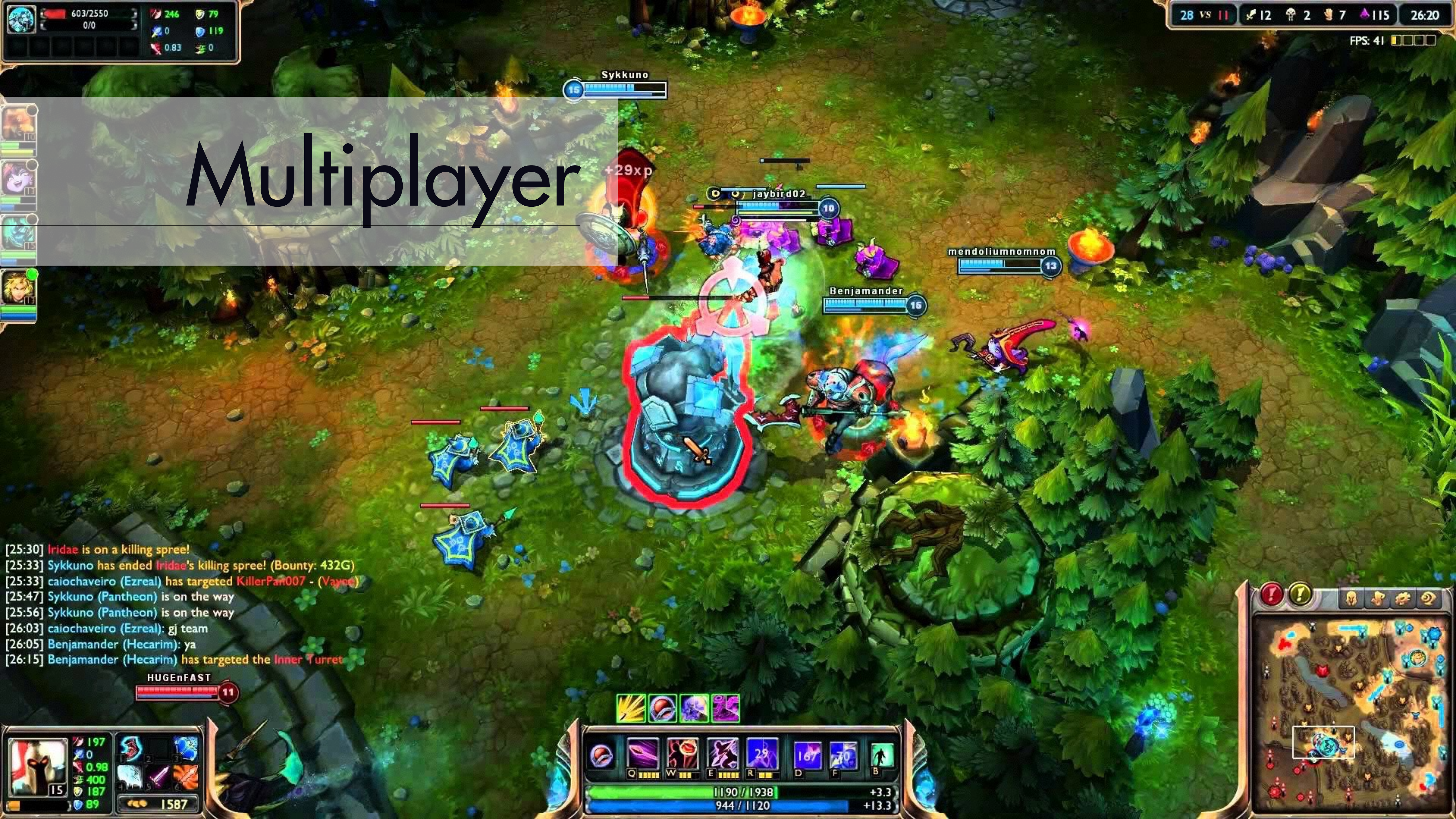




Multiplayer

[25:30] Iridae is on a killing spree!
[25:33] Sykkuno has ended Iridae's killing spree! (Bounty: 432G)
[25:33] caiochaveiro (Ezreal) has targeted KillerPan007 - (Vayne)
[25:47] Sykkuno (Pantheon) is on the way
[25:56] Sykkuno (Pantheon) is on the way
[26:03] caiochaveiro (Ezreal): gj team
[26:05] Benjamander (Hecarim): ya
[26:15] Benjamander (Hecarim) has targeted the Inner Turret

HUGEnFAST
11

15

197
0
0.98
400
187
89

1587

Q W E R D F B

1190/1938
944/1120

+3.3
+13.3

11

Multiplayer

- Local Multiplayer
 - Split Screen
- Serial Port
- Peer-to-Peer
- Client/Server
- Network of Servers

