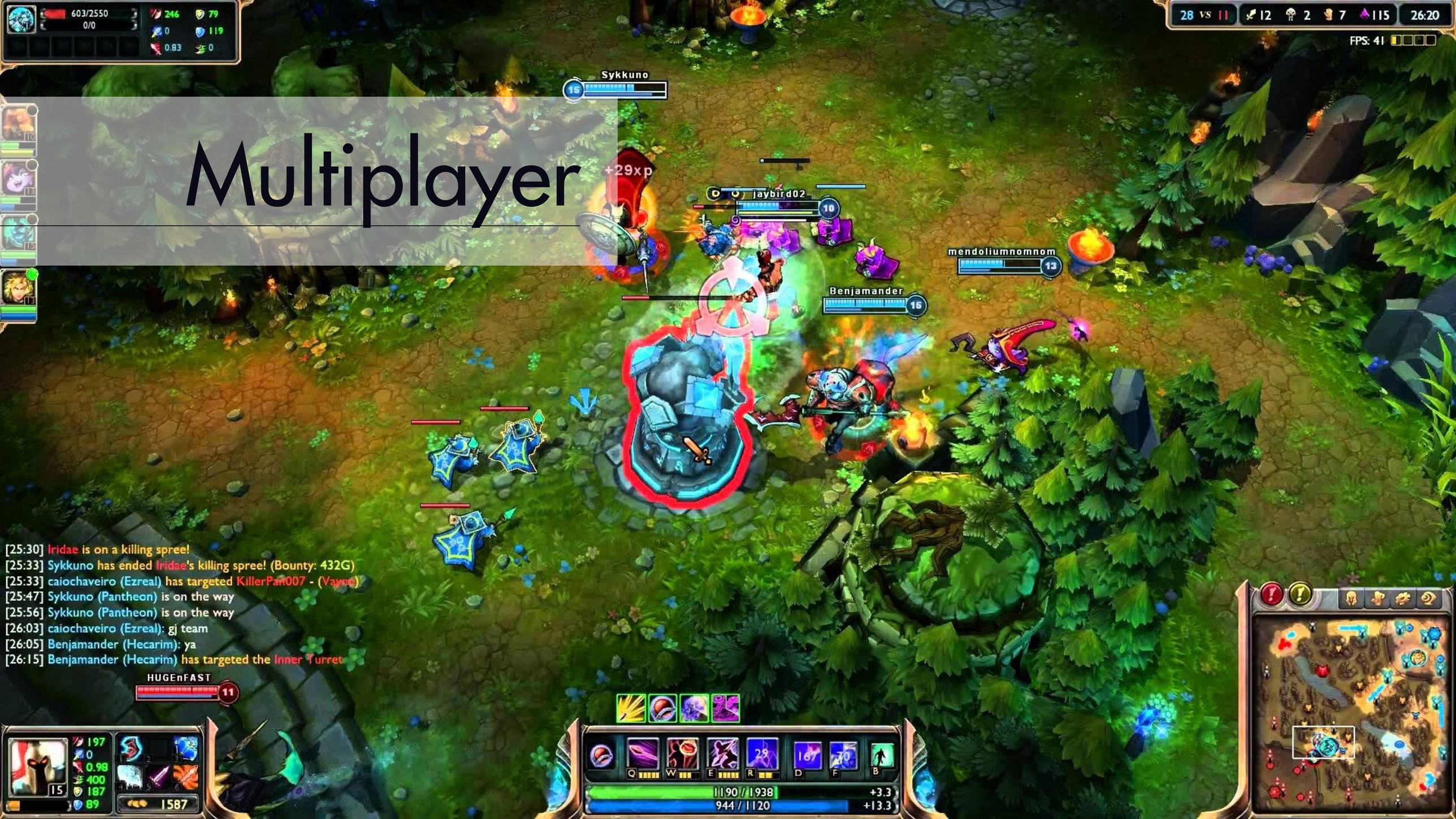
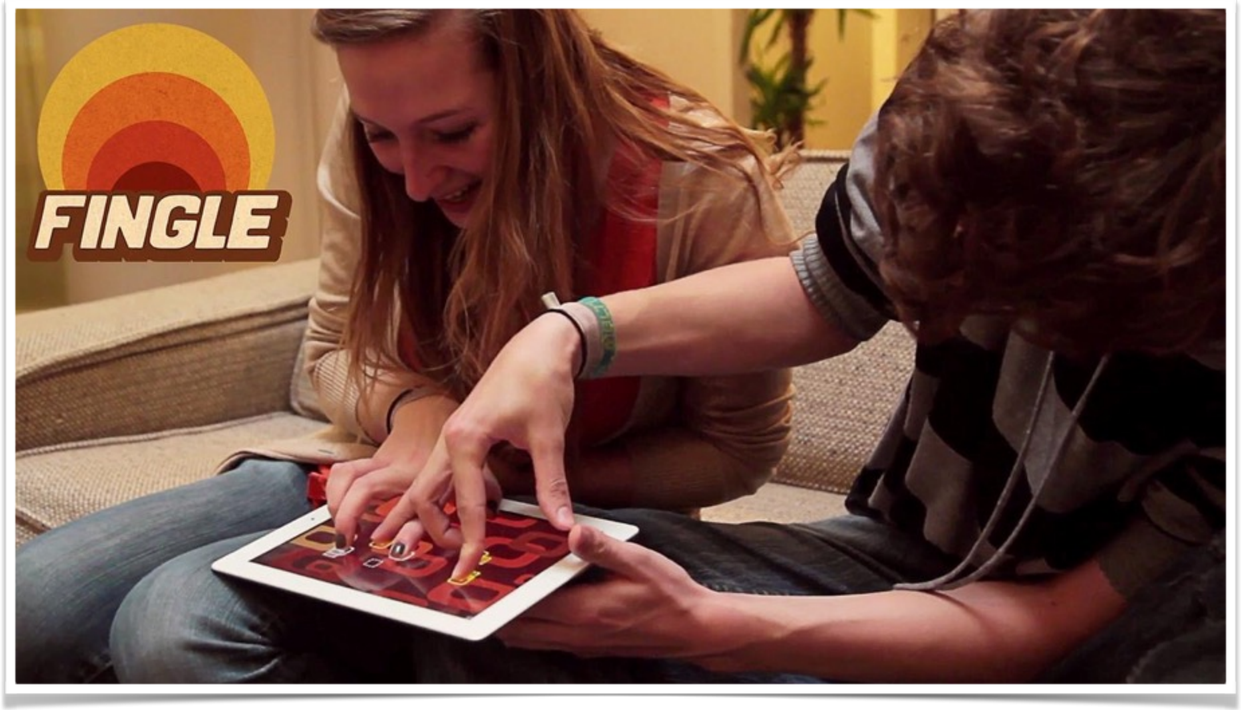

Multiplayer
Sykkuno
+29xp
jaybird02
mendoliumnomnom
Benjamander
[25:30] Iridae is on a killing spree!
[25:33] Sykkuno has ended Iridae's killing spree! (Bounty: 432G)
[25:33] caiochaveiro (Ezreal) has targeted KillerPan007 - (Vayne)
[25:47] Sykkuno (Pantheon) is on the way
[25:56] Sykkuno (Pantheon) 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
FPS: 41

