language

- Značkovací jazyk pre štrukturovanie webových stránok (CSS, JS)

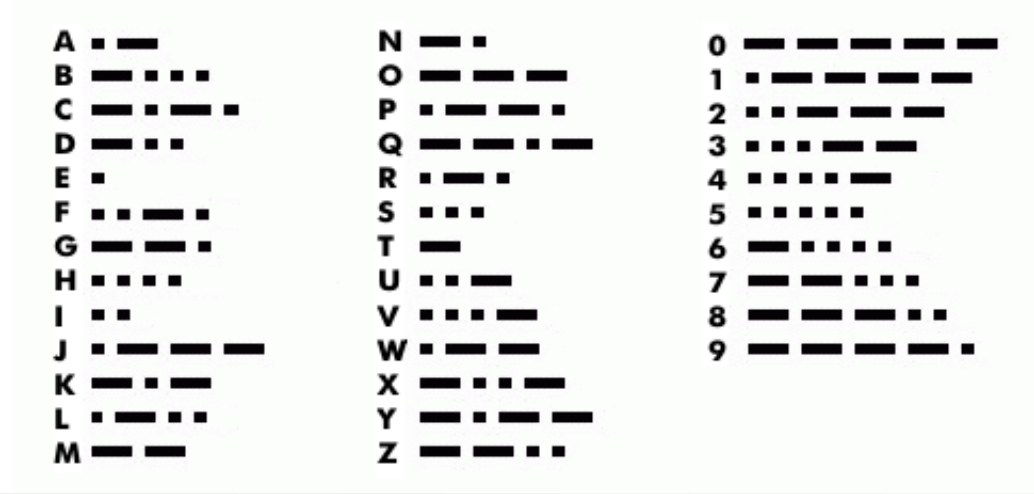
```
<!DOCTYPE html>
<html>
  <head>
    <title>Webová stránka</title>
    <meta charset="utf-8"/>
  </head>
  <body>
    <h1>Najkrajšie mačiatka</h1>
    <p>Veľa ľudí obľubuje <b>roztomilé veci.</b>
Pridajte sa k nim a podeľte sa ešte dnes o svoju
najmilšiu
<a href="https://en.wikipedia.org/wiki/Cat">mačku</a>
    </p>
    <img src="kitten.jpg" alt="Mačička" height="200"/>
    <br/>
    <h4>Dovidenia</h4>
  </body>
</html>
```

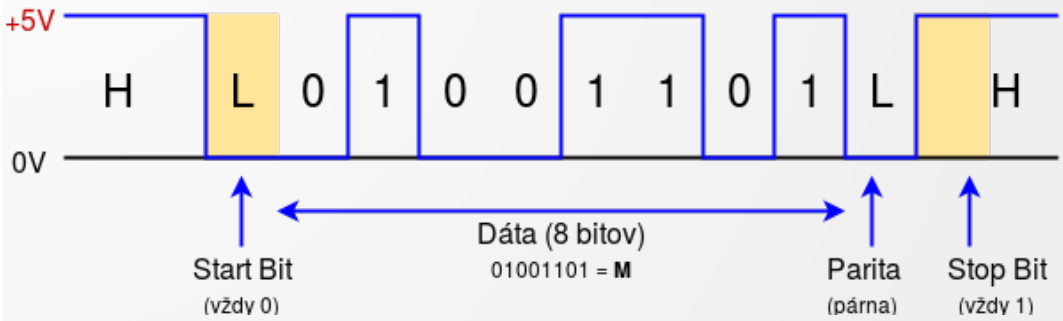




Komunikačný protokol

- Pravidlá na **výmenu dát** a **správu spojenia** medzi entitami komunikačného systému (konvencia, štandard)
- Riadi syntax, sémantiku a synchronizáciu komunikácie





Morseova abeceda

1) Bodka 1
2) Čiarka 3
3) Medzera písmená 3
4) Medzera slová 7

UART + ASCII

1) Rýchlosť prenosu (bit/s)
2) Parita (žiadna, párna, nepárna)
3) Počet bitov (štart, stop, dáta)

Hyper**T**ext **T**ransfer **P**rotocol

- Protokol pre výmenu hypertextových dokumentov (v HTML)

Požiadavka (Klient)

```
GET /index.html HTTP/1.1
Host: example.org
User-Agent: curl/7.47.0
Accept: text/html
```

Odpoveď (Server)

```
HTTP/1.1 200 OK
Content-Type: text/html
Date: Sun, 01 Jul 2018 15:54:15 GMT
Server: Apache
Content-Length: 1270

<!doctype html>
<html>
<head>
    <title>Example Domain</title>
...
```

Metódy:

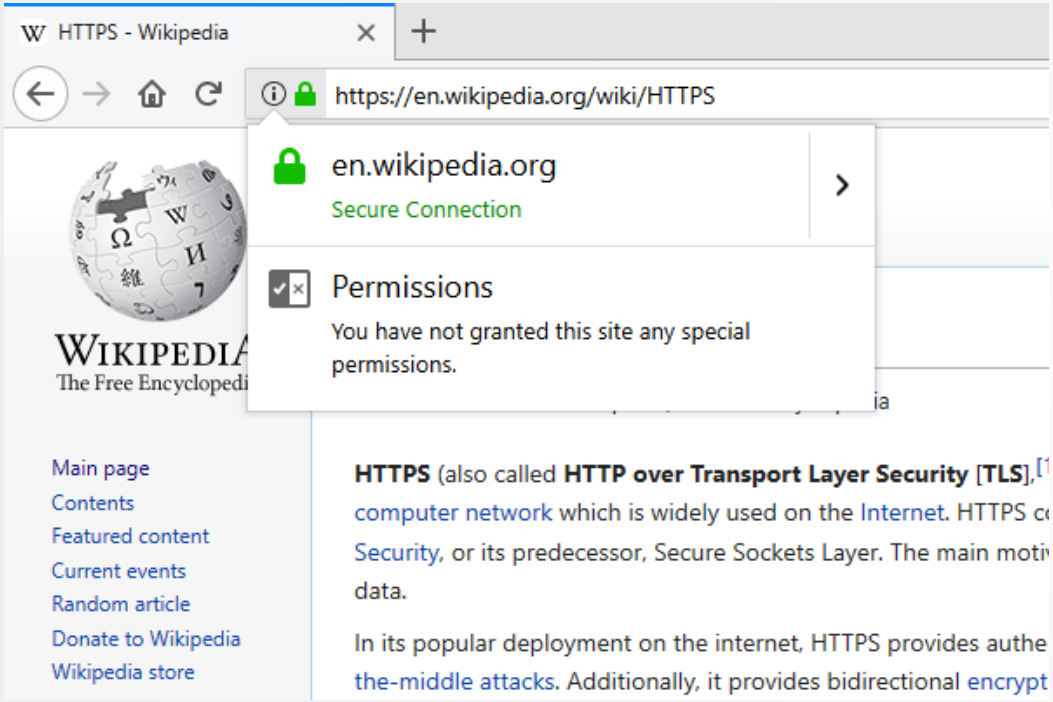
- GET, POST, PUT, PATCH, DELETE, HEAD, OPTIONS

Hlavičky, Kódy odpovede:

- https://httpstatuses.com/

RFC 2616

Na **S** záleží – HTTP**S** (HTTP + TLS/SSL)



- Motív: autentifikácia webstránky
- Posielanie zašifrovaných dát po nezabezpečnom spojení
- Dôverihodné podpísané **certifikáty X.509** (RSA public key)
- Vytvorí sa symetrický **session key** (AES) - výmena (DHE)

```
* Connected to stuba.sk (147.175.1.60) port 443 (#0)
* found 148 certificates in /etc/ssl/certs/ca-certificates.crt
* found 604 certificates in /etc/ssl/certs
* ALPN, offering http/1.1
* SSL connection using TLS1.2 / ECDHE_RSA_AES_128_GCM_SHA256
*        server certificate verification OK
*        server certificate status verification SKIPPED
*        common name: www.stuba.sk (matched)
*        server certificate expiration date OK
*        server certificate activation date OK
*        certificate public key: RSA
...
```

Uniform **R**esource **L**ocator

- Štrukturované označenie používané na presné označenie zdroja na internete

```
https://max:muster@www.example.com:8080/index.html?p1=A&p2=B#resource
\___/   \_/ \____/ \_____________/ \__/\_________/\_______/ \_______/
  |       |     |            |          |       |          |         |
Schéma    |    Heslo     Doména       Port    Cesta      Query    Fragment
       Užívateľ
```

https://www.google.com/search?q=hypertext

https://sk.wikipedia.org/wiki/Bratislava#Dejiny

http://www-03.ibm.com/ibm/history/ibm100/us/en/icons/fortran/breakthroughs/

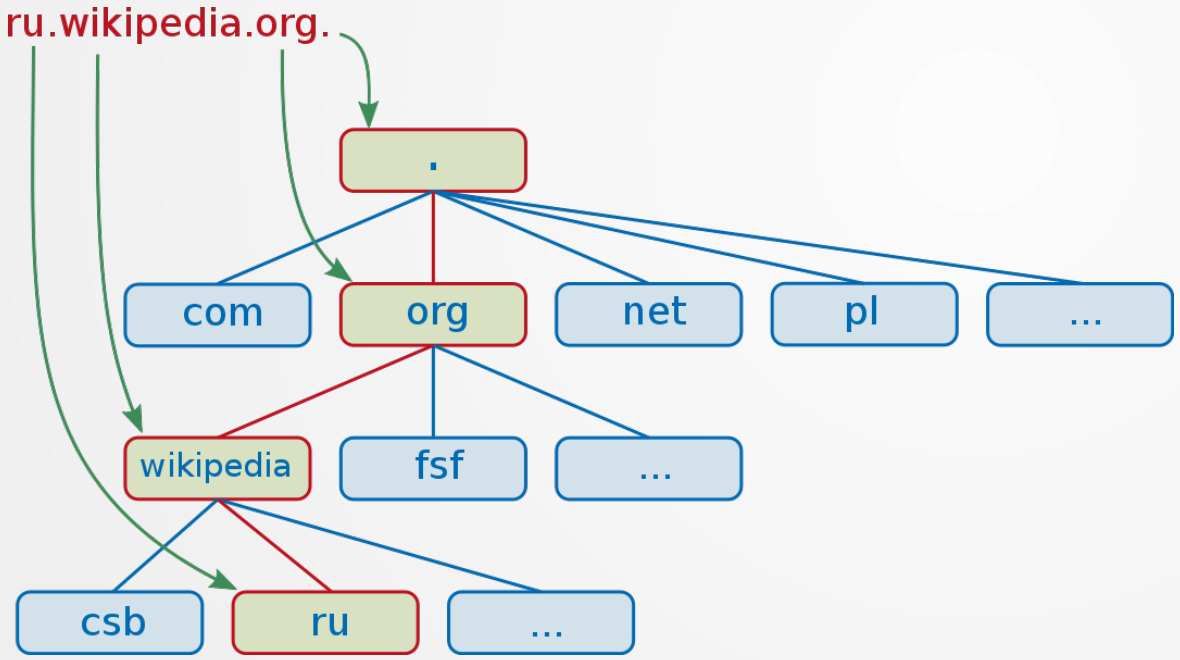
http://slovniky.korpus.sk/?w=hypertext&c=P9d4&d=kssj4

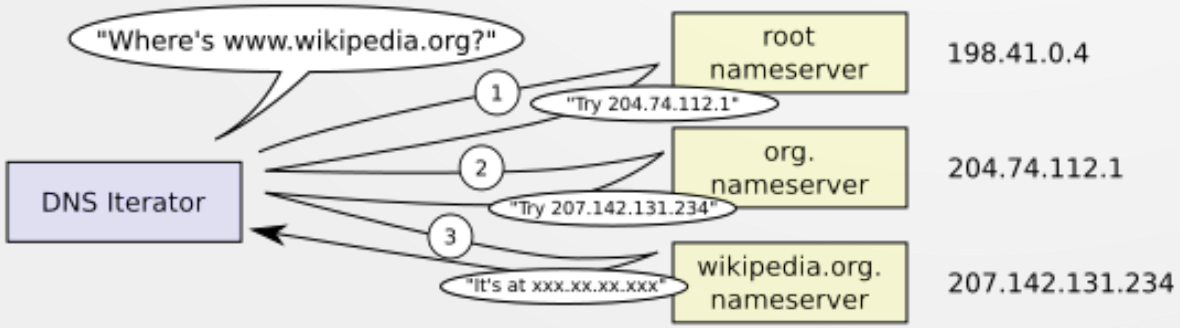
RFC 1738

Domain Name System

Internet Assigned Numbers Authority

- Hierarchická distribuovaná databáza názvov počítačov v sieti (Doména - IP)





nslookup wikipedia.org

- **A záznam** (IPv4)

