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Network

Exchanging data between systems

Grégor JOUET -- PhD Student

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Global Overview

1 Information Transmission

2 Information Routing & Global Networking Mechanisms

3 Common Protocols & Tools

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Day 1 Information Transmission

“On aurait dit des sémaphores. Les copains d’abord”

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Information Transmission

1 History

2 OSI

3 Some examples

4 Tools

5 C Network Programming

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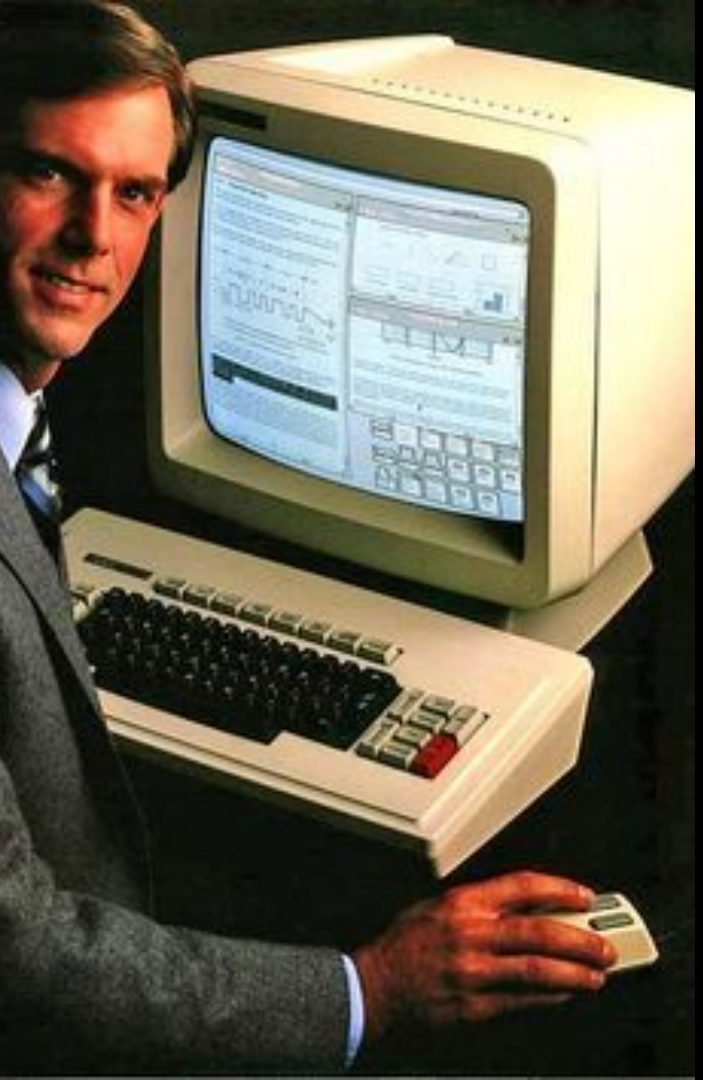

