Network - Programming

Networks

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Overview

- Network-Protocols
- Protocol family TCP/IP
- Transmission Control Protocol (TCP)
- First steps with sockets

Computer Network

- Problem:
  - Send data from computer A to computer B
  - A and B are (indirectly) connected via a network
- Solutions:
  - One protocol for everything
  - Family of specialized protocols, that are stacked

Network Layers

application	ssh,SMTP,HTTP
transport	TCP, UDP
network	IP
link	Ethernet

link layer

- models physical connection
- Hardware addresses
- Data in frames
- Sensitive to errors
- Checksums
- Example: Ethernet, . . .

network layer

- modells link between different networks
- Packets inside of frames
- connectionless, unreliable, best effort
- routing
- Own address space
- Example: Internet Protocol (IP)
- Domain Name System (DNS) for “readable“ addresses

transport layer

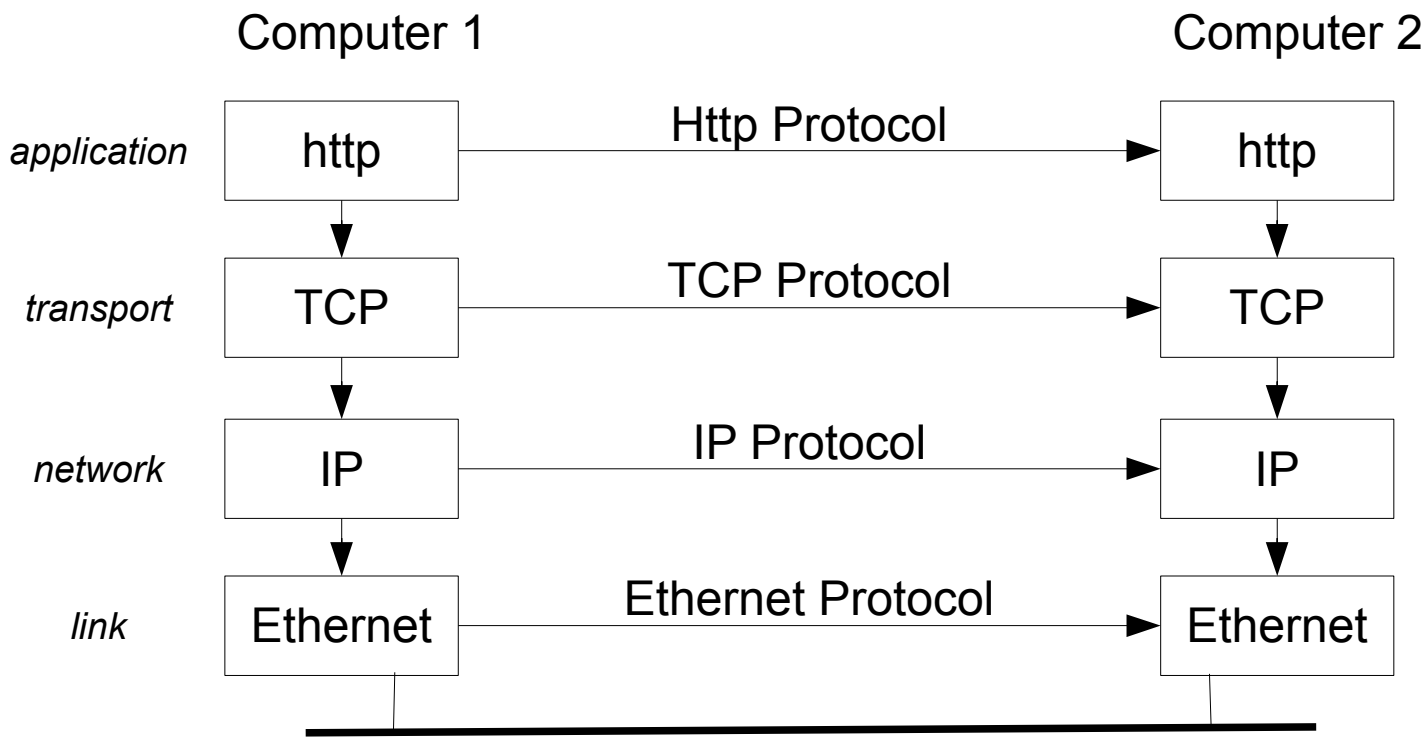
- demultiplexing, port numbers
- well known ports, `/etc/services`
- User Datagram Protocol (UDP):
  - Similar to IP: datagramme, connectionless, unreliable
- Transmission Control Protocol (TCP):
  - Data stream
  - “Connection“
- Reliability through billing procedure
- flow control, congestion avoidance