`91.198.174.192`

- **AAAA záznam** (IPv6)

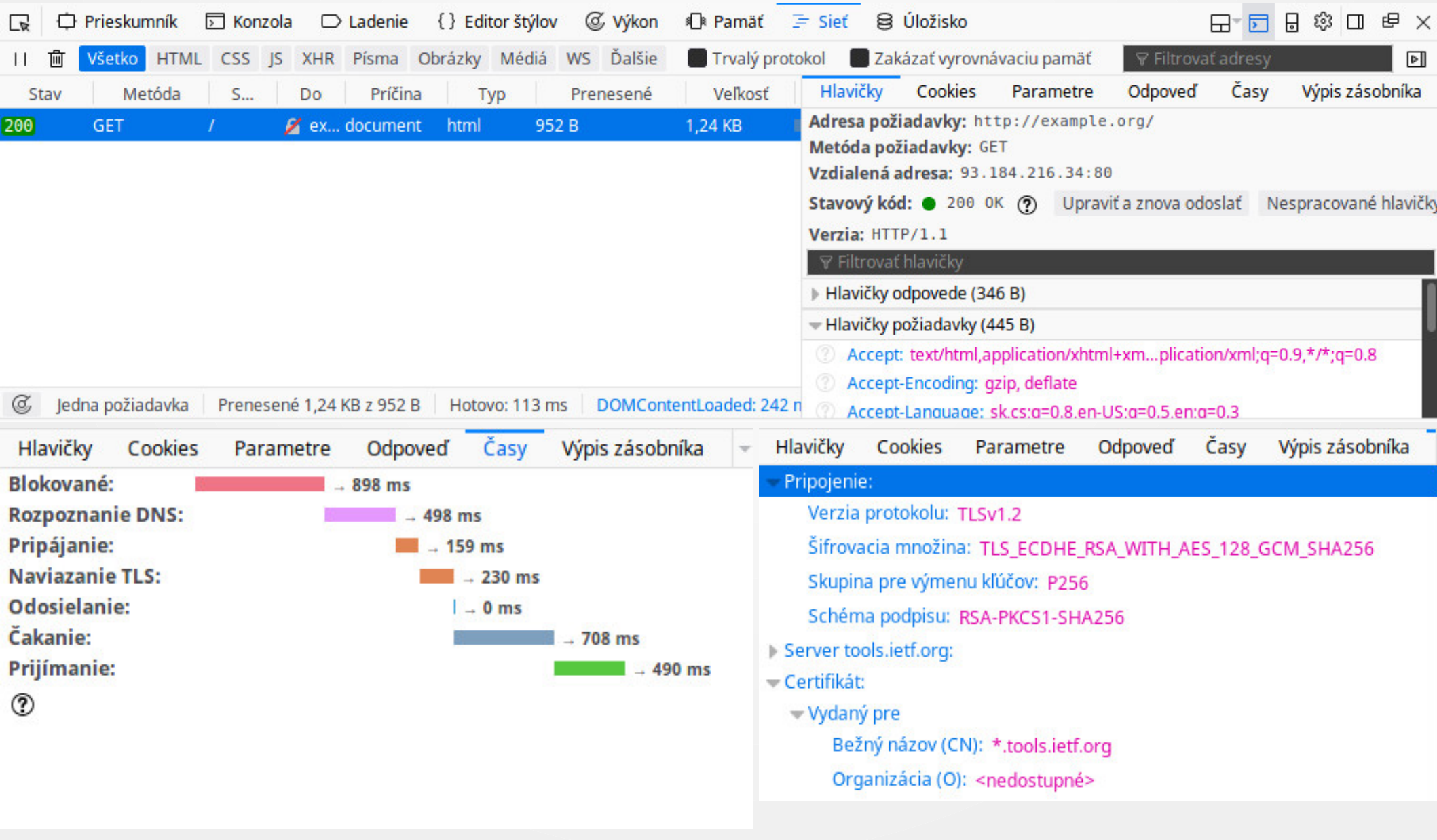
`2620:0:862:ed1a::1`

- **PTR záznam** (reverz)

`192.174.198.91.in-addr.arpa`
`- text-lb.esams.wikimedia.org`

RFC 1034

Vývojárske nástroje (F12)



Elektronická pošta (email)

Miroslav Hájek
Ulicová 10
921 03 Mestečko

Pani Nováková
Zákrutová 31
956 88 Dedina

From: Miro <hajek@server.sk>
To: Teta <novakova@pocitac.net>
Subject: Pozdrav
Date: Mon, 8 Mar 2010 19:55:06
Cc:
Bcc:
MIME-Version: 1.0
Content-Type: multipart/mixed; boundary=----

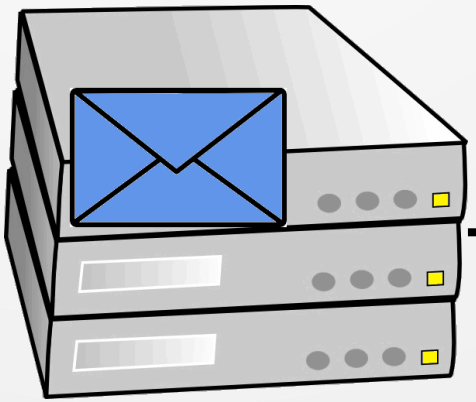
Content-type: text/plain;charset=utf-8
Posialam Vám po dlhom čase pozdravy z Mestečka.

Multipurpose Internet Mail Extensions

RFC 822
RFC 2046

Simple Mail Transfer Protocol

RFC 5321



Post Office Protocol

RFC 1939

Internet Message Access Protocol

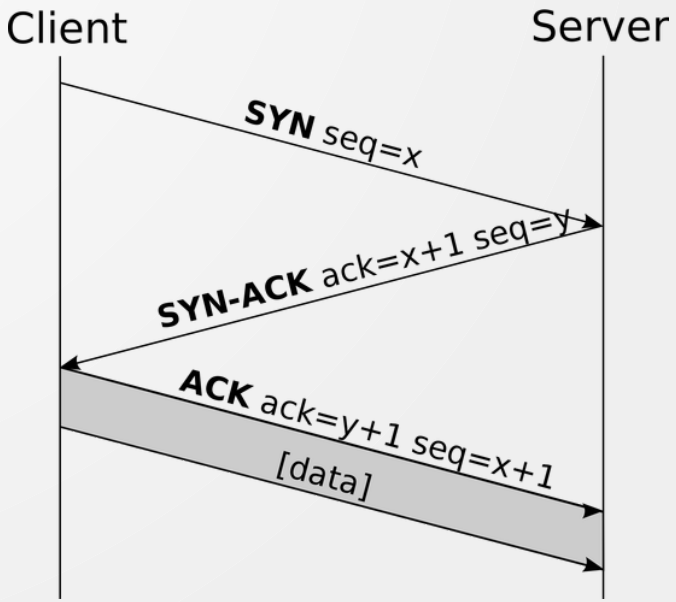
RFC 3501

Trasmission **C**ontrol **P**rotocol

- **Spojovo orientovaný** – komunikácia je uvedená a ukončená handshakom *[SYN, FIN]*
- **Spoľahlivý** – zachovanie poradia správ *(sequence number)*, ich potvrdzovanie *[ACK]*, prípadne znovuposlanie
- **Fragmentácia a Okná** – regulácia zahltenia siete

- Jednoduchý nespojový protokol – **U**ser **D**atagram **P**rotocol

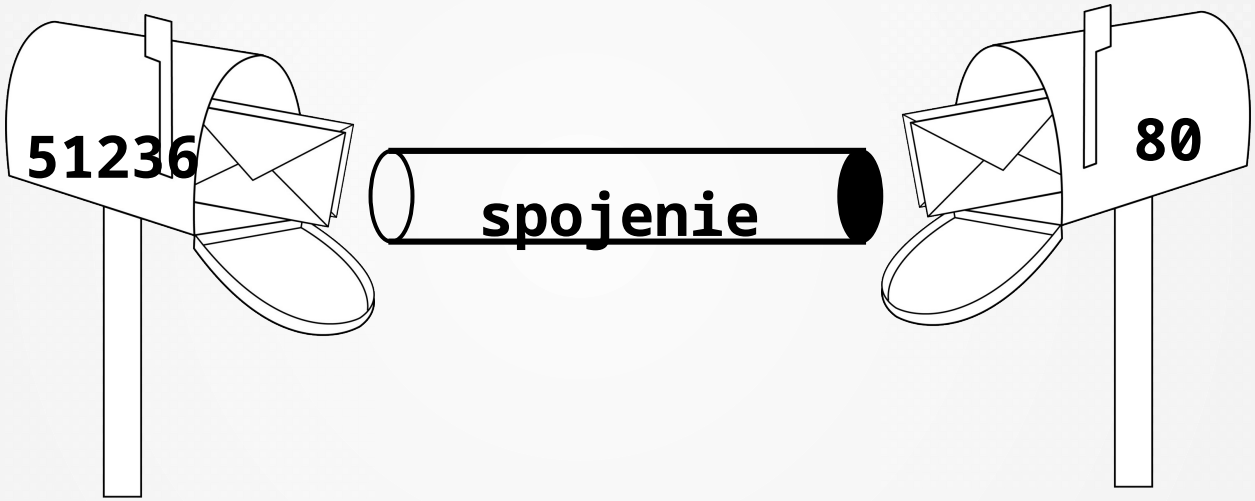
```
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|          Source Port          |       Destination Port        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        Sequence Number                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Acknowledgment Number                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Data |           |U|A|P|R|S|F|                               |
| Offset| Reserved  |R|C|S|S|Y|I|            Window             |
|       |           |G|K|H|T|N|N|                               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           Checksum            |         Urgent Pointer        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Options                    |    Padding    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                             data                              |
```



RFC 793

Sieťové porty

- Číslo „schránky“, kde aplikácia príjma/vysiela správy



Registrované porty:

http://www.iana.org/assignments/port-numbers

```
21  - FTP  (TCP)
25  - SMTP (TCP)
53  - DNS  (UDP)
80  - HTTP (TCP)
123 - NTP  (UDP)
143 - IMAP (TCP)
443 - HTTPS(TCP)
```

Internet Protocol IPv4

- **Adresovanie** – doručenie akémukoľvek bodu v sieti (internet)
- **Fragmentácia** a zloženie dát z/do viacerých paketov

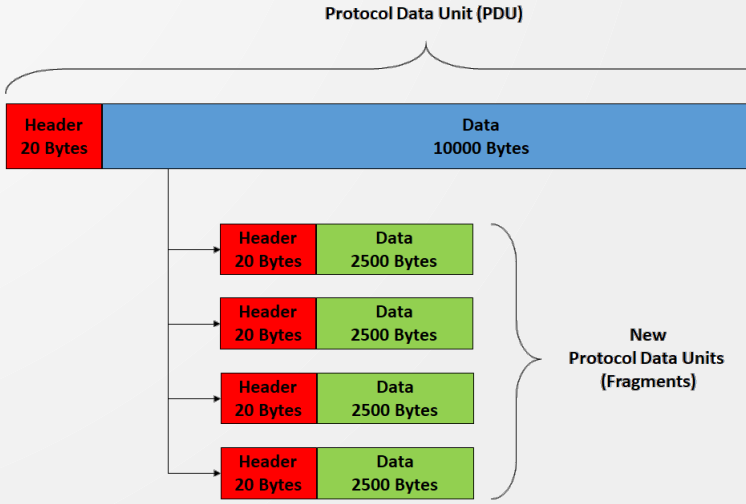
IPv4 adresa (32-bit):