1

History

Old internet commercials are the best kind of commercials

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2

OSI

One model to rule them all

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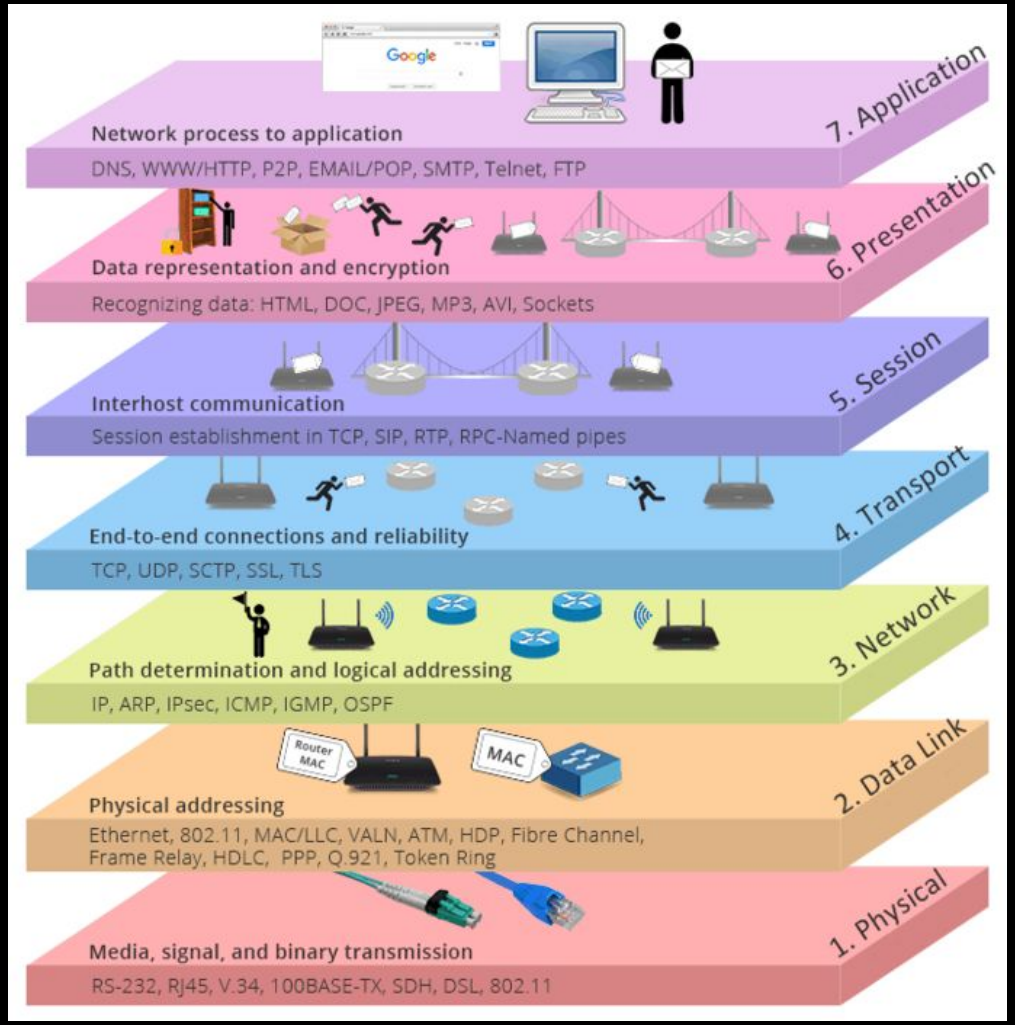

Close to user

Close to machine

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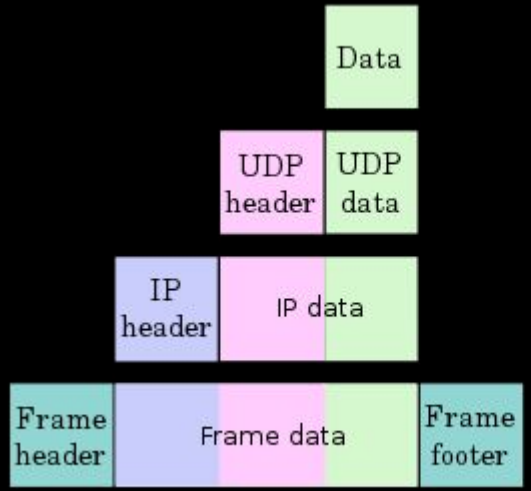
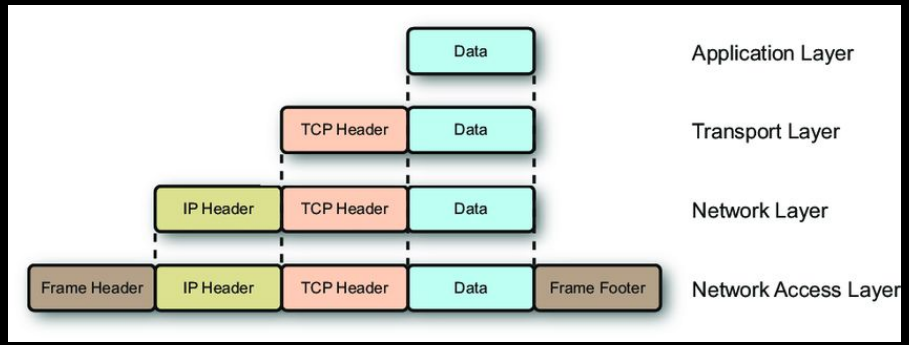
Encapsulation




```
▸ Frame 7560: 89 bytes on wire (712 bits), 89 bytes captured (712 bits) on interface enp4s0, id 0
▸ Ethernet II, Src: ASUSTekC_d3:83:21 (54:a0:50:d3:83:21), Dst: DWnetTec_b3:eb:b2 (78:b2:13:b3:eb:b2)
▸ Internet Protocol Version 4, Src: 192.168.1.39, Dst: 192.168.1.1
▸ User Datagram Protocol, Src Port: 58487, Dst Port: 53
▸ Domain Name System (query)
```

```
0000  78 b2 13 b3 eb b2 54 a0  50 d3 83 21 08 00 45 00   x·····T· P··!··E·
0010  00 4b f2 ab 40 00 40 11  c4 7d c0 a8 01 27 c0 a8   ·K··@·@· ·}···'··
0020  01 01 e4 77 00 35 00 37  83 c1 fb 5f 01 00 00 01   ···w·5·7 ···_····
0030  00 00 00 00 00 00 08 6c  6f 63 61 74 69 6f 6e 08   ·······l ocation·
0040  73 65 72 76 69 63 65 73  07 6d 6f 7a 69 6c 6c 61   services ·mozilla
0050  03 63 6f 6d 00 00 1c 00  01                       ·com···· ·
```