application layer

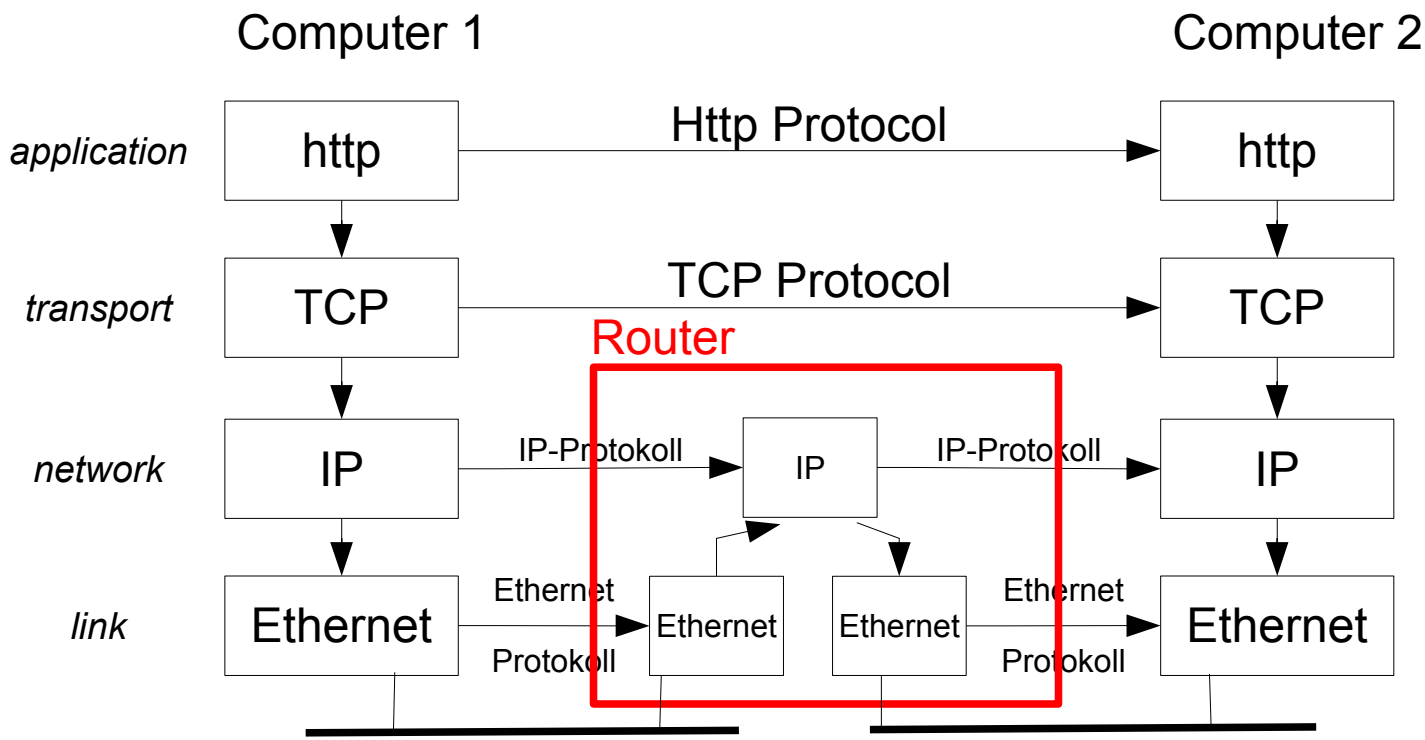
- Uses transport layer
- TCP or UDP relies on use case
- APIs:
  - Berkeley sockets
  - X/Open Transport Interface
  - . . .