# Multiplayer

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

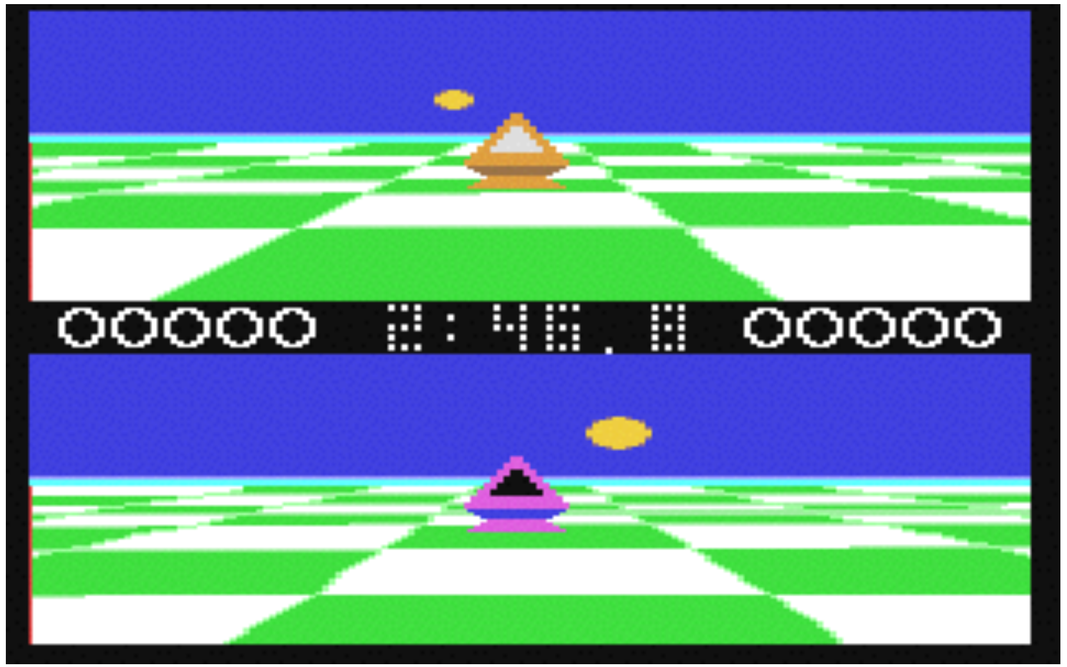
# Local (Couch) Multiplayer

Magnavox Odyssee




Fingle

# Splitscreen



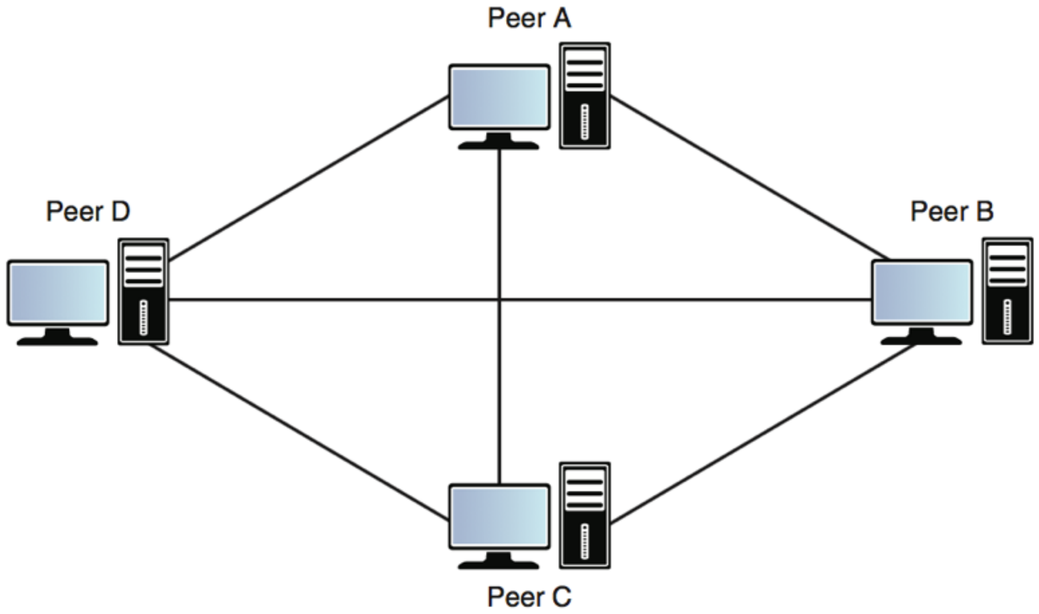
Ball Blazer

Fruit Ninja

# Serielle Verbindung

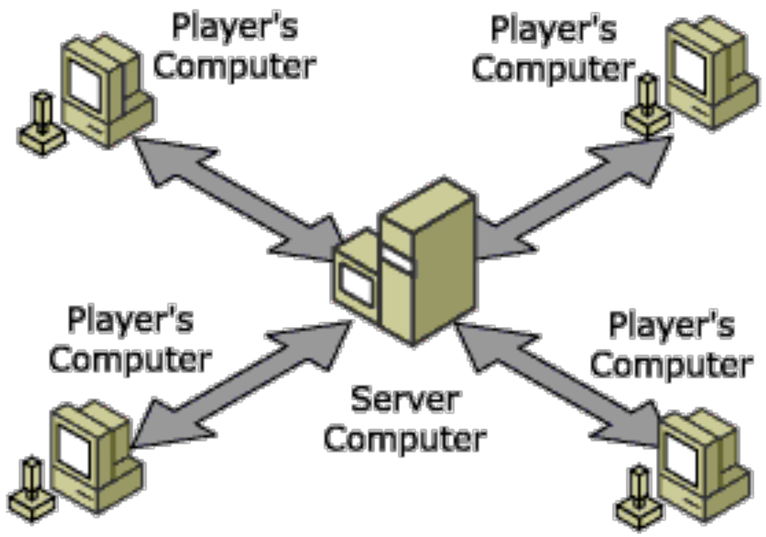

Game Link Cable

# Peer-to-Peer




Doom

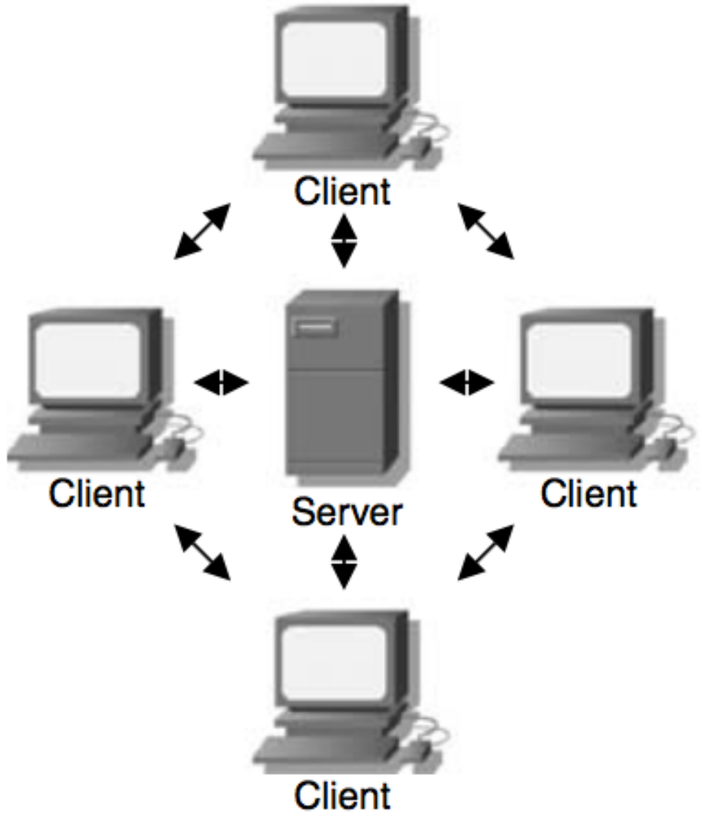
# Client / Server

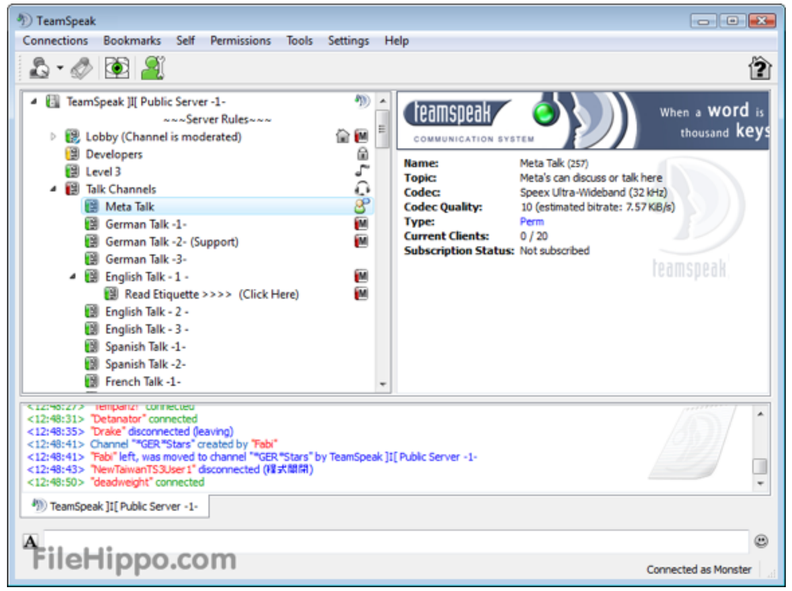



Browser-Client

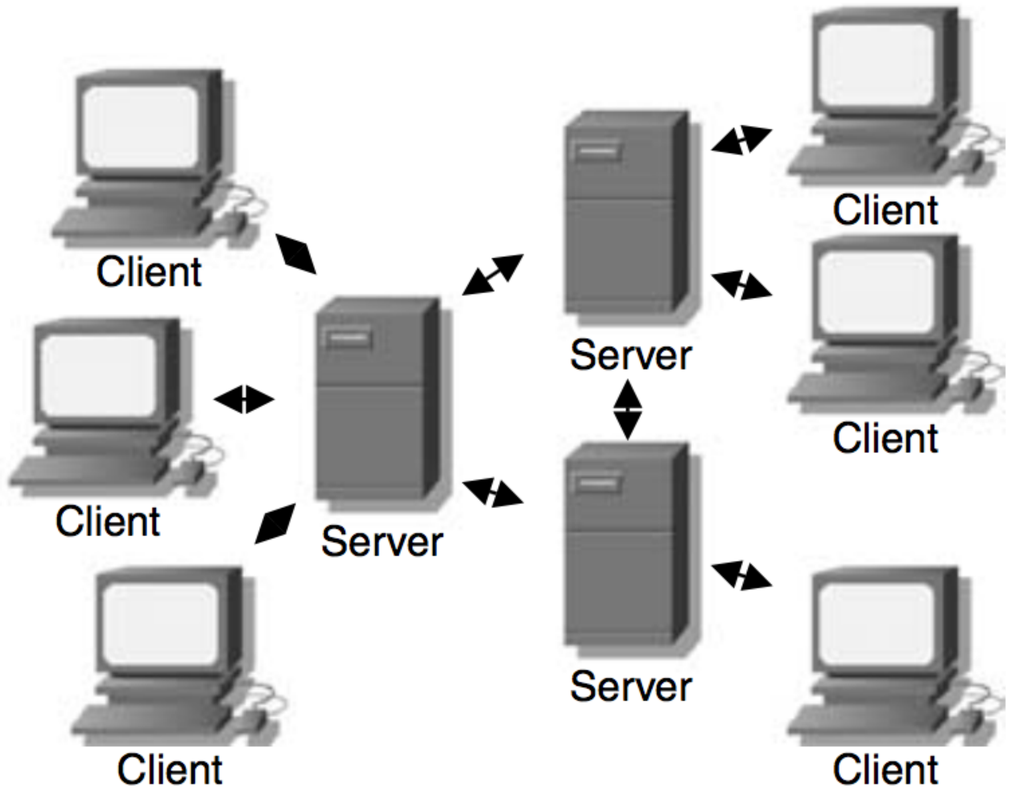
Clientprogramm

# Client/Server-P2P-Hybrid

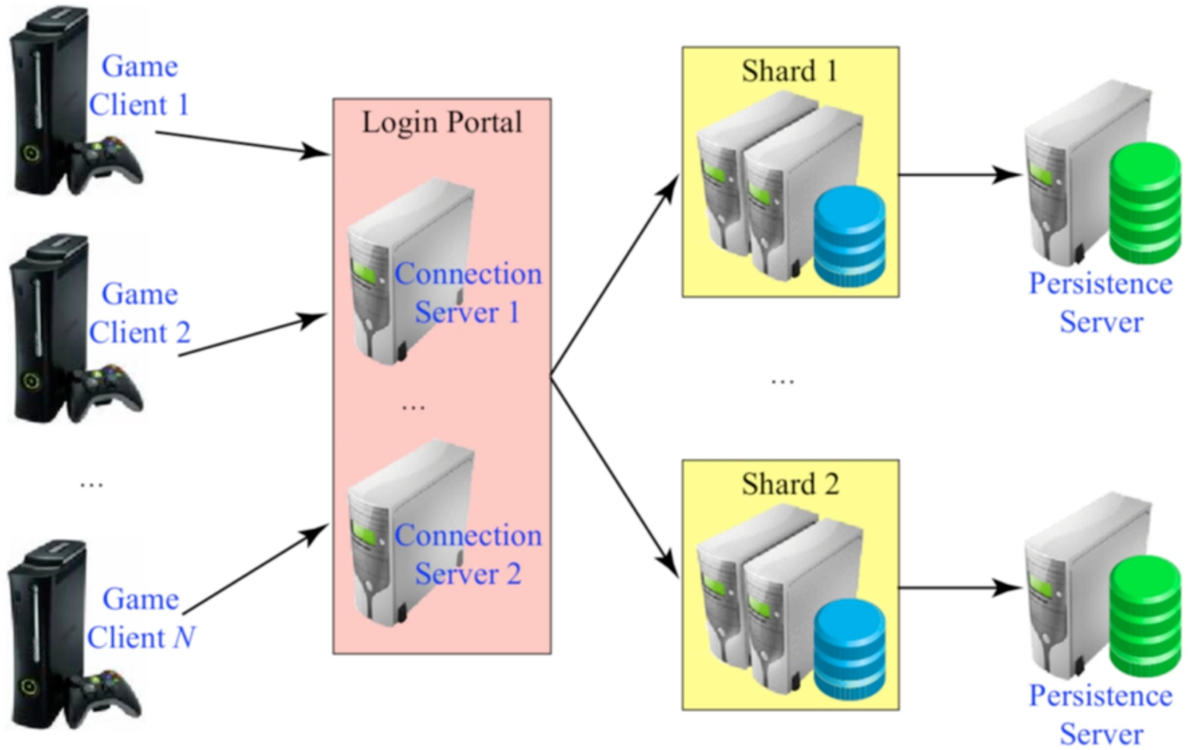


# Network of Servers

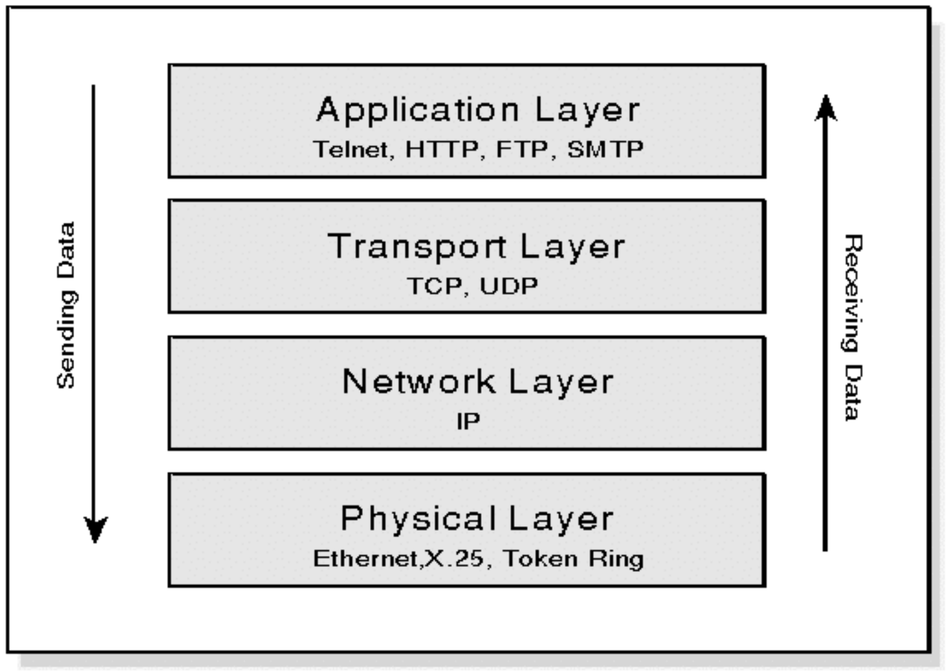


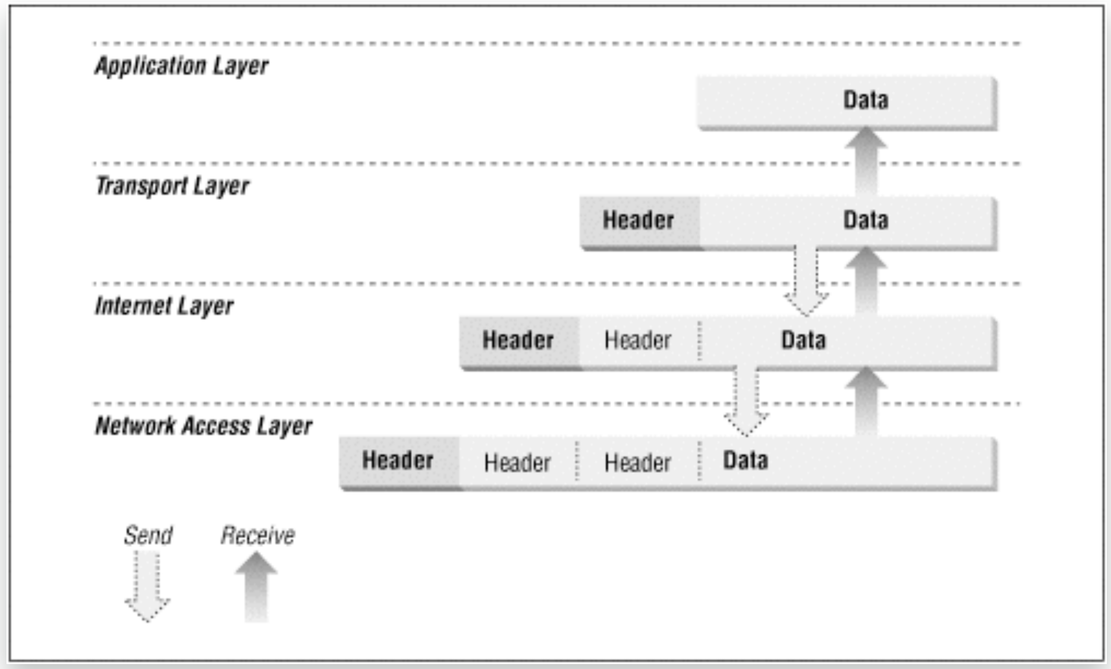
# Shards



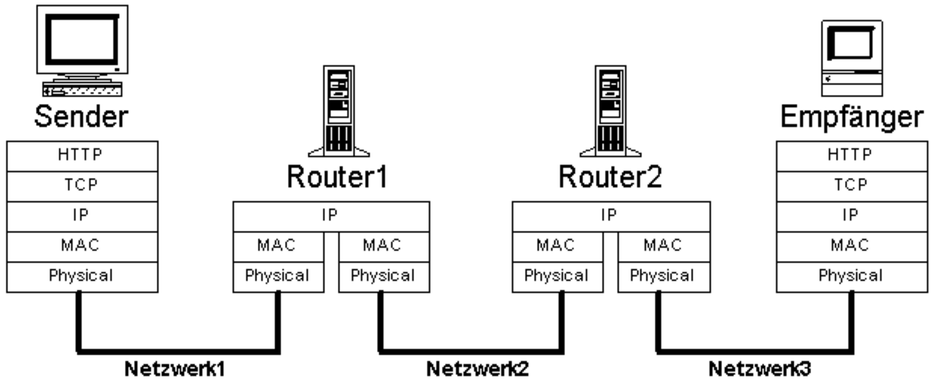

Server-Instanzen

