030.6121

# RJ45 Category 8
## Permanent Link

White Paper

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R&M

## The category 8.1 permanent link

Due to the prevalence of RJ45 applications and the full backward compatibility with existing cabling systems down to and including Category 6A, R&M has decided to use the PL of Category 8.1 – in other words, to retain the successful RJ45 approach.

Only the two-connector model can be implemented in the Category 8 environment. The permissible length of the Permanent Link (PL) with Category 8.x can be derived from the maximum electrical length of the transmission channel (channel, 32 m) as well as the length ($L_{PC}$) and type of the patch cords used.

This can be calculated as follows: $$L_{PL} = 32 - L_{PC} * X_{PC}$$

The factor $X_{PC}$ depends on the type of patch cord: AWG22/23: 1, AWG24: 1.25, AWG26: 2

The two standardization committees ISO/IEC SC25 and TIA TR42 have specified the maximum lengths for cabling elements. Unfortunately, these vary according to the committee:

| | ISO / IEC | TIA | R&M recommendation |
|---|---|---|---|
| Permanent Link | 5 m – 26 m | max. 24 m | 5 m – 24 m |
| Total length of patch cords | 2 m – 4 m | max. 6 m | 2 m – 4 m |
| Electrical channel length | max. 32 m | max. 32 m | max. 32 m |
| Mechanical channel length | max. 30 m | max. 30 m | max. 28 m |

Table 1: Length overview and R&M specification

Adhering to R&M's specifications ensures that all specifications of both standardization families are fulfilled even if different types of patch cords (AWG 26 - 22) are used in operation.

Schematically, a Category 8.1 channel can be represented as follows:

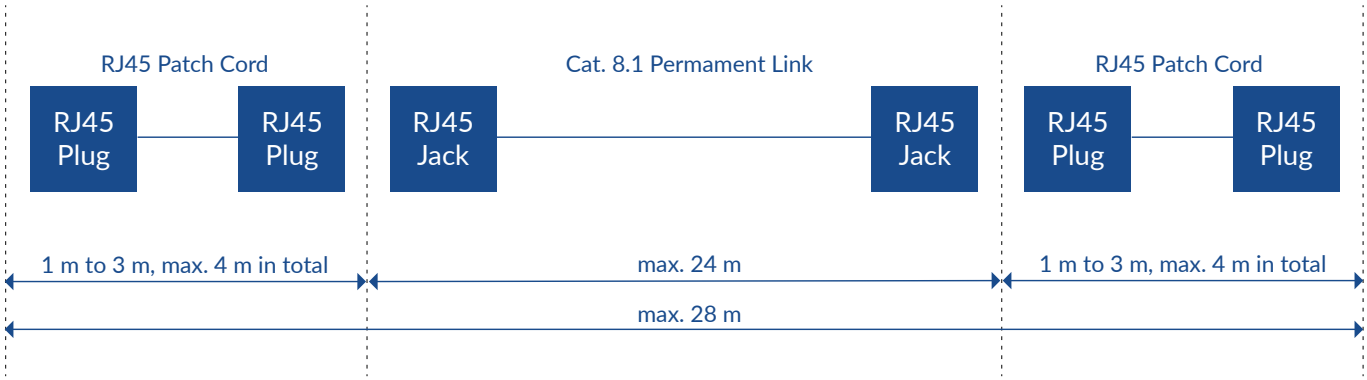


Figure 1: Schematic representation of Cat. 8.1 channel with length specification

An AWG22 installation cable of type 8.1 SF/UTP or F/UTP as well as of type 8.2 S/FTP or F/FTP is designated to be used for the PL. There is no purely unshielded variant and this would not be possible anyway due to the frequency of 2000 MHz. Shielded patch cords of type 8.x can be connected to this PL. If a patch cord is longer than 2 m, the total length of patch cords in use has to be coordinated to ensure that a total of 4 m is not exceeded.