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3

Some protocols

To get the idea

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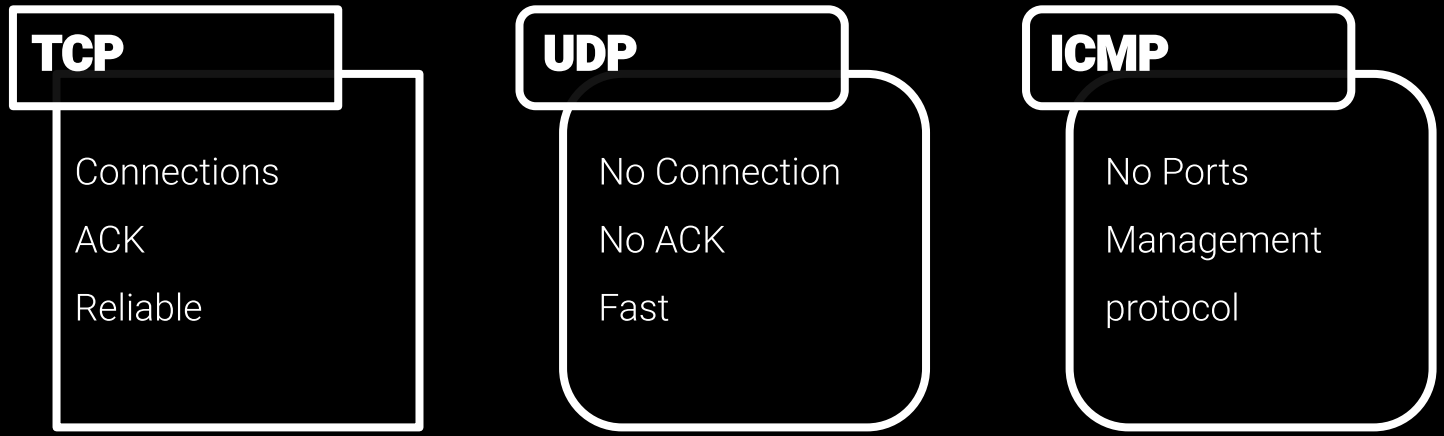
Some Protocols



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Sidetrack

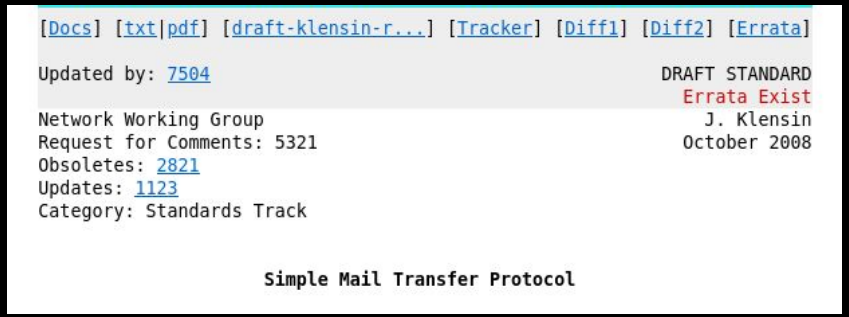
IETF & RFCs

[Docs] [txt|pdf] [draft-ietf-tls-...] [Tracker] [Diff1] [Diff2] [IPR] [Er

PROPOSED STANDARD
Errata Exist

Internet Engineering Task Force (IETF) — E. Rescorla
Request for Comments: 8446 — Mozilla
Obsoletes: 5077, 5246, 6961 — August 2018
Updates: 5705, 6066
Category: Standards Track
ISSN: 2070-1721