encapsulation

Communication in different Layers

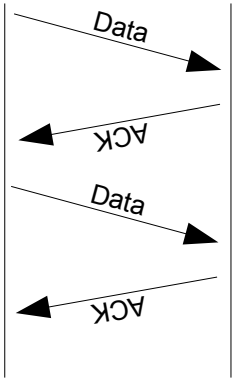


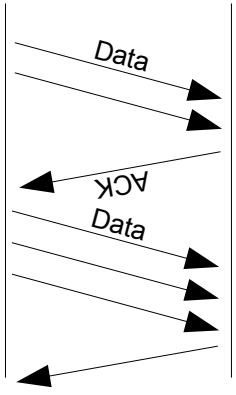
Routing


Computer 1
Computer 2
application
transport
network
link
http
Http Protocol
http
TCP
TCP Protocol
TCP
Router
IP
IP-Protokoll
IP
IP-Protokoll
IP
Ethernet
Ethernet
Protokoll
Ethernet
Ethernet
Ethernet
Protokoll
Ethernet

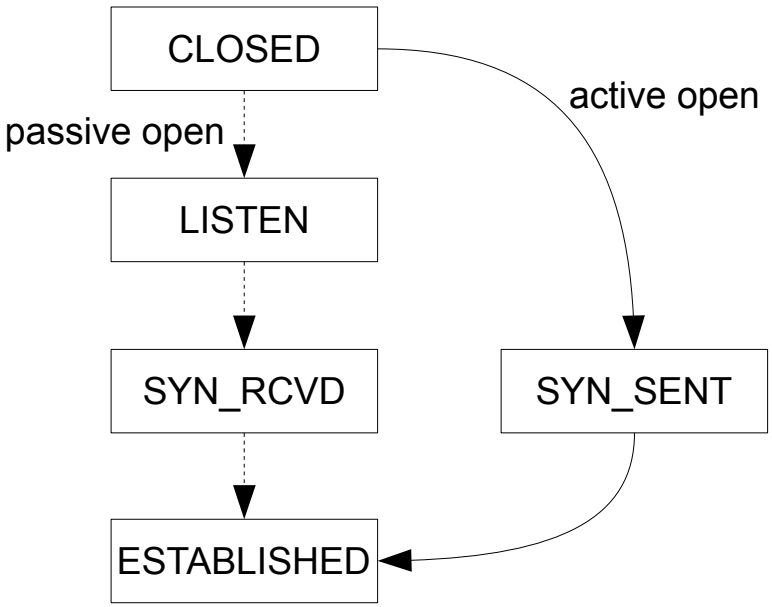
Transmission Control Protocol

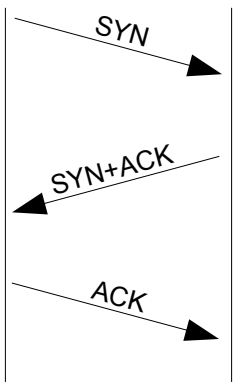
- Confirmation of recieved packets
- New delivery of lost packets
- sequence numbers



