60 - TCP / IP

- **History of TCP/IP**
- **Diagram of layers of TCP/IP**
- **TCP vs. UDP Protocols**
  - Garanteed data transport(eg. ftp) vs speed(eg. nfs)
  ICMP- Protocol
- **Ports numbers and their use**
  - Ports < 1024 are reserved for well known services
  - Sockets (Source Addr.+ Source Port combination)
- **Addressing cheme**
  - Types of networks and addressing range
  - Reserved address ranges
- **Netmask purpose**
- **Subnetting**
- **Examples of sub-networks**
  - Make some examples of subnets in a building
- **Network configuration : see Section 21: Network Config.**
- **Related Programs and services**
  `ifconfig -a | less` Lists all local network interfaces
  `ping`
  `ip addr`
  `traceroute -d` *`destination.IPAddr`*
  `netstat -nr`
  `netstat -taupe`
  `watch -n1 'netstat -ltu'`
  `hostname -f` (Full domain name)
  `hostname -d` (Domain name only
  `hostname -s` (short hostname only)
  `hostname -i` (Main IP Number of Host)
- **Files involved:**
  - `/etc/protocols` - List of protocols supported
  - `/etc/HOSTNAME` - Local host name
  - `/etc/host.conf` - Sequence of events in resilving names
  - `/etc/hosts` - Host IP# and name resolution local file
  - `/etc/resolv.conf` - List of Name Servers for name resolving
  - `/etc/sysconfig/network` - Configuration files for network.

TCP/IP

- **TCP/IP Protocol family description:**
  1. **Diagram of Protocol layers(Course Notes p.15)**
     ARP (**A**ddress **R**esolution **P**rotocol) IP No. to Ethernet address
     Ethernet Address is a Ethernet Card manufacturer unique No.
     Ethernet Card driver broadcasts it Ethernet address periodically
     Start `iptraf` / IP Trafic Monitor and look at ARP packets activity.

  2. **IP - Internet Protocol**
     1. - Transport the IP address and is responsible for Addressing and routing
     2. - No Confirmation of reception
     3. - Max Packet size: 65535 but Ethernet=max 1500 or older=576
     4. - Only CRC Check is done for validity of data

  3. **TCP - Transport Control Protocol**
     1. - Responsible to get the packets to destination
     2. - Full duplex oriented

  4. **UDP - User Datagram Protocol**
     1. - No feedback of reception of packets
     2. - Simplex mode oriented
     3. - Therefore fast but not secure protocol
     4. - Used in Multicasting (special broadcasting to multiple networks)

  5. **ICMP - Internet Control Message Protocol**
     1. Test and Control Measure Protocol (Ping uses this)
     2. Transport Protocol Layer 3

ICMP Messages:
Error Messages:

```
3  Destination unreachable (Zielstation nicht erreichbar)
4  Source quench (Buffer-Ressourcen verbraucht)
5  Redirect (Pfadumleitung)
11 Time exceeded (Timer abgelaufen)
12 Parameter Problem (Parameter Problem)
```

Information Messages:

```
0  Echo reply
8  Echo request
13 Time stamp
14 Time stamp reply
15 Information request
16 Information reply
17 Adress mask request
18 Adress mask reply
```

- **Ports used indification of TCP/UDP Services (see `/etc/services` file)**
    1. Port 1-1024 are well known ports
    2. - `http:` Port 80
    3. - `ftp:` Port 21
    4. - `pop3:` Port 110

    Note: When a port is commented out in this list then the service is only available in Receiver only.

- **IP Addressing Schemes:(see extra Addressing page)**
    1. Standard classes of IP Addressing for Internet (older method)
    2. CIDR (Classless Inter Domain Routing) scheme for Internet
       Addressing format: `192.168.12.19/24`
    3. IPv4(32 bit) and IPv6(128 bit)
    4. Reserved addresses for Intranet usage

- **Sockets and connection principle:**
  Socket is Combination of Addr. Port (eg. `192.168.12.34:21`)
  Connection is Combination of both Source and Destination sockets

- **Subnetting principle**
    1. Normal use of `192.168.x.x` for Intranet (`x.x.10.x` ---- `x.x.11.x` etc)
    2. Subnetting in the last address area (`192.168.x.`x)
    3. Example of departments in a building (50,52,9,29,12)
        1. Show the Address range distribution (`0----------255`)
        2. Decision of subnet size for each department.
        3. Assignment of netmasks for each group
        4. Hosts addresses assignment

- **Pinging a range of IPs (192.168.10.0 - 192.168.10.255)**
  - Install the port scanner 'nmap'
  - run the command:

```
nmap -n -sP 192.168.10.0/24 | cut -d" " -f2
```

- **Finding the Network address range from Host network settings**

Binary Method

1. Get the IP address and Netmask lasts numbers converted to binary:

2. eg1. addr: 192.168.10 .25 – 000|1 1001 – 000|00000 -Network addr.
Netmask: 255.255.255 .224 – 111|0 0000 – 000|11111 -Broadcast addr.

Result is:

Network addr. **0** (first Subnet address)
Broadcast addr. **31** (last subnet address)
Hosts addressing range: **1** to **30** (30 hosts) ----------

- **eg.2** addr: 192.168.10 .102 – 01|100110 – 01|000000 - Network addr.
255.255.255.192 – 11|000000 – 01|111111 - Broadcast addr.