## Untangling cable and category names

The names used when referring to Category 8 components may at times be confusing and unclear. But the division is easily and quickly clarified with an overview matrix. Basically, the TIA does not deal in transmission classes. Unlike ISO/IEC, there is no distinction between component category and link class. Furthermore, the ISO/IEC recognizes the additional categories Cat. 7 and Cat. $7_A$. However, there are no data applications for the corresponding transmission classes F and FA.

| Standard | ANSI / TIA | ISO / IEC | ISO / IEC | Characteristics |
|---|---|---|---|---|
| Component designation | Cat. 8 | Cat. 8.1 | Cat. 8.2 | |
| Link designation | Cat. 8 channel | Class I | Class II | |
| Installation cables | F/UTP or x/FTP, AWG 22 to 24, max. diameter 9 mm | F/UTP, SF/UTP or x/FTP, max. diameter 9 mm | x/FTP, max. diameter 9 mm | Exclusively S/FTP, AWG22 available, max. 2 GHz |
| Modules | RJ45 | RJ45 | GG45 or alternatively TERA | |
| Patch cords | Shielded, AWG 26 to 22, max. diameter 8 mm | Shielded, AWG 26 to 22 | Shielded, AWG 26 to 22 | Exclusively S/FTP, AWG26 available, max. 2 GHz |
| Connectors | RJ45 | RJ45 | GG45 / ARJ45 or alternatively TERA | |
| R&M system environment | | | | |

Table 2: R&M system landscape standard overview

The requirements made of the installation cables of Category 8.1 were defined for a x/UTP construction. For technical reasons, however, such cables are not yet available. Cat. 8.2 installation cables in S/FTP construction are, however, available and technically sophisticated. Every Cat. 8.2 cable also fulfills the requirements of Cat. 8.1. An S/FTP construction which only attains Cat. 8.1, and not Cat. 8.2, would be likely to have inherent technical deficits. This is why R&M only offers Cat. 8.2 installation cables even in a Class I system.

For more detailed information on implementing the R&M Class I system, refer to the installation and test guidelines.
Download link

## Why it makes sense to install Cat. 8.1 today

Technological change is becoming ever faster, quantities of data being downloaded are doubling every year which in turn is having a knock-on effect in terms of bandwidth requirement for certain applications. This inevitably leads to the question of what the right investment is. Viewed historically, the time between the launch of a new standard and full-coverage implementation in the LAN takes not quite a decade.

