Subnetting

What is Subnetting?

With subnetting you divide a network into several smaller separated subnetworks. The subnets are then called VLAN (Virtual Local Area Network).

Subnetting, but why?

There are only three good reasons for subnetting:

- **Security:** For example is the guest network normally separated from the main network, so no guest could track the data stream in the main network.
- **Scaleability:** When for example a new department is created in a company, it is often easier to create a new subnet than to integrate the new department in the existing network.
- **Treatment:** For example, the network with the IP-phones is given a higher priority than the computer network, because it's less critical if a website loads slightly slower, whereas choppy calls must be avoided.

Structure of the subnet mask

The most commonly used subnet mask is probaly this: **255.255.255.0**. The most important thing to understand, is that this is the more human-readable format. Behind it lies the actual binary form: **11111111.11111111.11111111.00000000**. This also reveals a key characteristic of subnet masks: They are always filled with ones from left to right. The individual blocks of a subnet mask are called octets. For example, 11010010 could never be an octet in a subnet mask. The table below lists all possible values an octet in a subnet mask can take.

Binary	Decimal
00000000	0
10000000	128
11000000	192
11100000	224
11110000	240
11111000	248
11111100	252
11111110	254
11111111	255

Standard notation

Network addresses are also written like this: **192.168.0.0/24**. Here, the 24 represents the number of ones – in this case, exactly three sets of eight ones followed by eight zeros (just like the previous example).
This means there are 256 addresses total (**192.168.0.0 - 192.168.0.255**). However, the first and the last addresses are never usable, leaving 254 available addresses.

Subnetting, but how?

First determine the required network size. For example, let's say we need to accommodate 500 devices in our network. We use the doubled binary sequence:

Binary sequence	1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, ...
Doubled binary sequence	2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048, ...

Our 500 devices fit in the 512 range. Since 512 is the 9th number in the doubled sequence, our subnet mask requires nine zeros (or 23 ones). It looks like this: **11111111.11111111.11111110.00000000** (or **255.255.254.0** in decimal). For the network **10.0.0.0/23**, this means IP addresses from **10.0.0.0** to **10.0.1.255** belong to the network, totaling 512 addresses (with 510 usable).

!!!IMPORTANT!!! If we had needed exactly 512 devices, we would have had to choose the next higher network (since two addresses are always unusable). In this case, we had need the **10.0.0.0/22** network with the subnet mask **255.255.252.0**, supporting 1024(1022) addresses.

Common Subnets

CIDR	Subnet mask	IP's (Usable)	Typical Use Case
/22	255.255.252.0	1024 (1022)	Large cloud networks
/23	255.255.254.0	512 (510)	Medium client networks
/24	255.255.255.0	256 (254)	Small client networks
/29	255.255.255.248	8 (6)	Redundant WAN connection
/30	255.255.255.252	4 (2)	Point-to-point WAN connection

Dividing into smaller subnets

Suppose a company uses the IP range 172.16.0.0 and needs to partition it into smaller subnets.
First, we carve out a block for a redundant WAN connection:
172.16.0.0/29 (172.16.0.0 - 172.16.0.7)
Next, we create a printer subnet. Since our example company has only 12 printers, we use a /28 network (16 addresses 14 usable).
The next available subnet would then be 172.16.0.16/28. But what about the addresses 172.16.0.8 - 172.16.0.15?
Here we have two options: either create another /29 network (8 addresses 6 usable) as 172.16.0.8/29, or leave them unallocated as reserved space. Importantly, we cannot start our /28 network at 172.16.0.8 because 8 is not divisible by 16.

!!!IMPORTANT!!! When subnetting, address space must be partitioned following technical constraints. A subnet must either begin with 0 or start at an address that's exactly divisible by the subnet size. /24 networks (256 addresses 254 usable) and above must always start with 0.
For example, a /26 network (64 addresses 62 usable) can only start at x.x.x.0, x.x.x.64, x.x.x128 or x.x.x.192.