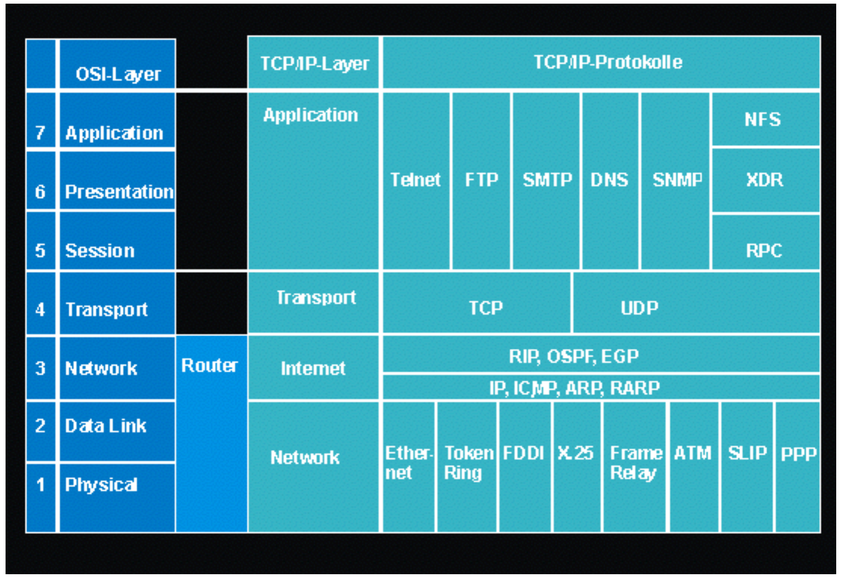
# Internet-Architektur



# Netzschichten

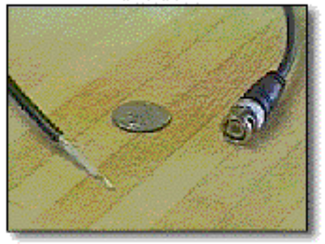


# Physische Schicht

Ethernet 10BASET, Ethernet 100BASET, Ethernet 1000BASET

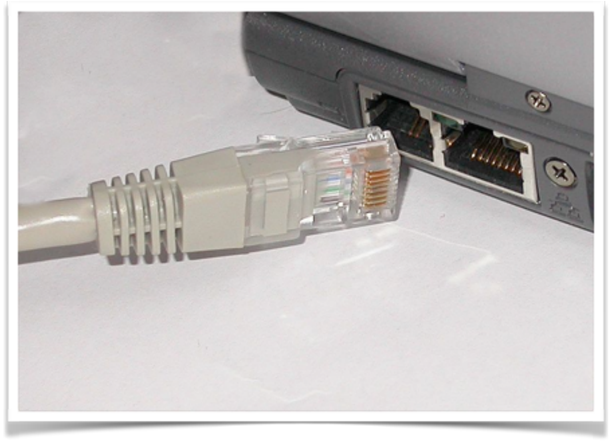
Coaxial



Fiber-optic

Unshielded Twisted Pair

Various types of network media.



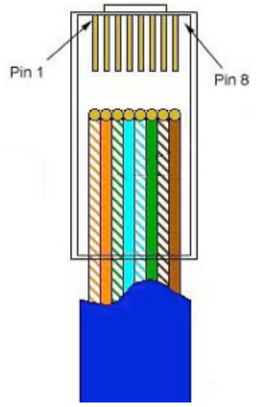
Twisted Pair
4- oder 8 Leitungspaare

Unshielded Twisted Pair

Shielded Twisted Pair

Koaxialkabel
50 W für Digitalanwendungen
75 W für Analoganwendungen

Glasfaberkabel (Lichtwellenleiter)




## RJ45 Belegung

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

# Netzzugang: WLAN



Protokolle

IEEE 802.11 a-n

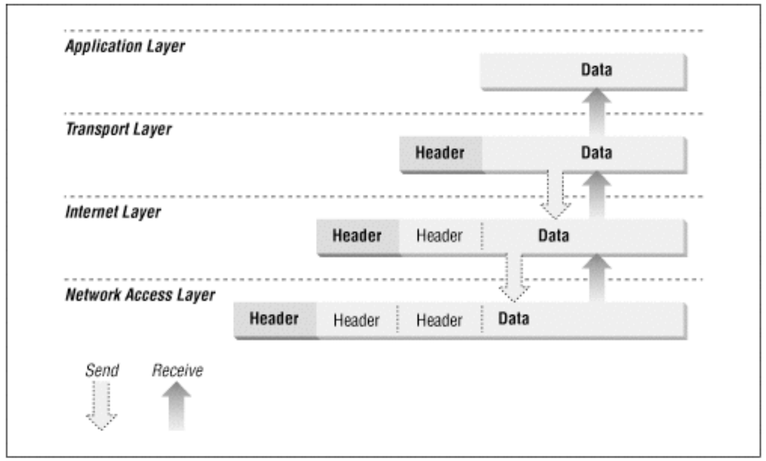
**Institute of Electrical and Electronics Engineers (IEEE)**