94.130.8.60

01011110.10000010.00001000.00111100

0x5E82083C

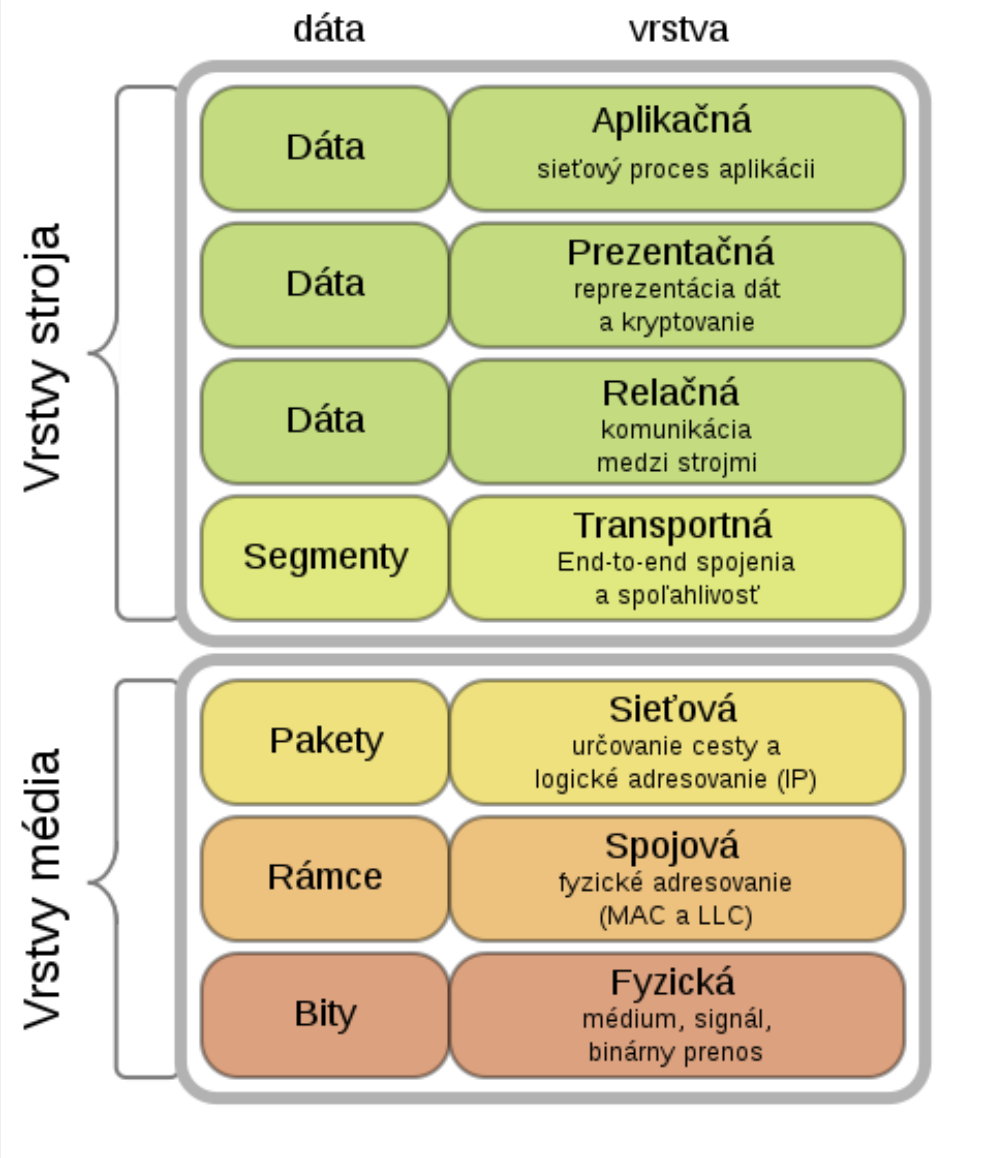
```
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Version|  IHL  |Type of Service|          Total Length         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|         Identification        |Flags|      Fragment Offset    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Time to Live |    Protocol   |         Header Checksum       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Source Address                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Destination Address                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Options                    |    Padding    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

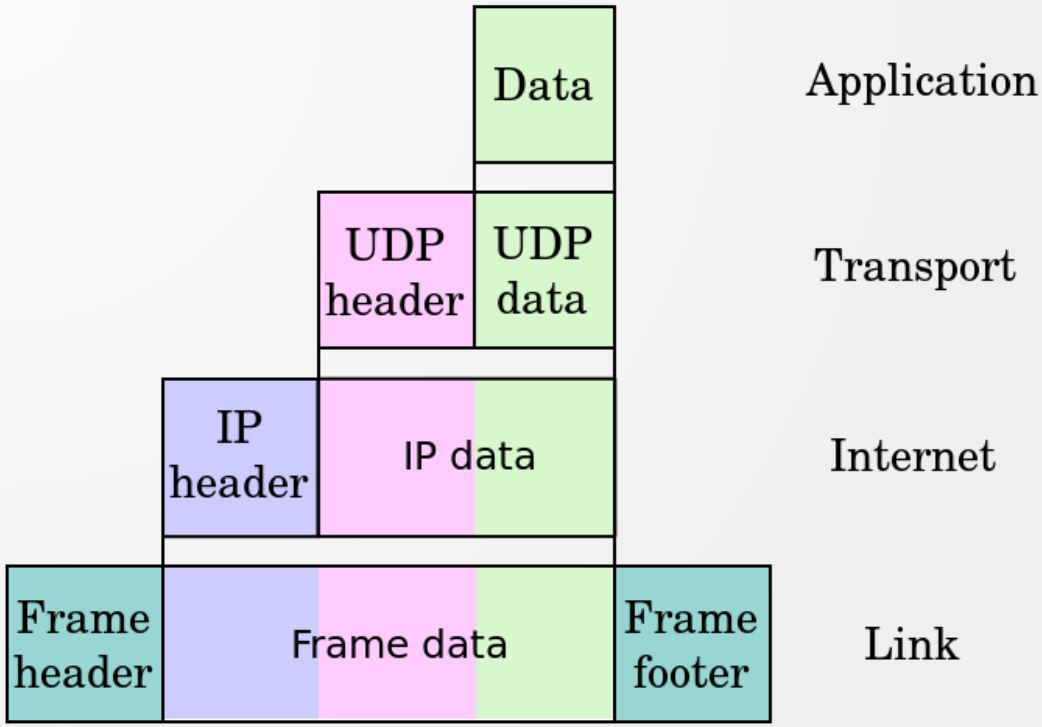


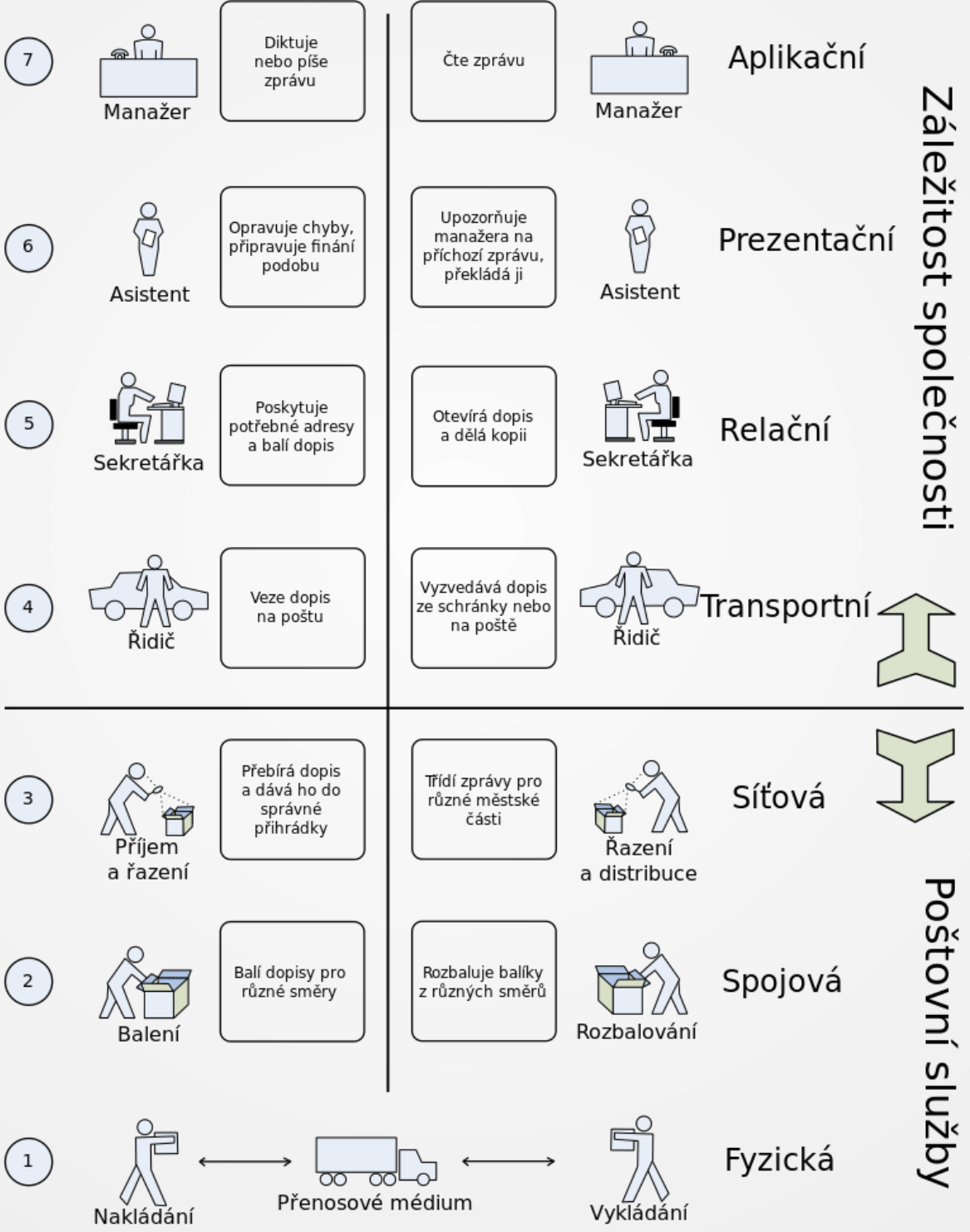
RFC 791

Model OSI

Open Systems Interconnection Reference Model (7 vrstvový)







Paralela mezi RM – OSI a dopisy

Sieťové zariadenia

Fyzická vrstva (1.)

Repeater (opakovač) – obnovuje degradovaný signál

Hub (rozbočovač) – prepája siete, prenášanie prevádzky

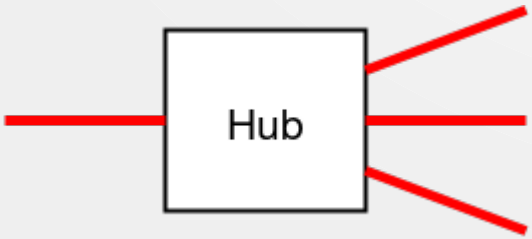
Spojová vrstva (2.)

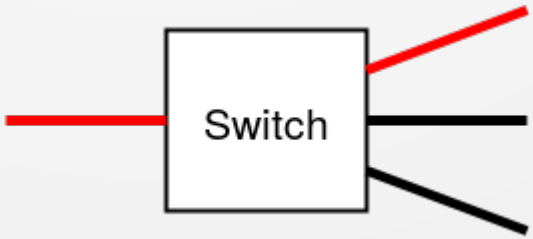
Switch (prepínač) – prepája zariadenia, oddelenie prevádzky

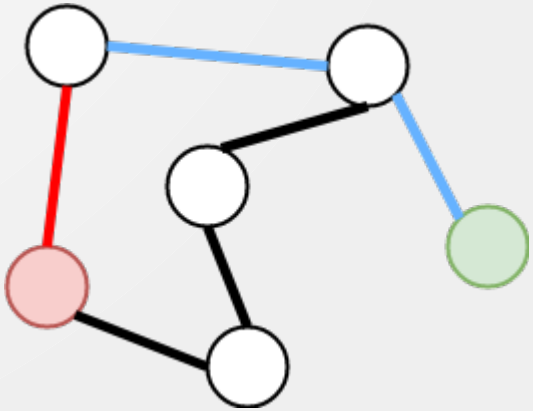
Sieťová vrstva (3.)

Router (smerovač) – presmerováva dáta v sieťach

Gateway (brána) – uzol spájajúci dve siete s odlišnými protokolmi
Default Gateway – router do vonkajšej siete (Internet)



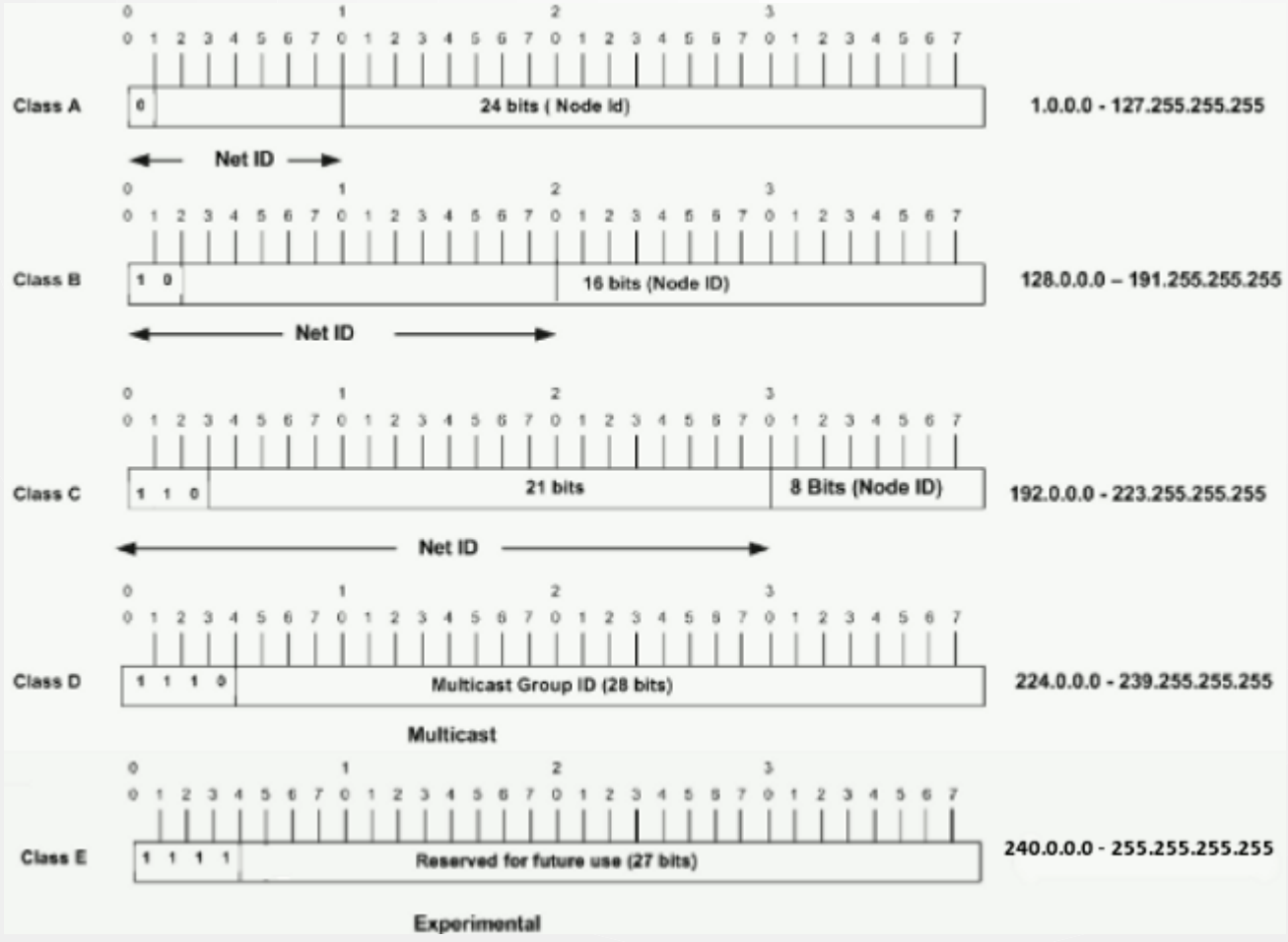




IP adresa - Podsiete

- Logické rozdelenie počítačovej siete na menšie časti

+ Rýchlosť – smerovacie tabuľky, zmenšenie zahltenia
+ Bezpečnosť – oddelenie skupín počítačov
+ Jednoduchšia správa a hľadanie problémov

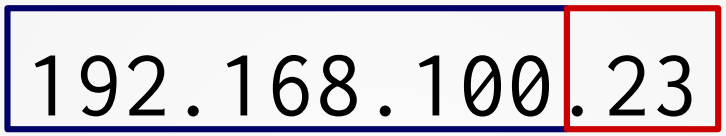


Masky sietí:

```
A: 255.0.0.0
B: 255.255.0.0
C: 255.255.255.0
```

Sieť – trieda C

IP adresa počítača



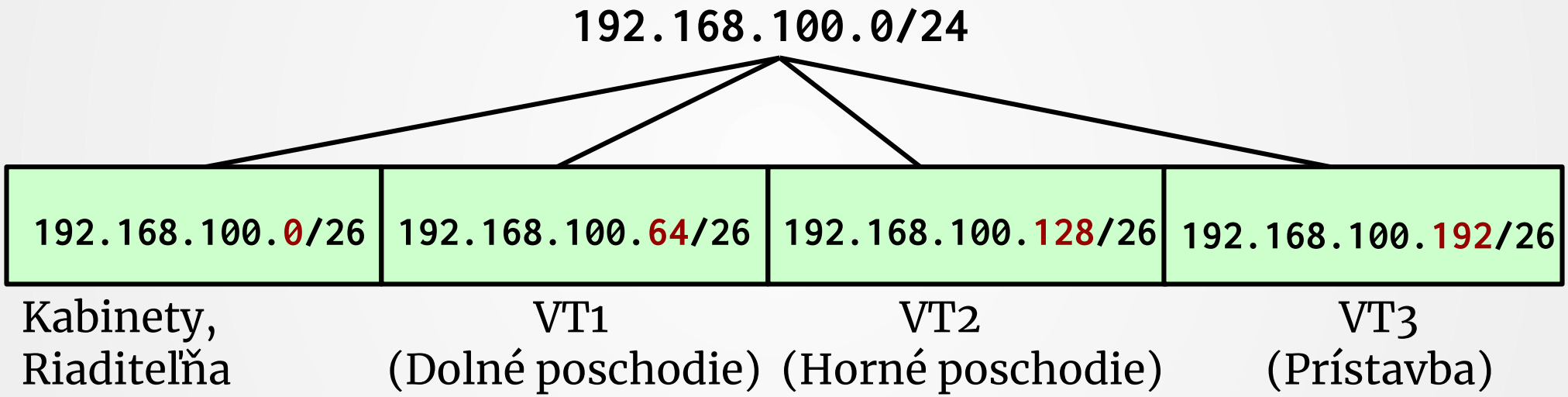
IP adresa	192.168.100.23	11000000.10101000.01100100.00010111
Maska podsiete	255.255.255.0	11111111.11111111.11111111.00000000
Sieť	198.168.100.0	11000000.10101000.01100100.00000000
Host	0.0.0.23	00000000.00000000.00000000.00010111

Počet hostov: 256 (8-bit)
Z toho:

- **.0**: Adresa siete
- **.255**: Spoločná adresa (broadcast)

CIDR (Classless Inter-Domain routing):
192.168.100.0/24

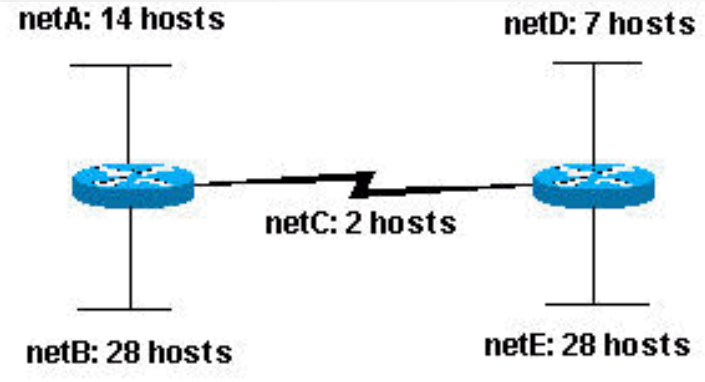
Príklad: školská sieť

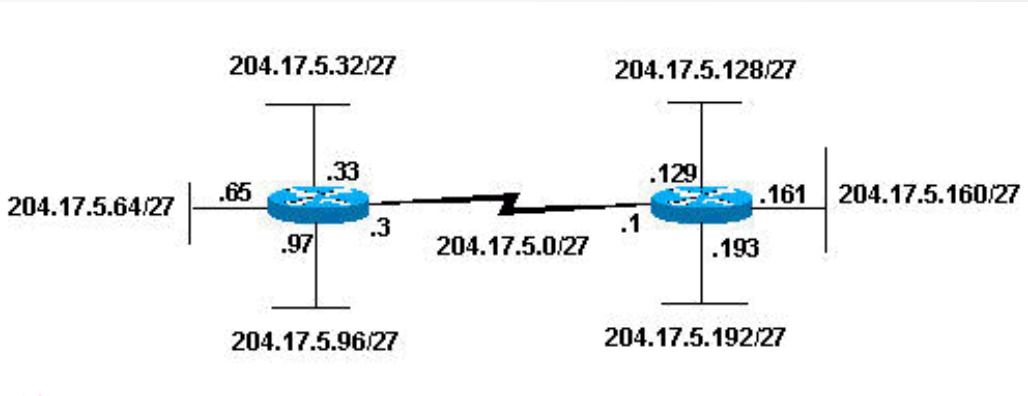


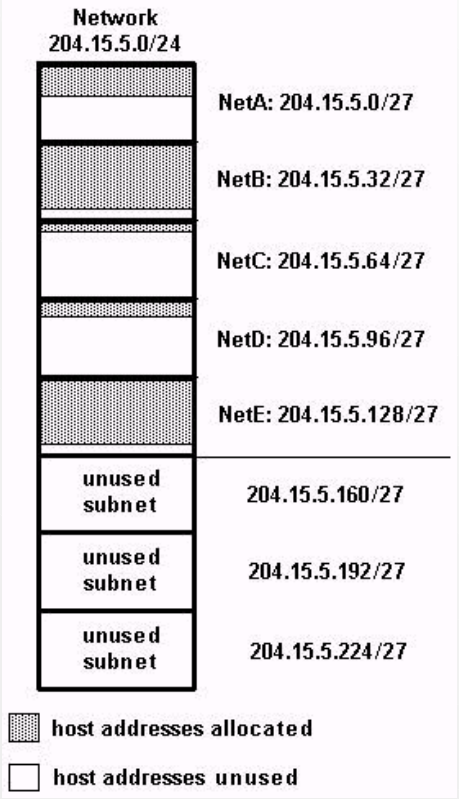