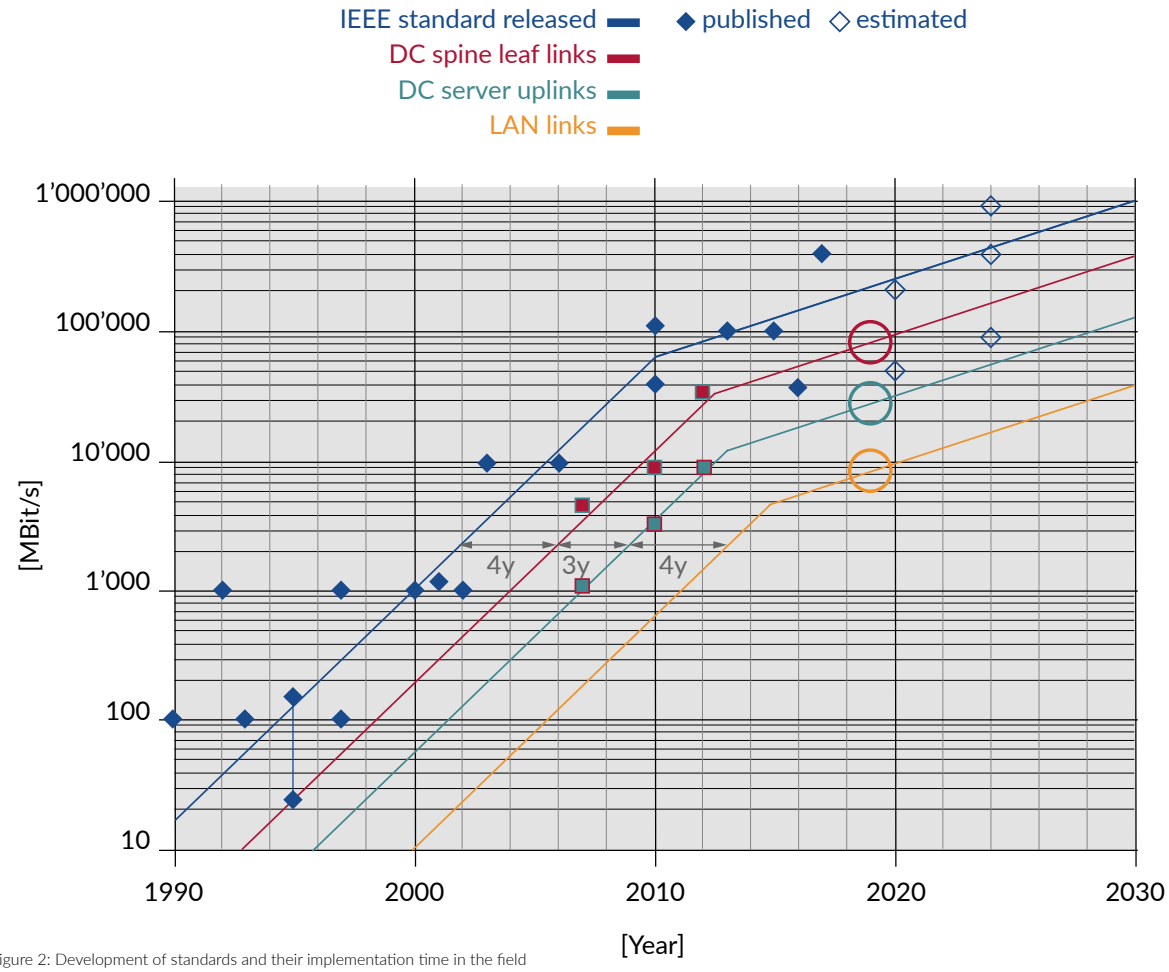


Figure 2: Development of standards and their implementation time in the field

So when a decision has to be made today to implement future-proof LAN cabling, the best practice is to rely on the most up-to-date standard at the time the decision has to be made. The reason for this is simple: The expected lifespan of LAN cabling of 10 – 15 years is considerably longer than the generation cycle of the electronic equipment. Up to five generations of network devices have to run on one and the same LAN.
If the LAN cabling cannot be used for the full lifespan due to insufficient bandwidth and thus has to be replaced early, the original investment has to be written off at a correspondingly faster rate.

40GBase-T was published by IEEE in 2016. If LAN cabling is to remain usable beyond 2026, it would be sensible to pro-actively prepare for this application.

Applications such as broadband hotspots, 5G pico cells, 8kUHD2 and other applications with a particular thirst for data have already been announced.

## Use in the data center

When it comes to data center cabling, it can be assumed that the adaptation mainly depends on prices and the availability of the terminal equipment. In principle, there are two general applications for data centers, top of rack (ToR) and end of row (EoR), which were the origin of the development of Category 8.

## End of row cabling

With end of row or middle of row cabling, Class I cabling is an affordable, flexible and backward-compatible (in other words easy to migrate) alternative to multimode fiber optic stretches on an MPO basis as a permanent link between the server cabinets and the switch cabinet for 10G/25G/40G transmission rates. The limitation of the PL length to 24 m is insignificant in this area as the required lengths are usually considerably shorter.

