9. Projekt: Web-Server

```
Sep 19 14:20:18 amd64 sshd[20494]: Accepted rsa for esser from ::ffff:87.234.201.207 port 61557
Sep 19 14:27:41 amd64 syslog-ng[7653]: STATS: dropped 0
Sep 20 01:00:01 amd64 /usr/sbin/cron[29278]: (root) CMD (/sbin/evlogmgr -c "severity=DEBUG")
Sep 20 01:00:01 amd64 syslog-ng[7653]: STATS: dropped 0
Sep 20 02:00:01 amd64 /usr/sbin/cron[30103]: (root) CMD (/sbin/evlogmgr -c 'age > "30d"')
Sep 20 02:00:01 amd64 syslog-ng[7653]: STATS: dropped 0
Sep 20 12:46:44 amd64 sshd[6516]: Accepted rsa for esser from ::ffff:87.234.201.207 port 62004
Sep 20 12:46:44 amd64 syslog-ng[7653]: STATS: dropped 0
Sep 20 12:48:41 amd64 sshd[6609]: Accepted rsa for esser from ::ffff:87.234.201.207 port 62105
Sep 20 12:54:44 amd64 sshd[6694]: Accepted rsa for esser from ::ffff:87.234.201.207 port 62514
Sep 20 15:27:35 amd64 sshd[9077]: Accepted rsa for esser from ::ffff:87.234.201.207 port 64242
Sep 20 15:27:35 amd64 syslog-ng[7653]: STATS: dropped 0
Sep 20 16:37:11 amd64 sshd[10102]: Accepted rsa for esser from ::ffff:87.234.201.207 port 63375
Sep 20 16:37:11 amd64 syslog-ng[7653]: STATS: dropped 0
Sep 20 16:38:10 amd64 sshd[10140]: Accepted rsa for esser from ::ffff:87.234.201.207 port 63546
Sep 21 01:00:01 amd64 /usr/sbin/cron[17[illegible]]: (root) CMD (/sbin/evlogmgr -c "severity=DEBUG")
Sep 21 01:00:01 amd64 syslog-ng[7653]: STATS: dropped 0
Sep 21 02:00:01 amd64 /usr/sbin/cron[17[illegible]]: (root) CMD (/sbin/evlogmgr -c 'age > "30d"')
Sep 21 02:00:01 amd64 syslog-ng[7653]: STATS: dropped 0
Sep 21 17:43:26 amd64 sshd[1088]: Accepted rsa for esser from ::ffff:87.234.201.207 port 63397
Sep 21 17:43:26 amd64 syslog-ng[7653]: STATS: dropped 0
Sep 21 17:53:39 amd64 sshd[31269]: Accepted rsa for esser from ::ffff:87.234.201.207 port 64391
Sep 21 18:43:26 amd64 syslog-ng[7653]: STATS: dropped 0
Sep 21 19:43:26 amd64 syslog-ng[7653]: STATS: dropped 0
Sep 22 01:00:01 amd64 /usr/sbin/cron[4674]: (root) CMD (/sbin/evlogmgr -c "severity=DEBUG")
Sep 22 01:00:01 amd64 syslog-ng[7653]: STATS: dropped 0
Sep 22 02:00:01 amd64 /usr/sbin/cron[549[illegible]]: (root) CMD (/sbin/evlogmgr -c 'age > "30d"')
Sep 22 02:00:01 amd64 syslog-ng[7653]: STATS: dropped 0
Sep 22 20:23:21 amd64 syslog-ng[7653]: STATS: dropped 0
Sep 23 01:00:01 amd64 /usr/sbin/cron[2473]: (root) CMD (/sbin/evlogmgr -c "severity=DEBUG")
Sep 23 01:00:01 amd64 syslog-ng[7653]: STATS: dropped 0
Sep 23 02:00:01 amd64 /usr/sbin/cron[25555]: (root) CMD (/sbin/evlogmgr -c 'age > "30d"')