```
$ ipcalc 192.168.100.1/26
Address:   192.168.100.1          11000000.10101000.01100100.00 000001
Netmask:   255.255.255.192 = 26   11111111.11111111.11111111.11 000000
Wildcard:  0.0.0.63               00000000.00000000.00000000.00 111111
=>
Network:   192.168.100.0/26       11000000.10101000.01100100.00 000000
HostMin:   192.168.100.1          11000000.10101000.01100100.00 000001
HostMax:   192.168.100.62         11000000.10101000.01100100.00 111110
Broadcast: 192.168.100.63         11000000.10101000.01100100.00 111111
Hosts/Net: 62                      Class C, Private Internet
```

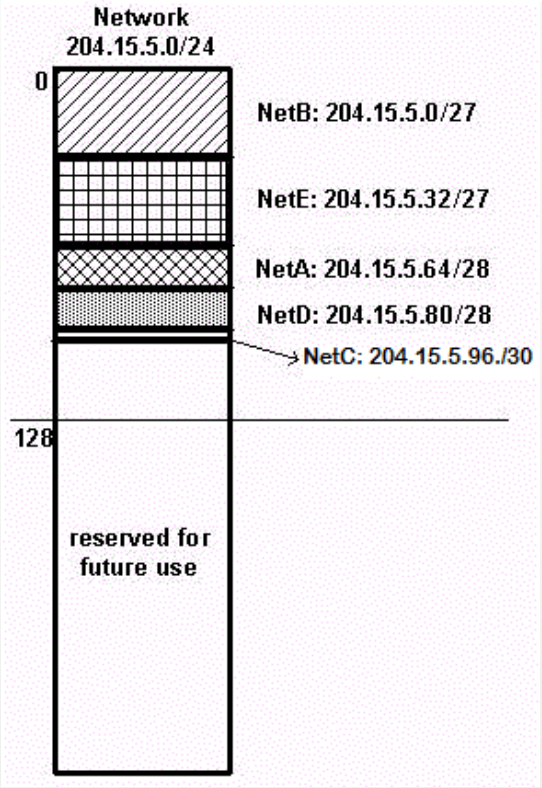
VLSM (Variable-Length Subnet Mask)

- Efektívnejšie rozdelenie siete s ohľadom na počet hostov







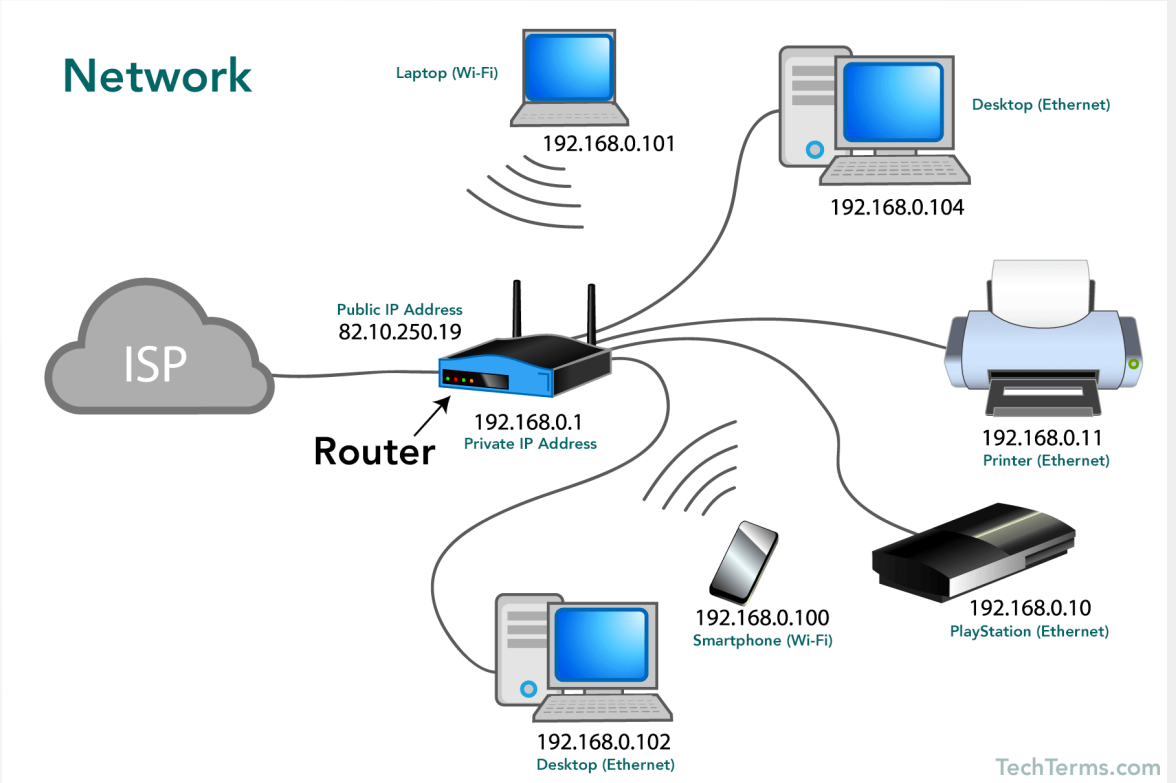


Network **A**ddress **T**ranslation

- **Dočasné** riešenie nedostatku IPv4 adries
- Najčastejšie: preklad súkromných na verejné IP adresy

Súkromné rozsahy
10.0.0.0/8
172.16.0.0/12
192.168.0.0/16

Výber z rezervovaných:
Localhost(loopback)
127.0.0.0/8



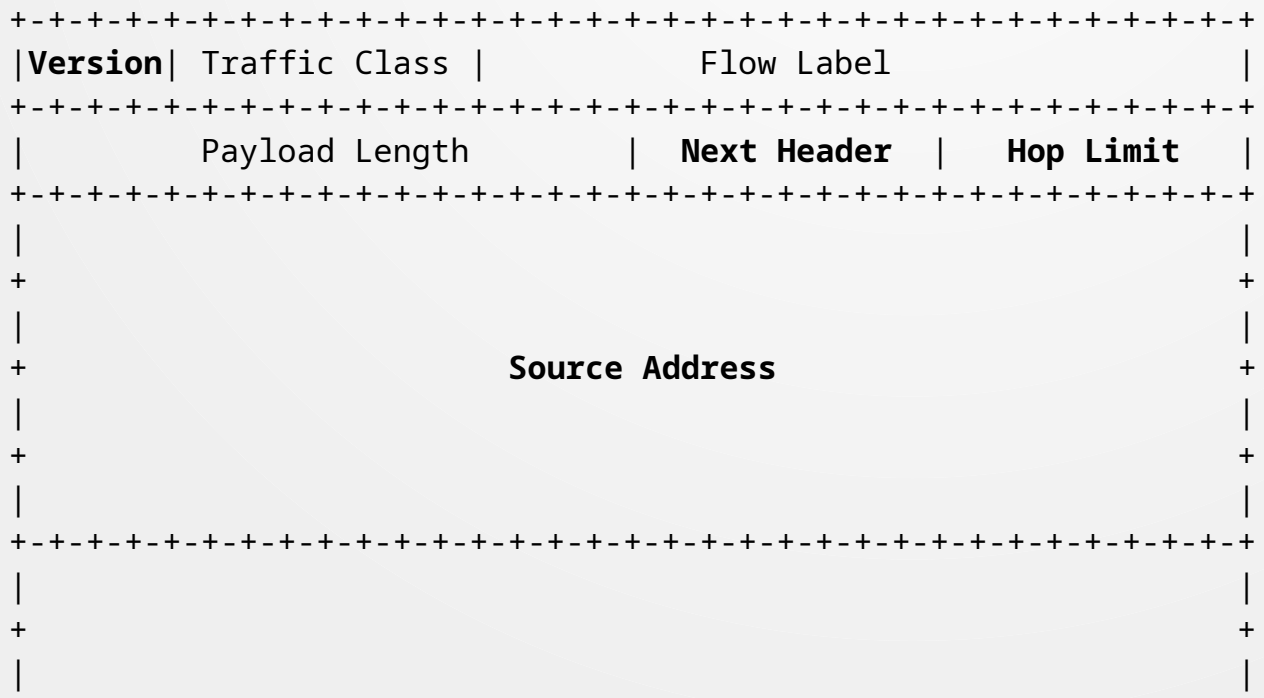
Súkromný	**Verejný**	**NAT preklad súkr.**
(A, 3000) <->	(S, 80)	(NR, 3000)
(B, 3000) <->	(T, 80)	(NR, 3000)
(B, 3000) <->	(S, 80)	(NR, 3001)

IPv6

- Riešenie nedostatku IPv4 adries pre celointernetové adresovanie
- Dlhšie adresy: (IPv4) 32-bit – (IPv6) 128-bit

2001:db8:0:0:8:800:200c:417a