Result is:

Network addr. **64** (first Subnet address)
Broadcast addr. **127** (last subnet address)
Hosts addressing range: **65** to **126** (62 hosts)

Decimal method

Host Address: 192.168.10 .102
Netmask: 255.255.255.192

Method: 1) 256–Netmask eg. 256–192=64
then this host is part of a subnet of **64 addresses**.

2) Look for a block in the column of **64** in table on next page where the host address (102) is located.

3) Result = 64 – 127 (64 to 127)

4) Then its:

Network Address: 192.168.10.64
Broadcast Address: 192.168.10.127
Hosts addressing range: **65** to **126** (62 hosts)

IP Address Blocks

4	4	8	16	32	64
0 - 3	128 - 131	0 - 7	0 - 15	0 - 31	0 - 63
4 - 7	132 - 135	8 - 15	16 - 31	32 - 63	64 - 127
8 - 11	136 - 139	16 - 23	32 - 47	64 - 95	128 - 191
12 - 15	140 - 143	24 - 31	48 - 63	96 - 127	192 - 255
16 - 19	144 - 147	32 - 39	64 - 79	128 - 159	
20 - 23	148 - 151	40 - 47	80 - 95	160 - 191	
24 - 27	152 - 155	48 - 55	96 - 111	192 - 223	
28 - 31	156 - 159	56 - 63	112 - 127	224 - 255	
32 - 35	160 - 163	64 - 71	128 - 143		
36 - 39	164 - 167	72 - 79	144 - 159		
40 - 43	168 - 171	80 - 87	160 - 175		
44 - 47	172 - 175	88 - 95	176 - 191		
48 - 51	176 - 179	96 - 103	192 - 207		
52 - 55	180 - 183	104 - 111	208 - 223		
56 - 59	184 - 187	112 - 119	224 - 239		
60 - 63	188 - 191	120 - 127	240 - 255		
64 - 67	192 - 195	128 - 135			
68 - 71	196 - 199	136 - 143			
72 - 75	200 - 203	144 - 151			
76 - 79	204 - 207	152 - 159			
80 - 83	208 - 211	160 - 167			
84 - 87	212 - 215	168 - 175			
88 - 91	216 - 219	176 - 183			
92 - 95	220 - 223	184 - 191			
96 - 99	224 - 227	192 - 199			
100 - 103	228 - 231	200 - 207			
104 - 107	232 - 235	208 - 215			
108 - 111	236 - 239	216 - 223			
112 - 115	240 - 243	224 - 231			
116 - 119	244 - 247	232 - 239			
120 - 123	248 - 251	240 - 247			
124 - 127	252 - 255	248 - 255			

Standard	CIDR	Standard	CIDR	Standard	CIDR	Standard	CIDR
128.0.0.0	/1	255.128.0.0	/9	255.255.128.0	/17	255.255.255.128	/25
192.0.0.0	/2	255.192.0.0	/10	255.255.192.0	/18	255.255.255.192	/26
224.0.0.0	/3	255.224.0.0	/11	255.255.224.0	/19	255.255.255.224	/27
240.0.0.0	/4	255.240.0.0	/12	255.255.240.0	/20	255.255.255.240	/28
248.0.0.0	/5	255.248.0.0	/13	255.255.248.0	/21	255.255.255.248	/29
252.0.0.0	/6	255.252.0.0	/14	255.255.252.0	/22	255.255.255.252	/30
254.0.0.0	/7	255.254.0.0	/15	255.255.254.0	/23	255.255.255.254	/31
255.0.0.0	/8	255.255.0.0	/16	255.255.255.0	/24	255.255.255.255	/32

TCP/IP Network Addressing

TCP = **T**ransmission **C**ontrol **P**rotocol **UDP**=**U**ser **D**atagram **P**rotocol
IP = **I**nternet **P**rotocol **ICMP**=**I**nternet **C**ontrol **M**essage **P**rotocol

Netzwerkadressen:

Klasse A	**1**	0	0	0	-	**127**	255	255	255
Klasse B	**128**	**0**	0	0	-	**191**	**255**	255	255
Klasse C	**192**	**0**	**0**	0	-	**223**	**255**	**255**	255

Reservierte Adressen für Private Netzwerk:

Klasse A	**10**	0	0	0	-	**10**	255	255	255
Klasse B	**172**	**16**	0	0	-	**172**	**31**	255	255
Klasse C	**192**	**168**	**0**	0	-	**192**	**168**	**255**	255
Localhost	**127**	0	0	0		**127**	255	255	255

Klasse D 224 - 239 (Multicasting)
Klasse E 240 - 255 (Internet Eigenbedarf)

Anzahl der Netzwerke und Computer:

	Netzwerke	**Computer**
Klasse A	125	2^{24}= 16'777'216
Klasse B	16'382	2^{16}= 65'536
Klasse C	2'097'150	2^{8} = 256
Total	2'113'658	3'724'410'368

Berechnung des Netmasks:

	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	
bit:	|	|	|	|	|	|	|	|	
	128	**64**	**32**	**16**	**8**	**4**	**2**	**1**	Number of
Netmask									Computers *
128	|								128-2=126
192	|	|							64-2=62
224	|	|	|						32-2=30
240	|	|	|	|					16-2=14
248	|	|	|	|	|				8-2=6
252	|	|	|	|	|	|			4-2=2
254	|	|	|	|	|	|	|		
255	|	|	|	|	|	|	|	|	

*-2 weil: `192.168.x.0`=Netzwerkadresse & `192.168.x.255`=Broadcast sind reserviert