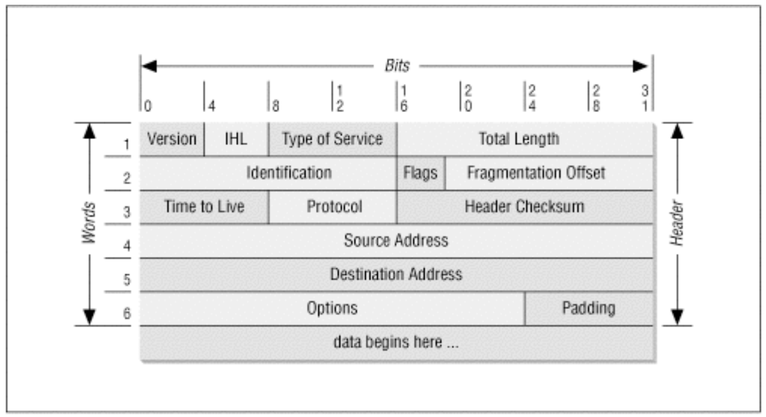
20-300 Mbit/s


# Netzzugang: Mobilfunk

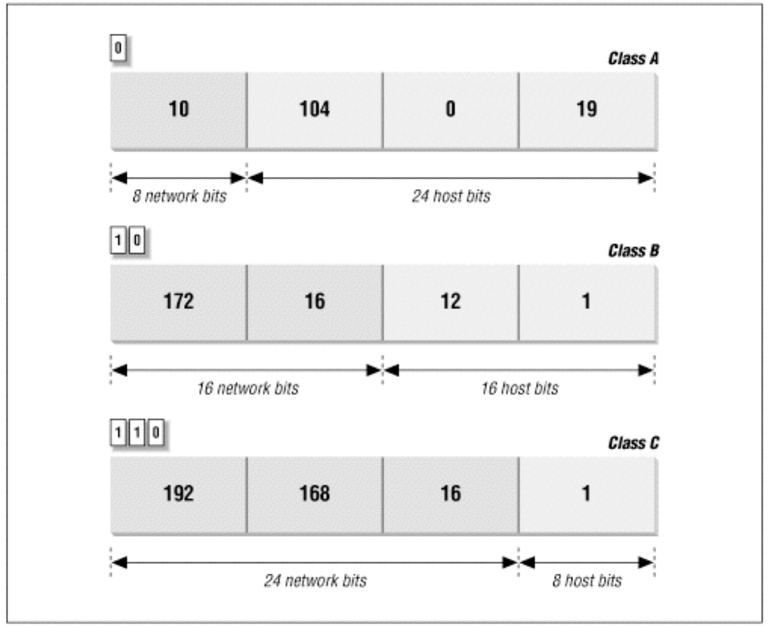
3G, 4G, UMTS, LTE

# Internet Protocol (IP)



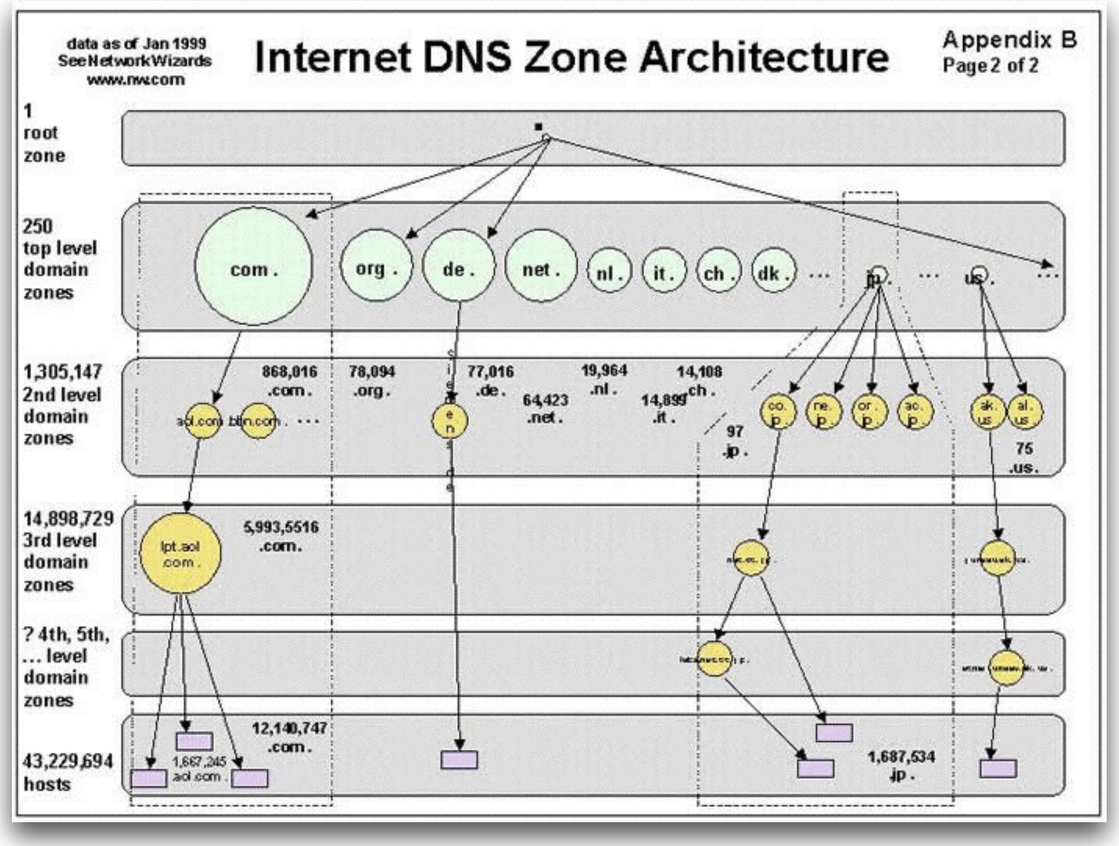




IP-Header




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.

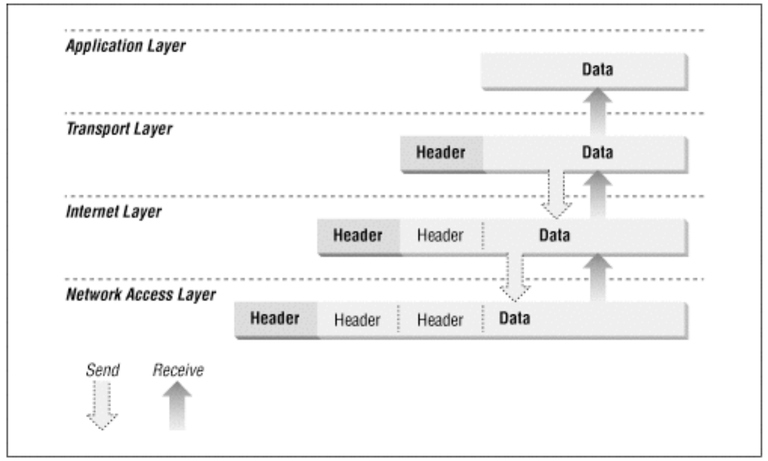
# Private Netze

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) |

RFC 1918

# Transmission Control Protocol (TCP)
# User Datagram Protocol (UDP)




Transportschicht

**TCP Segment Header Format**

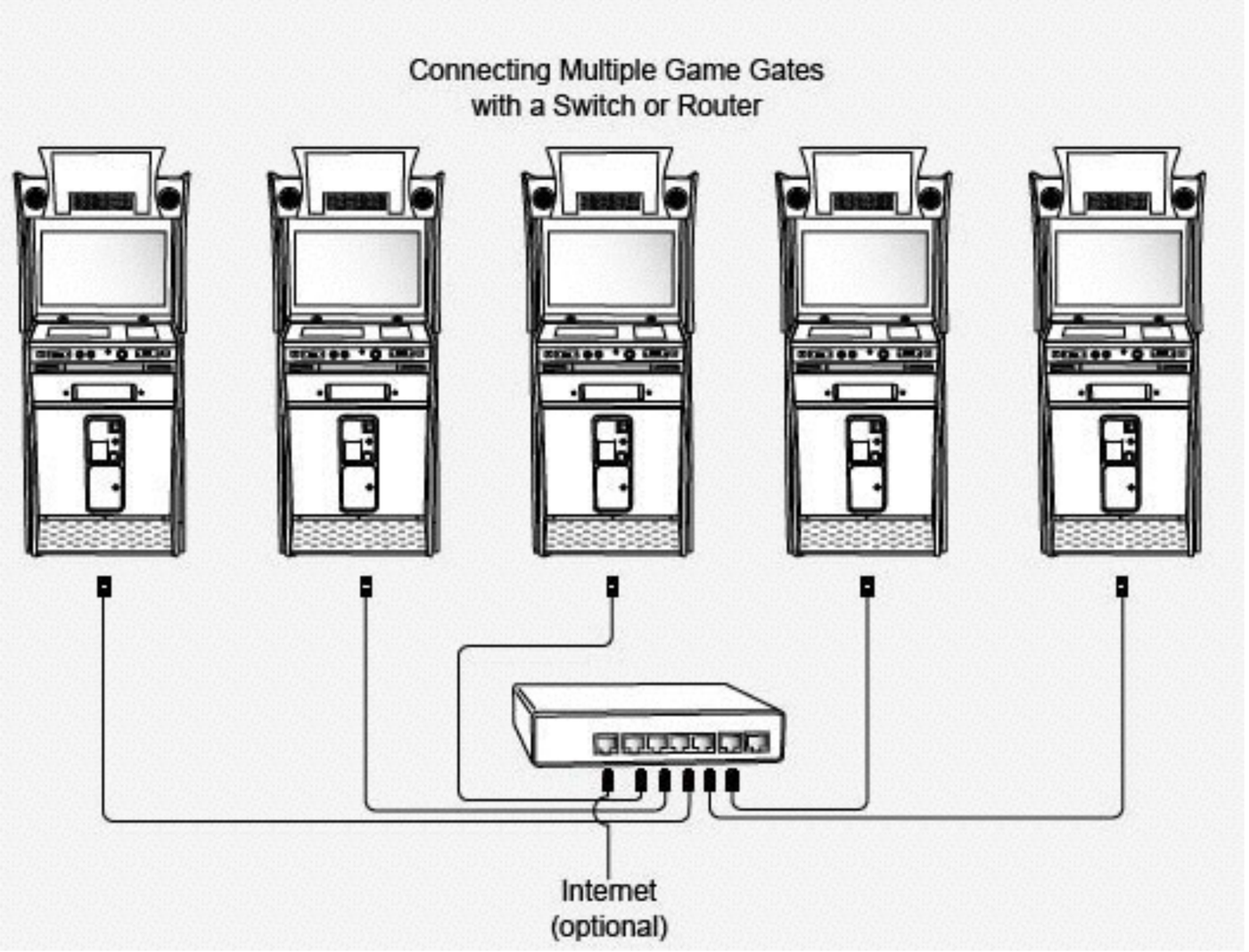
| Bit # | 0 – 7 | 8 – 15 | 16 – 23 | 24 – 31 |
|---|---|---|---|---|
| 0 | Source Port | | Destination Port | |
| 32 | Sequence Number | | | |
| 64 | Acknowledgment Number | | | |
| 96 | Data Offset | Res | Flags | Window Size |
| 128 | Header and Data Checksum | | Urgent Pointer | |
| 160... | Options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