Local (Couch) Multiplayer

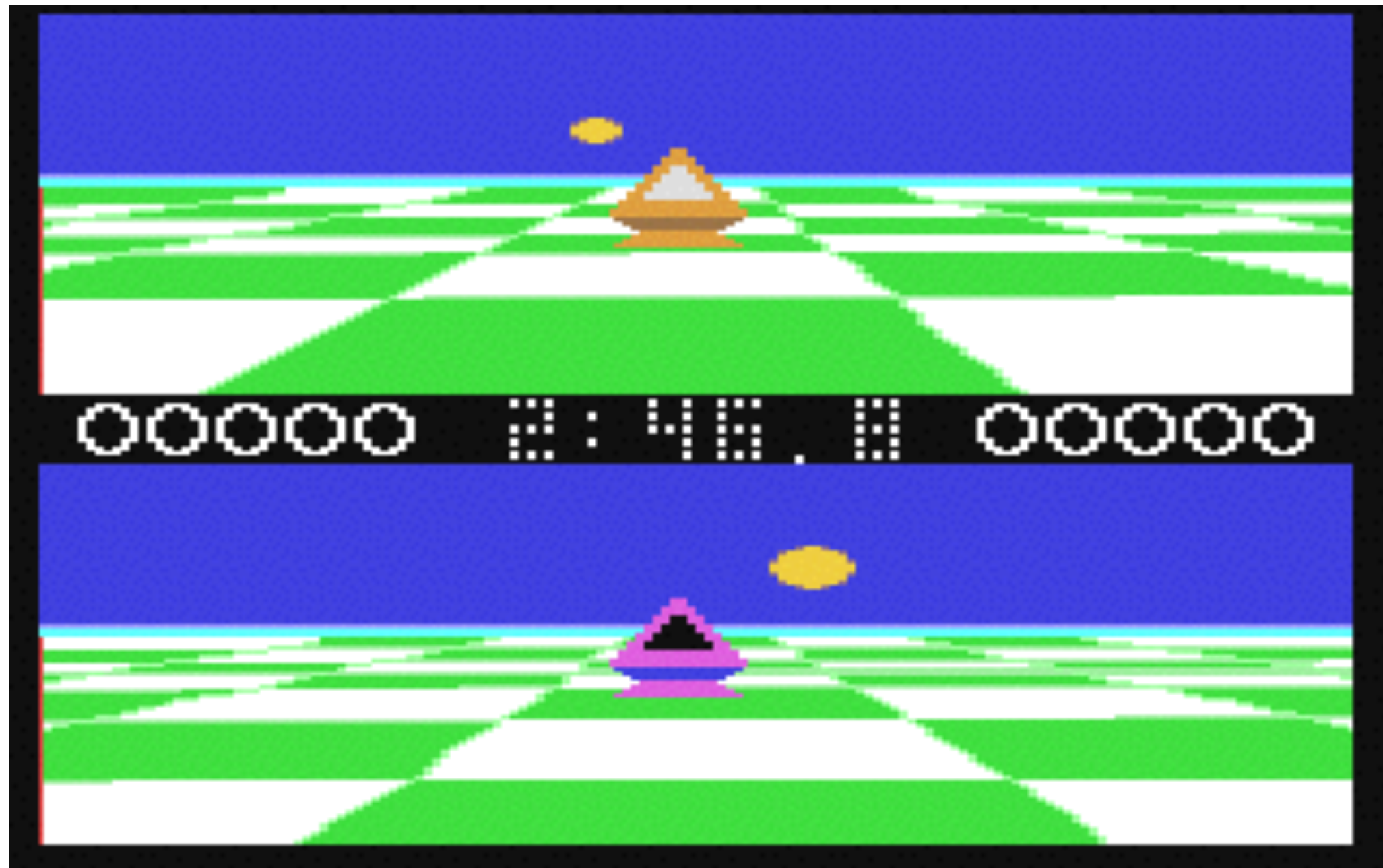


Magnavox Odyssey



Fingle

Splitscreen



Ball Blazer



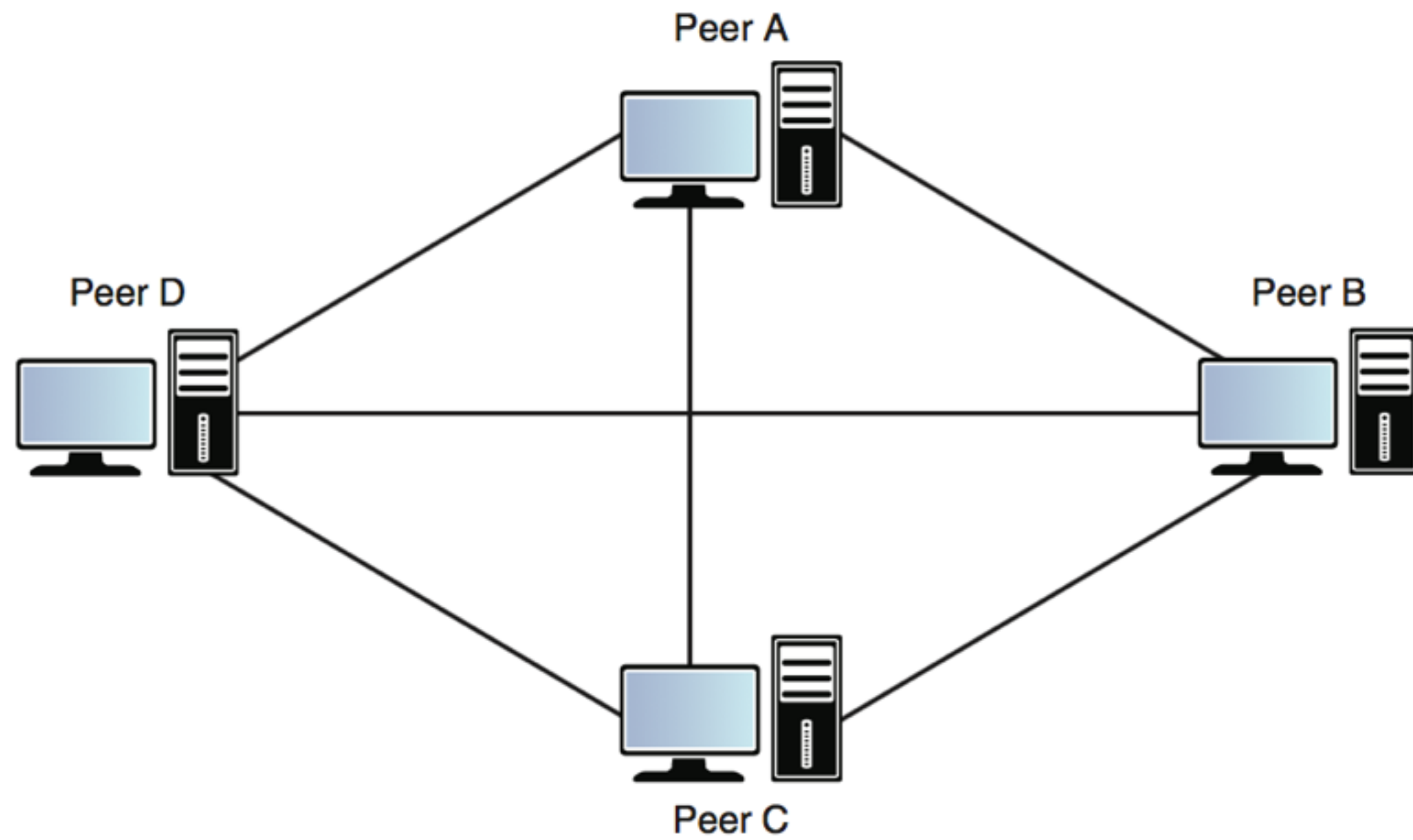
Fruit Ninja

Serielle Verbindung



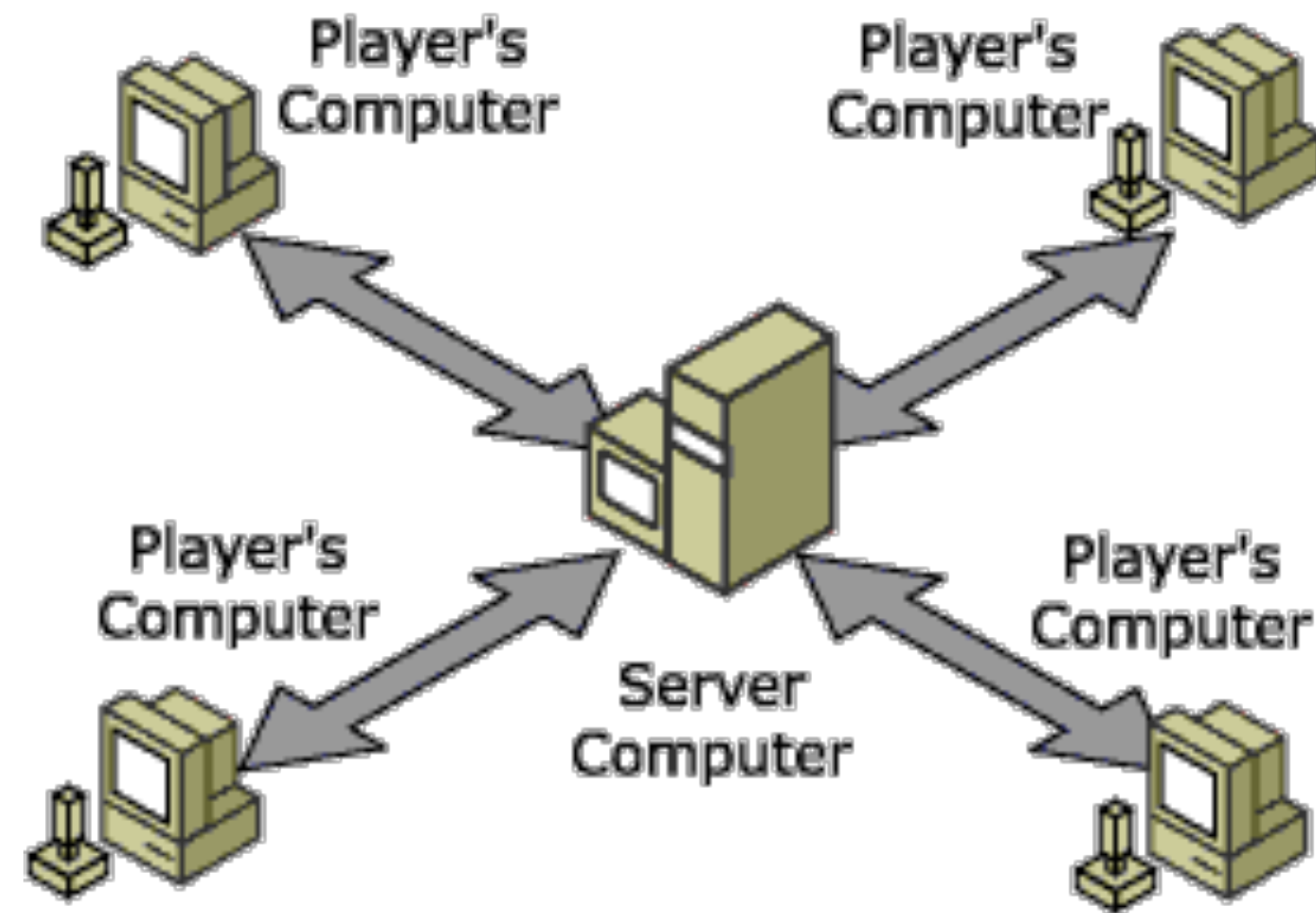
Game Link Cable

Peer-to-Peer



Doom

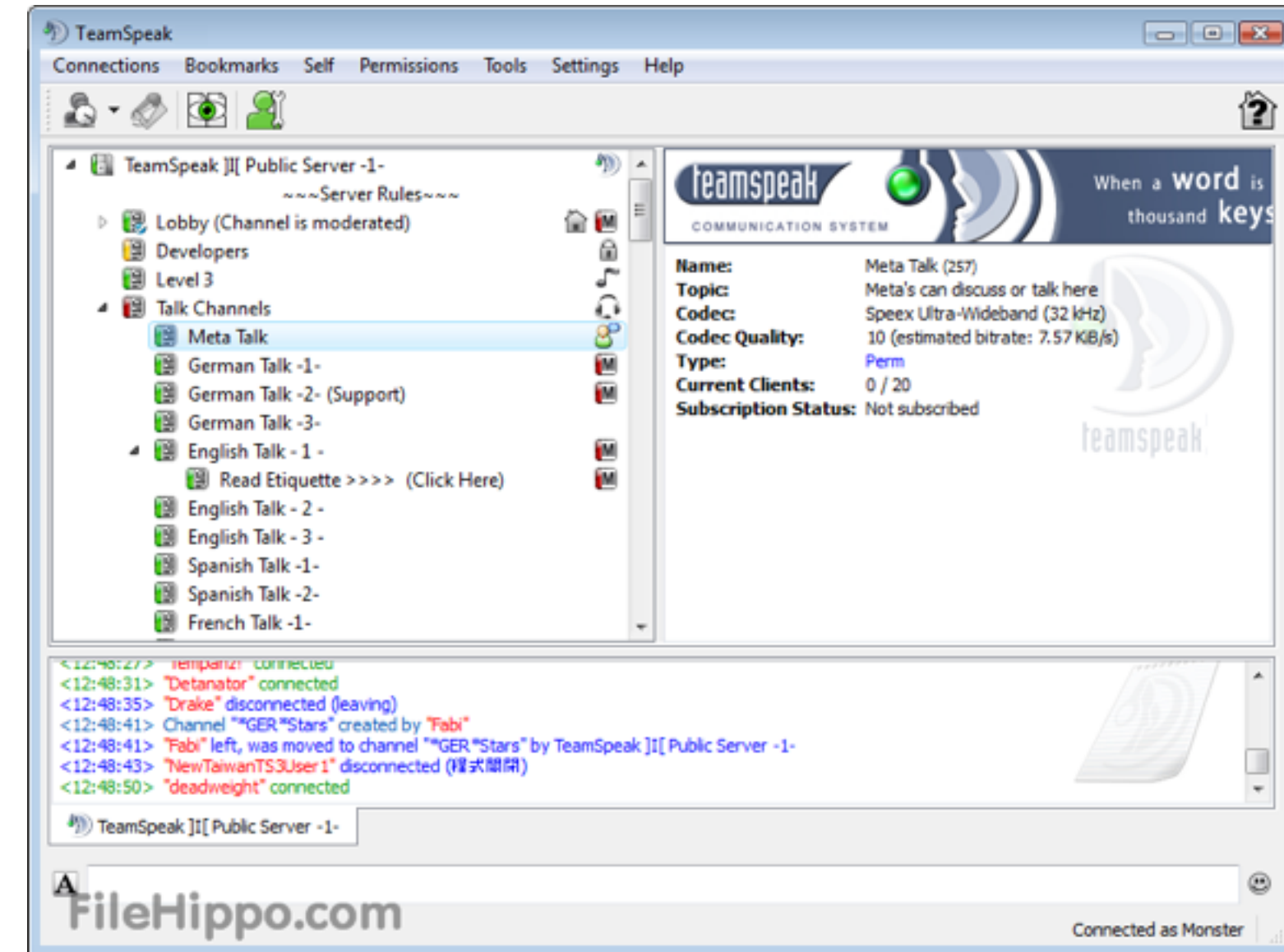
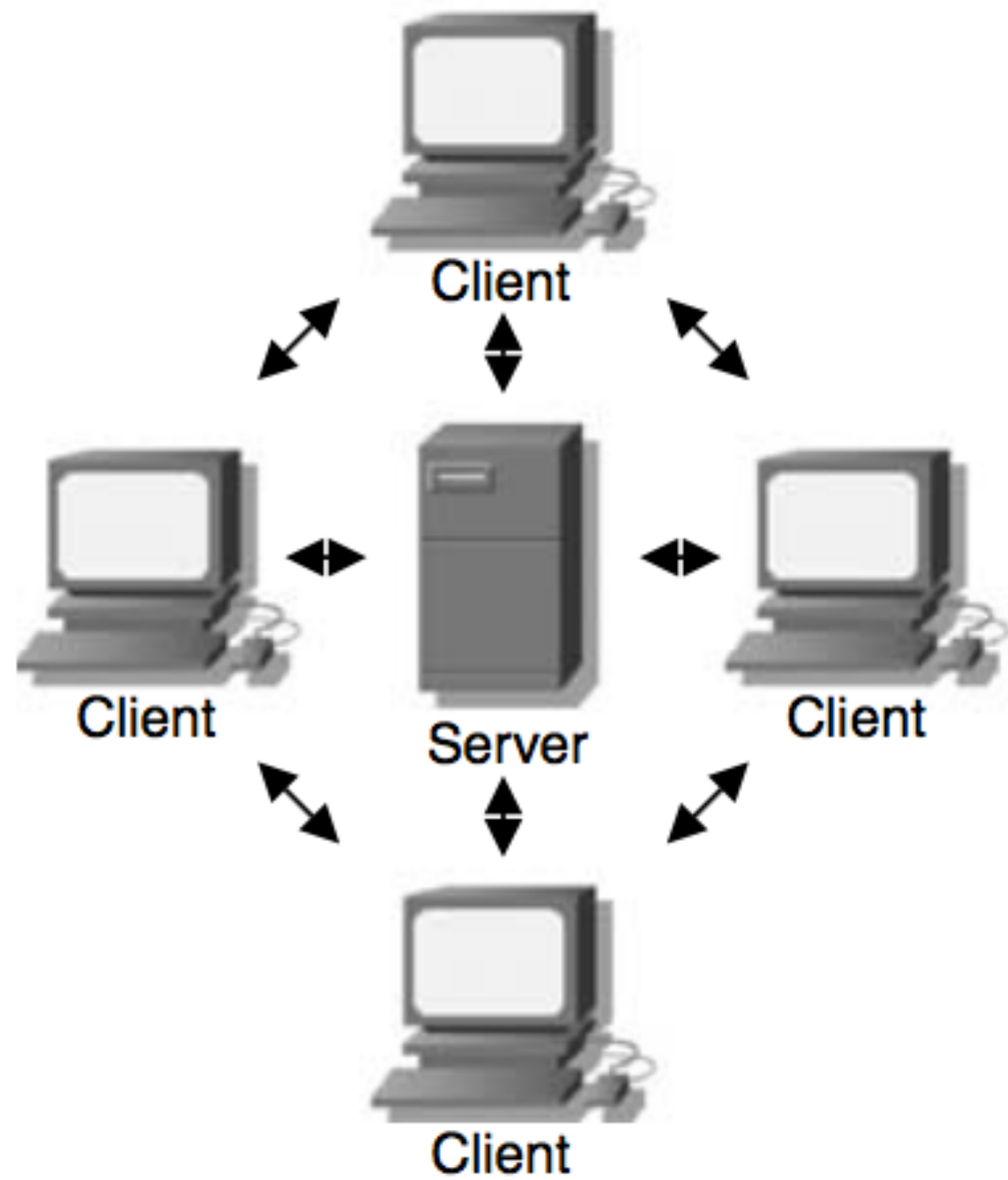
Client / Server