Sep 23 02:00:01 amd64 syslog-ng[7653]: STATS: dropped 0
Sep 23 18:04:05 amd64 sshd[6554]: Accepted publickey for esser from ::ffff:192.168.1.5 port 59771 ssh2
Sep 23 18:04:05 amd64 syslog-ng[7653]: STATS: dropped 0
Sep 23 18:04:34 amd64 sshd[6606]: Accepted rsa for esser from ::ffff:87.234.201.207 port 62093
Sep 24 01:00:01 amd64 /usr/sbin/cron[12436]: (root) CMD (/sbin/evlogmgr -c "severity=DEBUG")
Sep 24 01:00:01 amd64 syslog-ng[7653]: STATS: dropped 0
Sep 24 02:00:01 amd64 /usr/sbin/cron[13253]: (root) CMD (/sbin/evlogmgr -c 'age > "30d"')
Sep 24 02:00:01 amd64 syslog-ng[7653]: STATS: dropped 0
Sep 24 11:15:48 amd64 sshd[20998]: Accepted rsa for esser from ::ffff:87.234.201.207 port 64456
Sep 24 11:15:48 amd64 syslog-ng[7653]: STATS: dropped 0
Sep 24 13:49:08 amd64 sshd[23197]: Accepted rsa for esser from ::ffff:87.234.201.207 port 61330
Sep 24 13:49:08 amd64 syslog-ng[7653]: STATS: dropped 0
Sep 24 15:42:07 amd64 kernel: snd_seq_midi_event: unsupported module, tainting kernel.
Sep 24 15:42:07 amd64 syslog-ng[7653]: STATS: dropped 0
Sep 24 15:42:07 amd64 kernel: snd_seq_oss: unsupported module, tainting kernel.
Sep 24 20:25:31 amd64 sshd[29399]: Accepted rsa for esser from ::ffff:87.234.201.207 port 62566
Sep 24 20:25:31 amd64 syslog-ng[7653]: STATS: dropped 0
Sep 25 01:00:02 amd64 /usr/sbin/cron[662]: (root) CMD (/sbin/evlogmgr -c "severity=DEBUG")
Sep 25 01:00:02 amd64 syslog-ng[7653]: STATS: dropped 0
Sep 25 02:00:01 amd64 /usr/sbin/cron[1484]: (root) CMD (/sbin/evlogmgr -c 'age > "30d"')
Sep 25 02:00:02 amd64 syslog-ng[7653]: STATS: dropped 0
Sep 25 10:59:25 amd64 sshd[8889]: Accepted rsa for esser from ::ffff:87.234.201.207 port 64183
Sep 25 10:59:25 amd64 syslog-ng[7653]: STATS: dropped 0
Sep 25 10:59:47 amd64 sshd[8921]: Accepted rsa for esser from ::ffff:87.234.201.207 port 64253
Sep 25 11:30:02 amd64 sshd[9372]: Accepted rsa for esser from ::ffff:87.234.201.207 port 62029
Sep 25 11:59:25 amd64 syslog-ng[7653]: STATS: dropped 0
Sep 25 14:05:37 amd64 sshd[11554]: Accepted rsa for esser from ::ffff:87.234.201.207 port 62822
Sep 25 14:05:37 amd64 syslog-ng[7653]: STATS: dropped 0
Sep 25 14:06:10 amd64 sshd[11586]: Accepted rsa for esser from ::ffff:87.234.201.207 port 62951
Sep 25 14:07:17 amd64 sshd[11608]: Accepted rsa for esser from ::ffff:87.234.201.207 port 63392
Sep 25 14:08:33 amd64 sshd[11630]: Accepted rsa for esser from ::ffff:87.234.201.207 port 63709
Sep 25 15:25:33 amd64 sshd[12930]: Accepted rsa for esser from ::ffff:87.234.201.207 port 62778
```