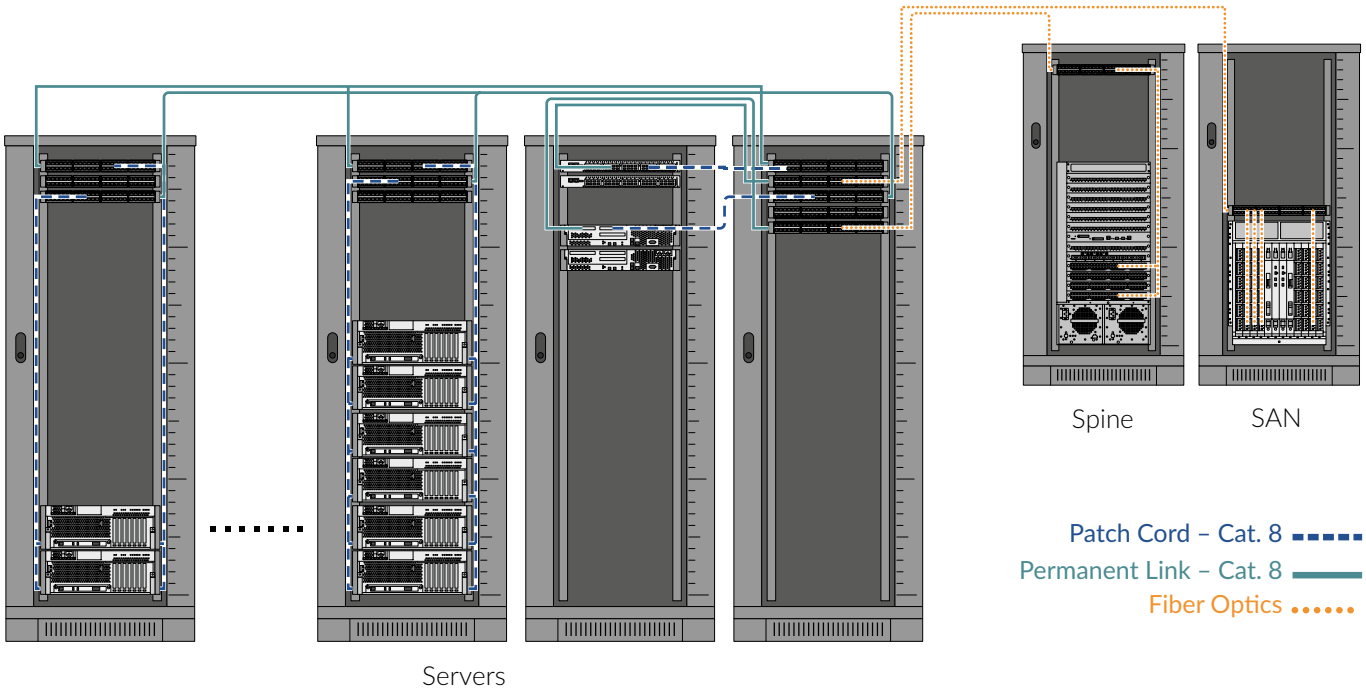


Figure 3: End of row cabling

## Top of rack cabling

With top of rack implementation, a Cat. 8.1 patch cord with 40GBase-T can replace existing SFP+ and QSFP connections at a low price and high density.