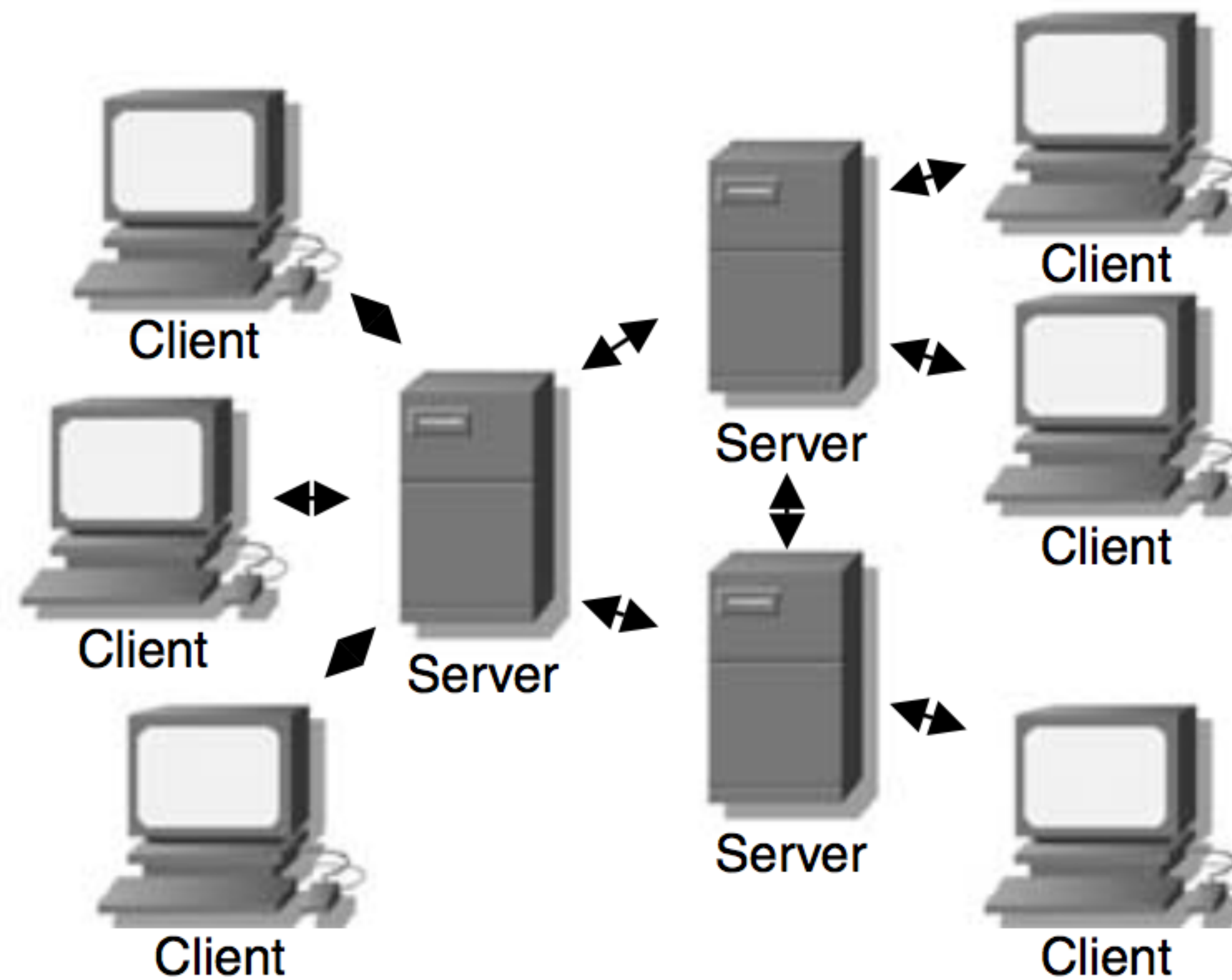
Browser-Client

Clientprogramm

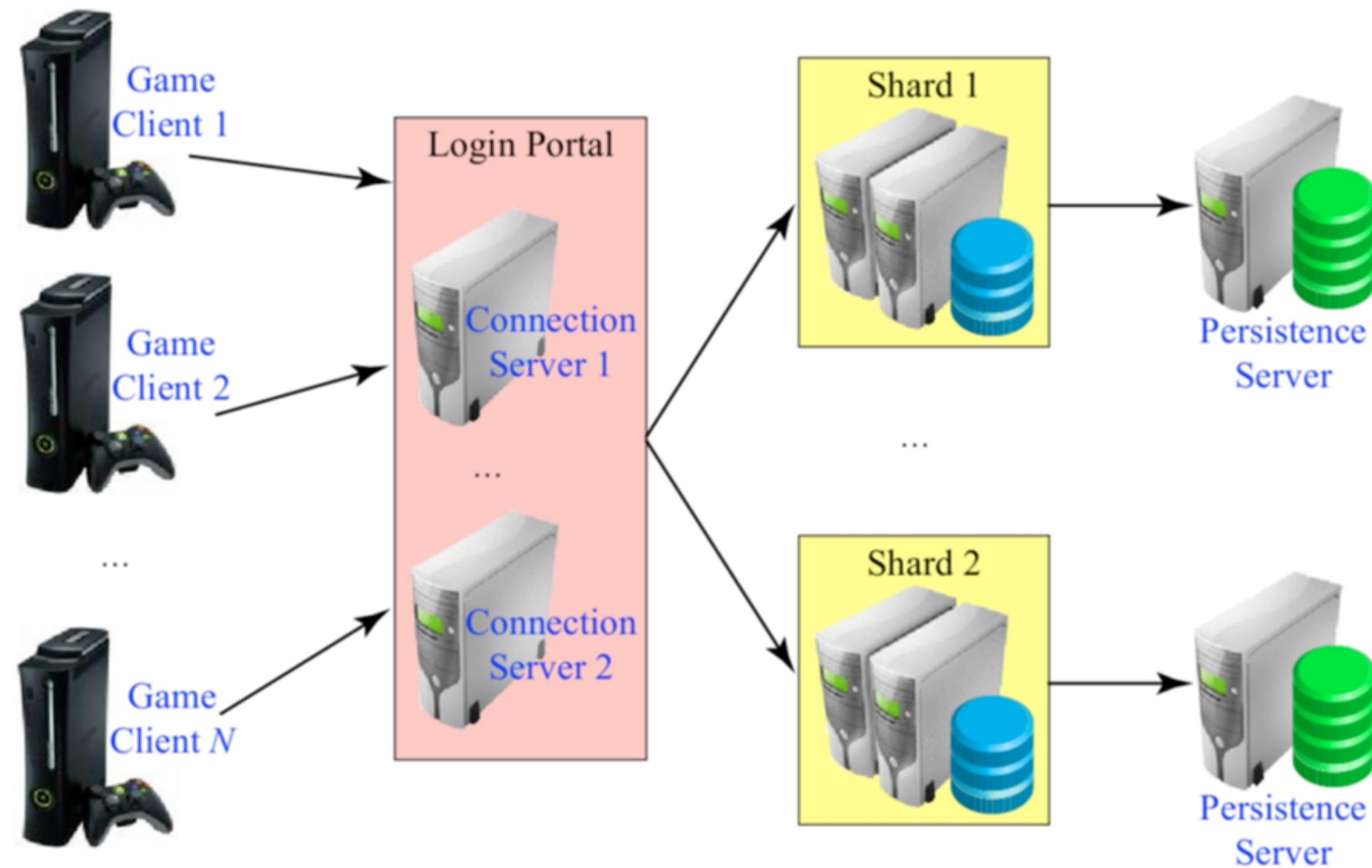
Client/Server-P2P-Hybrid



Network of Servers

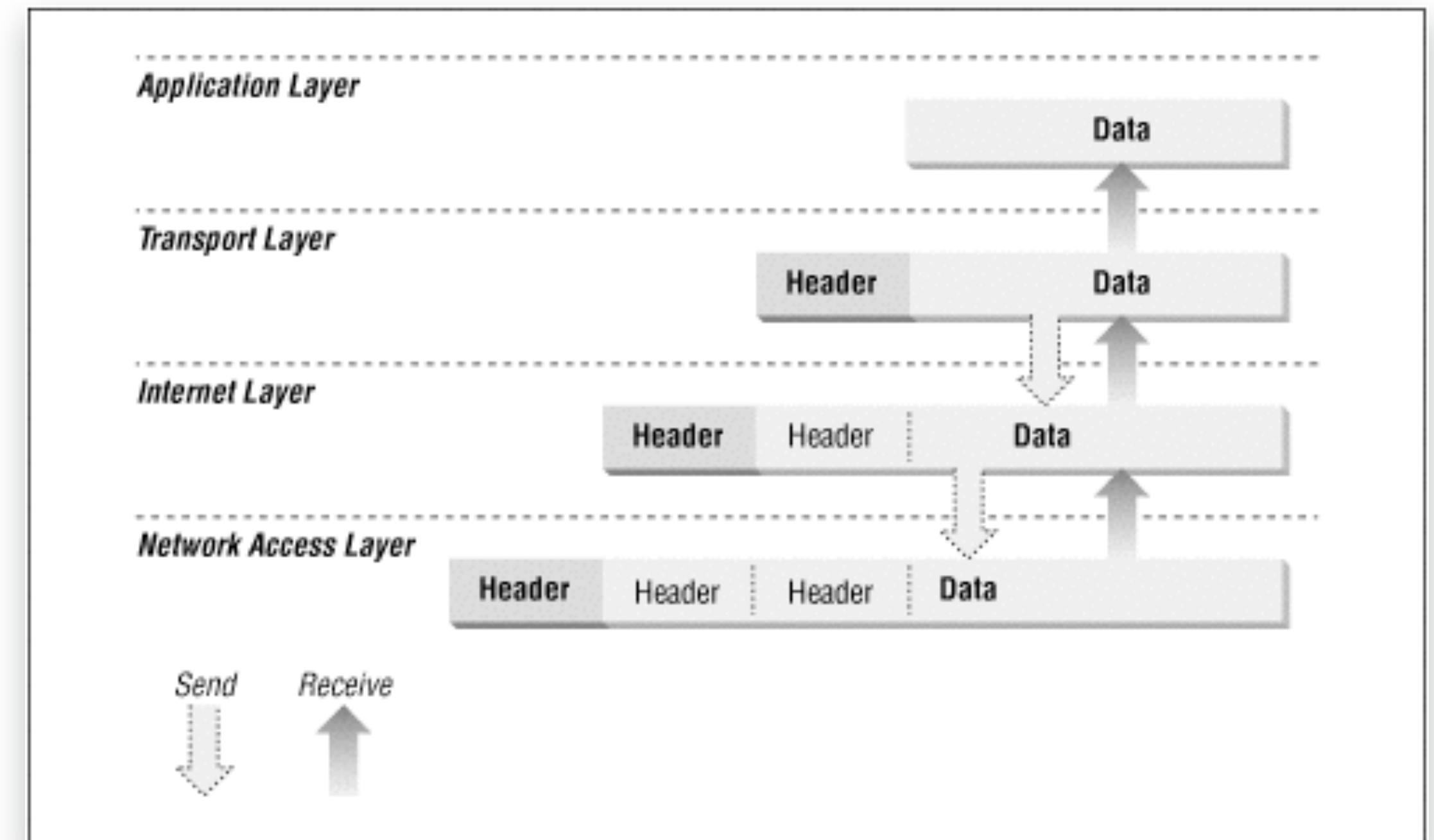
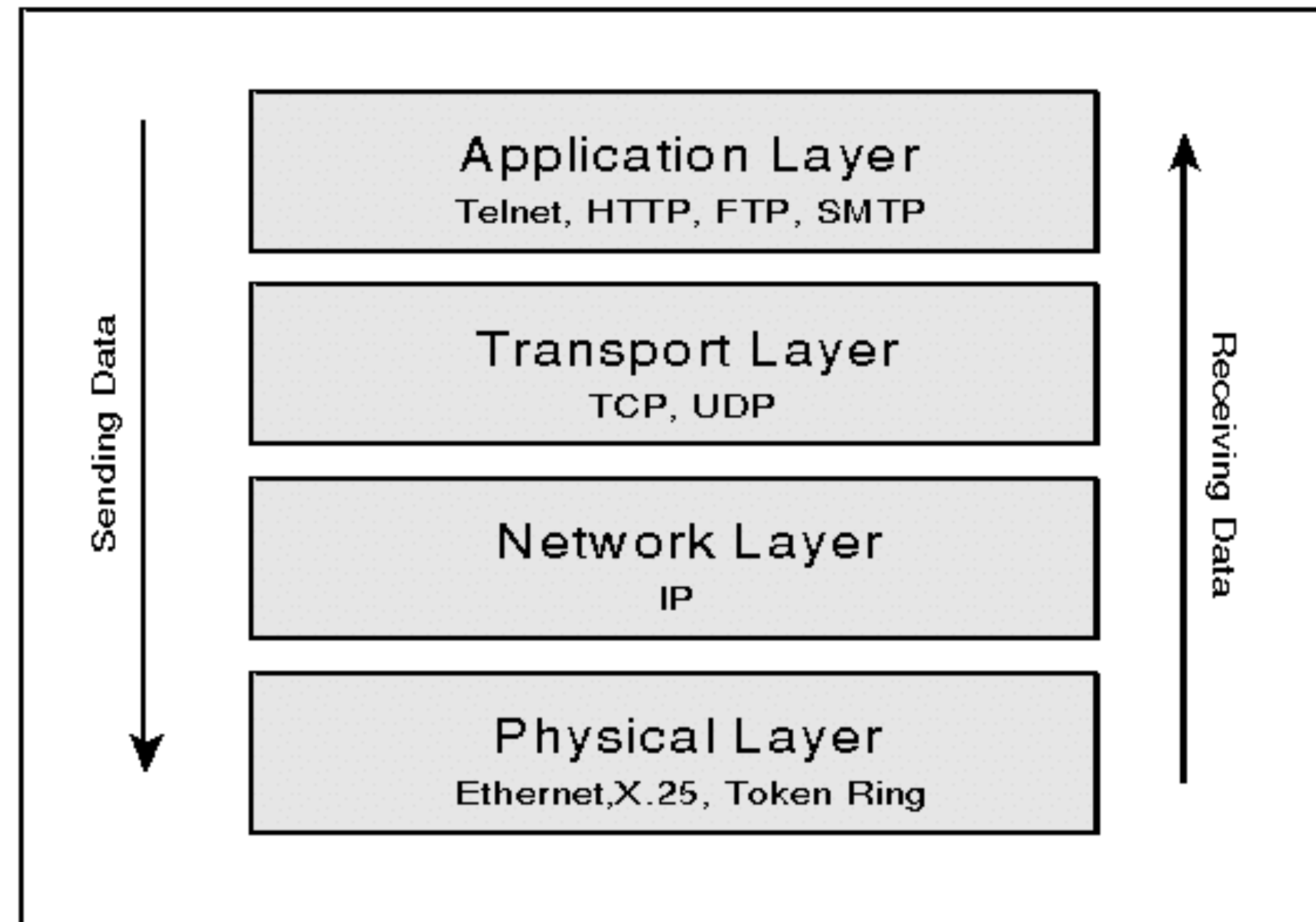


Shards

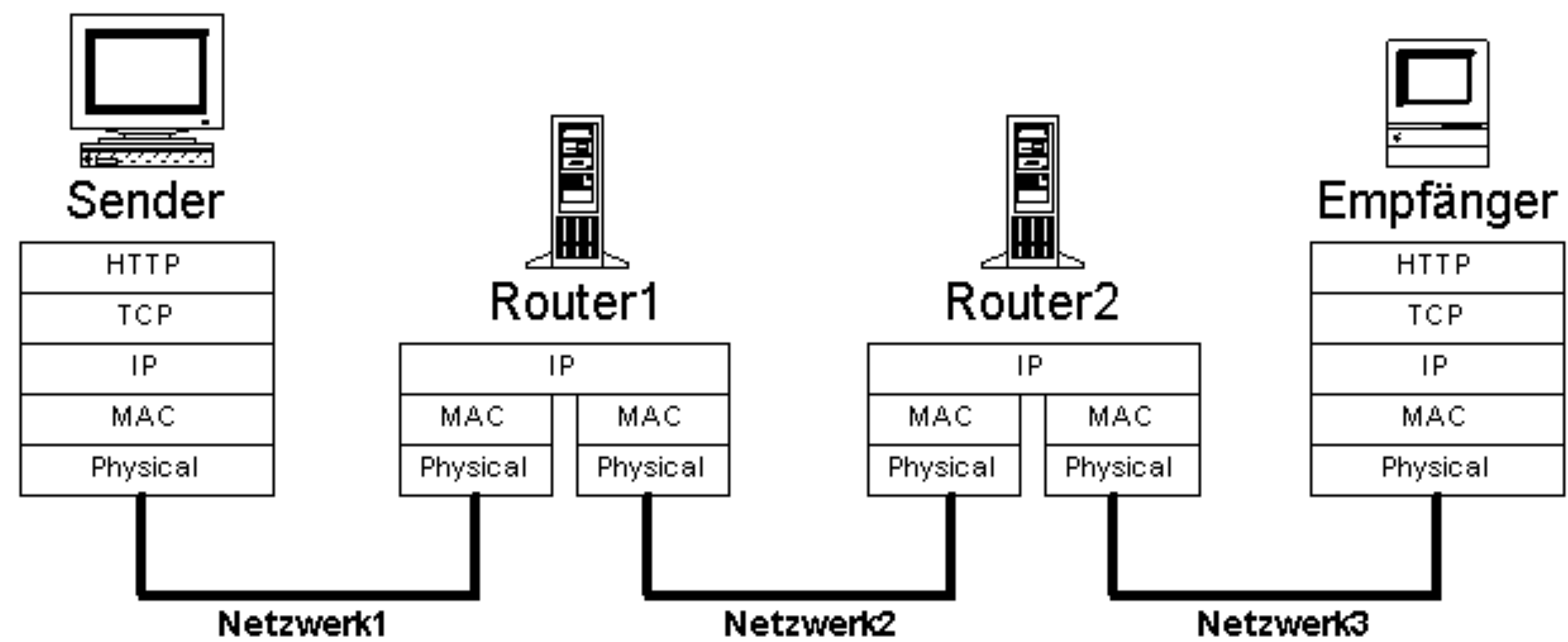


Server-Instanzen

Internet-Architektur



Netzsichten



	OSI-Layer		TCP/IP-Layer	TCP/IP-Protokolle							
7	Application		Application	Telnet	FTP	SMTP	DNS	SNMP	NFS		
6	Presentation								XDR		
5	Session								RPC		
4	Transport		Transport	TCP			UDP				
3	Network	Router	Internet	RIP, OSPF, EGP							
				IP, ICMP, ARP, RARP							
2	Data Link		Network	Ether-net	Token Ring	FDDI	X.25	Frame Relay	ATM	SLIP	PPP
1	Physical										

Physische Schicht

Ethernet 10BASET, Ethernet 100BASET, Ethernet 1000BASET

Twisted Pair

4- oder 8 Leitungspaare

Unshielded Twisted Pair

Shielded Twisted Pair

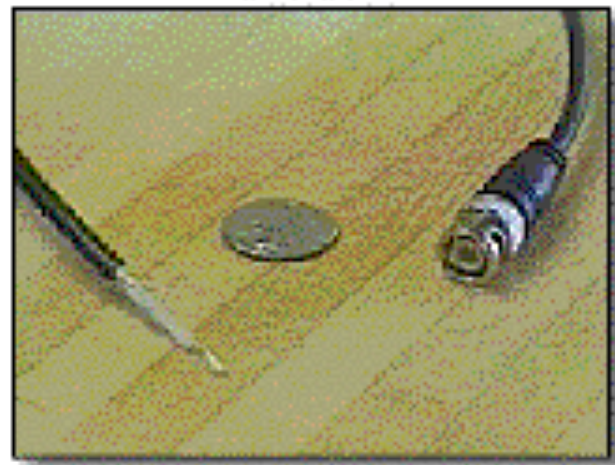
Koaxialkabel

50 W für Digitalanwendungen

75 W für Analoganwendungen

Glasfaserkabel (Lichtwellenleiter)

Coaxial



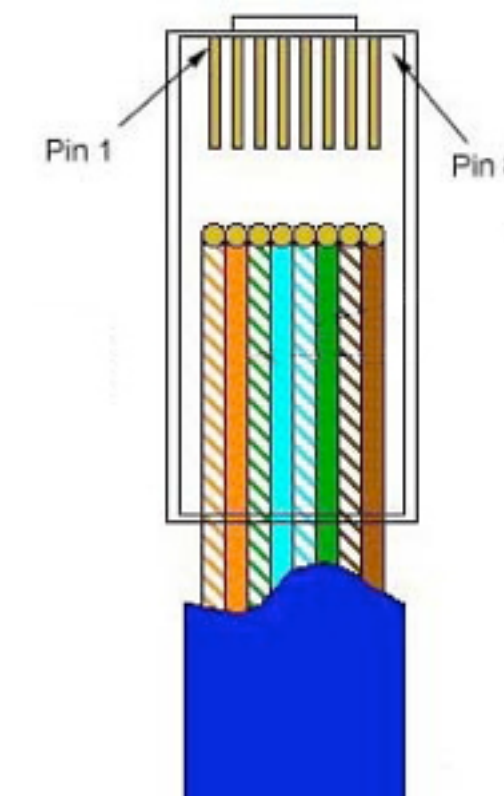
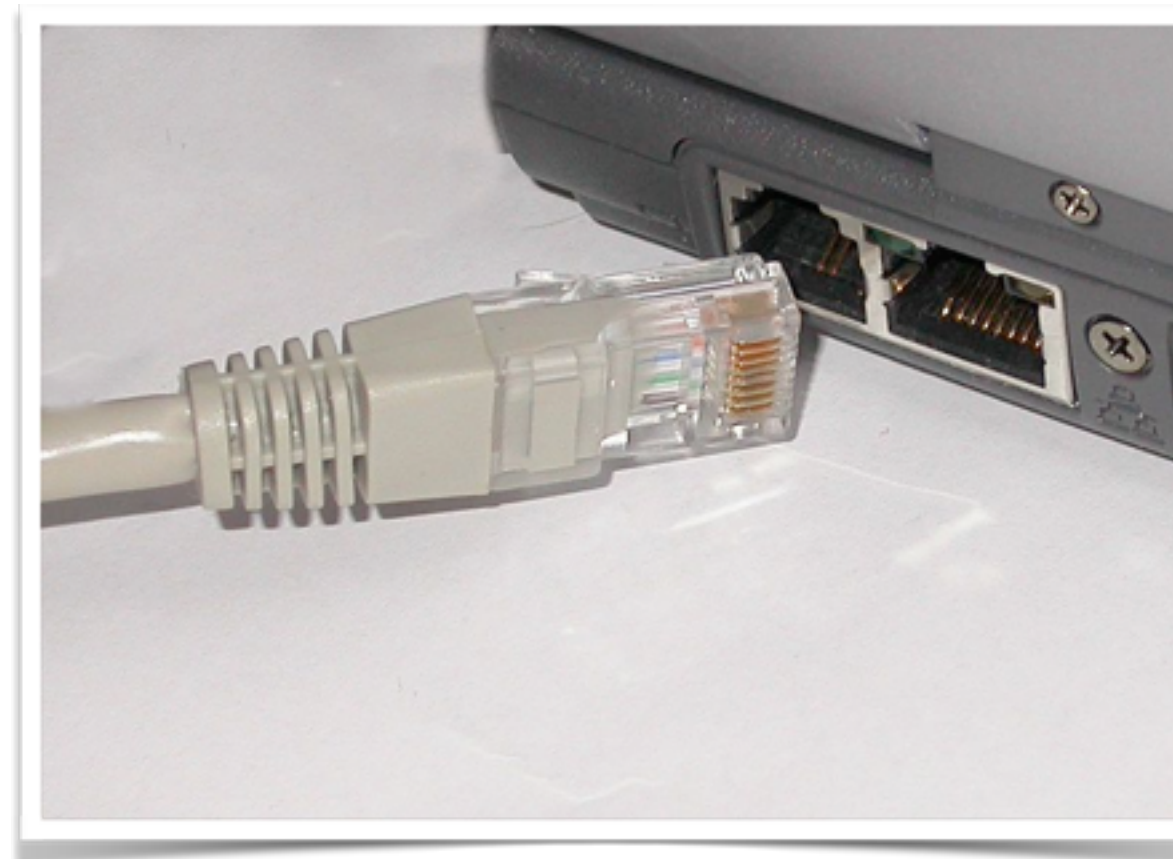
Fiber-optic



Unshielded Twisted Pair



Various types of network media.



RJ45 Belegung

Pin	Name	Beschreibung
1	TX+	Transceive Data+ (Weiß-Orange)
2	TX-	Transceive Data- (Orange)
3	RX+	Receive Data+ (Weiß-Grün)
4	n/c	Nicht verwendet (Blau)
5	n/c	Nicht verwendet (Weiß-Blau)
6	RX-	Receive Data- (Grün)
7	n/c	Nicht verwendet (Weiß-Braun)
8	n/c	Nicht verwendet (Braun)

Netzzugang: WLAN



Protokolle

IEEE 802.11 a-n

Institute of Electrical and Electronics Engineers
(IEEE)