**UDP Datagram Header Format**

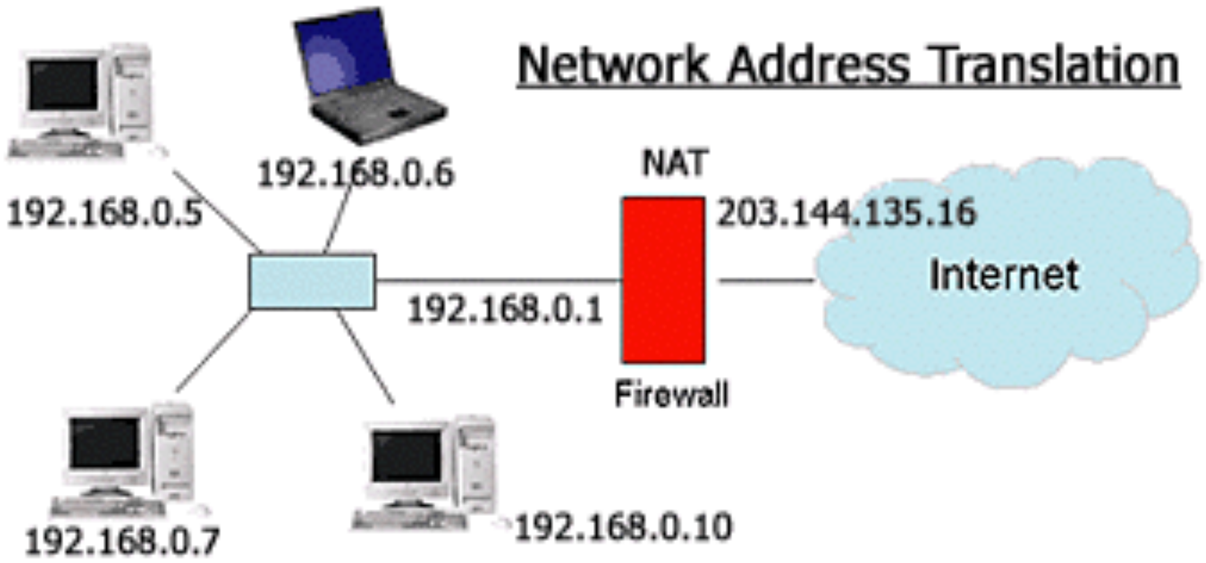
| Bit # | 0 – 7 | 8 – 15 | 16 – 23 | 24 – 31 |
|---|---|---|---|---|
| 0 | Source Port | | Destination Port | |
| 32 | Length | | Header and Data Checksum | |

TCP- und UDP-Header

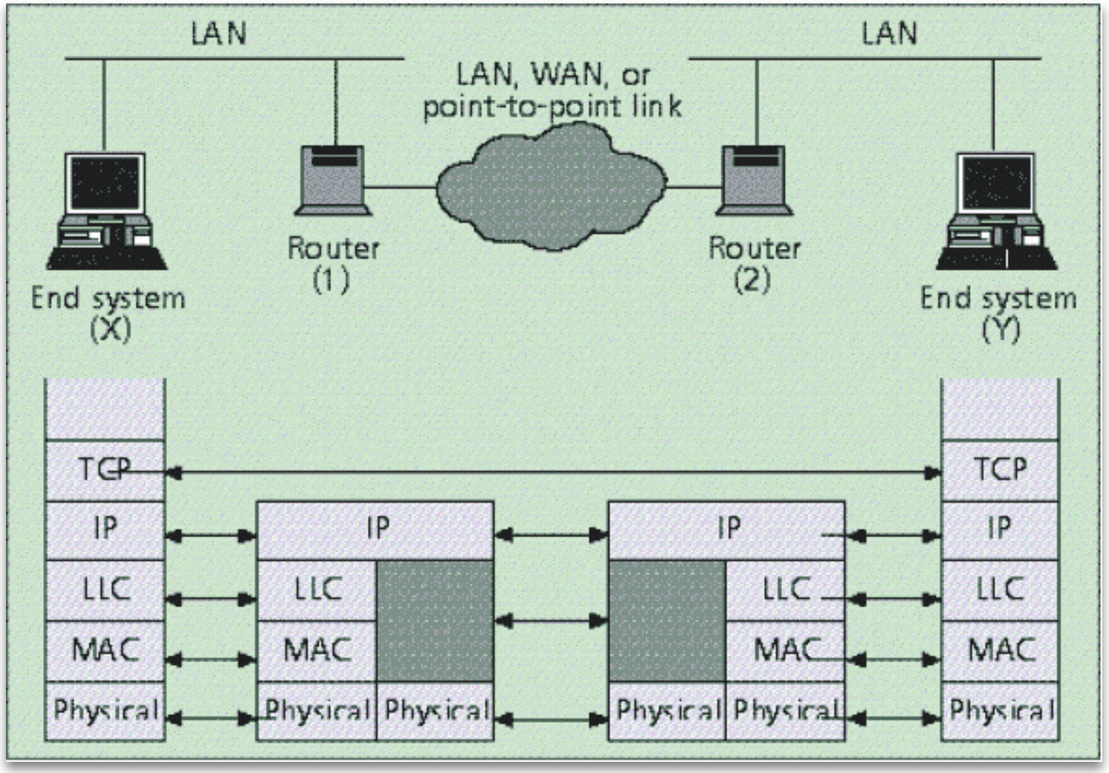
# LAN – Local Area Network

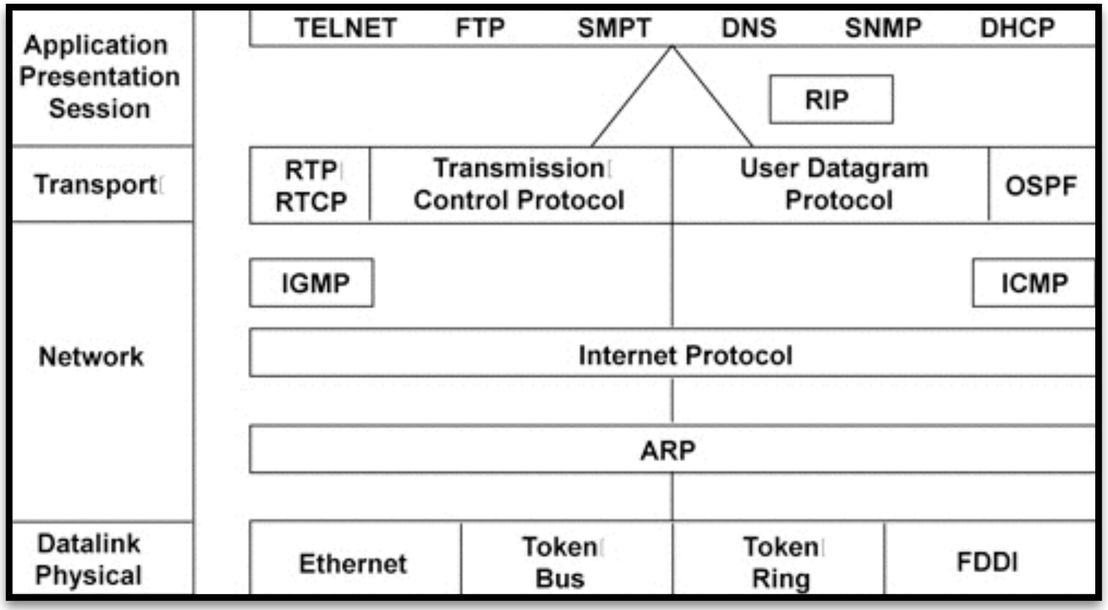


# NAT – Network Address Translation



# Netzwerk-Konfiguration




**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**

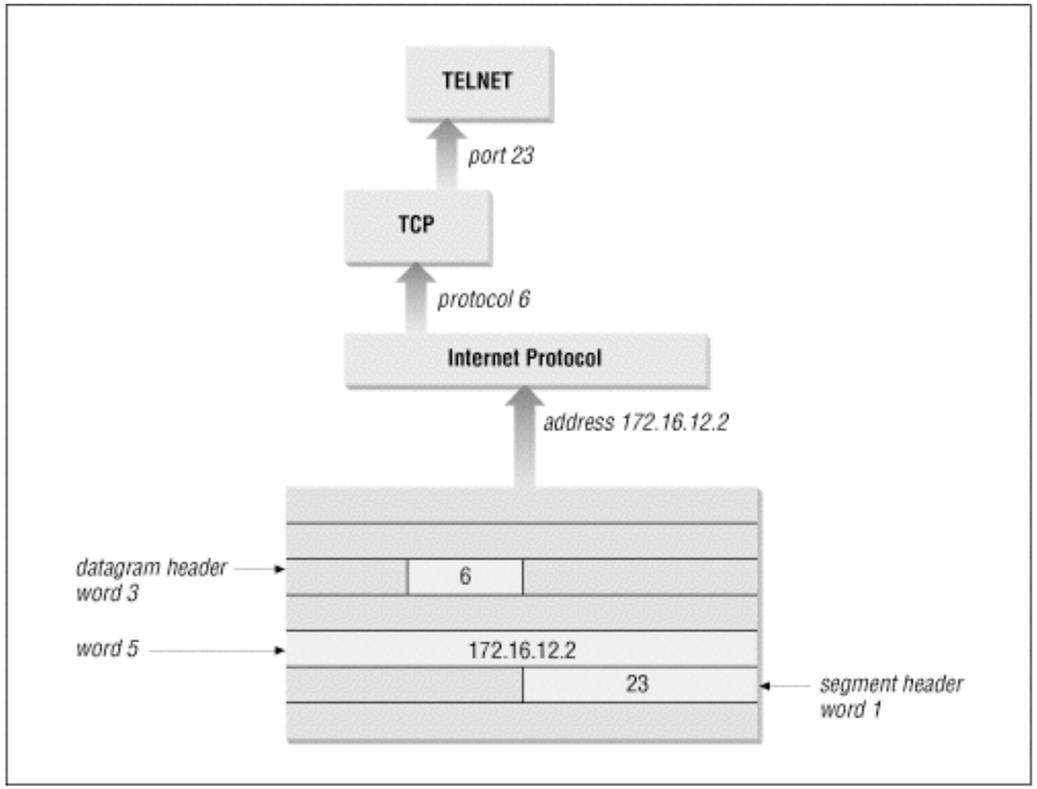
802.11 (WLAN) · 802.16 · Wi-Fi · WiMAX · ATM · DTM · Token ring · Ethernet · FDDI · Frame Relay · GPRS · EVDO · HSPA · HDLC · PPP · PPTP · L2TP · ISDN · ARCnet · (more)

**1. Physical layer**

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

This box: view · talk · edit

# Socket




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

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

# TCP-Ports



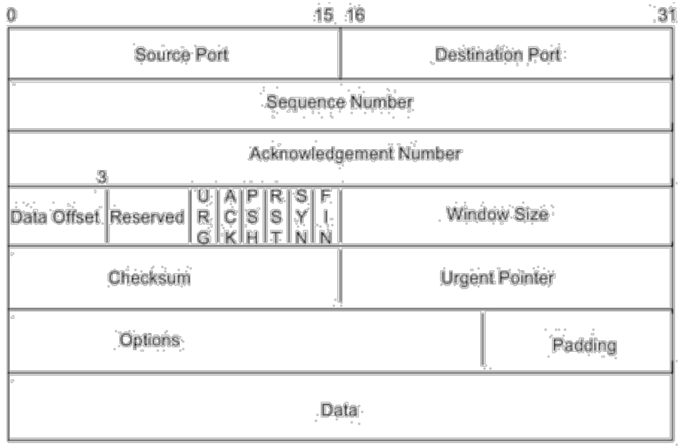
Port or Socket Numbers

Specific Assignments:

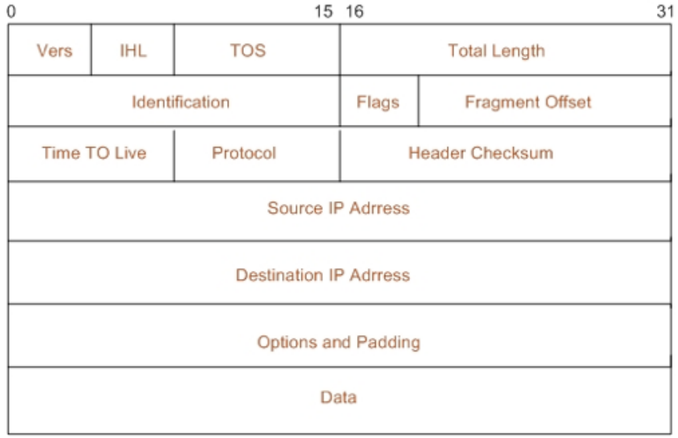
Network Standard Functions

| 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] |





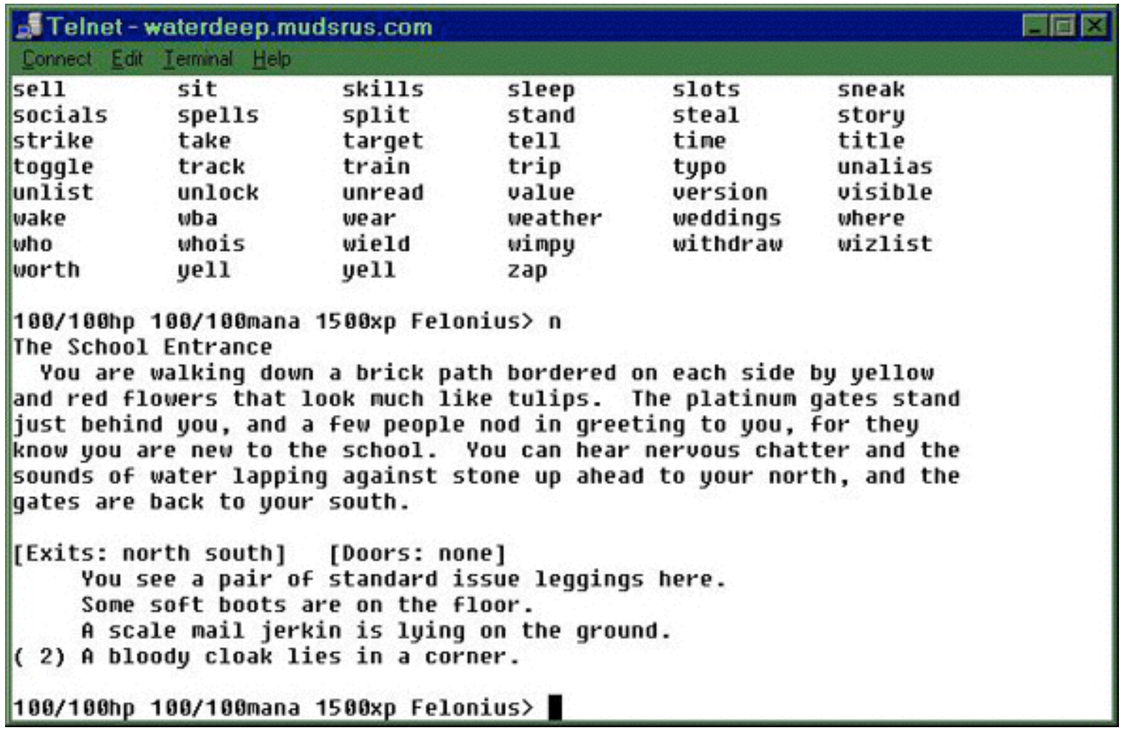

TCP-Header




IP-Header

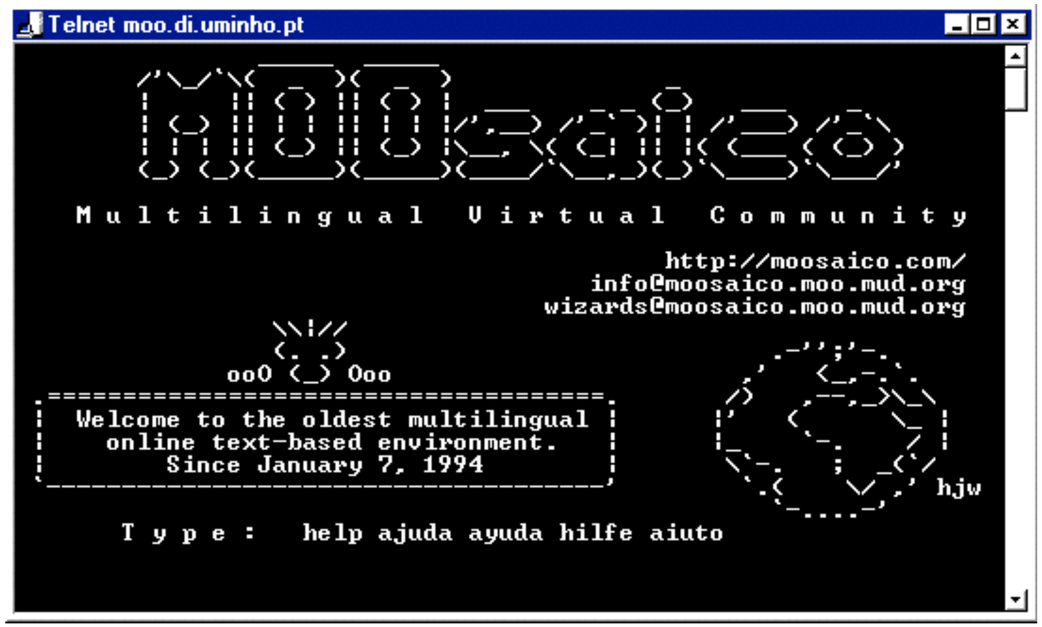
# Application Layer

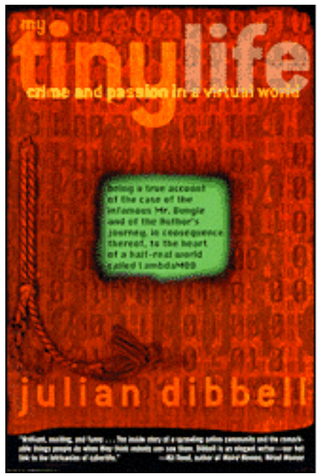
# MUD

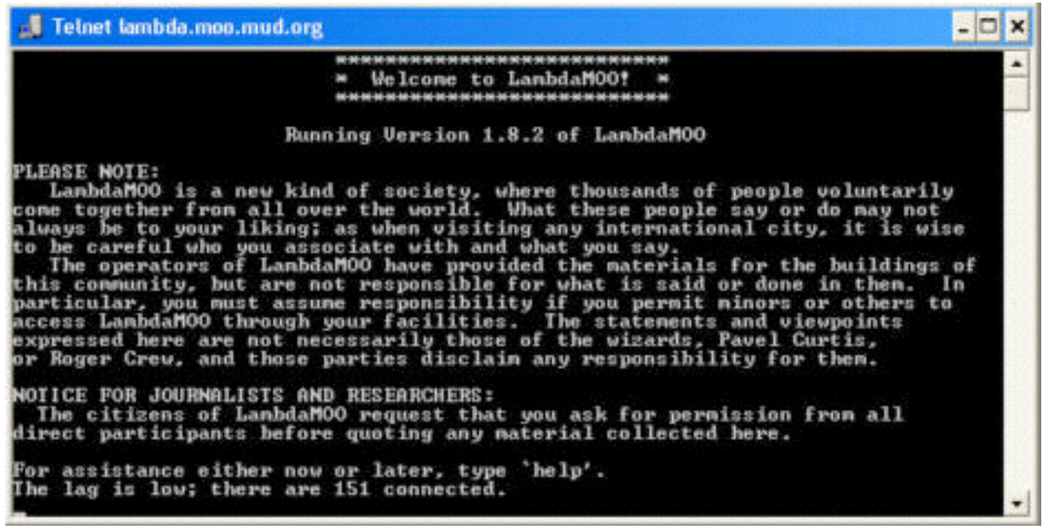



Telnet, Port 23

# MUCK, MUSH, MUSE, MOO



# Neverwinter Nights (1991)


AOL

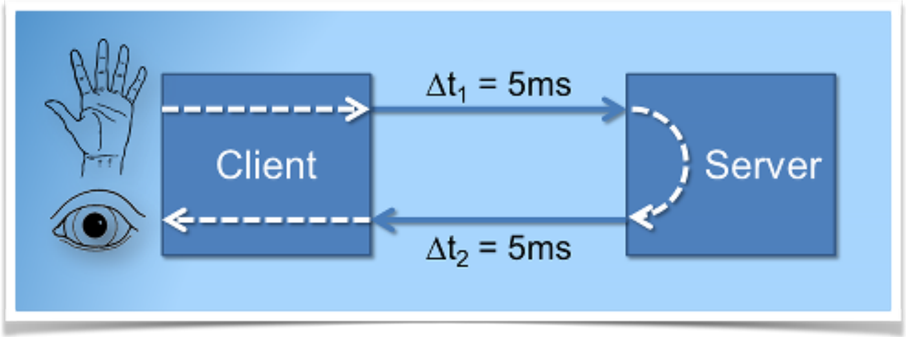

Ultima Online
TCP-Ports 5001-5010, 7775-7777, 8888, 9999
PAPERDOLL
ARMOR
CLOTHING
BACKPACK
MMORPGs