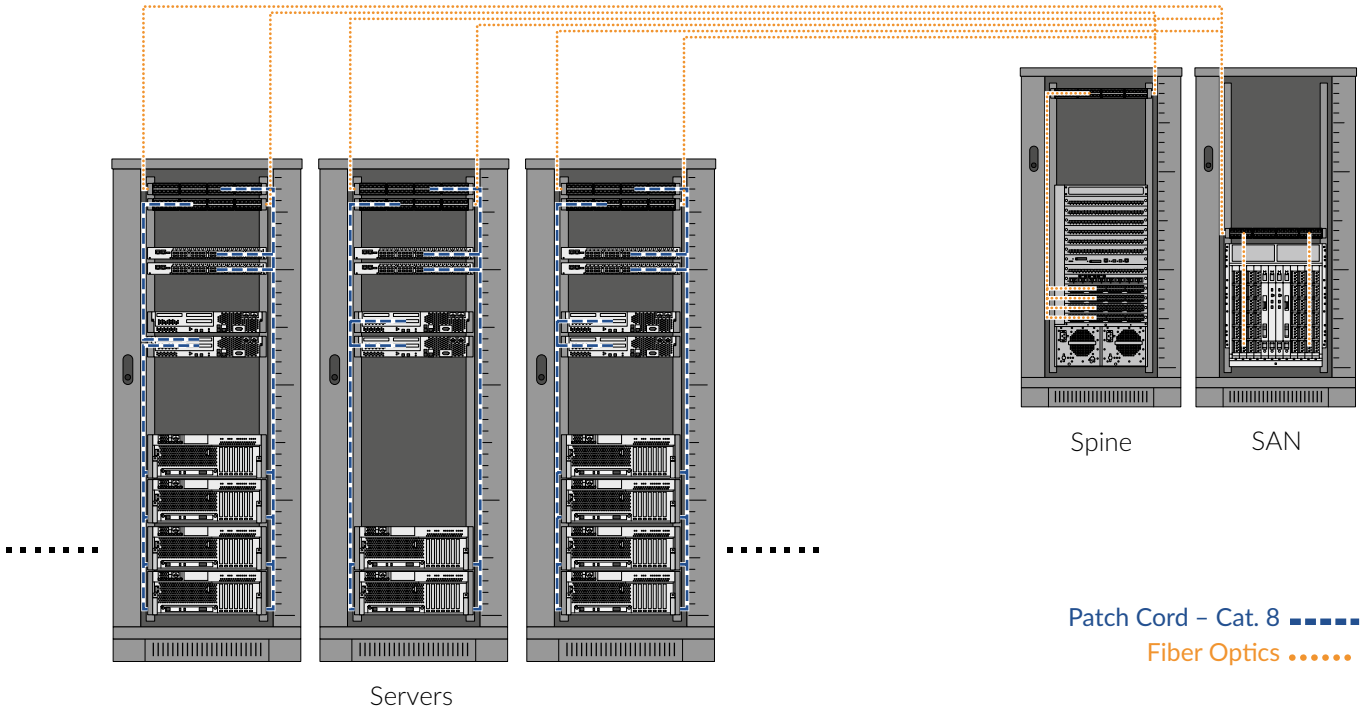


Figure 4: Top of rack cabling

## Category 8.1 also in the LAN environment

It is safe to assume that Cat. 8.1 will also be able to be used in the LAN environment when the 25GBase-T variant is launched.

The transmission frequencies of 1,600 MHz required for a data rate of 40GB/s limit the attainable link length to 24 meters due to the high attenuation values of the cabling at these frequencies. At 10 GB/s and 400 MHz, this length is still 90 m. Estimates for 25 GB/s and 1,000 MHz would suggest an attainable link length of 50 m. This achievable length is examined in more detail in the technical report from ISO/IEC TR11801-9909.

With an achievable link length of 50 m, around 60 % of all required links can be realized in the LAN environment. This makes Cat. 8.1 a feasible solution for the LAN.

## Sensible zone assignment

Today's office complexes are becoming even more modern and open-plan offices are divided into zones, whether for light, air-conditioning or because modern workplaces are not always occupied, for example due to people working at home or because of the demand for dynamic extension possibilities.

This can be used to great advantage for a range of applications. So as not to have to increase the number of floor distributors with electronic equipment, bandwidth can be defined differently to suit the workplace and its purpose.

### 40 GB/s zone

A workplace zone with up to 40 GB/s can be set up in a radius of 24 m around the floor distributor. This is an ideal environment for development departments and multimedia departments with large bandwidth requirements for image editing.

### 25 GB/s zone

The new standard workplace. Experience shows that the average length of a PL in the LAN area is 40-50 m. The majority of connections in a LAN would be in this range and would also permit demanding tasks. Service outlets (SO) could also be positioned in this area for the high-speed WLAN connection points.

### 10 GB/s zone

This zone covers all remaining building connections. In the future, it will also be sufficient for "normal" office workstations, building automation, printer connections and production lines.