The Transport Layer Security (TLS) Protocol Version 1.3

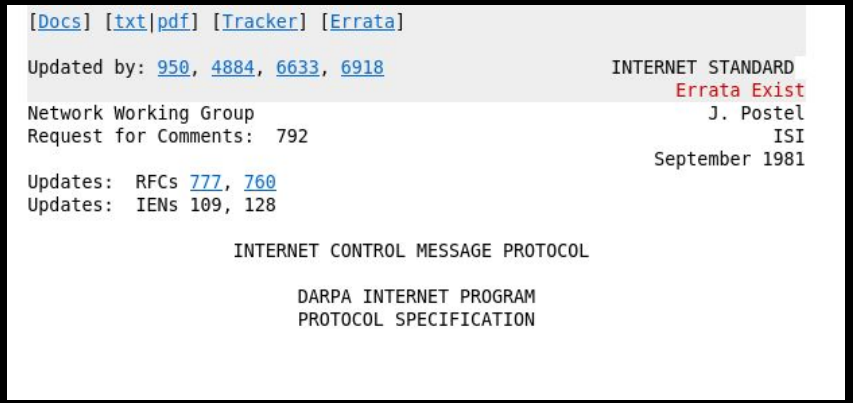


[Docs] [txt|pdf] [draft-klensin-r...] [Tracker] [Diff1] [Diff2] [Errata]

Updated by: 7504 — DRAFT STANDARD
Errata Exist

Network Working Group — J. Klensin
Request for Comments: 5321 — October 2008
Obsoletes: 2821
Updates: 1123
Category: Standards Track

Simple Mail Transfer Protocol



[Docs] [txt|pdf] [Tracker] [Errata]

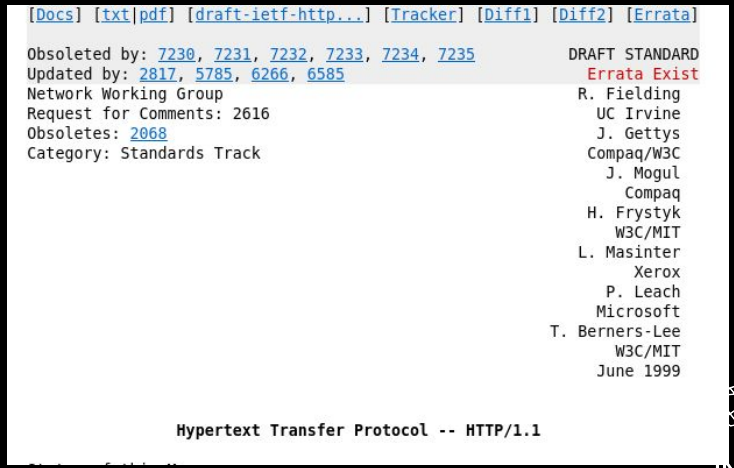
Updated by: 950, 4884, 6633, 6918 — INTERNET STANDARD
Errata Exist

Network Working Group — J. Postel
Request for Comments: 792 — ISI
September 1981

Updates: RFCs 777, 760
Updates: IENs 109, 128

INTERNET CONTROL MESSAGE PROTOCOL

DARPA INTERNET PROGRAM
PROTOCOL SPECIFICATION



[Docs] [txt|pdf] [draft-ietf-http...] [Tracker] [Diff1] [Diff2] [Errata]

Obsoleted by: 7230, 7231, 7232, 7233, 7234, 7235 — DRAFT STANDARD
Updated by: 2817, 5785, 6266, 6585 — Errata Exist

Network Working Group — R. Fielding
Request for Comments: 2616 — UC Irvine
Obsoletes: 2068 — J. Gettys
Category: Standards Track — Compaq/W3C
J. Mogul
Compaq
H. Frystyk
W3C/MIT
L. Masinter
Xerox
P. Leach
Microsoft
T. Berners-Lee
W3C/MIT
June 1999