# Netzqualität

- Datenübertragungsrate
- Verluste (Drop)
- Latenz
- Jitter

# Latenz / Ping

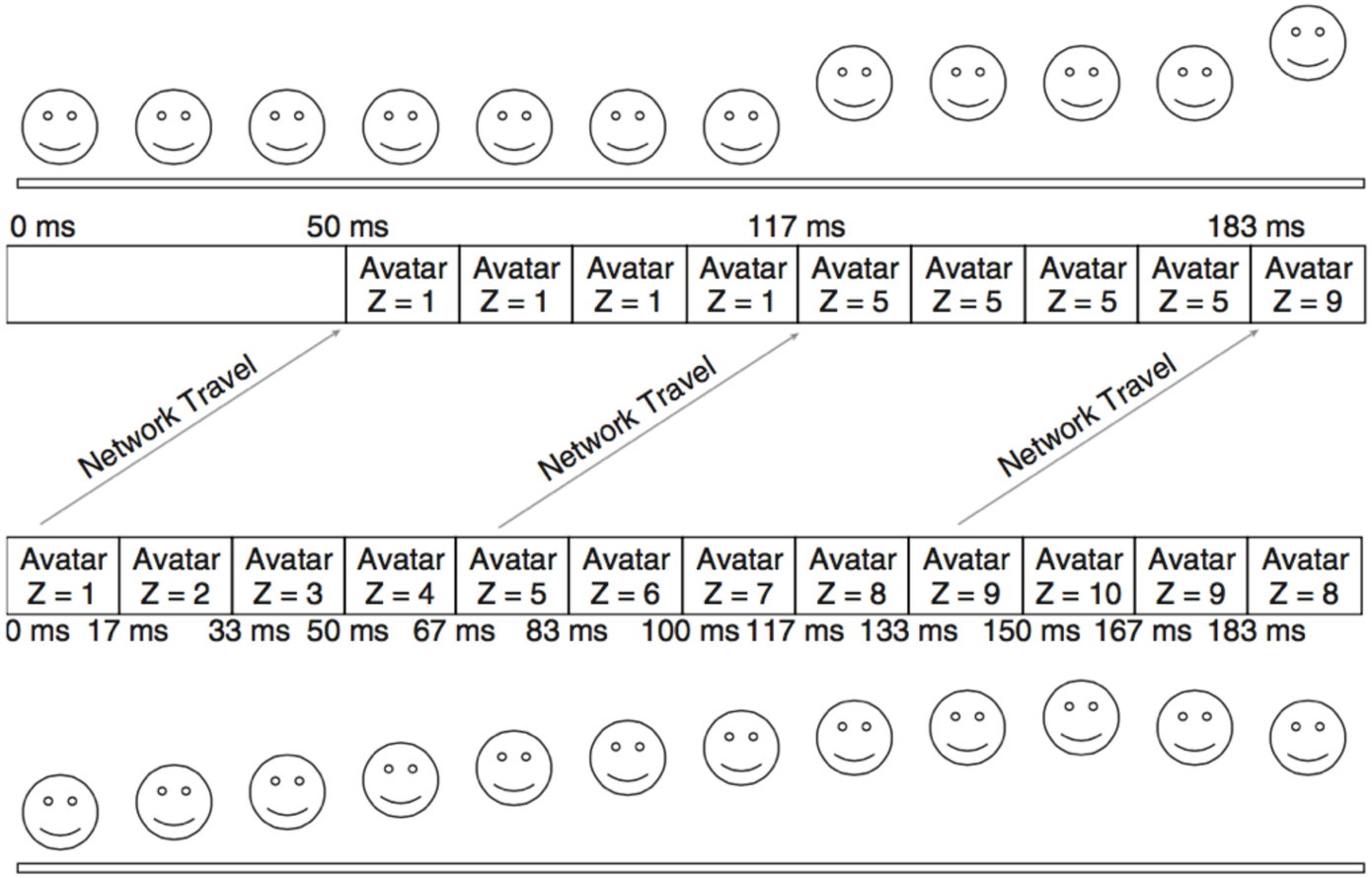
Round Trip Time (RTT) ≈ 2 x Latenz



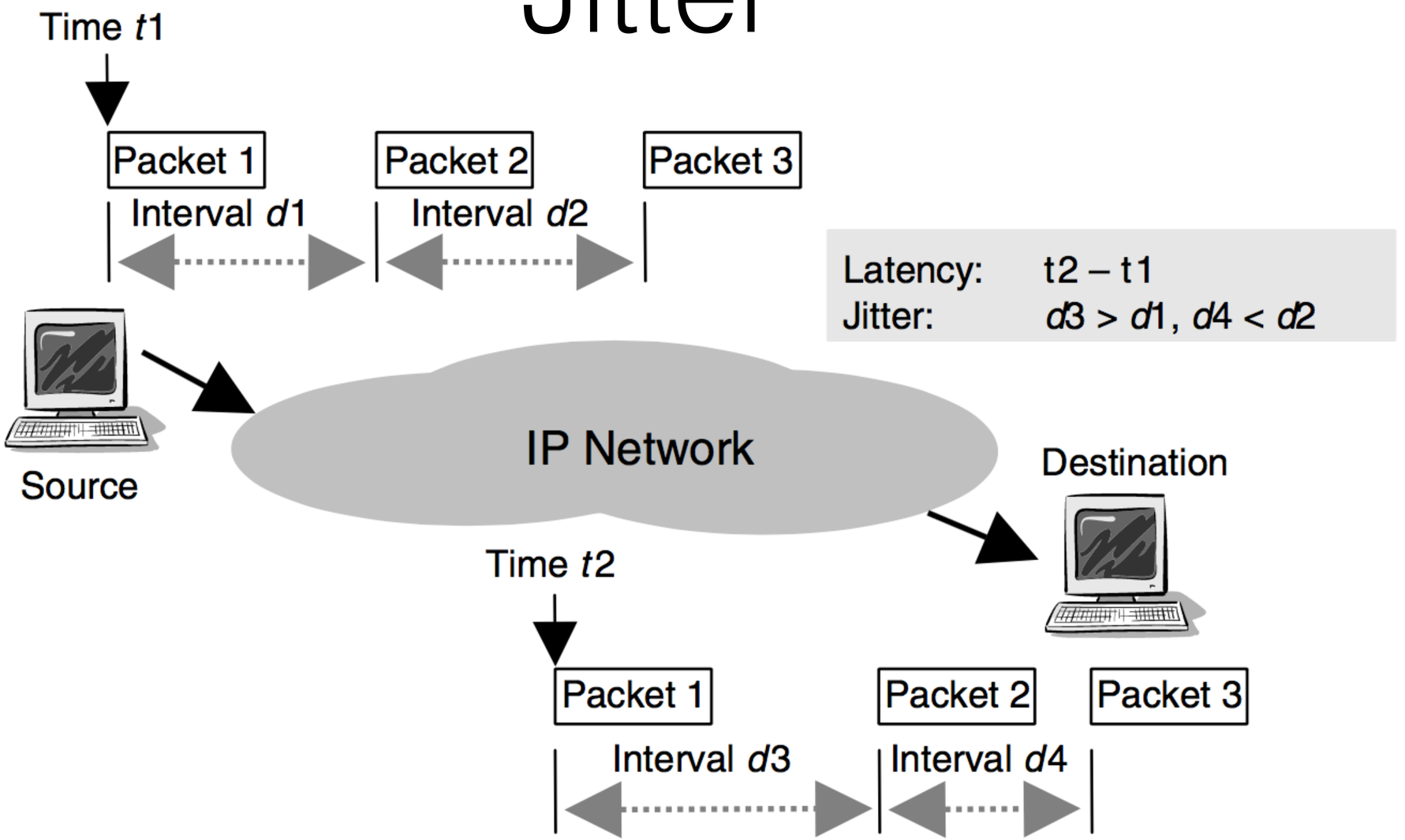


- Prozessorzeit
- Übertragungszeit
- Warteschlange
- Laufzeit:
  0.3 m/ns = 300 m / µs = 300 km / ms
  12.000 km benötigen 40 ms = 80 ms RTT

# Lag


0 ms
50 ms
117 ms
183 ms
Avatar Z = 1
Avatar Z = 1
Avatar Z = 1
Avatar Z = 1
Avatar Z = 5
Avatar Z = 5
Avatar Z = 5
Avatar Z = 5
Avatar Z = 9
Network Travel
Network Travel
Network Travel
Avatar Z = 1
Avatar Z = 2
Avatar Z = 3
Avatar Z = 4
Avatar Z = 5
Avatar Z = 6
Avatar Z = 7
Avatar Z = 8
Avatar Z = 9
Avatar Z = 10
Avatar Z = 9
Avatar Z = 8
0 ms 17 ms 33 ms 50 ms 67 ms 83 ms 100 ms 117 ms 133 ms 150 ms 167 ms 183 ms

# Jitter


Time t1
Packet 1
Packet 2
Packet 3
Interval d1
Interval d2
Latency: t2 – t1
Jitter: d3 > d1, d4 < d2
IP Network
Source
Destination
Time t2
Packet 1
Packet 2
Packet 3
Interval d3
Interval d4

# 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/

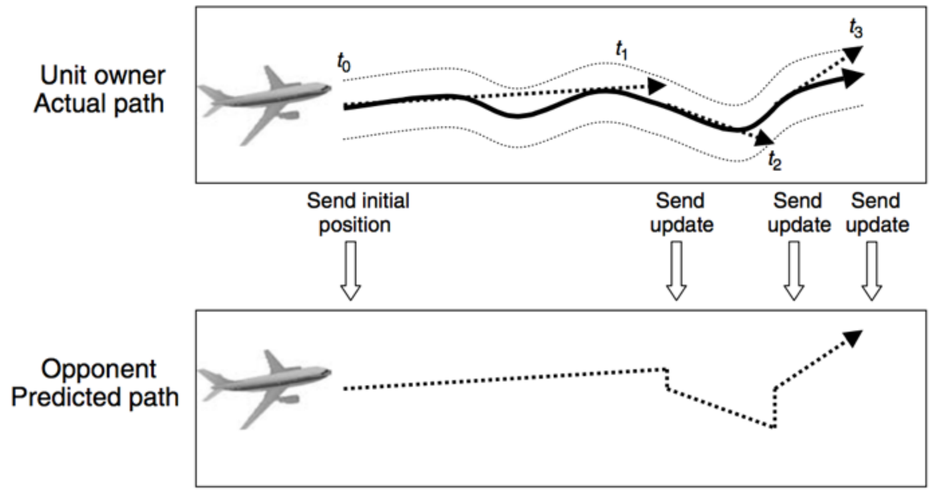
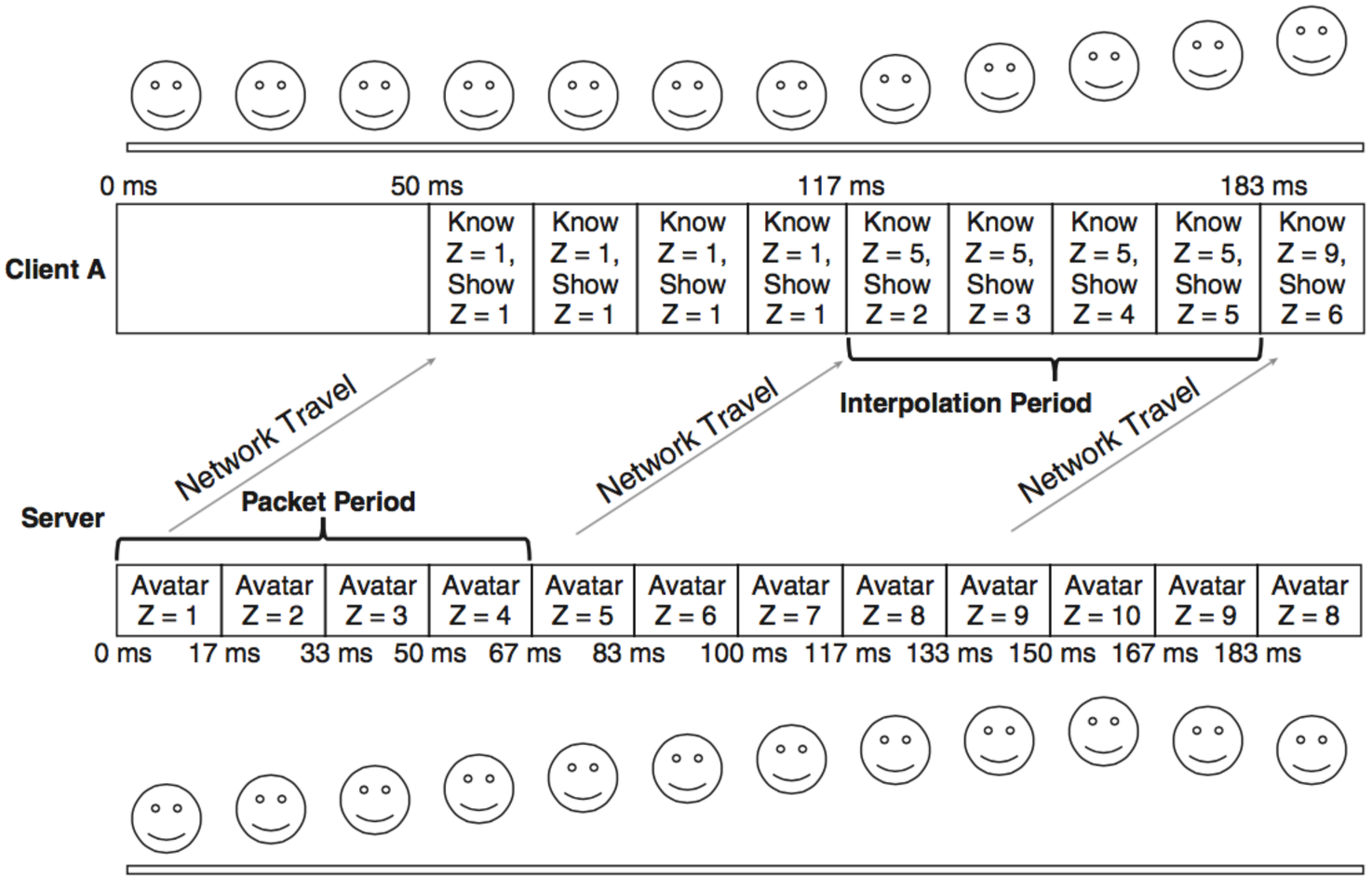