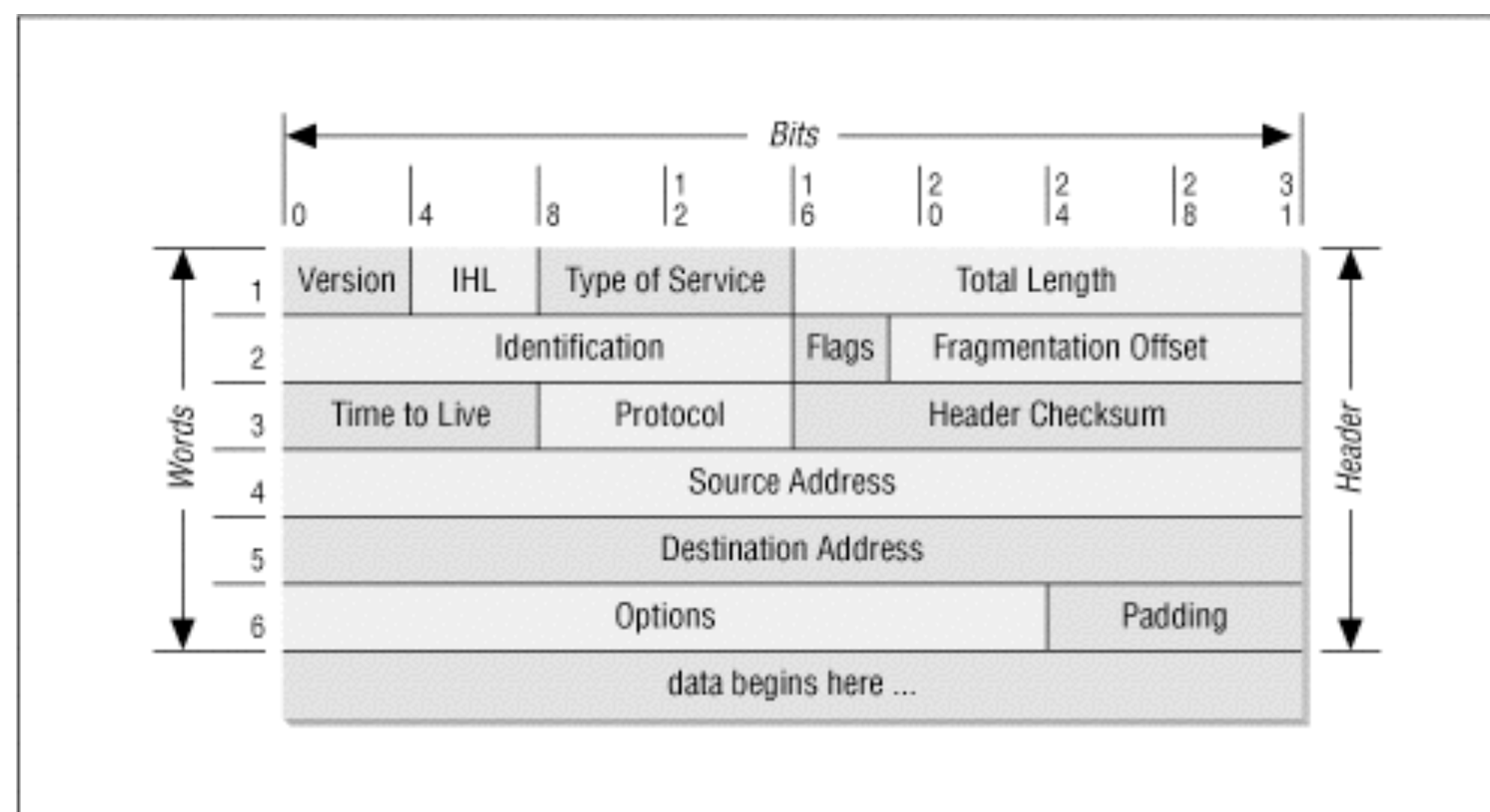
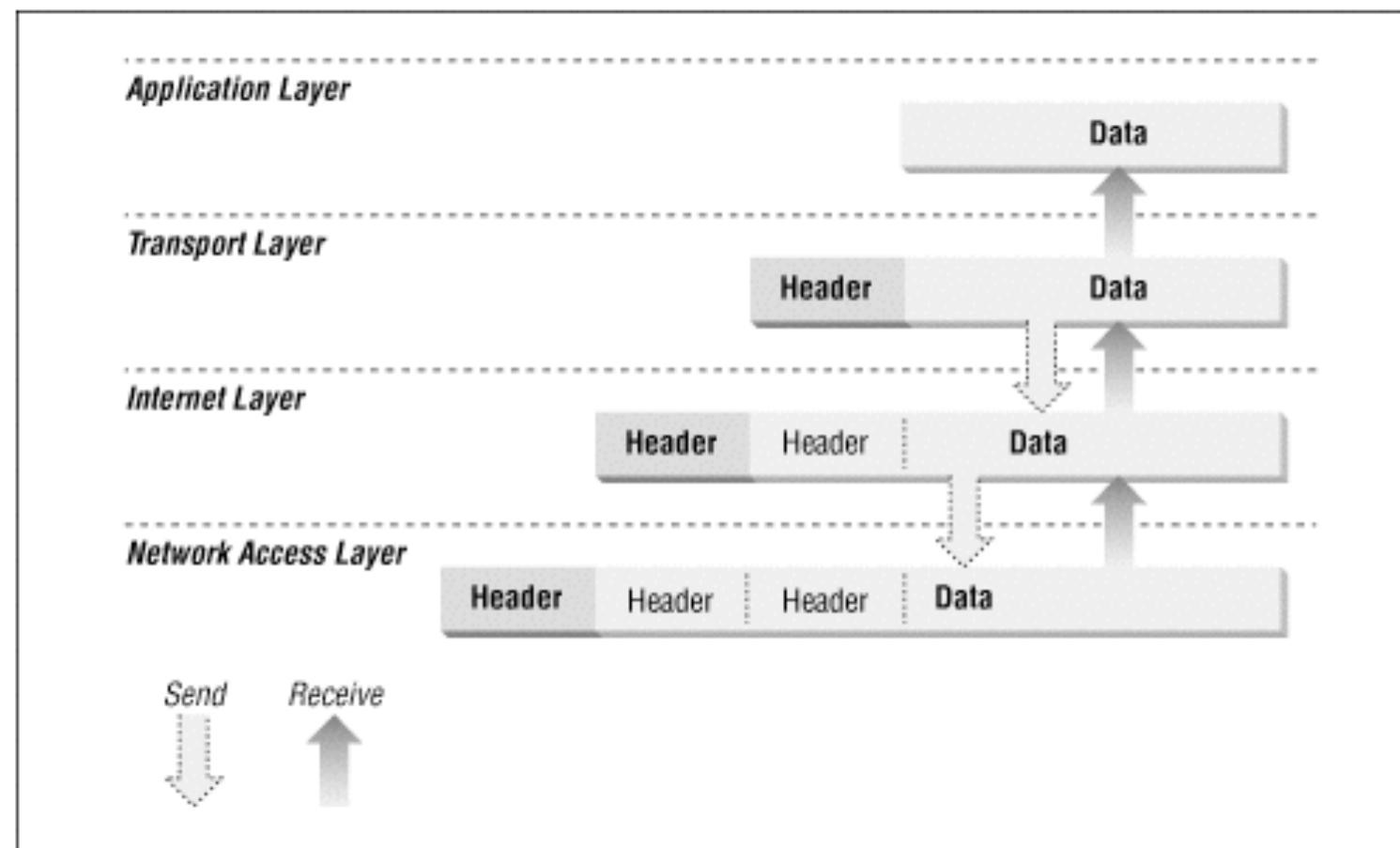
20-300 Mbit/s



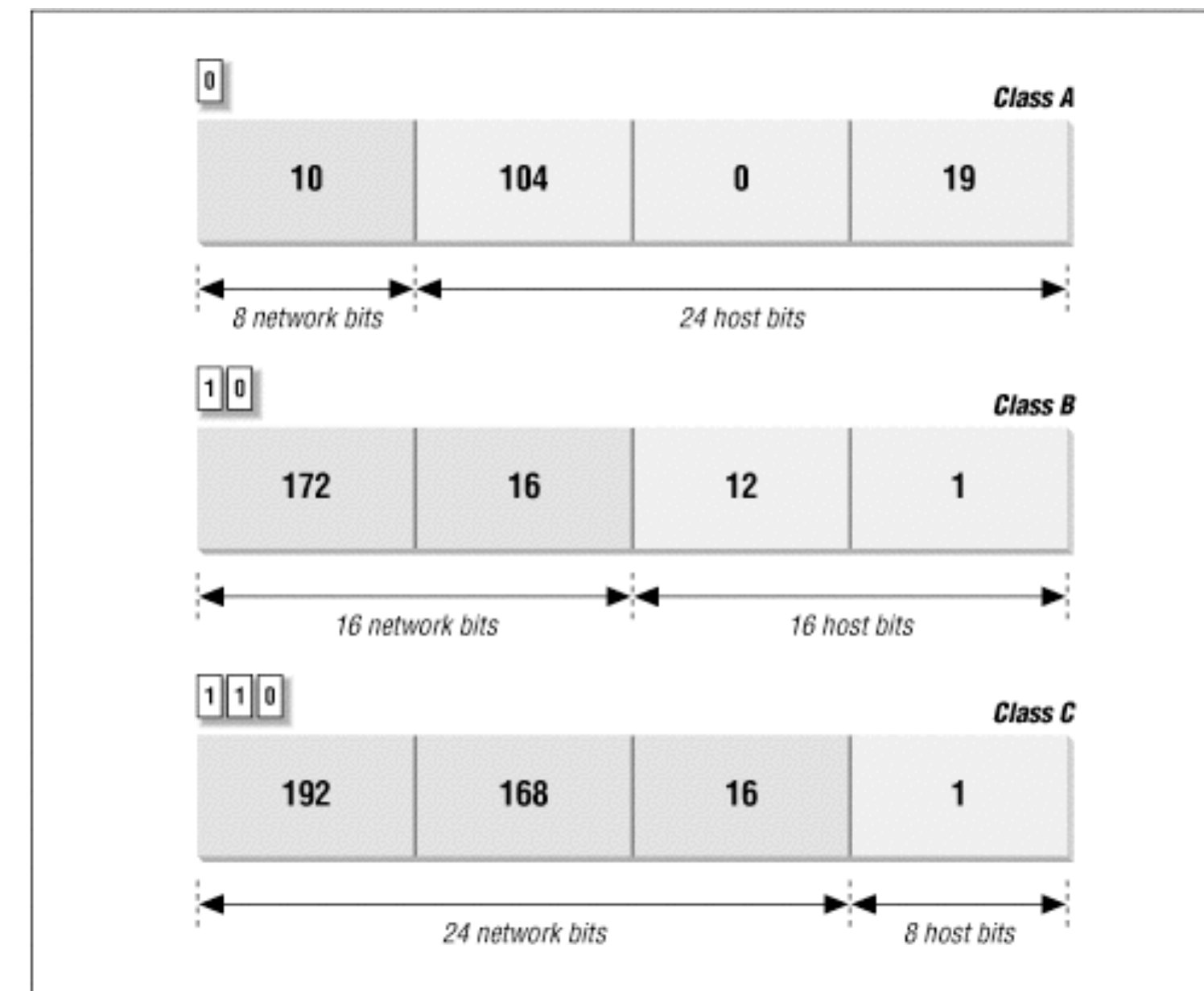
Netzzugang: Mobilfunk

3G, 4G, UMTS, LTE

Internet Protocol (IP)

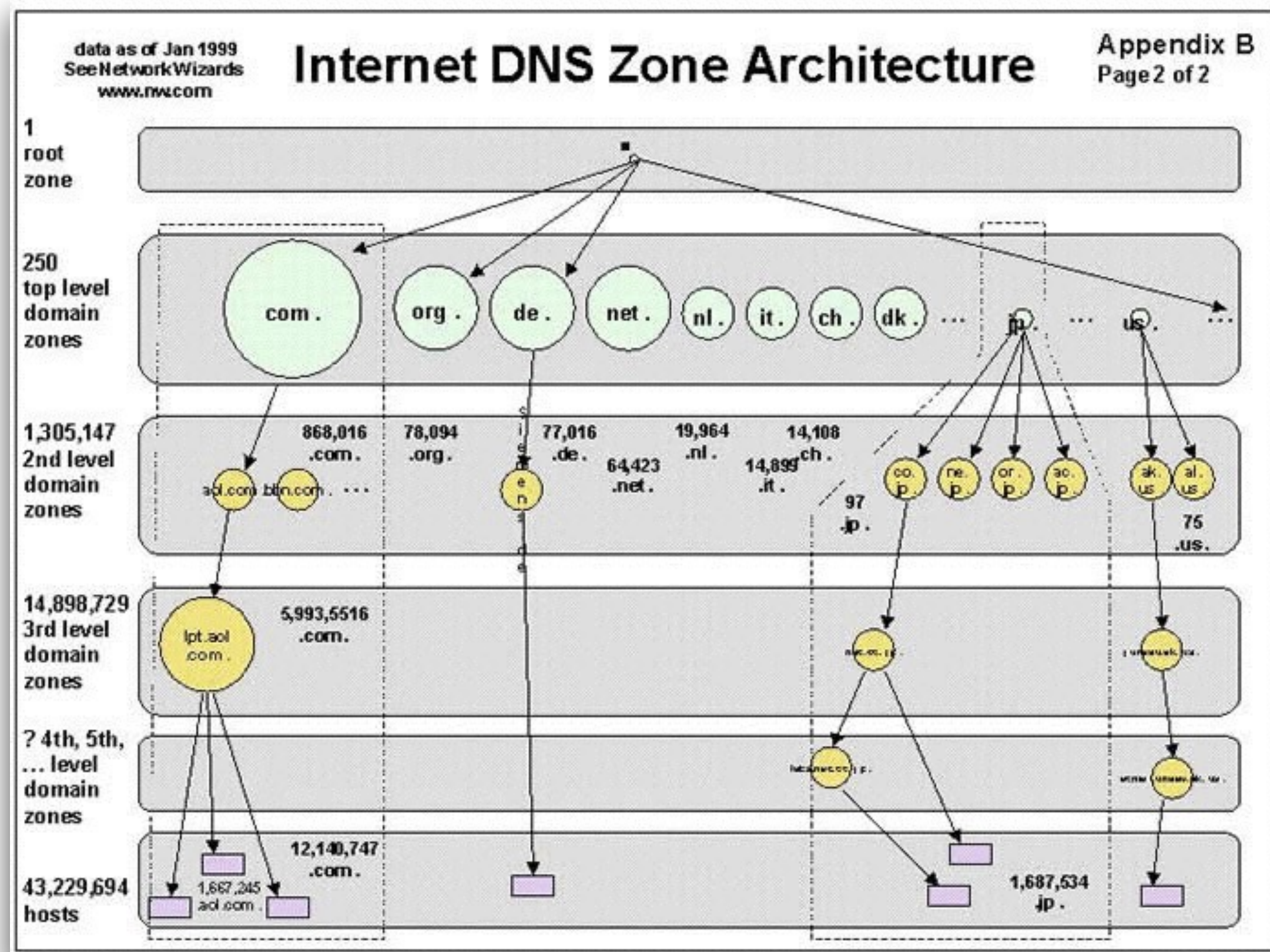


IP-Header



IP-Adresse, z.B. 132.180.108.67

IP: Domain Name System (DNS)



Es gibt 13 Root-Nameserver, die nach dem Schema x.root-servers.net benannt sind. Jeder Root-Nameserver ist unter einer IPv4-Adresse erreichbar, die meisten zusätzlich unter einer IPv6-Adresse. Die meisten Root-Nameserver setzen Anycast zur Lastverteilung ein, sodass die 13 Adressen von tatsächlich mehreren hundert Servern an verschiedenen Orten der Welt bedient werden.

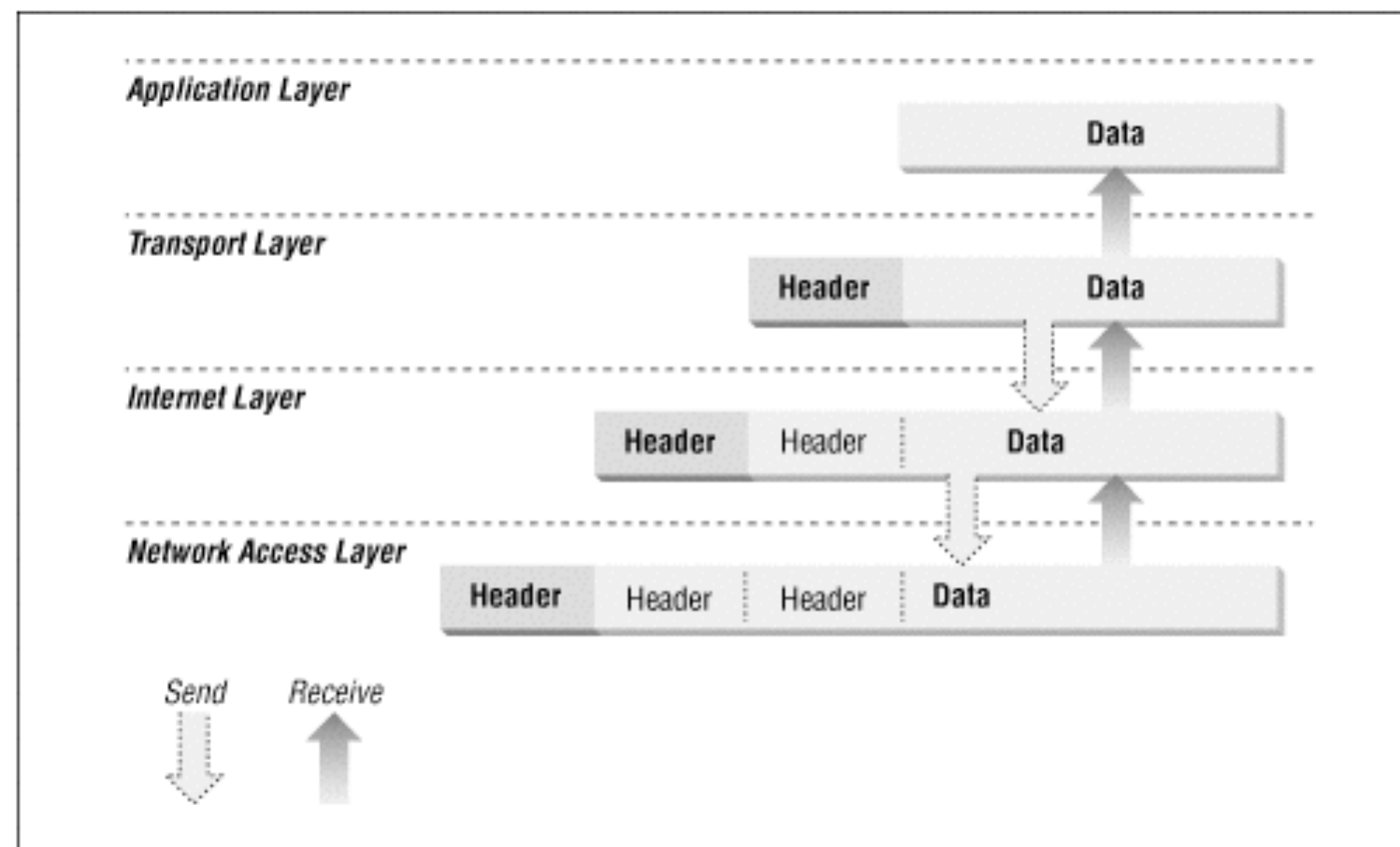
Private Netze

The Internet Assigned Numbers Authority (IANA) has reserved the following three blocks of the IP address space for private internets:

10.0.0.0	-	10.255.255.255 (10/8 prefix)
172.16.0.0	-	172.31.255.255 (172.16/12 prefix)
192.168.0.0	-	192.168.255.255 (192.168/16 prefix)

Transmission Control Protocol (TCP)

User Datagram Protocol (UDP)