Hypertext Transfer Protocol -- HTTP/1.1

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4

Tools

Use those **and** your brain

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Tools

Useful tools

ip Manage interfaces
netstat Manage Connections
netcat Quickly open connections

wireshark Deep dive in the network

```
win32gg@Enceladeus ~ ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
2: enp4s0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000
    link/ether 54:a0:50:d3:83:21 brd ff:ff:ff:ff:ff:ff
    inet 192.168.1.39/24 brd 192.168.1.255 scope global dynamic noprefixroute enp4s0
       valid_lft 66428sec preferred_lft 55628sec
    inet6 2a01:cb00:7d2:6600:f15f:c915:8d19:11d5/64 scope global dynamic mngtmpaddr noprefixroute
       valid_lft 1632sec preferred_lft 432sec
    inet6 2a01:cb00:7d2:6600:c849:5956:4ffd:f28e/64 scope global dynamic noprefixroute
       valid_lft 1786sec preferred_lft 586sec
    inet6 fe80::945a:df55:1852:7252/64 scope link noprefixroute
       valid_lft forever preferred_lft forever
    inet6 fe80::6e16:9f1b:23bf:9198/64 scope link noprefixroute
       valid_lft forever preferred_lft forever
3: wlp3s0: <NO-CARRIER,BROADCAST,MULTICAST,UP> mtu 1500 qdisc mq state DOWN group default qlen 1000
    link/ether d2:27:71:c9:6b:bf brd ff:ff:ff:ff:ff:ff permaddr 80:a5:89:9a:3f:37
```

```
win32gg@Enceladeus ~ netstat -t -4 -n
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address         State
tcp        0      0 192.168.1.39:46830      [redacted]              ESTABLISHED
tcp        0      0 192.168.1.39:54542      [redacted]              ESTABLISHED
tcp        0      0 192.168.1.39:37098      [redacted]              CLOSE_WAIT
tcp        0      0 192.168.1.39:54996      [redacted]              ESTABLISHED
tcp       64      0 192.168.1.39:55896      [redacted]              CLOSE_WAIT
tcp        0      0 192.168.1.39:60592      [redacted]              ESTABLISHED
tcp        0      0 127.0.0.1:46624         127.0.0.1:44532         ESTABLISHED
tcp        0      0 192.168.1.39:52230      [redacted]:443          TIME_WAIT
tcp        0      0 192.168.1.39:52456      [redacted]:3            ESTABLISHED
tcp        0      0 192.168.1.39:60130      [redacted]:3            ESTABLISHED
tcp       13      0 192.168.1.39:59424      [redacted]              CLOSE_WAIT
tcp        0      0 192.168.1.39:48239      [redacted]:7023         ESTABLISHED
tcp        0      0 192.168.1.39:55186      [redacted]:443          ESTABLISHED
tcp        0      0 127.0.0.1:44532         [redacted]              ESTABLISHED
tcp        0      0 192.168.1.39:39918      [redacted]:443          ESTABLISHED
tcp        0      0 192.168.1.39:38384      [redacted]:43           ESTABLISHED
tcp        0      0 192.168.1.39:56660      [redacted]:43           ESTABLISHED
```

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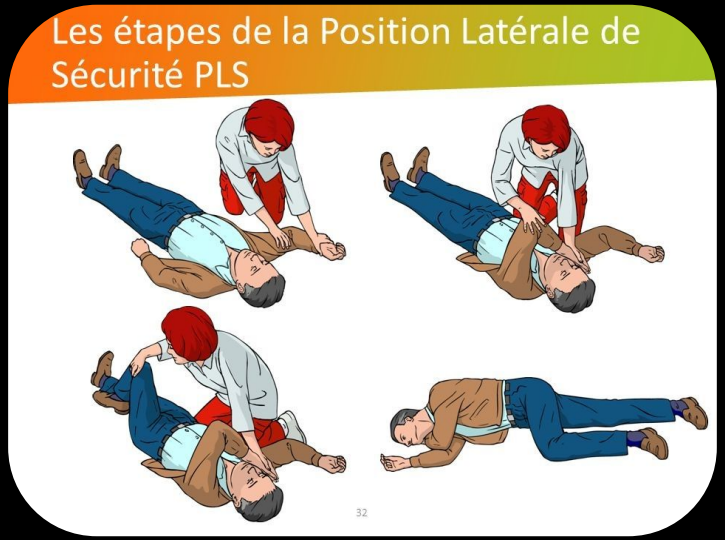