```
ff01:0:0:0:0:0:0:101          = ff01::101
0:0:0:0:0:0:0:1               = ::1          (loopback /128)
fe80::38dc:51e2:2dfb:d7ac/64                 (local link)
```



Podsiete

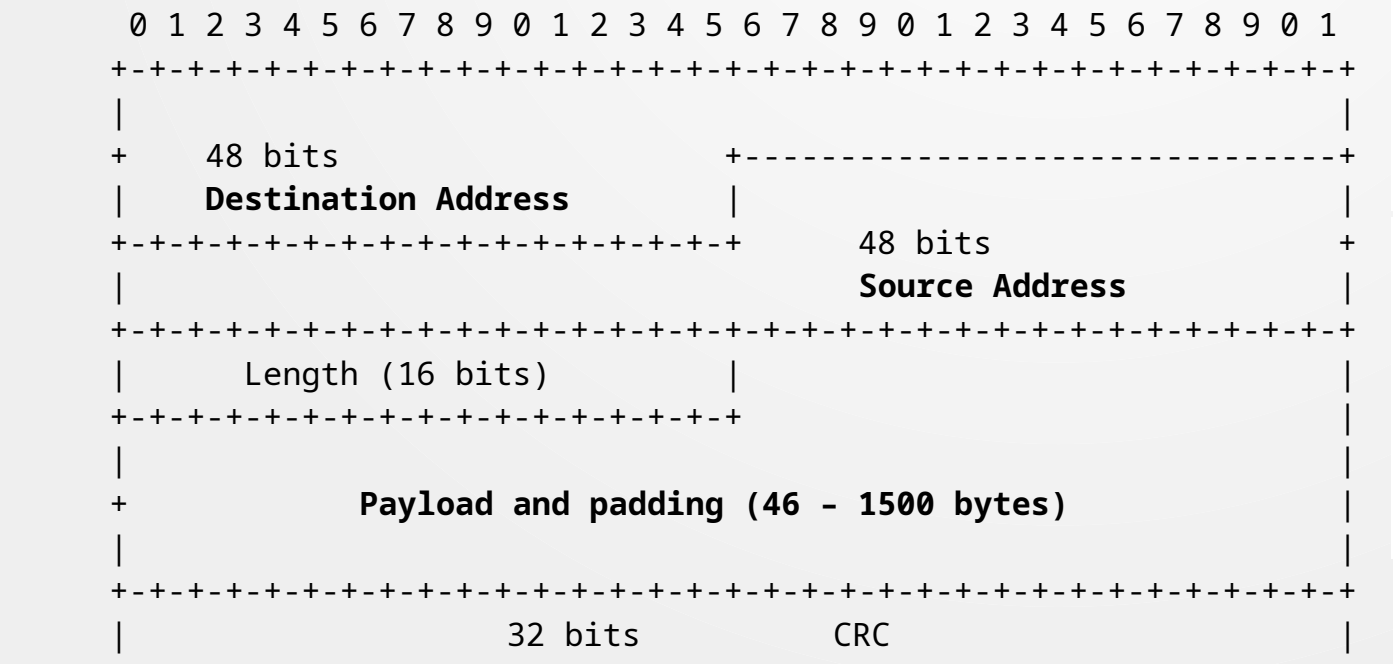
```
/32 - ISP
/48 - firmy
/56 - malé skupiny
/64 - domácnosť
```

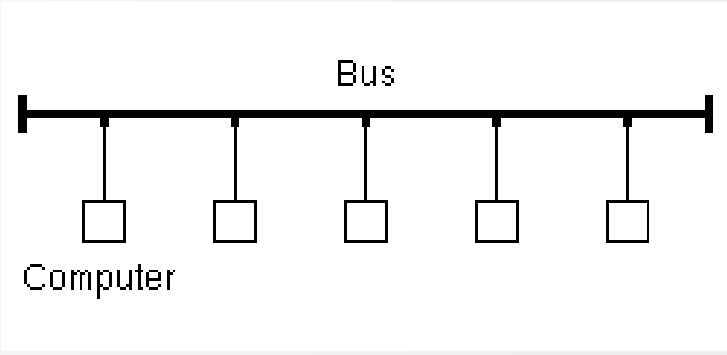
- zem: 510 072 000 km^2
- $IPv6/m^2 = 6,67 \times 10^{23}$
- $IPv4/km^2 = 8$

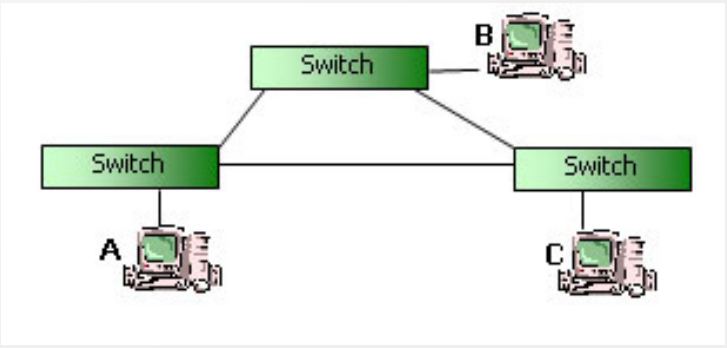
RFC 2460

Ethernet IEEE 802.3

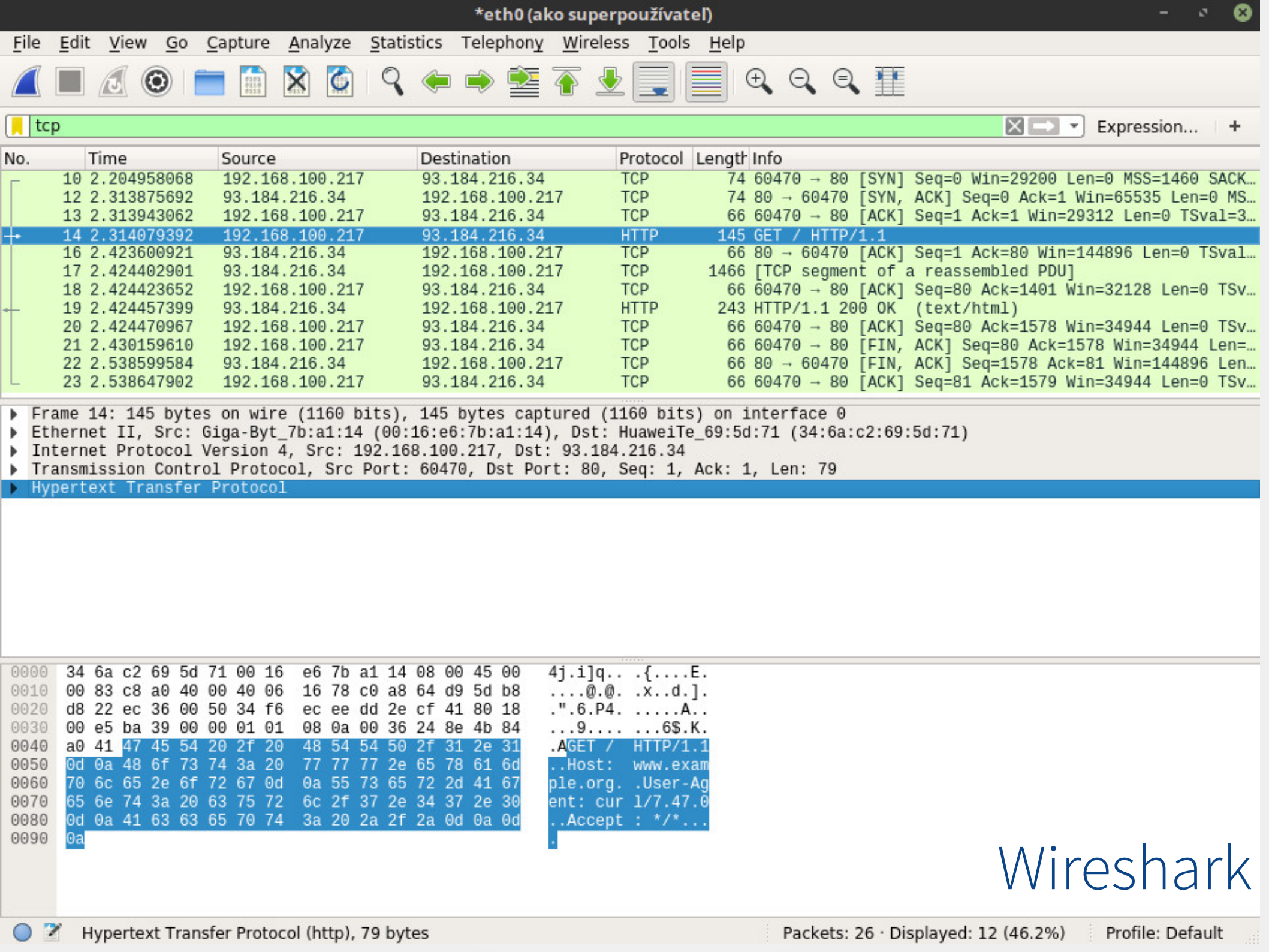
- Zabezpečuje **prepojenie susedných počíačov** na (lokálnej) sieti
- Každá sieťová karta má jedinečnú 48-bitovú MAC adresu (**M**edium **A**ccess **C**ontrol)
- **Funkcie:**
  - Regulovanie rýchlosti toku dát
  - Kontola chýb prenosu
  - Rozdelenie sekvencie bitov do rámcov







Riešenie kolízii na linke (kedysi a dnes)


*eth0 (ako superpoužívateľ)
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
tcp
Expression...
No. Time Source Destination Protocol Length Info
10 2.204958068 192.168.100.217 93.184.216.34 TCP 74 60470 → 80 [SYN] Seq=0 Win=29200 Len=0 MSS=1460 SACK…
12 2.313875692 93.184.216.34 192.168.100.217 TCP 74 80 → 60470 [SYN, ACK] Seq=0 Ack=1 Win=65535 Len=0 MS…
13 2.313943062 192.168.100.217 93.184.216.34 TCP 66 60470 → 80 [ACK] Seq=1 Ack=1 Win=29312 Len=0 TSval=3…
14 2.314079392 192.168.100.217 93.184.216.34 HTTP 145 GET / HTTP/1.1
16 2.423600921 93.184.216.34 192.168.100.217 TCP 66 80 → 60470 [ACK] Seq=1 Ack=80 Win=144896 Len=0 TSval…
17 2.424402901 93.184.216.34 192.168.100.217 TCP 1466 [TCP segment of a reassembled PDU]
18 2.424423652 192.168.100.217 93.184.216.34 TCP 66 60470 → 80 [ACK] Seq=80 Ack=1401 Win=32128 Len=0 TSv…
19 2.424457399 93.184.216.34 192.168.100.217 HTTP 243 HTTP/1.1 200 OK (text/html)
20 2.424470967 192.168.100.217 93.184.216.34 TCP 66 60470 → 80 [ACK] Seq=80 Ack=1578 Win=34944 Len=0 TSv…
21 2.430159610 192.168.100.217 93.184.216.34 TCP 66 60470 → 80 [FIN, ACK] Seq=80 Ack=1578 Win=34944 Len=…
22 2.538599584 93.184.216.34 192.168.100.217 TCP 66 80 → 60470 [FIN, ACK] Seq=1578 Ack=81 Win=144896 Len…
23 2.538647902 192.168.100.217 93.184.216.34 TCP 66 60470 → 80 [ACK] Seq=81 Ack=1579 Win=34944 Len=0 TSv…
Frame 14: 145 bytes on wire (1160 bits), 145 bytes captured (1160 bits) on interface 0
Ethernet II, Src: Giga-Byt_7b:a1:14 (00:16:e6:7b:a1:14), Dst: HuaweiTe_69:5d:71 (34:6a:c2:69:5d:71)
Internet Protocol Version 4, Src: 192.168.100.217, Dst: 93.184.216.34
Transmission Control Protocol, Src Port: 60470, Dst Port: 80, Seq: 1, Ack: 1, Len: 79
Hypertext Transfer Protocol
0000 34 6a c2 69 5d 71 00 16 e6 7b a1 14 08 00 45 00 4j.i]q.. .{....E.
0010 00 83 c8 a0 40 00 40 06 16 78 c0 a8 64 d9 5d b8 ....@.@. .x..d.].
0020 d8 22 ec 36 00 50 34 f6 ec ee dd 2e cf 41 80 18 ."6.P4. .....A..
0030 00 e5 ba 39 00 00 01 01 08 0a 00 36 24 8e 4b 84 ...9.... ...6$.K.
0040 a0 41 47 45 54 20 2f 20 48 54 54 50 2f 31 2e 31 .AGET / HTTP/1.1
0050 0d 0a 48 6f 73 74 3a 20 77 77 77 2e 65 78 61 6d ..Host: www.exam
0060 70 6c 65 2e 6f 72 67 0d 0a 55 73 65 72 2d 41 67 ple.org. .User-Ag
0070 65 6e 74 3a 20 63 75 72 6c 2f 37 2e 34 37 2e 30 ent: cur l/7.47.0
0080 0d 0a 41 63 63 65 70 74 3a 20 2a 2f 2a 0d 0a 0d ..Accept : */*...
0090 0a .
Wireshark
Hypertext Transfer Protocol (http), 79 bytes
Packets: 26 · Displayed: 12 (46.2%)
Profile: Default

Nástroj ipconfig (windows)

```
C:\> ipconfig /all
Ethernet adapter Local Area Connection 2:
        Description . . . . . . . . . . . : Intel(R) PRO/1000 MT Network Connection
        Physical Address. . . . . . . . . : 00-15-F2-C2-41-DE
        Dhcp Enabled. . . . . . . . . . . : Yes
        Autoconfiguration Enabled . . . . : Yes
        IP Address. . . . . . . . . . . . : 192.168.100.14
        Subnet Mask . . . . . . . . . . . : 255.255.255.0
        Default Gateway . . . . . . . . . : 192.168.100.1
        DHCP Server . . . . . . . . . . . : 192.168.100.1
        DNS Servers . . . . . . . . . . . : 192.168.100.1
```

Nástroj ifconfig (linux)

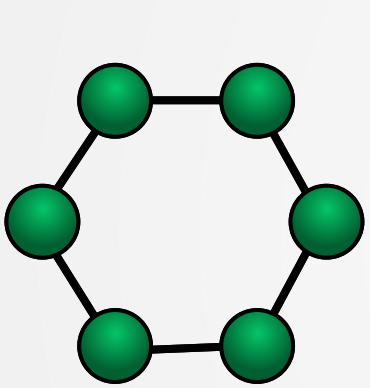
```
$ ifconfig
enp3s0    Link encap:Ethernet  HWaddr 08:60:6e:e6:36:ac
          inet addr:192.168.201.40  Bcast:192.168.201.255  Mask:255.255.255.0
          inet6 addr: 2a01:390:63:0:84e2:70ad:bc73:8381/64 Scope:Global
          inet6 addr: 2a01:390:63:0:60bc:7b1b:a4c1:54f0/64 Scope:Global
          inet6 addr: fe80::86e9:9e40:abec:ec9f/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:1191705 errors:0 dropped:0 overruns:0 frame:0
          TX packets:207366 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:262289092 (262.2 MB)  TX bytes:74066707 (74.0 MB)

lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          inet6 addr: ::1/128 Scope:Host
          UP LOOPBACK RUNNING  MTU:65536  Metric:1
          RX packets:18545 errors:0 dropped:0 overruns:0 frame:0
          TX packets:18545 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1
          RX bytes:13383433 (13.3 MB)  TX bytes:13383433 (13.3 MB)
```

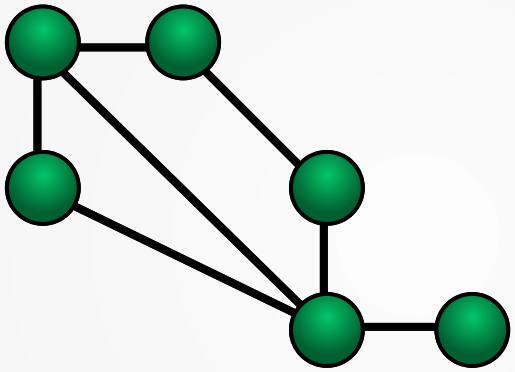
Nástroj arp-scan