Transportschicht

TCP Segment Header Format

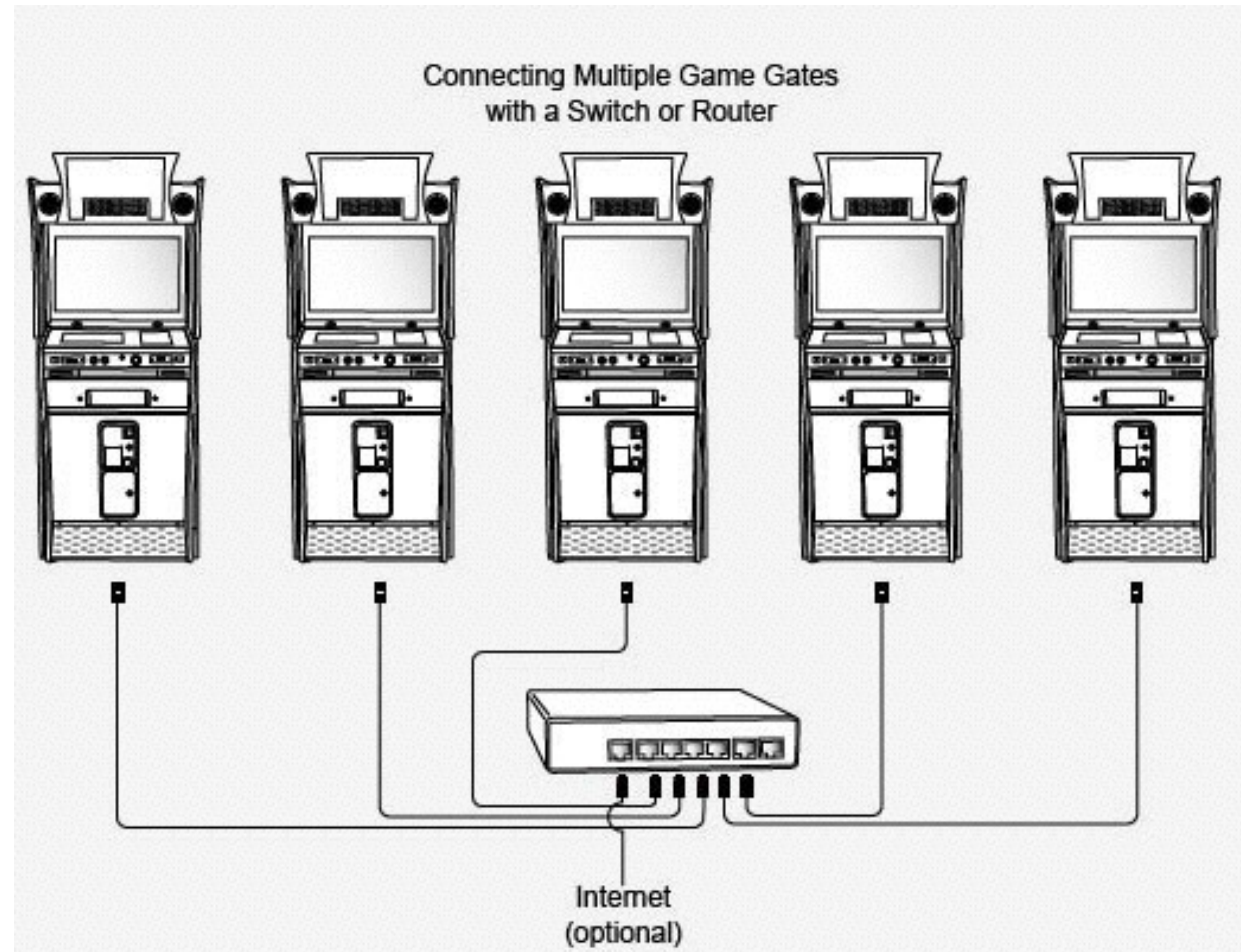
Bit #	0	7	8	15	16	23	24	31
0	Source Port				Destination Port			
32	Sequence Number							
64	Acknowledgment Number							
96	Data Offset	Res	Flags		Window Size			
128	Header and Data Checksum				Urgent Pointer			
160...	Options							

UDP Datagram Header Format

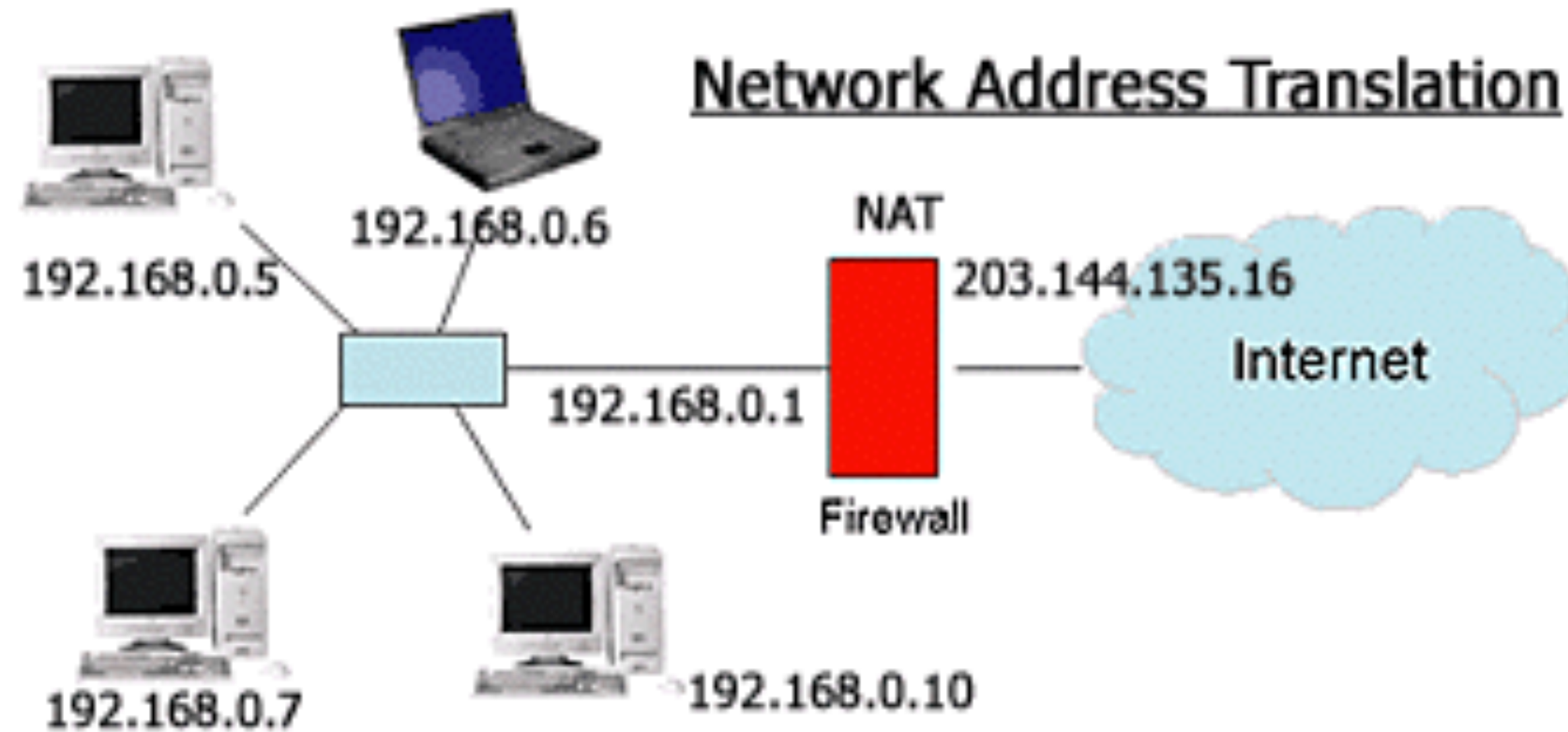
Bit #	0	7	8	15	16	23	24	31
0	Source Port				Destination Port			
32	Length				Header and Data Checksum			

TCP- und UDP-Header

LAN – Local Area Network



NAT – Network Address Translation

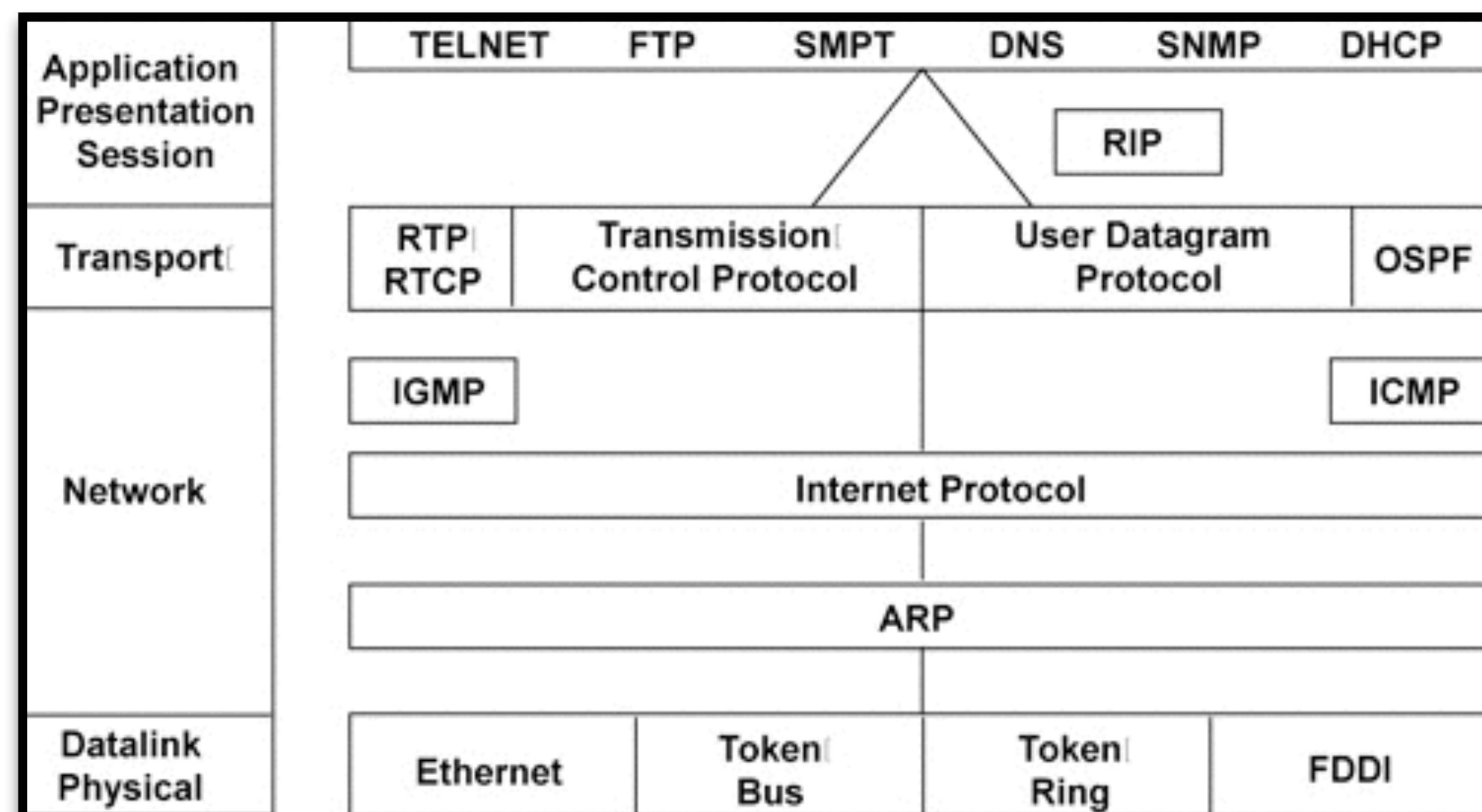
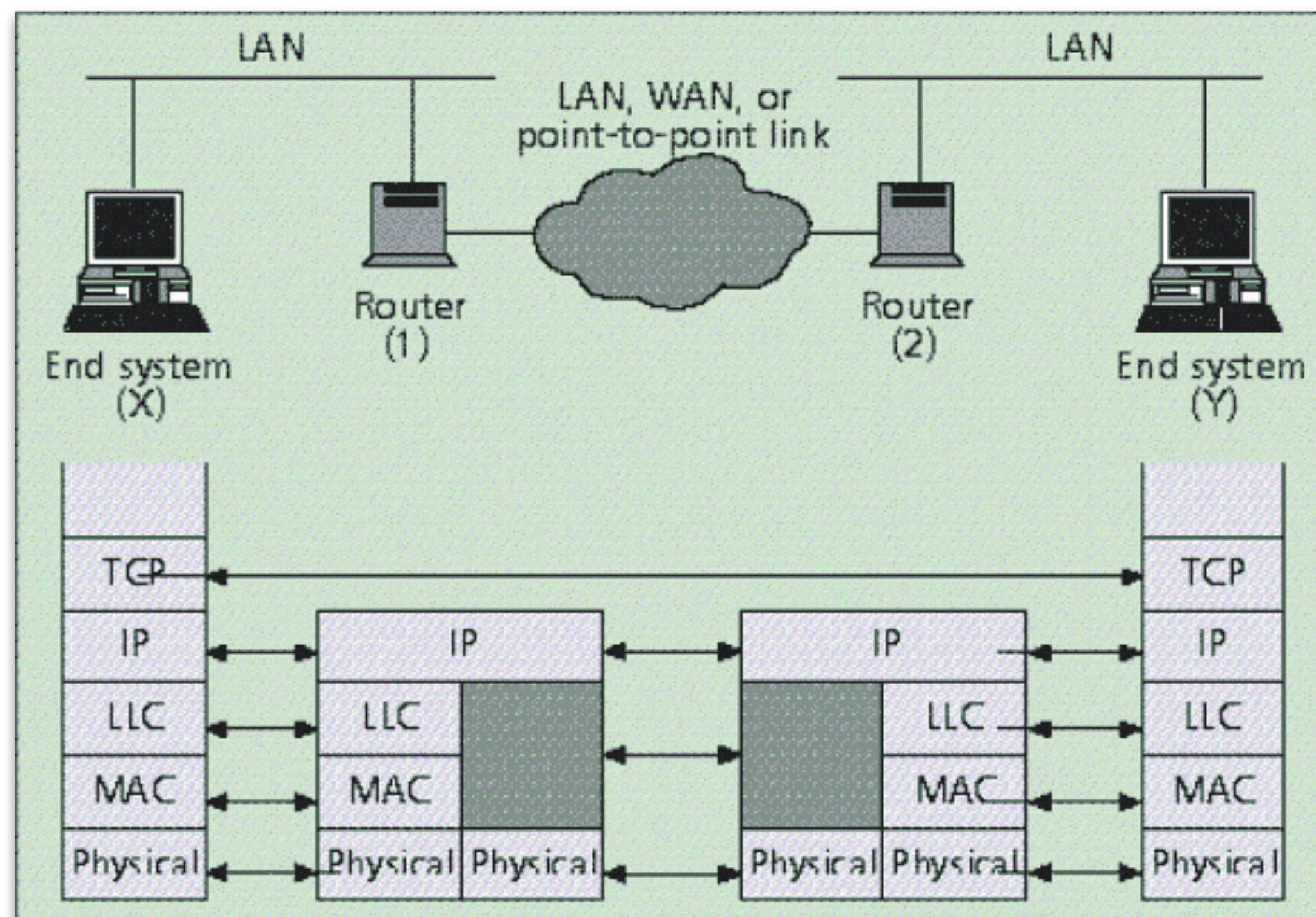


Netzwerk-Konfiguration

Netzwerk konfigurieren

Allgemeine Einstellungen	Zusätzliche Einstellungen
Drahtloser Modus	Aus (Ethernet)
Netzwerkname (SSID)	
Netzwerktyp	
Drahtlose Sicherheit	
IP-Einstellungen	Manuell
IP-Adresse	192.168.178.23
Subnetz-Maske	255.255.255.0
Gateway	192.168.178.1
DNS-Einstellungen	Manuell
Primärer DNS-Server	192.168.178.1
Sekundärer DNS-Server	0.0.0.0

A Auswählen **B** Zurück



The five-layer TCP/IP model

5. Application layer

DHCP · DNS · FTP · Gopher · HTTP · IMAP4 · IRC · NNTP · XMPP · POP3 · SIP · SMTP · SNMP · SSH · TELNET · RPC · RTCP · RTSP · TLS · SDP · SOAP · GTP · STUN · NTP · (more)

4. Transport layer

TCP · UDP · DCCP · SCTP · RTP · RSVP · (more)

3. Network/Internet layer

IP (IPv4 · IPv6) · OSPF · IS-IS · BGP · IPsec · ARP · RARP · RIP · ICMP · ICMPv6 · IGMP · (more)

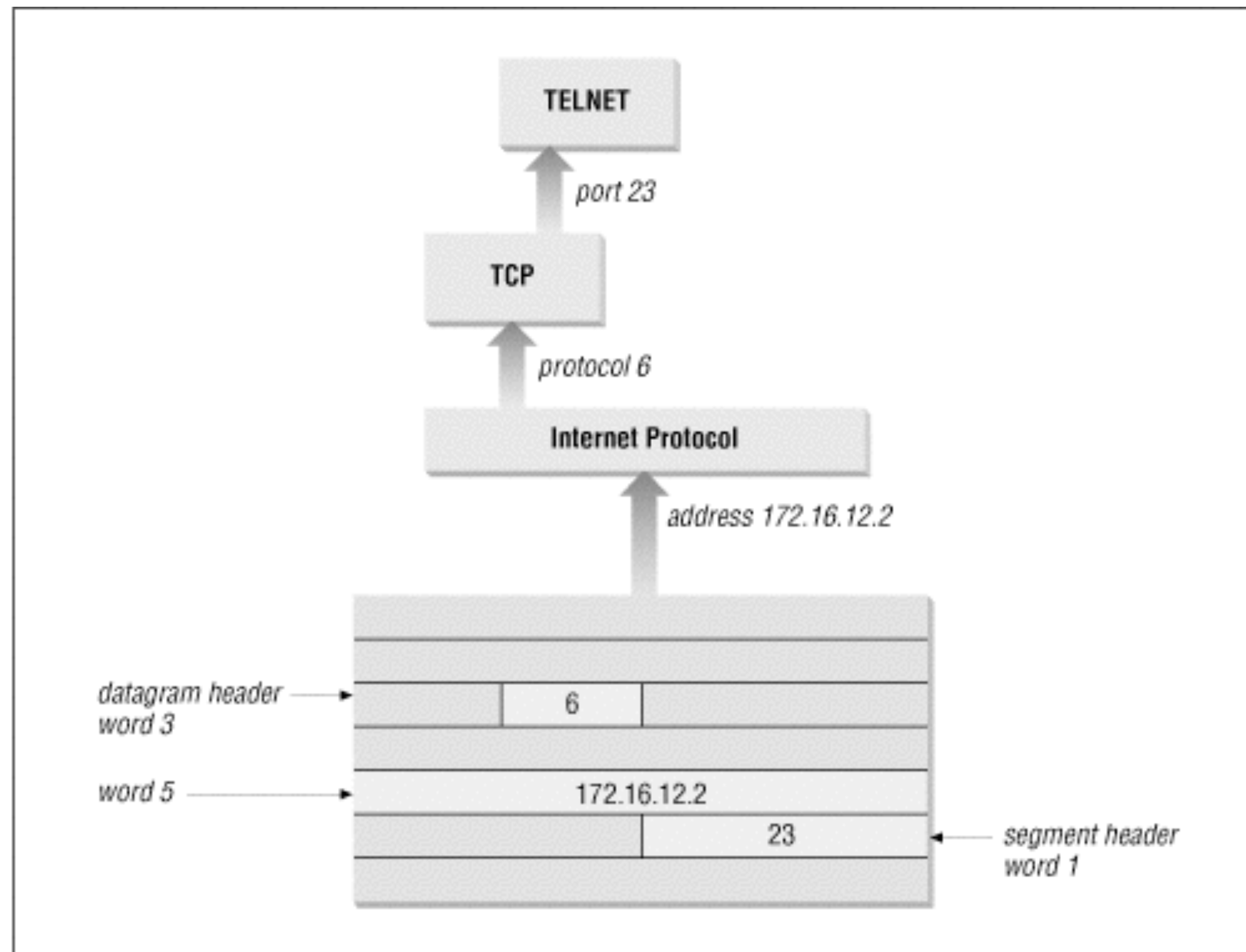
2. Data link layer

802.11 (WLAN) · 802.16 · Wi-Fi · WiMAX · ATM · DTM · Token ring · Ethernet · FDDI · Frame Relay · GPRS · EVDO · HSPA · HDLC · PPP · PPTP · L2TP · ISDN · ARCnet · (more)

1. Physical layer

Ethernet physical layer · Modems · PLC · SONET/SDH · G.709 · Optical fiber · Coaxial cable · Twisted pair · (more)

Socket



Eine erfolgreiche Verbindung benötigt zumindest eine Zieladresse, ein Protokoll und eine Portnummer.