5

C Network Programming

Houla

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socket(2) - Linux man page

Name

socket - create an endpoint for communication

Synopsis

#include <sys/types.h> /* See NOTES */
#include <sys/socket.h>

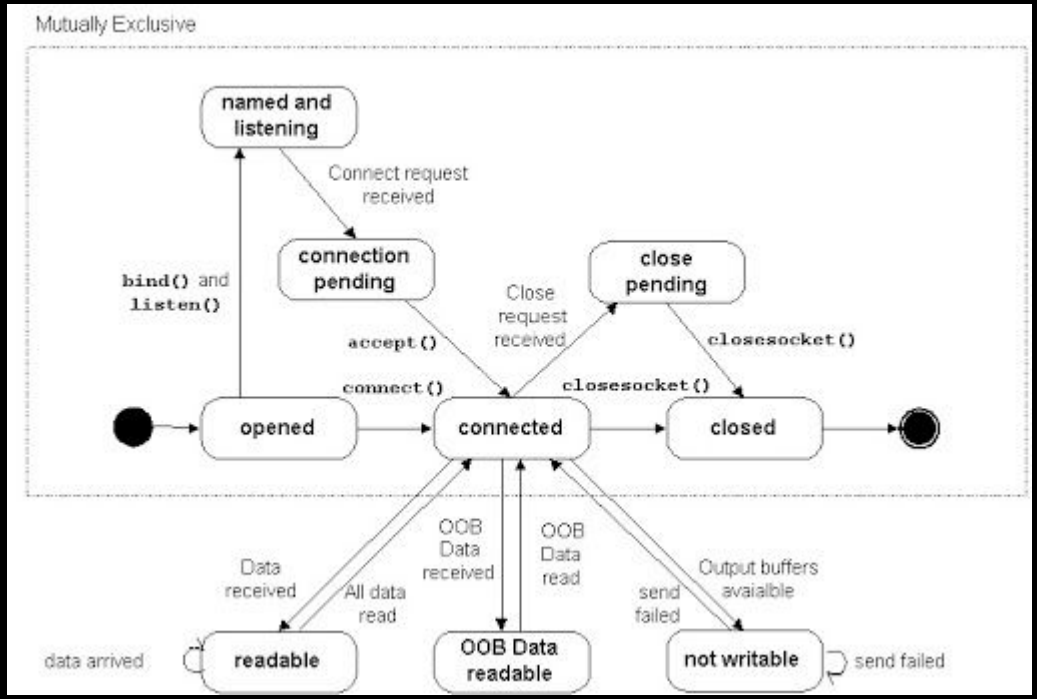
int socket(int *domain*, **int** *type*, **int** *protocol*);

Description

socket() creates an endpoint for communication and returns a descriptor.

The *domain* argument specifies a communication domain; this selects the protocol family
communication. These families are defined in <*sys/socket.h*>. The currently understood f

Name	Purpose	Man page
AF_UNIX, **AF_LOCAL**	Local communication	***unix***(7)
AF_INET	IPv4 Internet protocols	***ip***(7)
AF_INET6	IPv6 Internet protocols	***ipv6***(7)
AF_IPX	IPX - Novell protocols	
AF_NETLINK	Kernel user interface device	***netlink***(7)
AF_X25	ITU-T X.25 / ISO-8208 protocol	***x25***(7)
AF_AX25	Amateur radio AX.25 protocol	
AF_ATMPVC	Access to raw ATM PVCs	
AF_APPLETALK	Appletalk	***ddp***(7)
AF_PACKET	Low level packet interface	***packet***(7)



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Day 2 Information Routing & Global Networking Mechanisms

Qu'on appelle "l'internet" aussi

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Information Routing

1 IP & Network

2 Routing

3 NAT

4 Common Protocols

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1

IP

Addressing the problem

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```
✘ win32gg@Enceladeus ~ ipcalc 192.168.1.0 255.255.255.0
Address:   192.168.1.0          11000000.10101000.00000001. 00000000
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

win32gg@Enceladeus ~ ipcalc 10.8.0.0/8
Address:   10.8.0.0             00001010. 00001000.00000000.00000000
Netmask:   255.0.0.0 = 8        11111111. 00000000.00000000.00000000
Wildcard:  0.255.255.255        00000000. 11111111.11111111.11111111
=>
Network:   10.0.0.0/8           00001010. 00000000.00000000.00000000
HostMin:   10.0.0.1             00001010. 00000000.00000000.00000001
HostMax:   10.255.255.254       00001010. 11111111.11111111.11111110
Broadcast: 10.255.255.255       00001010. 11111111.11111111.11111111
Hosts/Net: 16777214              Class A, Private Internet