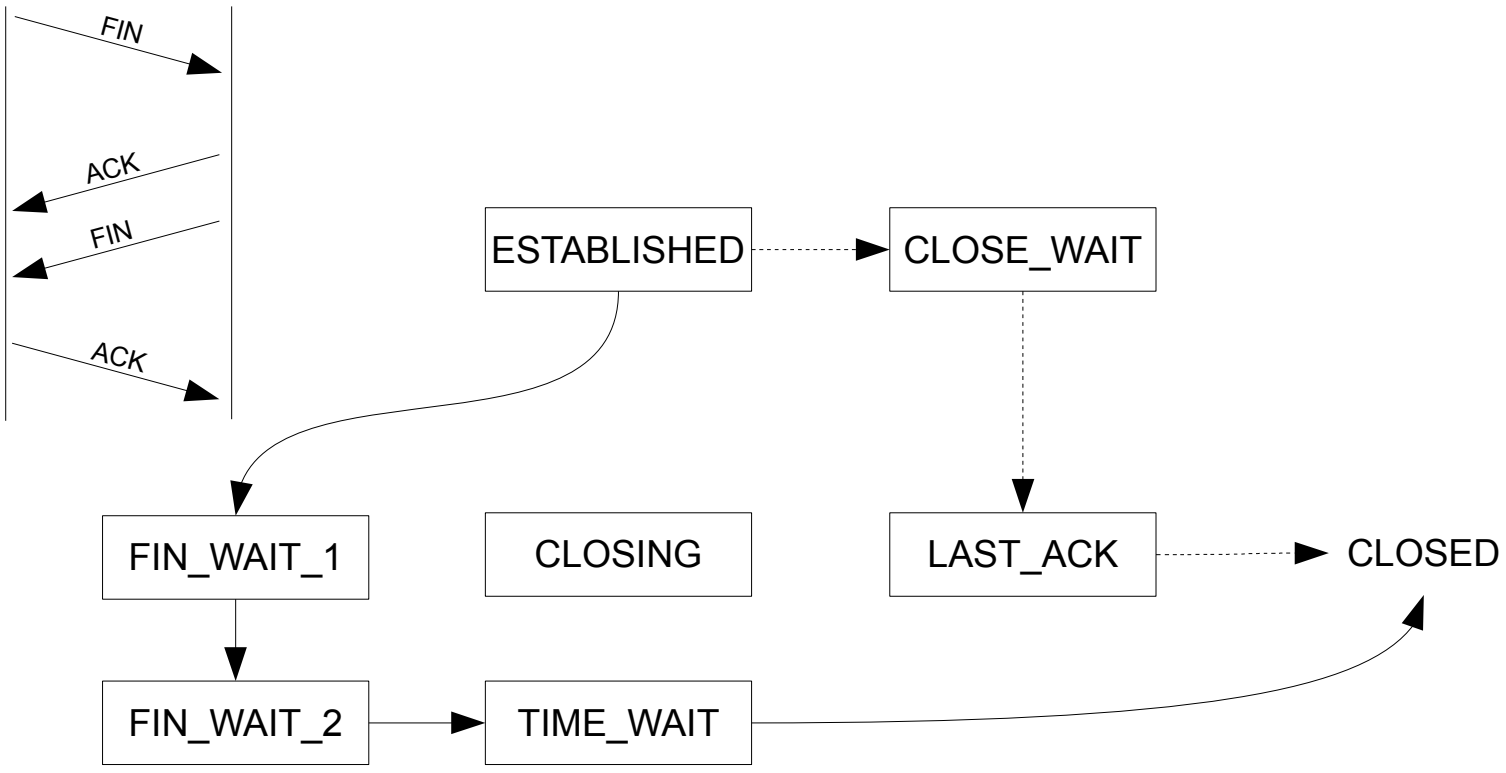


Starting a Connection





Closing a Connection



TCP Usage

- Connection identified by a socket pair:
  (IP-AddresseL, PortL, IP-AddresseR, PortR)
- Show connection details:

```
$ netstat -A inet | more
…
Proto Recv-Q Send-Q Local Address Foreign Address State
tcp 0 0 leonardo.TF:1018 kaylee.TF:nfs ESTABLISHED
tcp 0 0 leonardo.TF:50657 simon.TF:nfs TIME_WAIT
tcp 0 0 leonardo.TF:38896 donatello.TF:ssh ESTABLISHED
…
(TF = TechFak.Uni-Bielefeld.DE)
```

Hands on!

- Open a ssh connection to another computer, e.g. from goldfinger to compute.linux. Observe the output in two different terminals on every computer of netstat. Which entries will be added?
- Close the connection. How is the output of netstat altered?

Hands on!

- You can find the scripts server.pl and client.pl in the archive Netzwerke.tar.gz.(Extract the content of the archive with

  ```
  $ tar -xvf Netzwerke.tar.gz
  ```

  From now on you need three open terminals.
- Start the server. You have to specifiy a port number:

  ```
  $ server.pl 54321
  ```
- Have a look at the current status of the server:

  ```
  $ netstat -a | grep 54321
  ```

Hands on!

- Let the client read data from the server:

  ```
  $ client.pl 54321
  ```

  Use meanwhile netstat for analyzing the connection.
- Start the client two times more. What will be changed in every call?
- Start the client with a fixed port number:

  ```
  $ client.pl 54321 55443
  ```

  Repeat the call again twice.

Hands on!

- Start more clients simultaniously:

```
$ client.pl 54321 & [enter]
$ client.pl 54321 & [enter]
$ client.pl 54321 & [enter]
```

  What can you observe?

- Start two clients with the same fixed port number simultaniously:

```
$ client.pl 54321 55443 & [enter]
$ client.pl 54321 55443 & [enter]
```

  What happens?

- Quit the server and try restart it instantly. What happens?
- What will happen, if you quit the client with CTRL+C while reading data from the server?