Programmier-Projekt

- Implementierung eines Web-Servers mit folgenden Features
  - Frei wählbares Document-Root-Verzeichnis und frei wählbarer Port
  - gzip-Kompression (vgl. mod_deflate bei Apache),
  - beliebig viele parallele Verbindungen, über Threads realisiert
  - Server beendet sich/gibt Statusinfo, wenn das Dokument /EXIT bzw. /STATUS angefordert wird
  - Connection: Keep-Alive
  - Pfadüberprüfung gegen ../../-Attacken
  - Aktive Inhalte (auf Server-Seite ausgeführte Skripte)

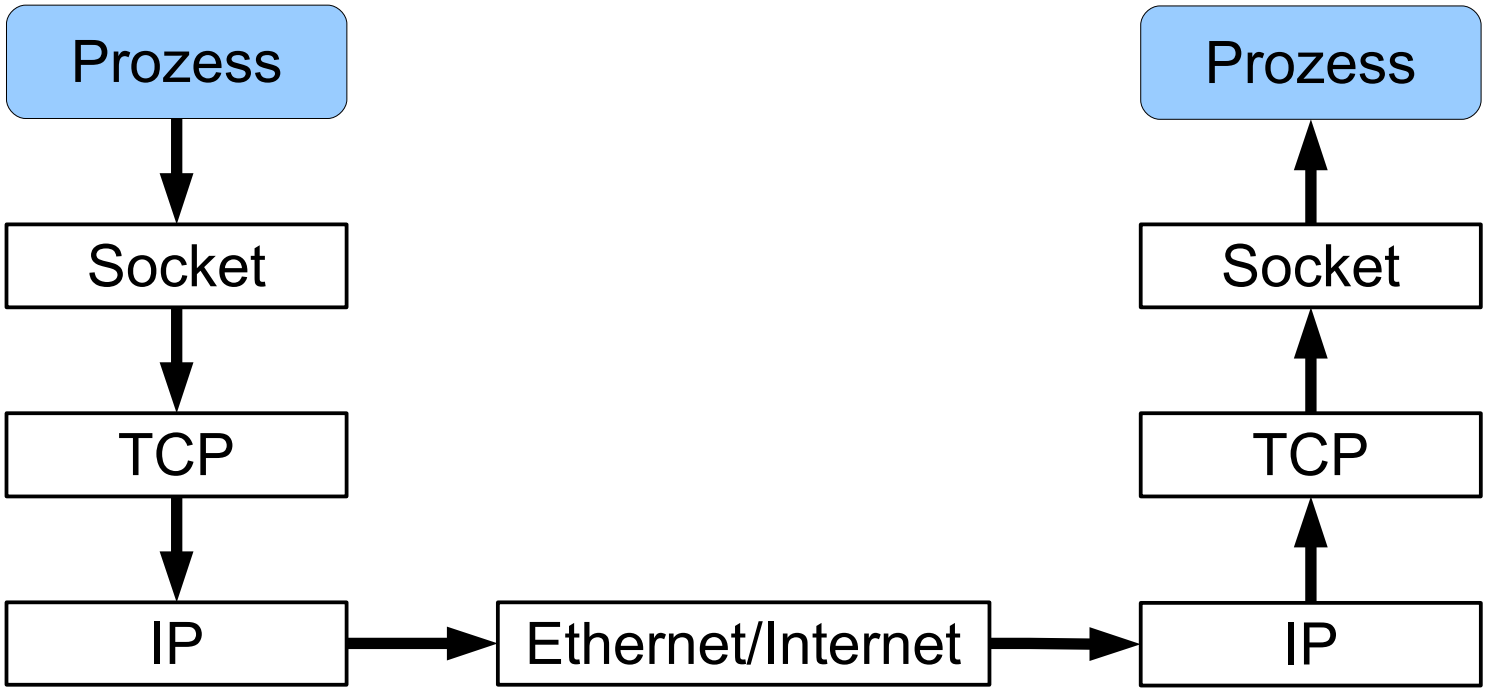
Projekt: Grundlagen

Übersicht

- Datenstrukturen für Sockets
- `socket()`, `bind()`, `listen()`, `accept()`
- `htons()`, `ntohs()`, `inet_ntoa()`, `inet_aton()`
- Socket-Deskriptoren als File-Deskriptoren
- Basics zu HTTP