win32gg@Enceladeus ~
```

ipcalc le sauveur \o/

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Address Class	RANGE	Default Subnet Mask
A	1.0.0.0 to 126.255.255.255	255.0.0.0
B	128.0.0.0 to 191.255.255.255	255.255.0.0
C	192.0.0.0 to 223.255.255.255	255.255.255.0
D	224.0.0.0 to 239.255.255.255	Reserved for Multicasting
E	240.0.0.0 to 254.255.255.255	Experimental
Note: Class A addresses 127.0.0.0 to 127.255.255.255 cannot be used and is reserved for loopback testing.		

2

Routing

From A to B

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Exemple de schéma réseau

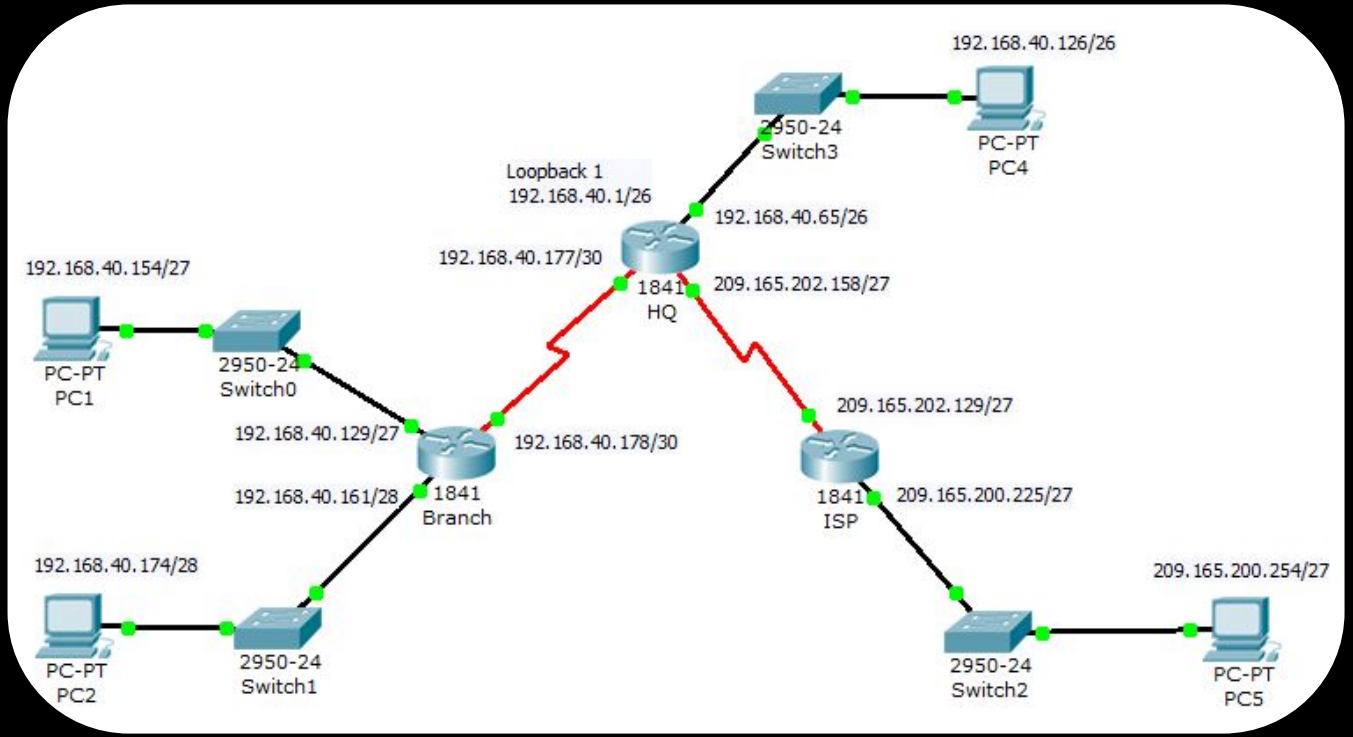

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Table de routage

```
win32gg@Enceladeus ~ ip r
default via 192.168.1.1 dev enp4s0 proto dhcp src 192.168.1.39 metric 202
172.17.0.0/16 dev docker0 proto kernel scope link src 172.17.0.1 linkdown
172.18.0.0/16 dev br-728506e1786f proto kernel scope link src 172.18.0.1 linkdown
172.31.0.0/16 dev br-0987a1d271fd proto kernel scope link src 172.31.0.1
192.168.1.0/24 dev enp4s0 proto dhcp scope link src 192.168.1.39 metric 202
win32gg@Enceladeus ~
```