```
$ sudo arp-scan --interface=enp3s0 --localnet
Interface: enp3s0, datalink type: EN10MB (Ethernet)
Starting arp-scan 1.8.1 with 256 hosts (http://www.nta-monitor.com/tools/arp-scan/)
192.168.201.1   00:09:0f:09:00:09   Fortinet Inc.
192.168.201.2   00:50:56:a7:34:c7   VMware, Inc.
192.168.201.3   00:50:56:a7:02:e6   VMware, Inc.
192.168.201.4   00:50:56:a7:4b:8a   VMware, Inc.
192.168.201.5   00:50:56:a7:07:8e   VMware, Inc.
192.168.201.11  00:0b:82:7c:87:77   Grandstream Networks, Inc.
192.168.201.12  00:0b:82:7c:87:75   Grandstream Networks, Inc.
192.168.201.14  50:e5:49:57:7d:c8   GIGA-BYTE TECHNOLOGY CO.,LTD.
192.168.201.17  08:60:6e:e6:37:71   (Unknown)
192.168.201.20  52:54:00:db:34:d3   QEMU
192.168.201.26  90:e6:ba:c2:32:b8   ASUSTek COMPUTER INC.
192.168.201.25  5c:b0:66:d8:72:4e   (Unknown)
192.168.201.28  40:61:86:5e:59:9a   MICRO-STAR INT'L CO.,LTD
192.168.201.33  44:d9:e7:90:de:0f   (Unknown)
192.168.201.34  e4:8d:8c:3e:fc:68   (Unknown)
192.168.201.24  7c:2f:80:46:35:13   Gigaset Communications GmbH
...
121 packets received by filter, 0 packets dropped by kernel
Ending arp-scan 1.8.1: 256 hosts scanned in 1.114 seconds (229.80 hosts/sec).
```

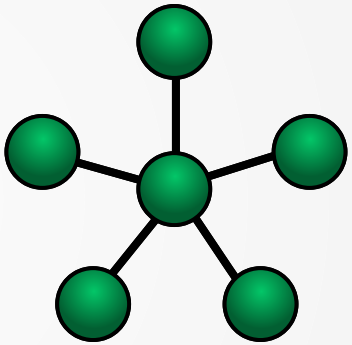
Topológie sietí



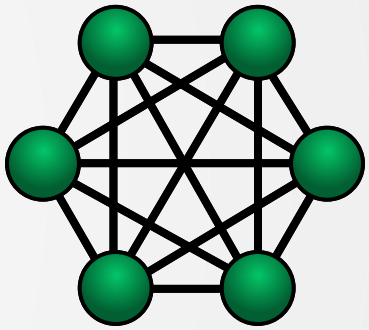
Ring



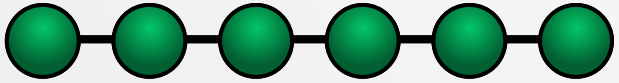
Mesh



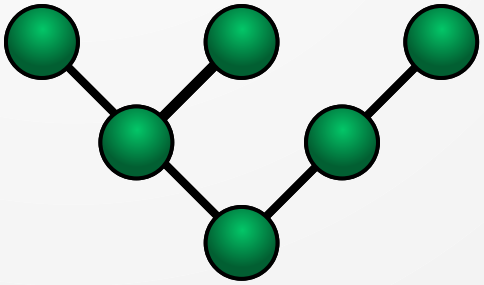
Star



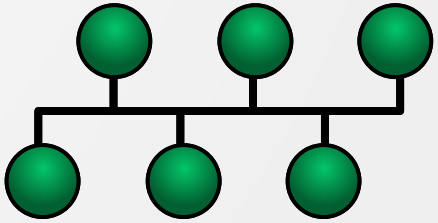
Fully Connected



Line



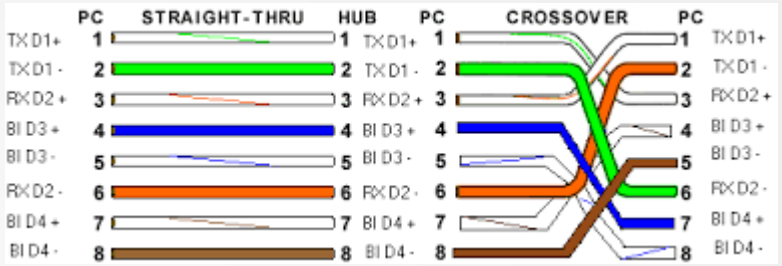
Tree

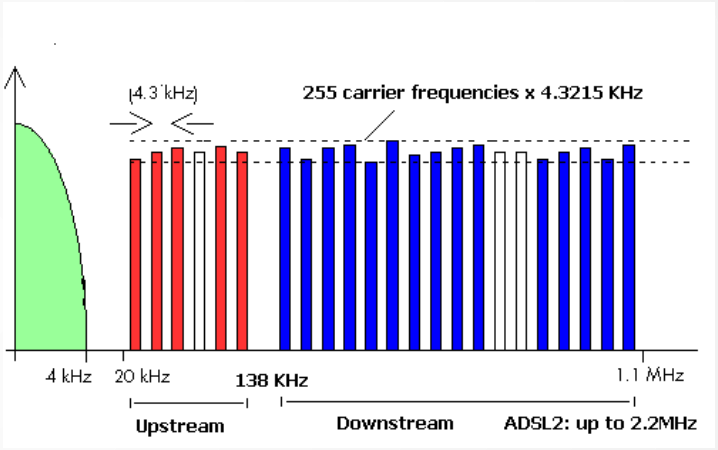


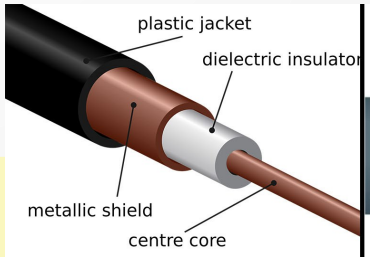
Bus

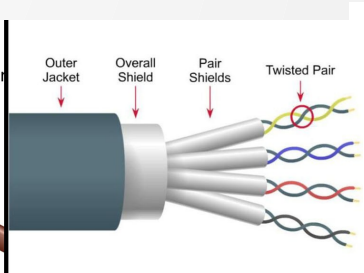
Fyzické prepoje

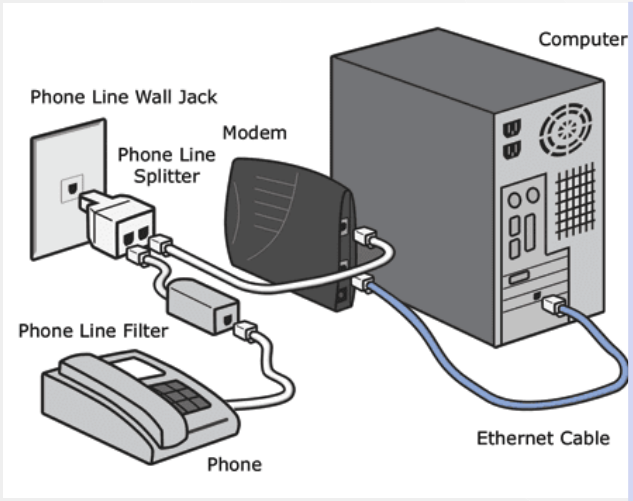
- xDSL (metalika)
- FTTx (optika)
- Bezdrôtový prístup (WiFi, FWA)
- Káblový prístup (CATV)
- Satelit
- PLC
- Koaxiál (BNC)
- Krútená dvojinka (RJ45)

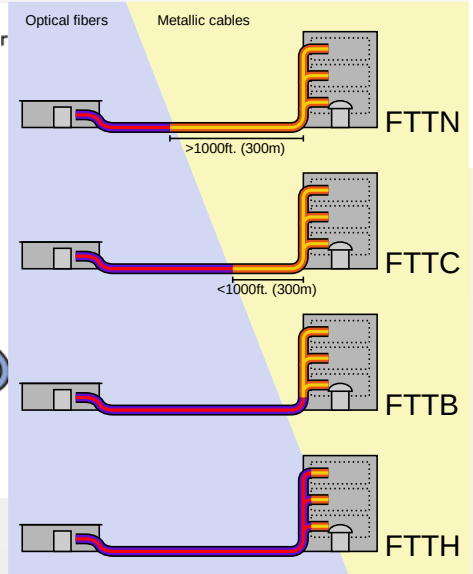


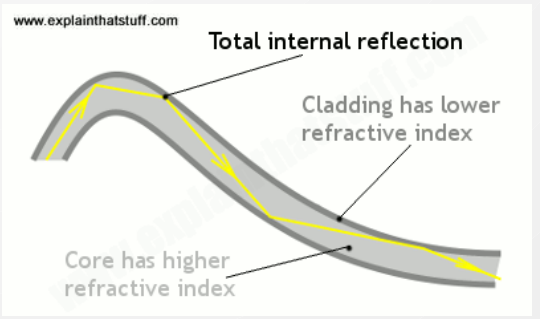






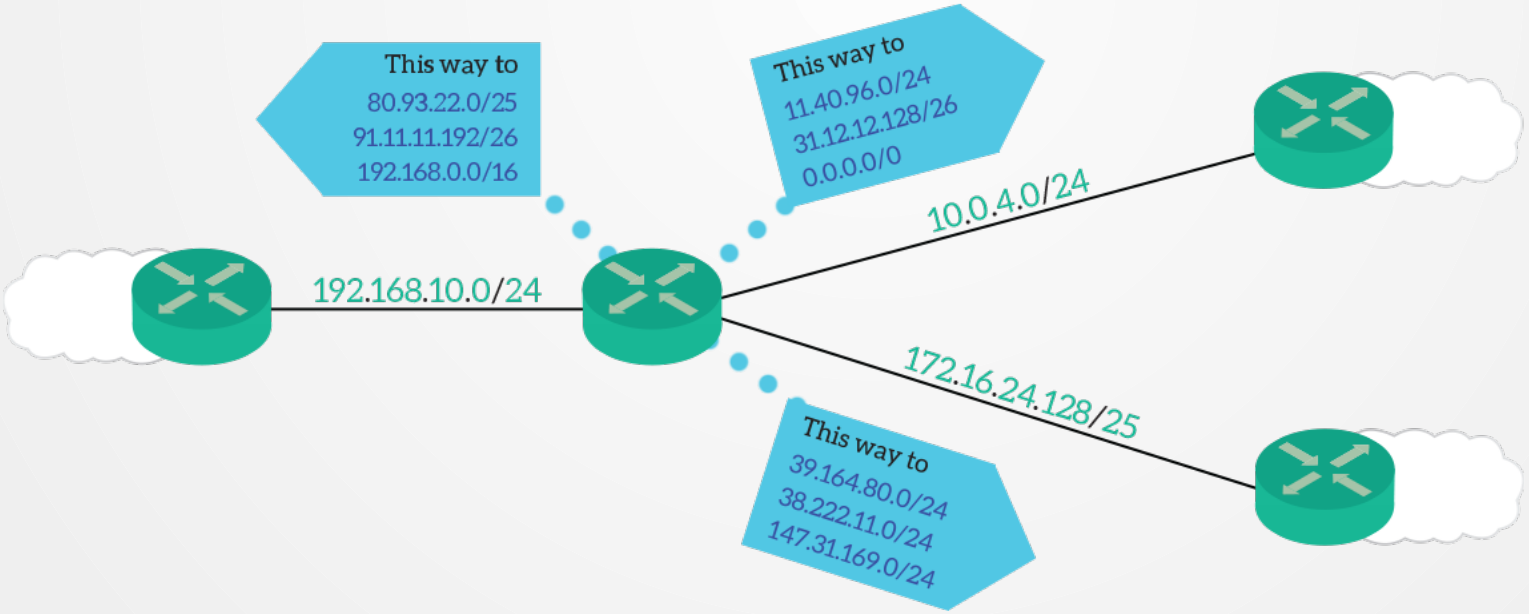


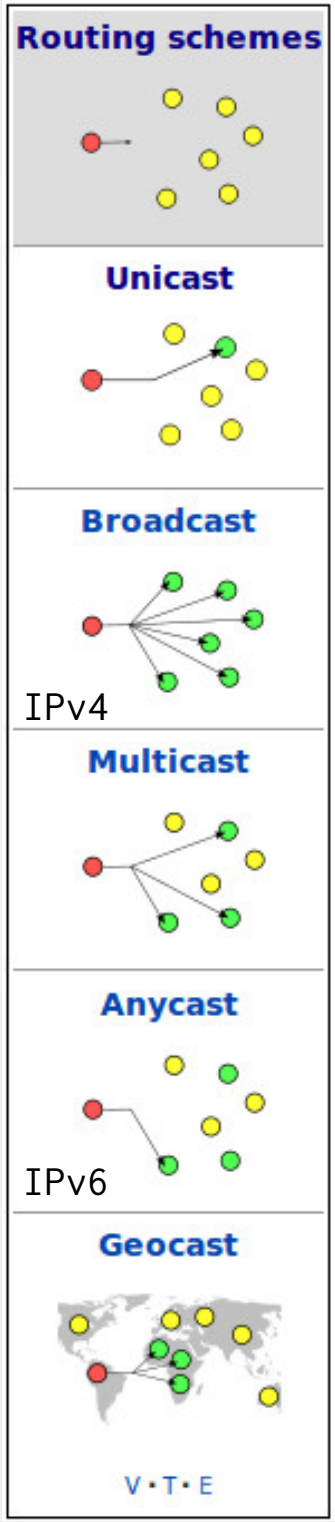




Smerovanie

- Výber najvhodnejšej trasy pre paket zo zdroja do cieľa
- Smerovacie tabuľky routera určia adresu ďalšieho hopu
- Routre sa informujú o spojeniach - graf

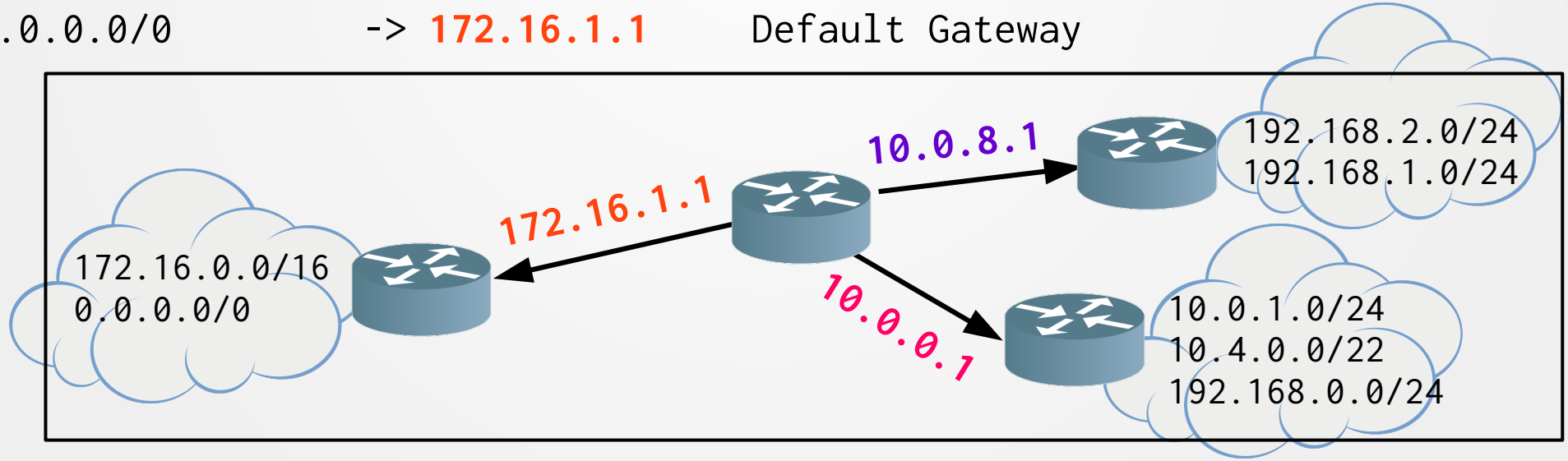




Smerovacie tabuľky

Cieľ: 192.168.1.1 11000000.10101000.00000001.00000001

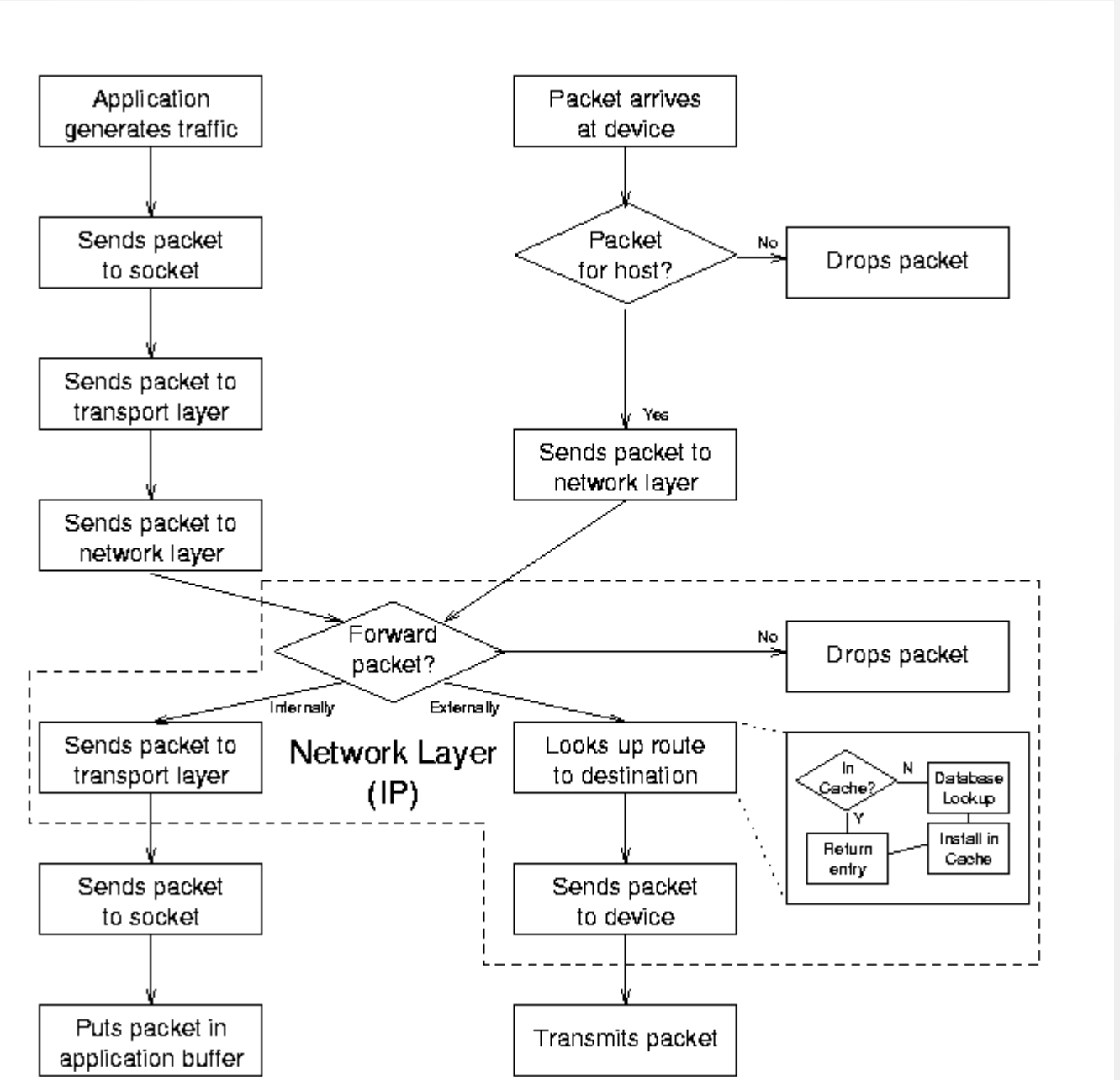
Destination		Next Hop (Gateway)	
10.0.1.0/24	->	10.0.0.1	00001010.00000000.00000000.00000001
192.168.2.0/24	->	10.0.8.1	11000000.10101000.00000010.00000000
172.16.0.0/16	->	172.16.1.1	10101100.00010000.00000000.00000000
10.4.0.0/22	->	10.0.0.1	00001010.00000100.00000000.00000000
192.168.0.0/24	->	10.0.0.1	11000000.10101000.00000000.00000000
192.168.1.0/25	->	10.0.8.1	11000000.10101000.00000001.00000000
0.0.0.0/0	->	172.16.1.1	Default Gateway



Kernel IP routing table

Destination	Gateway	Genmask	Flags	Metric	Ref	Use	Iface
default	192.168.100.1	0.0.0.0	UG	100	0	0	eth0
192.168.100.0	*	255.255.255.0	U	100	0	0	eth0
192.168.100.0	*	255.255.255.0	U	600	0	0	wlan0

Smerovanie paketov



Nástroj traceroute

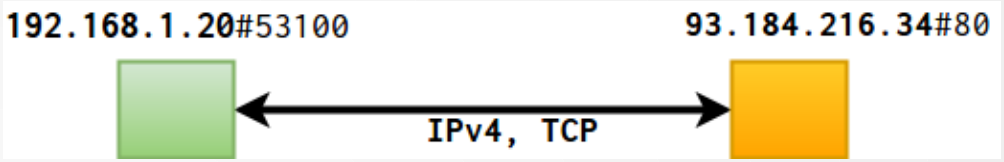
```
traceroute to slovensko.sk (195.49.191.194), 30 hops max, 60 byte packets
 1  fw.ghubba.edu.sk (10.0.0.1)  0.186 ms
 2  193.87.105.225 (193.87.105.225)  0.521 ms
 3  Govnet-gw1.six.sk (192.108.148.185)  0.892 ms
 4  195.49.191.194 (195.49.191.194)  0.792 ms
 5  195.49.191.194 (195.49.191.194)  1.382 ms
 6  195.49.191.194 (195.49.191.194)  1.822 ms
```

http://www.bgplookingglass.com/
http://www.six.sk/index.php?page=looking_gl
http://www.cogentco.com/en/network/looking-
https://lg.telia.net/