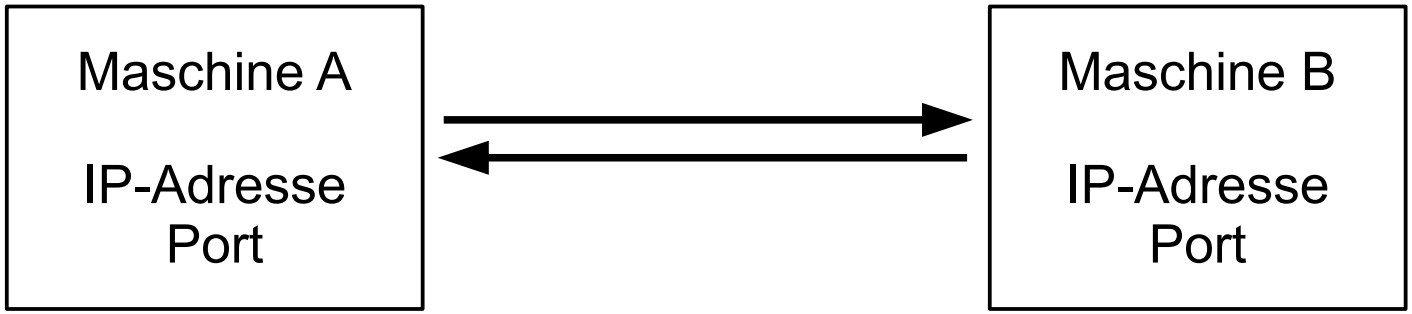
TCP, IP & Co. (1)

- Hier keine Theorie zu Netzwerken, Layers etc.
- Sockets erlauben Kommunikation über TCP/IP



TCP, IP & Co. (2)

- TCP (Transmission Control Protocol): verbindungsorientiert, zuverlässig; nutzt IP (Internet Protocol)
- TCP-Verbindung: (IP_1, $Port_1$, IP_2, $Port_2$)



(Port nötig, da mehrere Verbindungen möglich)

TCP, IP & Co. (3)

- `netstat` zeigt (u. a.) offene TCP-Verbindungen an, bekannte Ports erscheinen mit Namen

```
[esser@macbookpro:C-Projekte]$ netstat
Active Internet connections (w/o servers)
Proto Rec-Q Snd-Q  Local Address    Foreign Address         State
tcp4       0      0  macbookpro.59433 faui1s219.inform.https ESTABLISHED
tcp4       0      0  macbookpro.59432 channelproxy-shv.https ESTABLISHED
tcp4       0      0  macbookpro.59428 edge-star-shv-07.https ESTABLISHED
tcp4       0      0  macbookpro.59348 my.ohmportal.de.imaps  ESTABLISHED
tcp4       0      0  macbookpro.59347 imap.1und1.de.imap2    ESTABLISHED
tcp4       0      0  macbookpro.59241 173.194.116.149.https  ESTABLISHED
[...]
[esser@macbookpro:~]$ egrep "^imap|^https" /etc/services | grep tcp
imap2           143/tcp         # Internet Message Access Protocol
https           443/tcp         # http protocol over TLS/SSL
imaps           993/tcp         # imap4 protocol over TLS/SSL
```

TCP, IP & Co. (4)

- `netstat -a` zeigt zusätzlich Server an, d. h., Sockets, die auf Verbindungsanfragen warten:

```
[esser@macbookpro:C-Projekte]$ netstat -a
Active Internet connections (servers and established)
Proto Rec-Q Snd-Q  Local Address    Foreign Address         State
tcp4       0      0  macbookpro.59433 faui1s219.inform.https ESTABLISHED
tcp4       0      0  *.http-alt       *.*                    LISTEN
tcp4       0      0  macbookpro.59432 channelproxy-shv.https ESTABLISHED
[...]
```