**Figure 6.7** Opponent Prediction, showing actual path versus predicted path. The opponent uses the last known unit information in computing its path. The unit owner sends updates when the predicted location differs from the actual location by more than a given threshold

Player Movement
Opponent Prediction Path

# Latenz-Kompensation

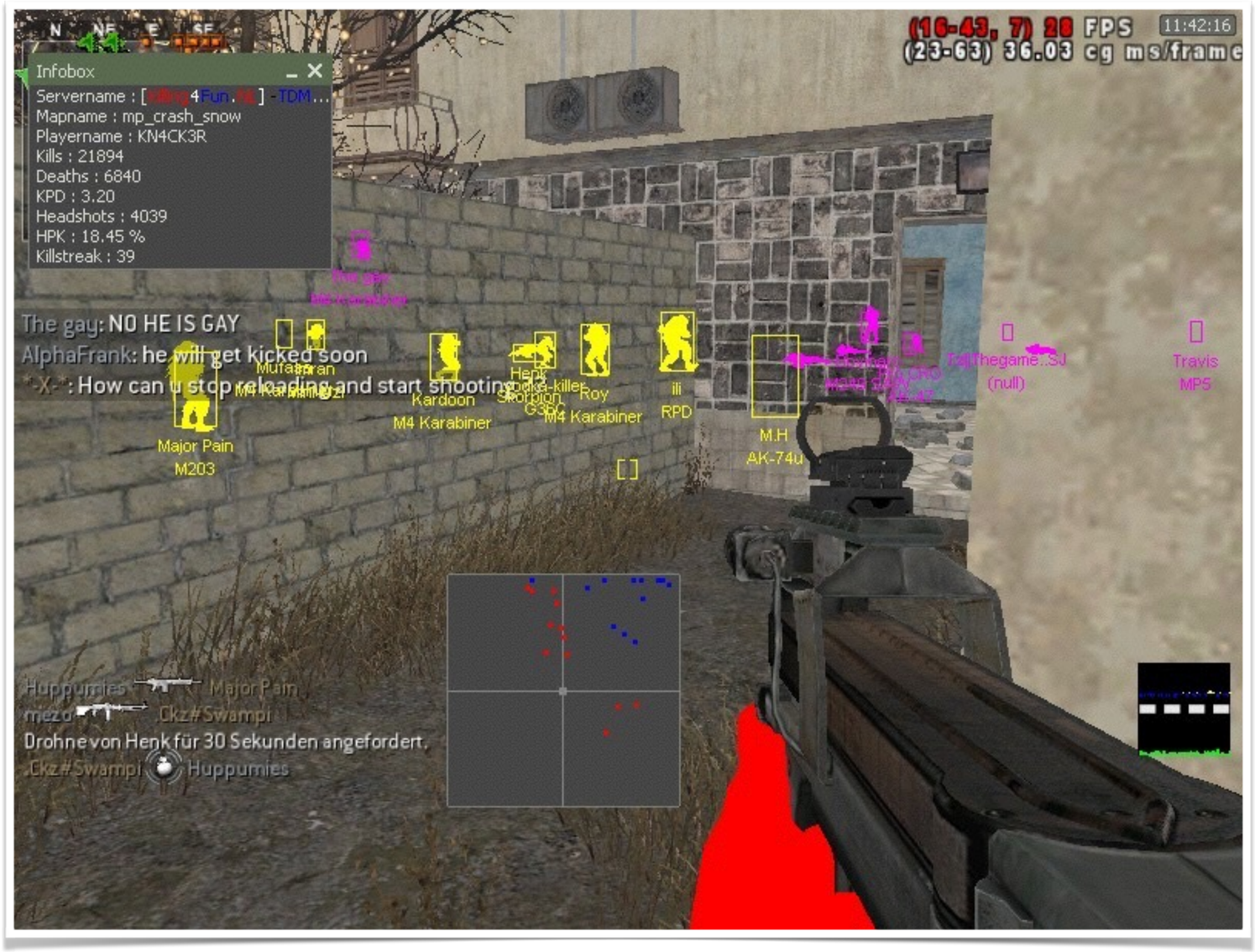


# Lag Compensation

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.

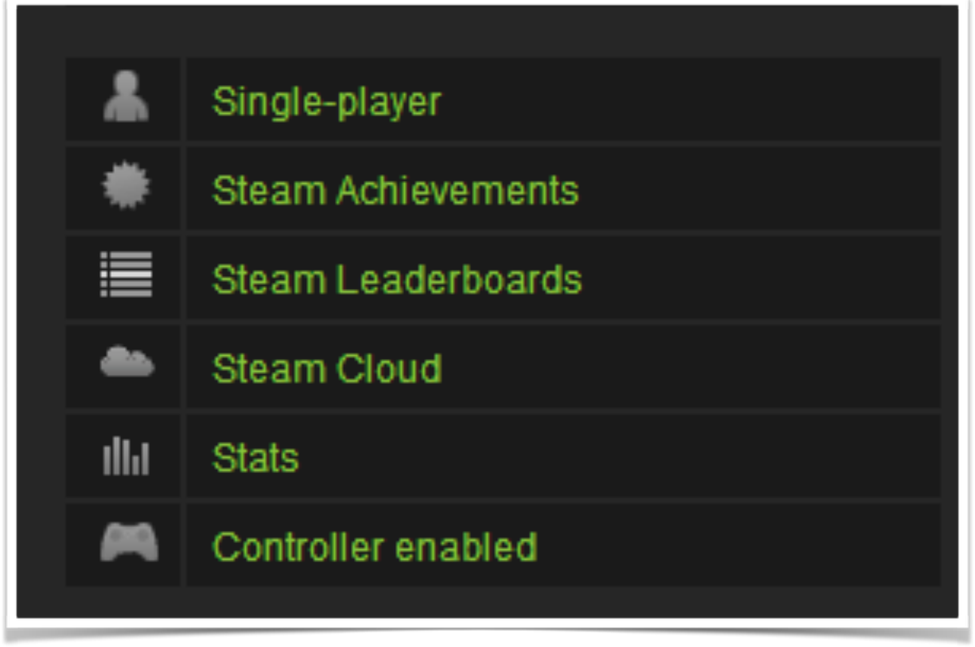
https://developer.valvesoftware.com/wiki/Source_Multiplayer_Networking

# Cheating




Call of Duty 4 1.7
Wallhack, Names


Matchmaking in StarCraft 2




Steam Services

# Services

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

# 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

# MMORPG-Merkmale

Gilden

Real-Time

- 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

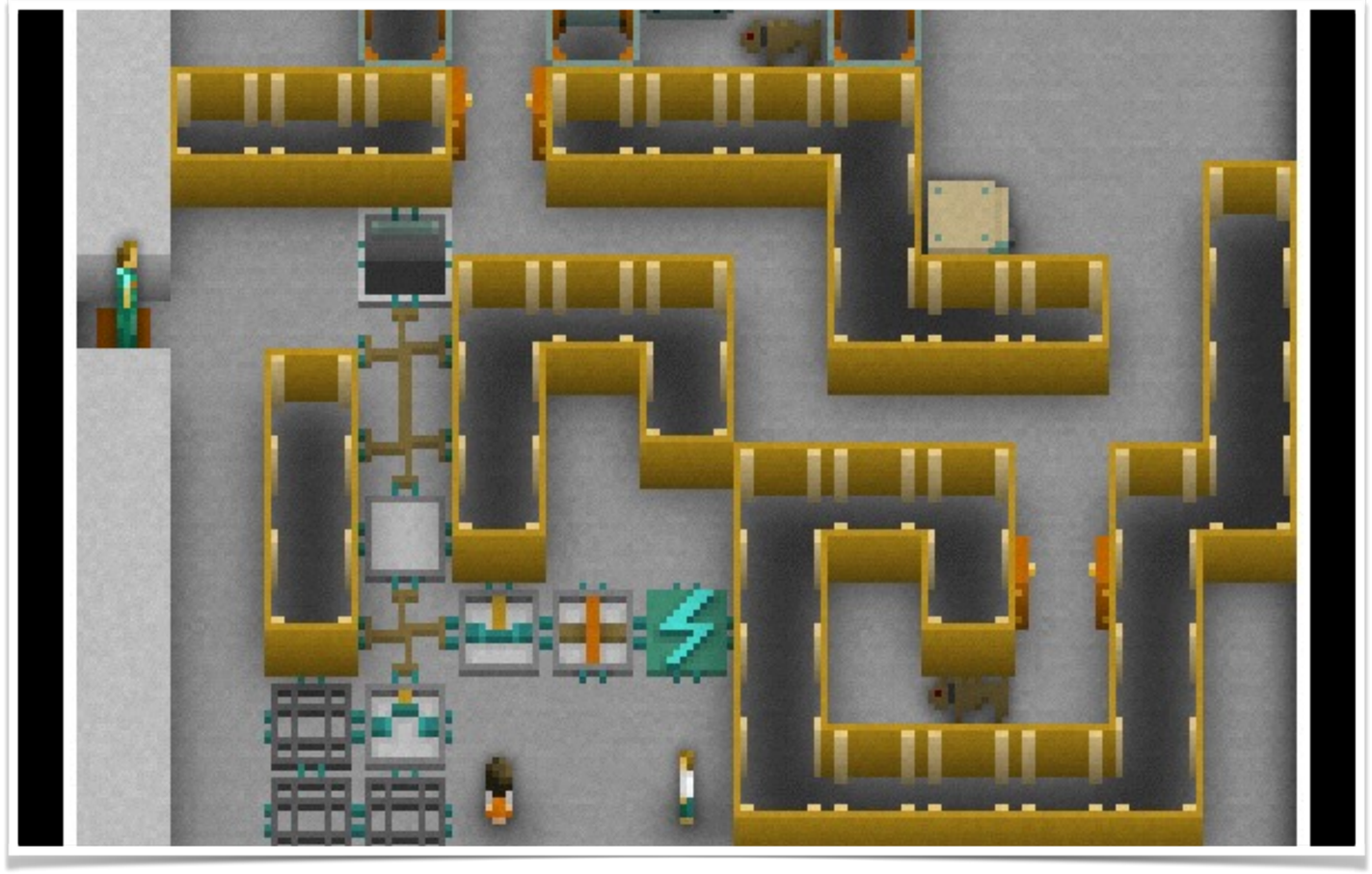
http://www.techeblog.com/index.php/tech-gadget/world-of-warcraft-player-controls-36-characters-simultaneously

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