Diese Kombination wird auch als **Socket** bezeichnet.

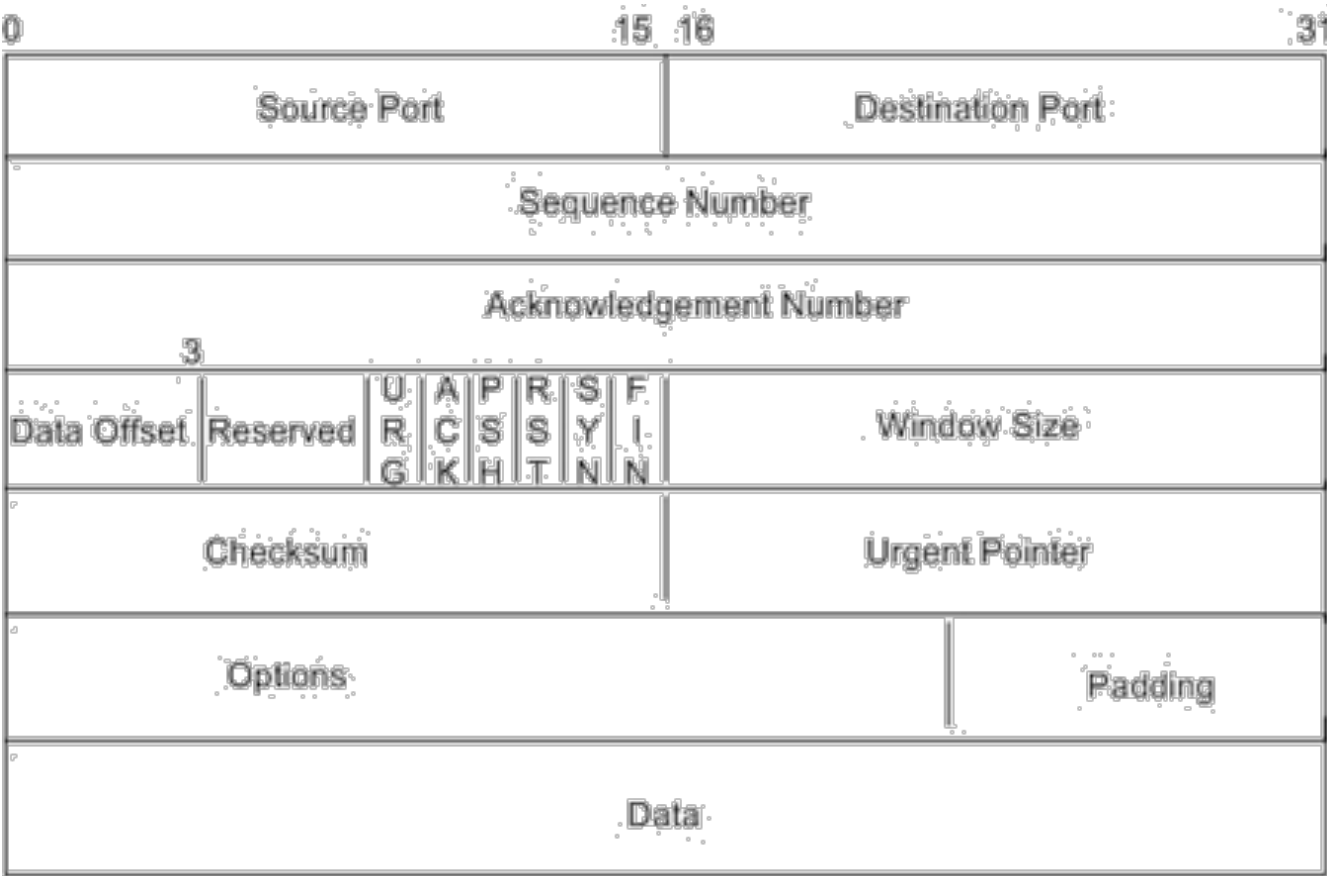
Port or Socket Numbers

Specific Assignments:

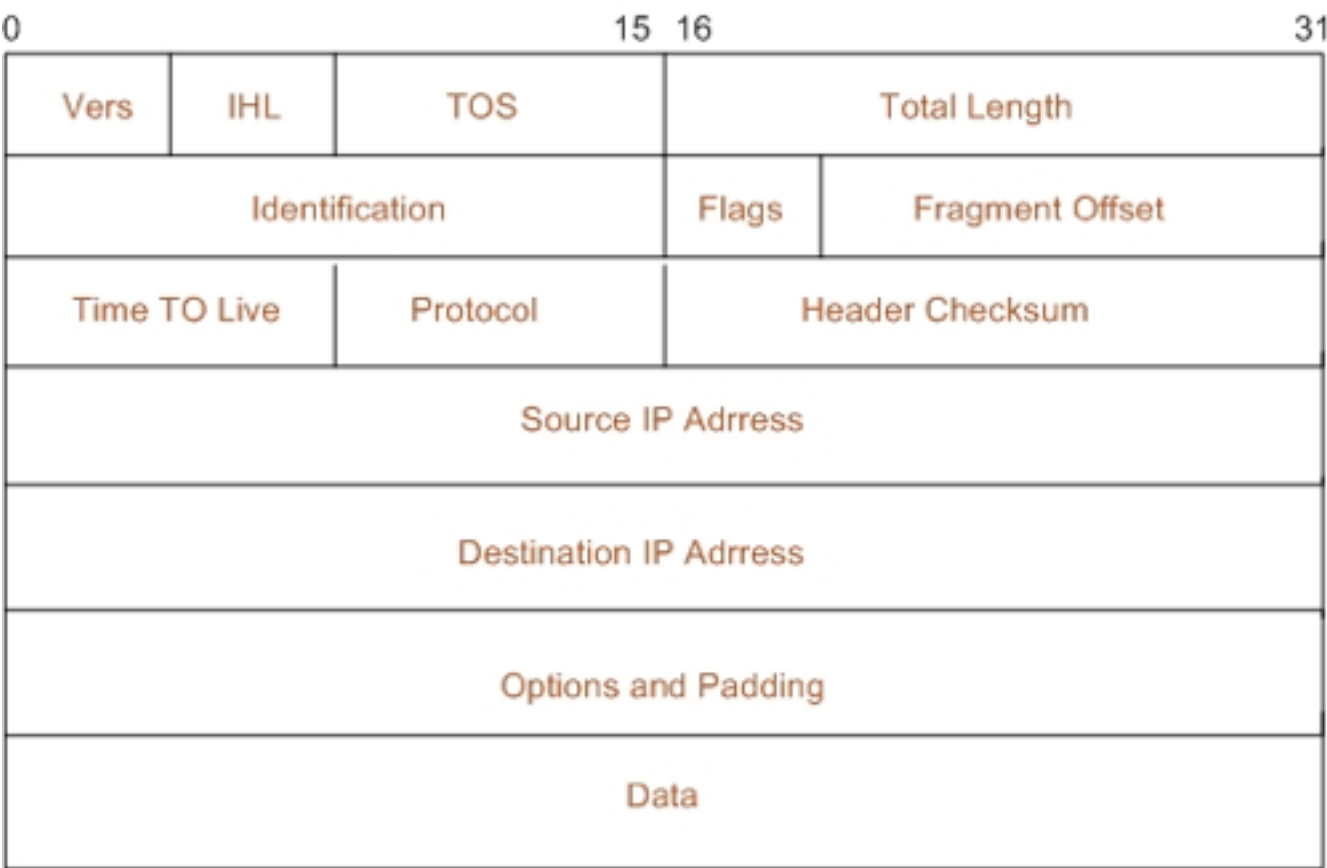
Network Standard Functions

Decimal	Octal	Description	References
-----	-----	-----	-----
1	1	Old Telnet	[40,JBP]
3	3	Old File Transfer	[27,11,24,JBP]
5	5	Remote Job Entry	[6,17,JBP]
7	7	Echo	[35,JBP]
9	11	Discard	[32,JBP]
11	13	Who is on or SYSTAT	[JBP]
13	15	Date and Time	[JBP]
15	17	Who is up or NETSTAT	[JBP]
17	21	Short Text Message	[JBP]
19	23	Character generator or TTYTST	[31,JBP]
21	25	New File Transfer	[36,JBP]
23	27	New Telnet	[41,JBP]
25	31	SMTP	[54,JBP]
27	33	NSW User System w/COMPASS FE	[14,RHT]
29	35	MSG-3 ICP	[29,RHT]
31	37	MSG-3 Authentication	[29,RHT]
33	41	Unassigned	[JBP]
35	43	IO Station Spooler	[JBP]
37	45	Time Server	[22,JBP]
39	47	Unassigned	[JBP]
41	51	Graphics	[46,17,JBP]
42	52	Name Server	[38,JBP]
43	53	WhoIs	[JAKE]
45	55	Message Processing Module	[37,JBP]
47	57	NI FTP	[50,CJB]
49	61	RAND Network Graphics Conference	[30,MO2]
51	63	Message Generator Control	[52,DFP]
53	65	AUTODIN II FTP	[21,EC5]
55	67	ISI Graphics Language	[3,RB6]
57	71	MTP	[45,JBP]
59	73	New MIT Host Status	[SWG]
61-63	75-77	Unassigned	[JBP]

TCP-Ports



TCP-Header



IP-Header

Application Layer

MUD

```
Telnet - waterdeep.mudsrus.com
Connect Edit Terminal Help
sell      sit      skills  sleep    slots    sneak
socials   spells  split   stand    steal    story
strike    take    target  tell     time     title
toggle    track   train   trip     typo     unalias
unlist     unlock  unread  value    version  visible
wake       wba     wear    weather  weddings where
who        whois   wield    wimpy    withdraw wizlist
worth     yell    yell    zap

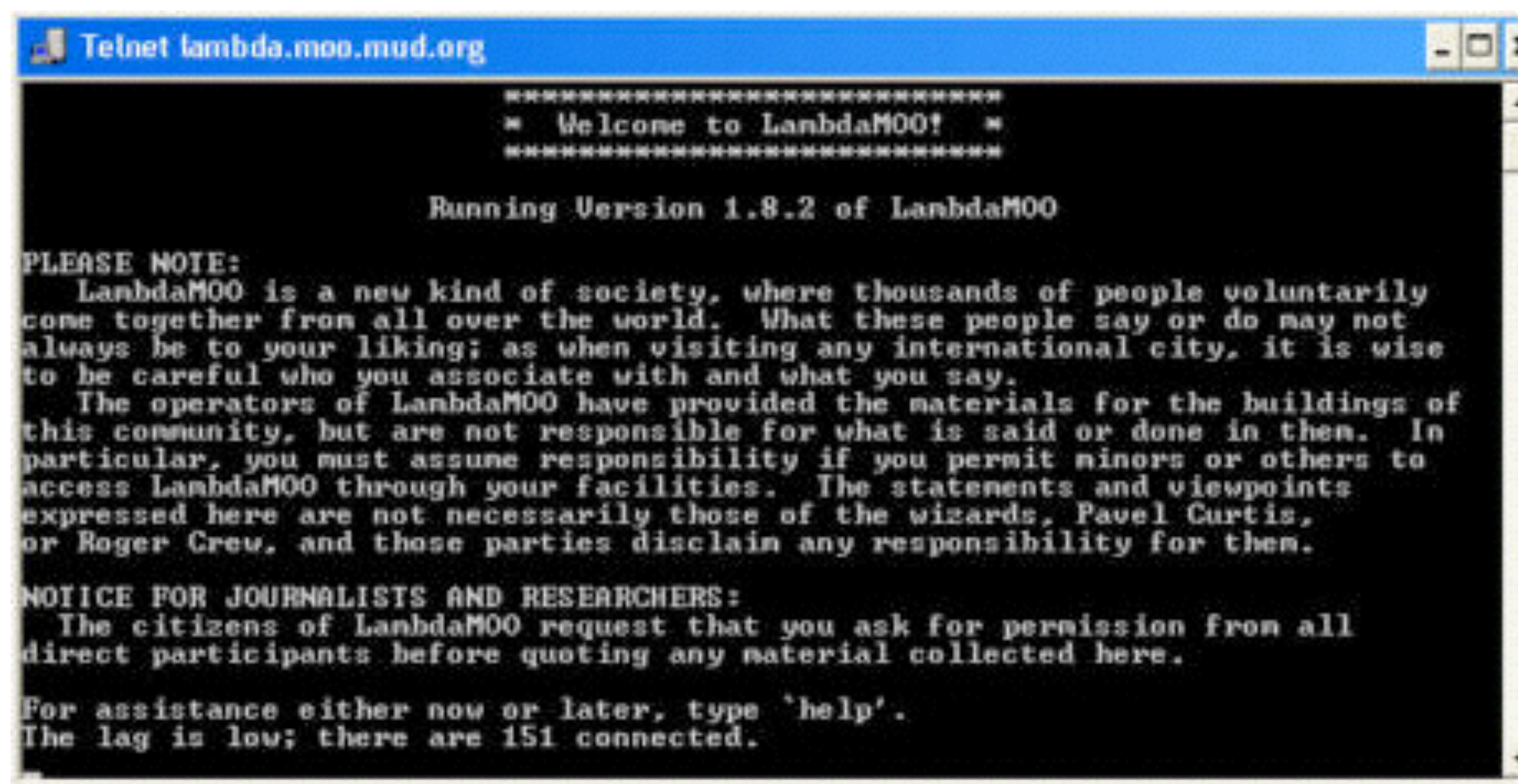
100/100hp 100/100mana 1500xp Felonius> n
The School Entrance
  You are walking down a brick path bordered on each side by yellow
and red flowers that look much like tulips. The platinum gates stand
just behind you, and a few people nod in greeting to you, for they
know you are new to the school. You can hear nervous chatter and the
sounds of water lapping against stone up ahead to your north, and the
gates are back to your south.

[Exits: north south] [Doors: none]
  You see a pair of standard issue leggings here.
  Some soft boots are on the floor.
  A scale mail jerkin is lying on the ground.
( 2) A bloody cloak lies in a corner.

100/100hp 100/100mana 1500xp Felonius> █
```

Telnet, Port 23

MUCK, MUSH, MUSE, MOO



Neverwinter Nights (1991)