```
traceroute to wikipedia.org (91.198.174.192), 30 hops max, 60 byte packets
 1  192.168.100.1 (192.168.100.1)  2.334 ms
 2  95-105-153-1.dynamic.orange.sk (95.105.153.1)
 3  192.168.100.165 (192.168.100.165)  5.785 ms
 4  213-151-196-2.static.orange.sk (213.151.196.2)  7.692 ms
 5  213-151-198-238.static.orange.sk (213.151.198.238)  9.226 ms
 6  brat-b1-link.telia.net (213.248.69.53)  8.524 ms
 7  win-bb2-link.telia.net (62.115.119.188)  15.709 ms
 8  hbg-bb4-link.telia.net (62.115.119.50)  34.455 ms
 9  adm-bb4-link.telia.net (80.91.246.200)  41.648 ms
10  adm-b3-link.telia.net (62.115.122.191)  36.059 ms
11  wikimedia-ic-316335-adm-b3.c.telia.net (62.115.145.25)  43.564 ms
12  text-lb.esams.wikimedia.org (91.198.174.192)  34.388 ms
```

```
traceroute to www.reddit.com (151.101.113.140), 30 hops max, 60 byte packets
...
 6  be4166.ccr21.bts01.atlas.cogentco.com (149.6.26.45)  11.149 ms
 7  be2988.ccr51.vie01.atlas.cogentco.com (154.54.59.86)  6.766 ms
 8  be2974.ccr21.muc03.atlas.cogentco.com (154.54.58.5)  13.731 ms
 9  be2959.ccr41.fra03.atlas.cogentco.com (154.54.36.53)  20.053 ms
10  fastly.demarc.cogentco.com (149.6.43.134)  18.672 ms
11  151.101.113.140 (151.101.113.140)  18.529 ms
```

client.py




```
import socket

server = "93.184.216.34"            # "example.org" / "127.0.0.1"
port = 80                           # 1234
message = ("GET / HTTP/1.1\r\n"
           "Host: {}\r\n"
           "Connection: close\r\n\r\n")

s = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
s.connect((server, port))
s.sendall(bytes(message.format(server), 'utf8'))

while True:
    data = s.recv(512)
    if not data: break
    print(str(data, 'utf8'))
s.close()
```

server.py

```
import socket
from datetime import datetime

host = ''
port = 1234
response = ("HTTP/1.1 200 OK\n"
            "Server: My-Simple-Server\n"
            "Date: {}\n"
            "Content-Type: Content-Type: text/html; charset=utf-8\n"
            "Content-Length: {}\n"
            "Connection: close\n\n")

s = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
s.bind((host, port))
s.listen(3)

while True:
    client, address = s.accept()
    print("Connected by: {}".format(address))
    data = client.recv(512)

    time = datetime.utcnow().strftime("%a, %d %b %Y %H:%M:%S GMT")
    html = open('index.html', 'r').read()
    b = len(bytes(html, 'utf8'))

    client.send(bytes(response.format(time, b) + html, 'utf8'))
    client.close()
s.close()
```

Ďakujem za pozornosť

“The biggest communication problem is
we do not listen to understand.
We listen to reply.”

— Stephen R. Covey

Zdroje

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