```
win32gg@Enceladeus ~ route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
0.0.0.0         192.168.1.1     0.0.0.0         UG    202    0        0 enp4s0
172.17.0.0      0.0.0.0         255.255.0.0     U     0      0        0 docker0
172.18.0.0      0.0.0.0         255.255.0.0     U     0      0        0 br-728506e178
172.31.0.0      0.0.0.0         255.255.0.0     U     0      0        0 br-0987a1d271
192.168.1.0     0.0.0.0         255.255.255.0   U     202    0        0 enp4s0
win32gg@Enceladeus ~
```

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3

NAT

Network Address Translation

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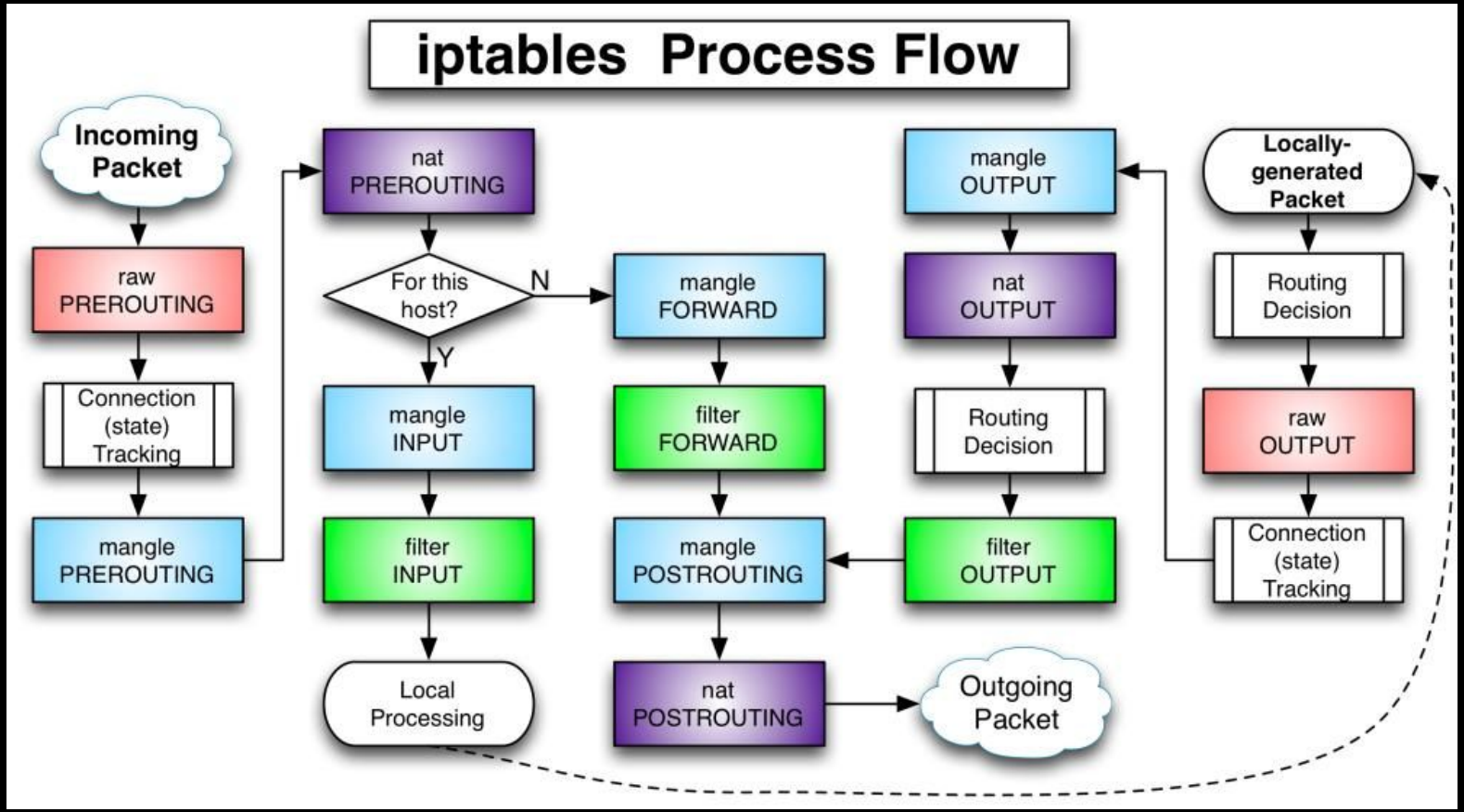

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Common Protocols

Que vous utilisez tout le temps

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It's not DNS

There's no way it's DNS

It was DNS

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Day 3 Supplemental Content

And practice

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Supplemental Content

1 TLS

2 HTTP

3 TP à choix multiples

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Network Troubleshooting guide

Connection Refused: Server not started, firewall rejecting, routing OK,
Connection Timeout: Routing wrong, firewall dropping,
No route to host: Immediate routing wrong
Connection reset: Clogged network, application problem

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