AOL



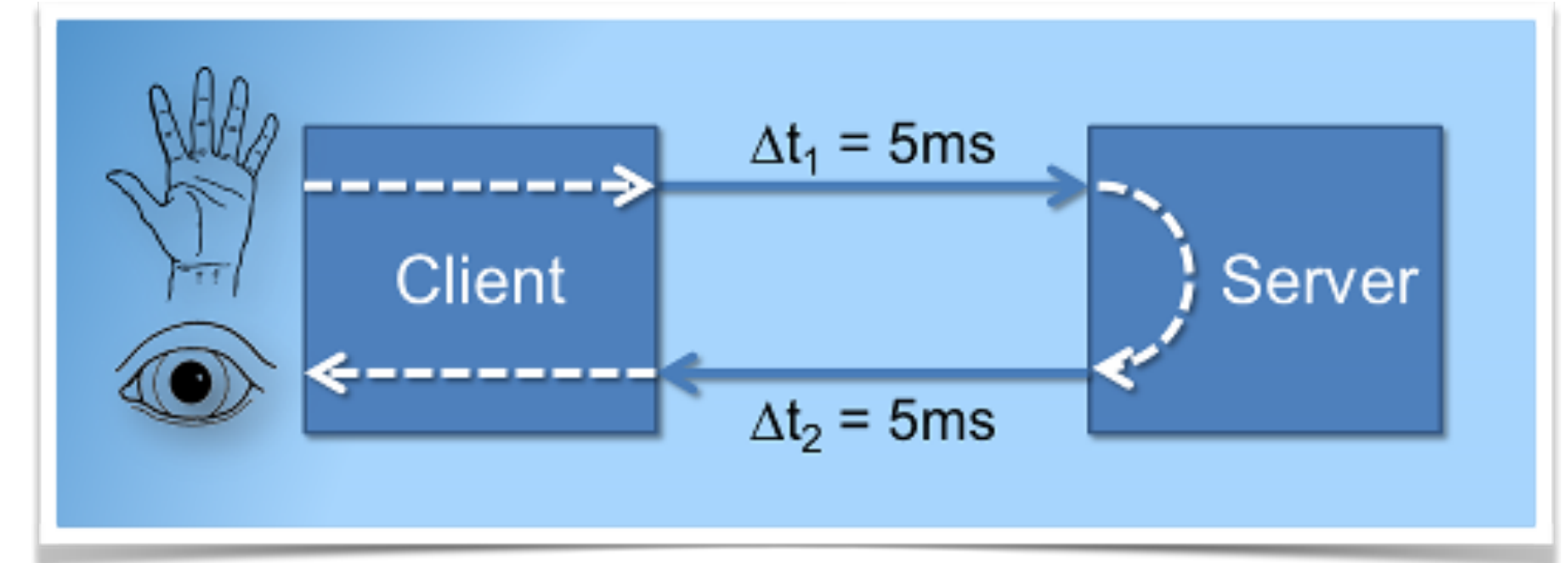
MMORPGs

Netzqualität

- Datenübertragungsrate
- Verluste (Drop)
- Latenz
- Jitter

Latenz / Ping

Round Trip Time (RTT) $\approx$ 2 x Latenz



Servers

History

Favorites

Friends

Refresh

Server name	Players	Map	Game mode	Ping	Min	Max
[CoCoA] 24/7 Asia (Test)	0/24	moor	Free-For-All	58	N/A	N/A
Official Classic Server #19 [24p] - SING (Mu	0/24	argonswall	Last Team Standing	62	N/A	N/A
Official Classic Server #17 [32p] - SING (Mu	0/32	stoneshillvillage	Last Team Standing	71	N/A	N/A
Official Classic Server #18 [32p] - SING (Mu	0/32	stoneshillvillage	Last Team Standing	84	N/A	N/A
Barbarian Battleground	14/32	stoneshill	Team Objective	95	N/A	N/A
games.on.net #08 NSW Team Objective	0/32	citadel	Team Objective	200	N/A	N/A
games.on.net #09 NSW FFA	0/32	arena3	Free-For-All	189	N/A	N/A
games.on.net #06 NSW Full Rotation	0/32	citadel	Team Objective	166	N/A	N/A
games.on.net #10 NSW Team DM	0/32	frigid	Team Deathmatch	166	N/A	N/A
-[FTGG]- Private Server	0/32	stoneshill	Team Objective	110	N/A	N/A
games.on.net #07 NSW Team Objective + fist	10/32	battlegrounds	Team Objective	174	N/A	N/A
games.on.net #17 VIC FFA	0/32	arena3	Free-For-All	189	N/A	N/A
eXemplar TO 24/7 Q MASTERS WELCOME	0/32	battlegrounds	Team Objective	211	N/A	N/A
games.on.net #11 CTF	0/32	moor	Capture The Flag	167	N/A	N/A
games.on.net #25 NSW Team Objective 3rd	0/32	stoneshill	Team Objective	172	N/A	N/A
games.on.net #12 NSW LTS	0/32	frigid	Last Team Standing	187	N/A	N/A
games.on.net #13 NSW Duel	2/32	arena	Duel	176	N/A	N/A
games.on.net #03 SA FFA	0/32	arena3	Free-For-All	161	N/A	N/A
games.on.net #15 VIC Team Objective	0/32	darkforest	Team Objective	155	N/A	N/A
games.on.net #22 SA Team DM	0/32	darkforest	Team Deathmatch	197	N/A	N/A
games.on.net #05 SA CTF	0/32	moor	Capture The Flag	197	N/A	N/A
games.on.net #04 SA Team Objective	0/32	stoneshill	Team Objective	197	N/A	N/A
games.on.net #23 SA LTS	0/32	arena3	Last Team Standing	204	N/A	N/A
games.on.net #16 VIC Team Objective + fists	0/32	stoneshill	Team Objective	250	N/A	N/A
games.on.net #18 VIC Team DM	0/32	frigid	Team Deathmatch	218	N/A	N/A
games.on.net #19 VIC Duel	0/32	arena	Duel	234	N/A	N/A
games.on.net #20 VIC LTS	0/32	frigid	Last Team Standing	269	N/A	N/A
Varghalla [Full Map Rotation] [Team Bacon]	0/32	battlegrounds	Team Objective	235	N/A	N/A

Open server filter

Return

Connect

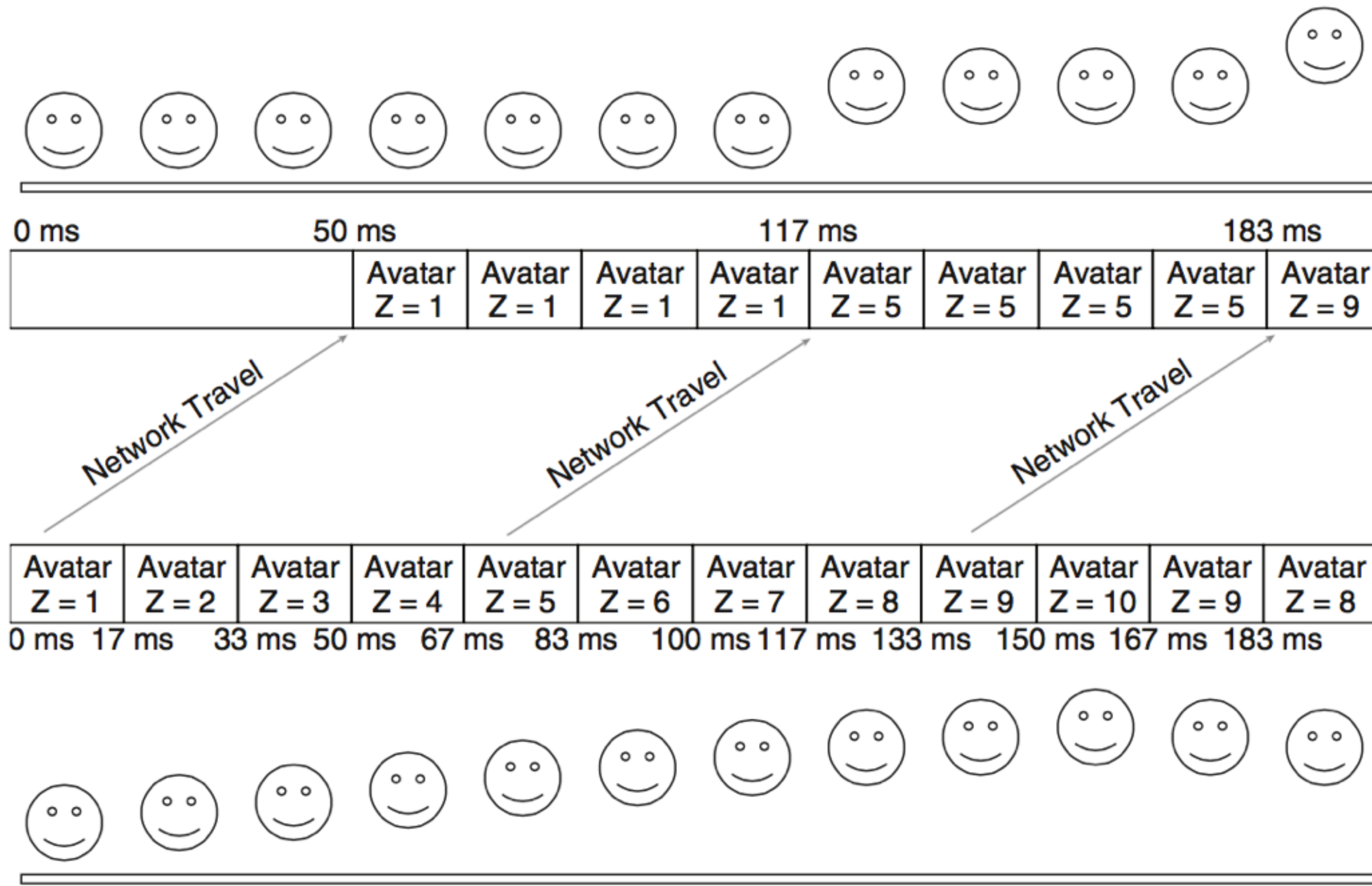
- Prozessorzeit
- Übertragungszeit
- Warteschlange

- Laufzeit:

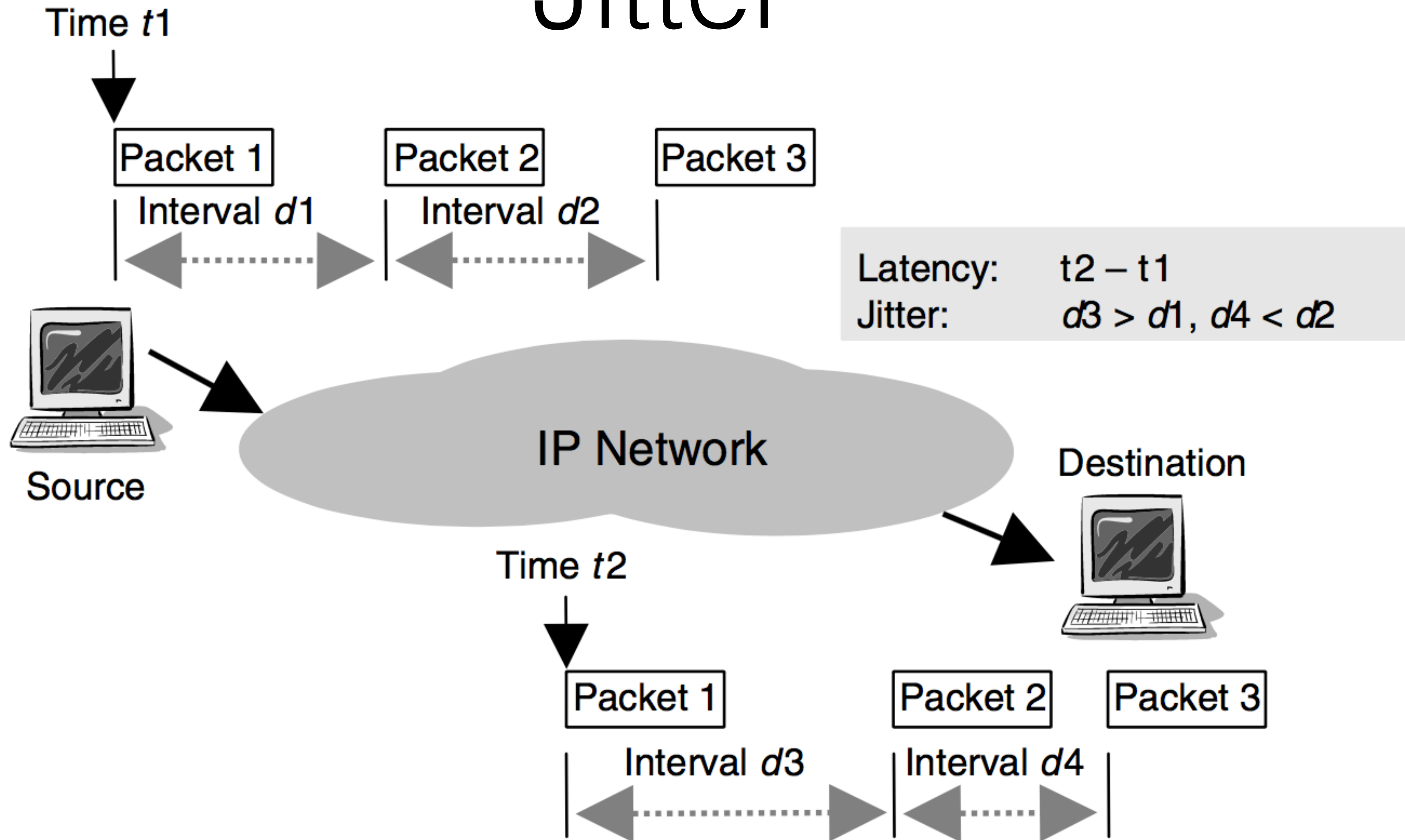
$$0.3 \text{ m/ns} = 300 \text{ m} / \mu\text{s} = 300 \text{ km} / \text{ms}$$

$$12.000 \text{ km} \text{ benötigen } 40 \text{ ms} = 80 \text{ ms RTT}$$

Lag



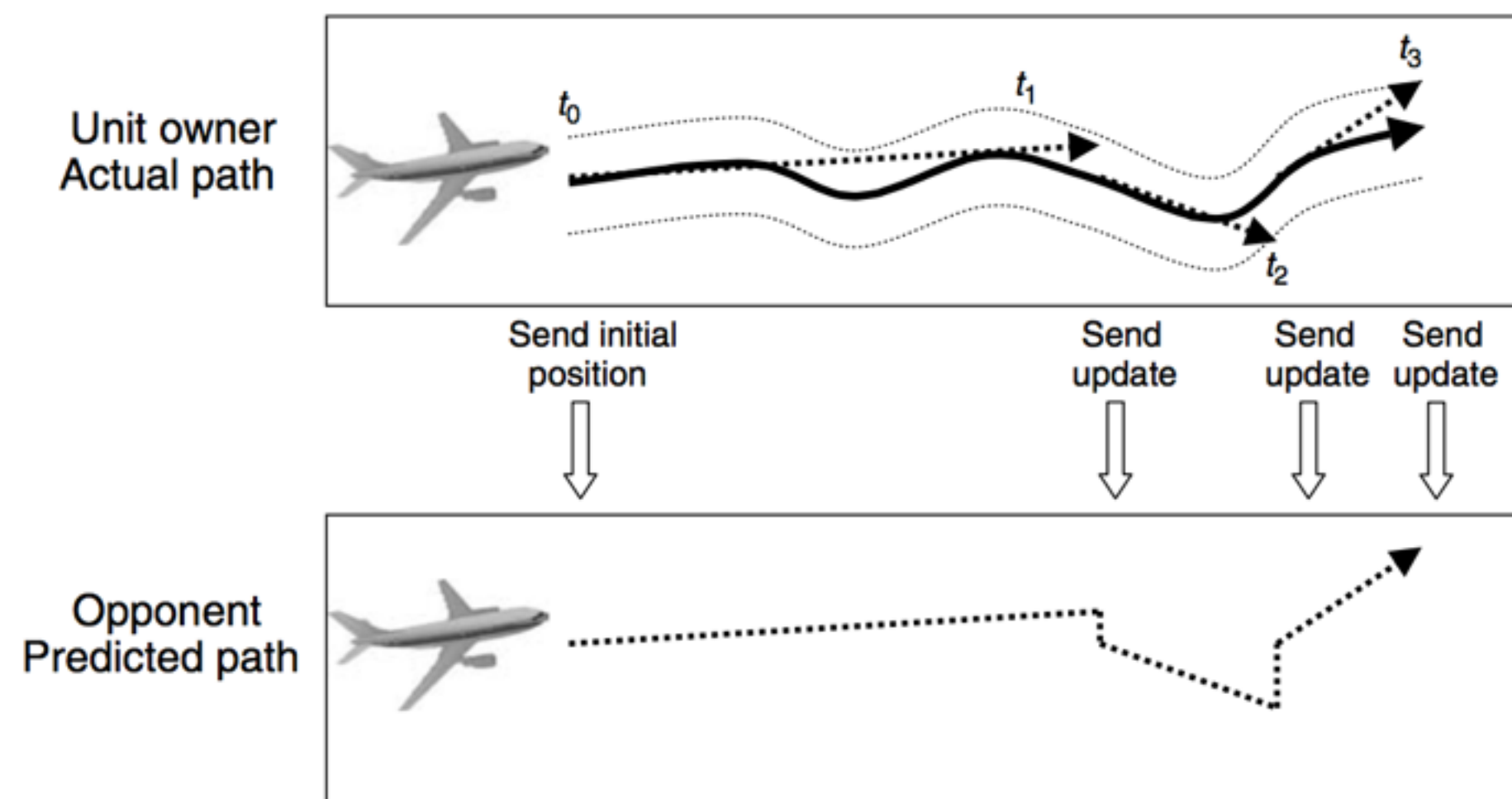
Jitter



Client-Side Prediction

This problem was historically solved in two parts. The first part was client-side prediction of movement developed by John Carmack for QuakeWorld, and later incorporated as part of Unreal's networking model by Tim Sweeney. The second part was latency compensation developed by Yahn Bernier at Valve for Counterstrike.