Datenstrukturen

- Socket-Deskriptoren
  - einfache Integers, wie File-Deskriptoren
  - `socket()` und `accept()` geben Socket-Deskriptoren zurück
- IP-Adressen

```
struct sockaddr_in {
    short            sin_family;   // Typ,  z. B. AF_INET
    unsigned short   sin_port;     // Port, z. B. htons (8080)
    struct in_addr   sin_addr;     // kodierte Adresse
    char             sin_zero[8];  // freier Platz
};

struct in_addr {
    unsigned long s_addr;          // mit inet_aton() füllen
                                   // oder auf INADDR_ANY setzen
};
```

Sockets erzeugen

- Es gibt zwei Arten von Sockets (für unsere Zwecke)
  - generischer Socket, der mit `socket()` erzeugt wird → kann verwendet werden,
    - um einen TCP-Port zu binden; bleibt dann dauerhaft „in Betrieb“ (Server)
    - um eine Verbindung zu einem Server aufzubauen (Client)
  - Verbindungs-Socket, der mit `accept()` erzeugt wird → ist nur für eine konkrete Verbindung (mit einem Client) zuständig

Sockets erzeugen

- Server
  - `sd = socket ()`
  - Server-Adresse konfigurieren
  - `bind (sd, Server-Adresse)`
  - `listen (sd)`
  - `conn = accept (sd, &Client-Adresse)`
    (zweiter Socket!)
- Client
  - `sd = socket ()`
  - Ziel-Adresse konfigurieren
  - `connect (sd, &Ziel-Adresse)`

TCP-Server erzeugen (1)

```
int sd;   // socket descriptor for server
struct sockaddr_in server;

sd = socket (PF_INET, SOCK_STREAM, 0);
// PF_INET: Protocol Family, Internet
// SOCK_STREAM: TCP

server.sin_port         = htons(PORT);
server.sin_addr.s_addr = INADDR_ANY;
server.sin_family       = AF_INET;
                      // Address Family, Internet
```

TCP-Server erzeugen (2)

```
int conn;  // socket descriptor for connection
#define SOCKADDR_SIZE sizeof(struct sockaddr_in)
int clilen = SOCKADDR_SIZE;
struct sockaddr_in client;

bind (sd, (struct sockaddr *)&server,
      SOCKADDR_SIZE)

listen (sd, 0);

conn = accept (sd, (struct sockaddr *) &client,
                &clilen);
```

TCP-Server erzeugen (3)

```
char buf[bufsize];

// lesen: wie aus Datei
readbytes = read (conn, &buf, bufsize);

// schreiben: wie in Datei
write (conn, &buf, n);

// diese Verbindung schliessen
shutdown (conn, SHUT_RDWR);
close (conn);

// auch dup2() funktioniert mit socket descr.
```

htons(), ntohs()

- TCP/IP gibt Standard-Byte-Order vor (Network Byte Order, Big-Endian, most-significant byte first)
- Linux-PC verwendet Little-Endian (least-significant byte first)
- `htons()` und `ntohs()` konvertieren Portnummern: **h**ost **to** **n**etwork bzw. **n**etwork **to** **h**ost
- darum:

```
server.sin_port          = htons(PORT);
```

inet_ntoa()

- Aus Adress-Eintrag IP-Adresse auslesen mit `inet_ntoa()`:

```
struct sockaddr_in client;
accept (sd, (struct sockaddr *) &client,
        &clilen);
printf ("Client-Adresse: %s \n",
        inet_ntoa (client.sin_addr));
```

- wertet `client.sin_addr.s_addr` aus

HTTP Basics

- TCP-Verbindung über Sockets, ASCII-Protokoll
- Client → Server:

```
GET /index.html HTTP/1.1
Host: domainname.top
User-Agent: Mozilla/5.0 (...)
```

- Server → Client:

```
HTTP/1.1 201 OK
Content-Type: text/html

<html>
...
```

```
HTTP/1.1 404 Not found
Content-Type: text/html

<html>
...
```