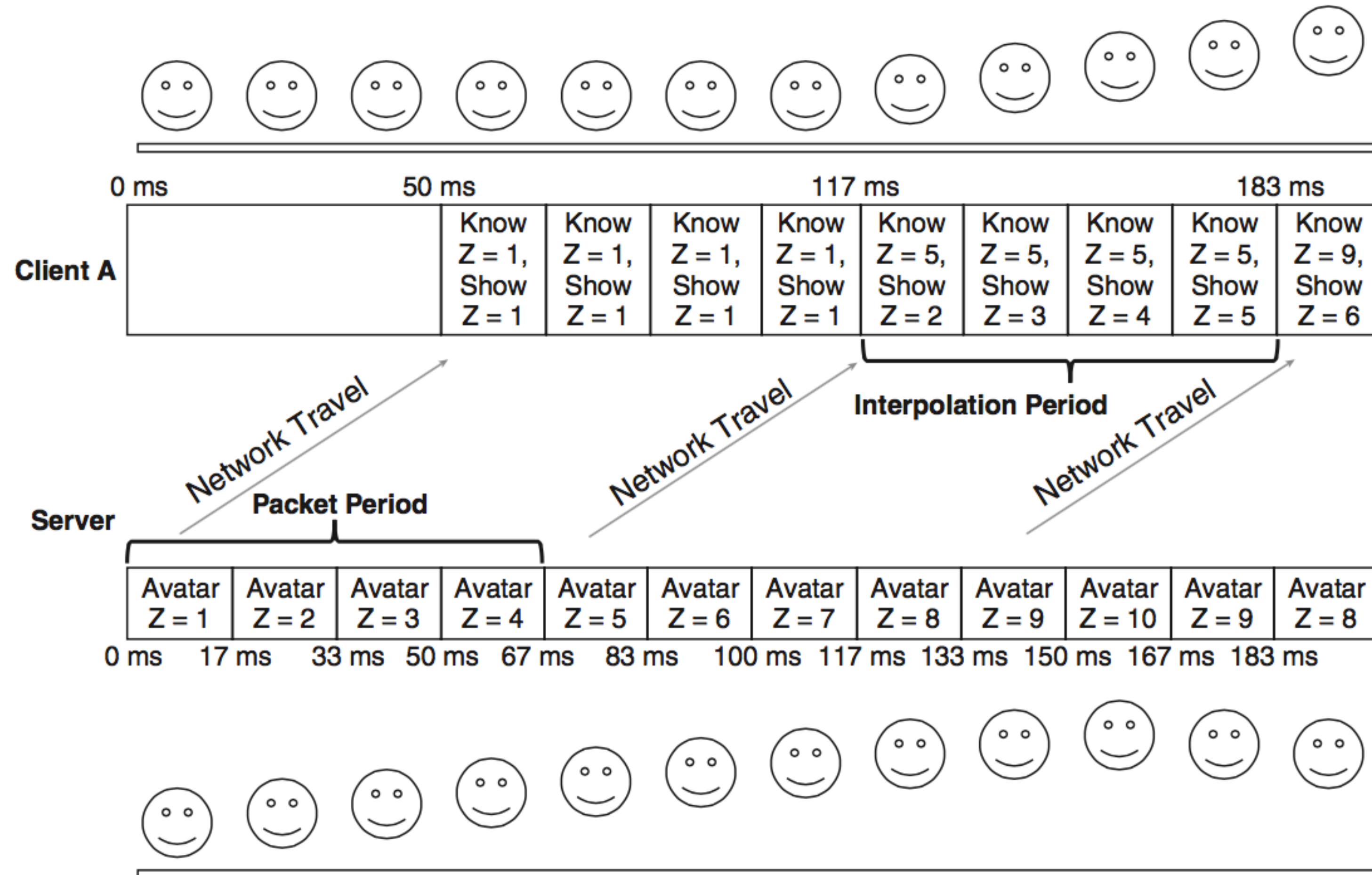
<http://gafferongames.com/networking-for-game-programmers/what-every-programmer-needs-to-know-about-game-networking/>



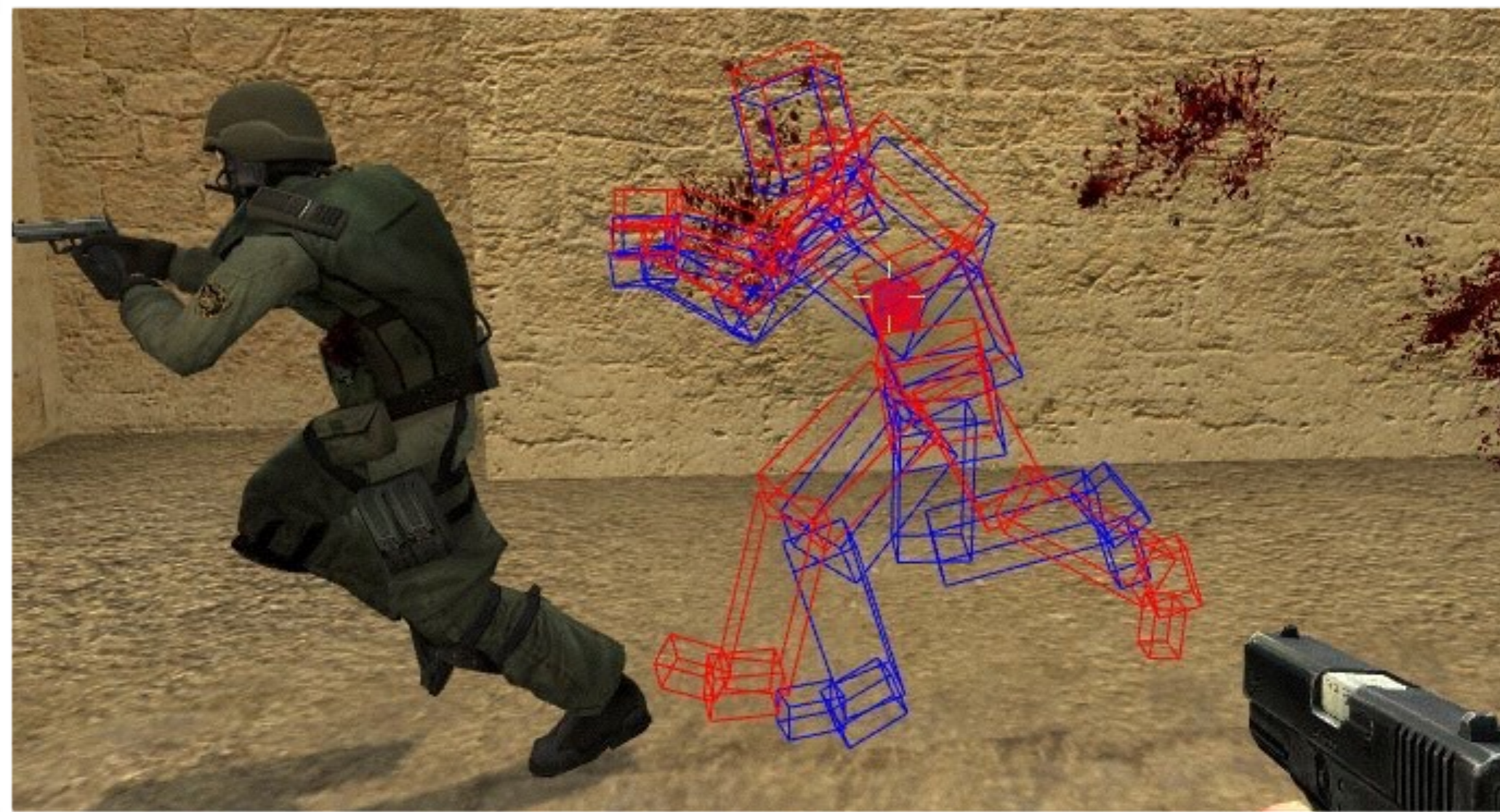
Player Movement
Opponent Prediction Path

Figure 6.7 Opponent Prediction, showing actual path versus predicted path. The opponent uses the last known unit information in computing its path. The unit owner sends updates when the predicted location differs from the actual location by more than a given threshold

Latenz-Kompensation



Lag Compensation



Let's say a player shoots at a target at client time 10.5. The firing information is packed into a user command and sent to the server. While the packet is on its way through the network, the server continues to simulate the world, and the target might have moved to a different position. The user command arrives at server time 10.6 and the server wouldn't detect the hit, even though the player has aimed exactly at the target. This error is corrected by the server-side lag compensation.

https://developer.valvesoftware.com/wiki/Source_Multiplayer_Networking

Cheating



Call of Duty 4 1.7
Wallhack, Names

Services

- Initialization, Running, and Shutdown
- Lobbies und Matchmaking
- Statistiken
- Achievements, Leaderboards
- Cloud Storage



Matchmaking in StarCraft 2

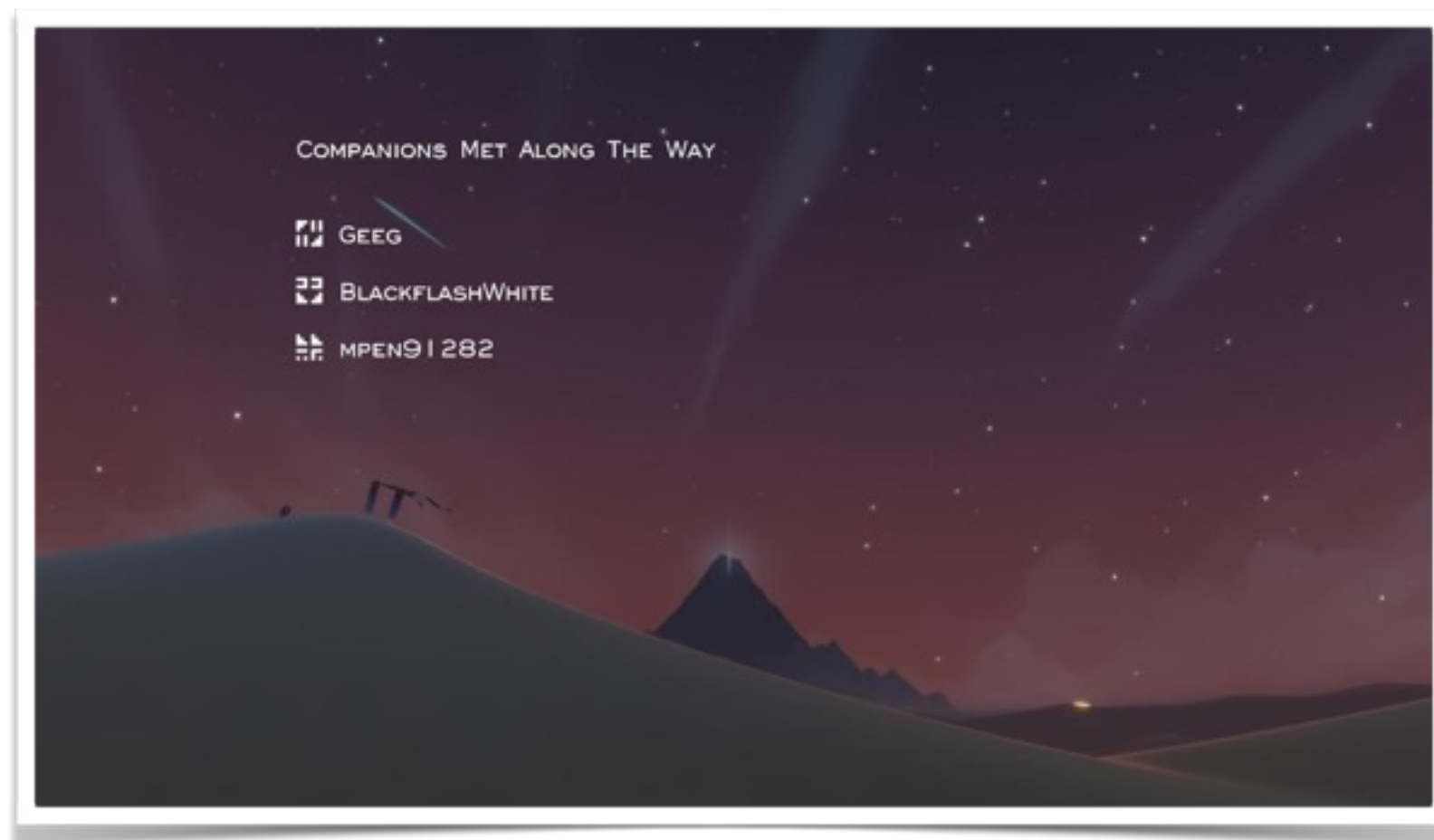


Steam Services

Rolecoding



Clash of Clans



Journey

- Player interaction (PvP, PvE, Tausch)
- Privatheit (Nickname, Profil)
- Zugangskontrolle (Spieler, Zuschauer)
- Gruppenzugehörigkeit (Gilden, Raids)
- Role Playing (Kostüme, Sprache)



Online-Spiele

Mehrspielermodus

Deathmatch

Capture the Flag

Koop-Modus

King of the Hill

Search and Destroy

Rush

Eroberung

Last Man Standing



Asymmetrisches Spiel



Giants: Citizen Kabuto, 2000



Gilden



Real-Time

MMORPG-Merkmale

Game Master (Server Admin)

Soziale Strukturen (Gilden, Clans, Raids)

PvE (Quests, Instanzen)

PvP (Duelle, Arena, Battlegrounds, War)

Interaktion (Chat, Channels, BB)

Persistenz

Mini-Games (RuneScape)

Quests

Dispositive Struktur



<http://www.techeblog.com/index.php/tech-gadget/world-of-warcraft-player-controls-36-characters-simultaneously>

Joe Ludwig (2008) Analysis: Why Aren't There More Console MMOs?

Platform Holders Demand a Share

Certification

No Keyboard

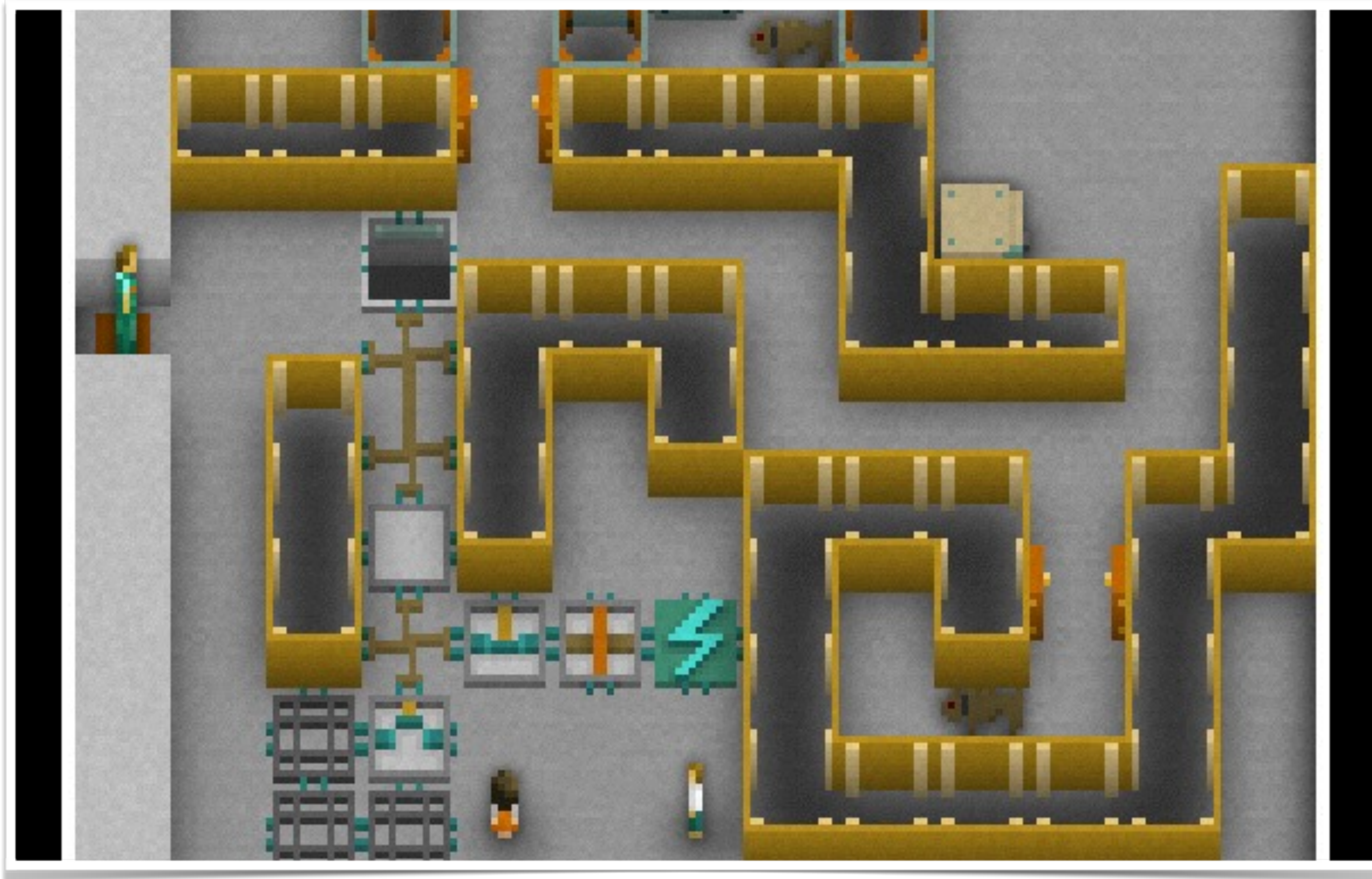
Long Development Times

Consoles Have a Smaller Installed Base

Duo Play

http://www.gamasutra.com/php-bin/news_index.php?story=18768

Asynchrones Spiel



The Castle Doctrine

Persistenz



OGame Fleet Save