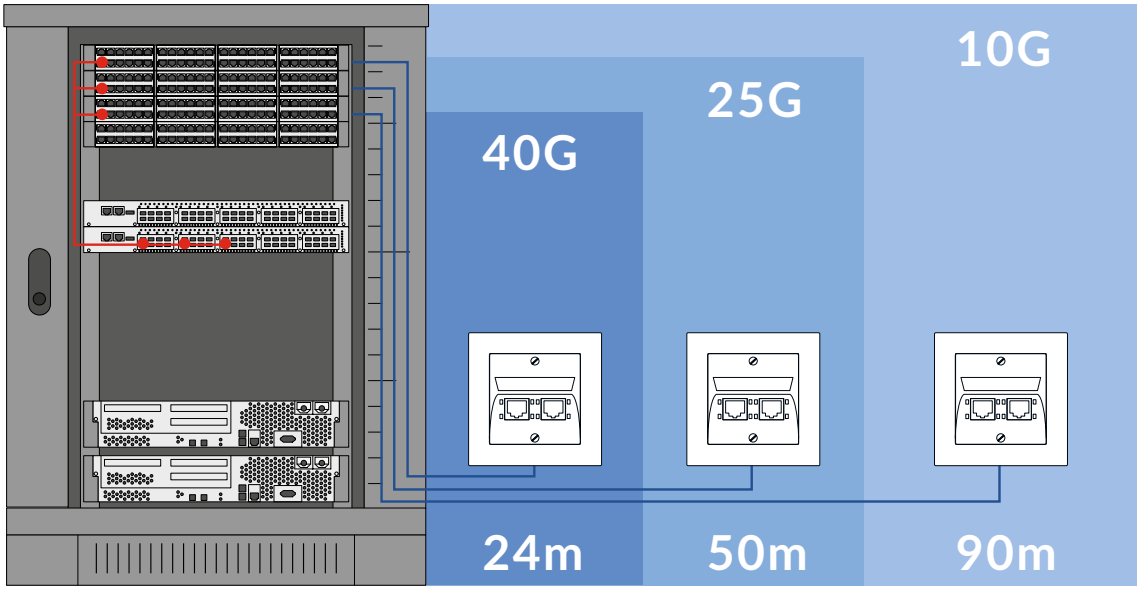


Figure 5: Variable speed zones in the LAN with Cat. 8.1

The advantage of this concept is obvious: a standard cabling structure with one cable type and one connection module type. That simplifies initial cabling and subsequently maintenance. As soon as the required electronic equipment is available, it can be connected and the increased bandwidth is available immediately without the need for any new cabling or adjustments to outlets.

The prerequisite for this solution: the use of RJ45-based, backward-compatible cabling components such as those of the Cat. 8.1 system from R&M.

## Usage sample for a modern office building

This example shows a 23 storey building for an estimated 100 work places (WP) per floor. The area consists of approximately 25 m x 50 m. For WLAN coverage 4 wireless access points (WAP) are foreseen for each floor.

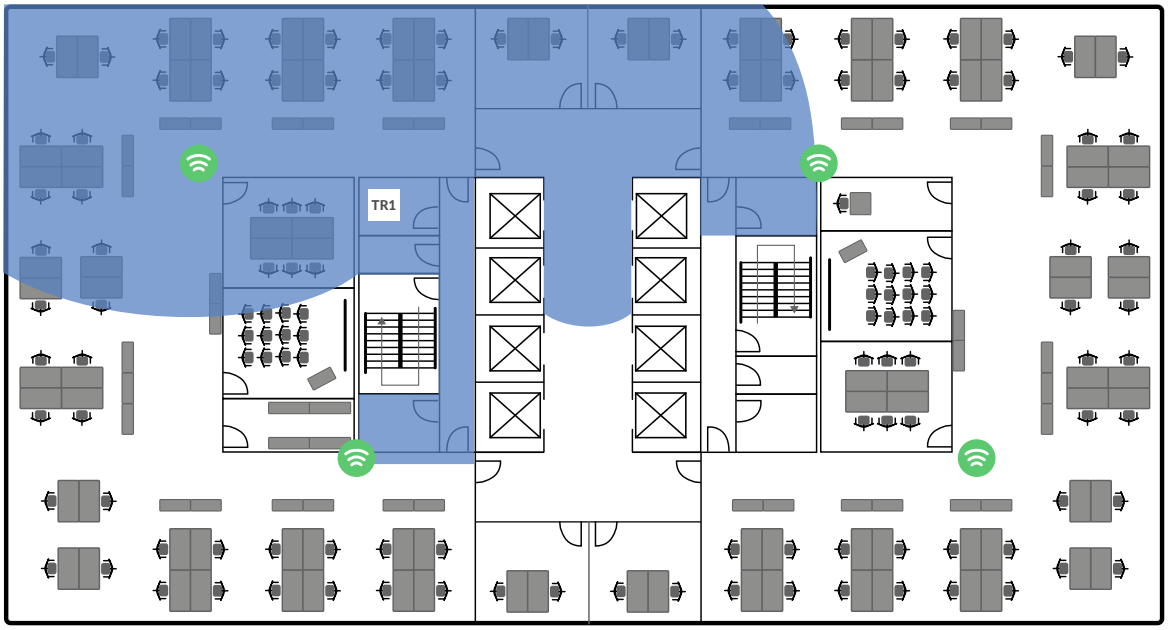


Figure 6: 24 m zone with one floor distributor TR1 (telecom room)

Using the 24 m zone around TR1 allows coverage for 30 work spaces from a total of 100 and 3 out of 4 for WAP.

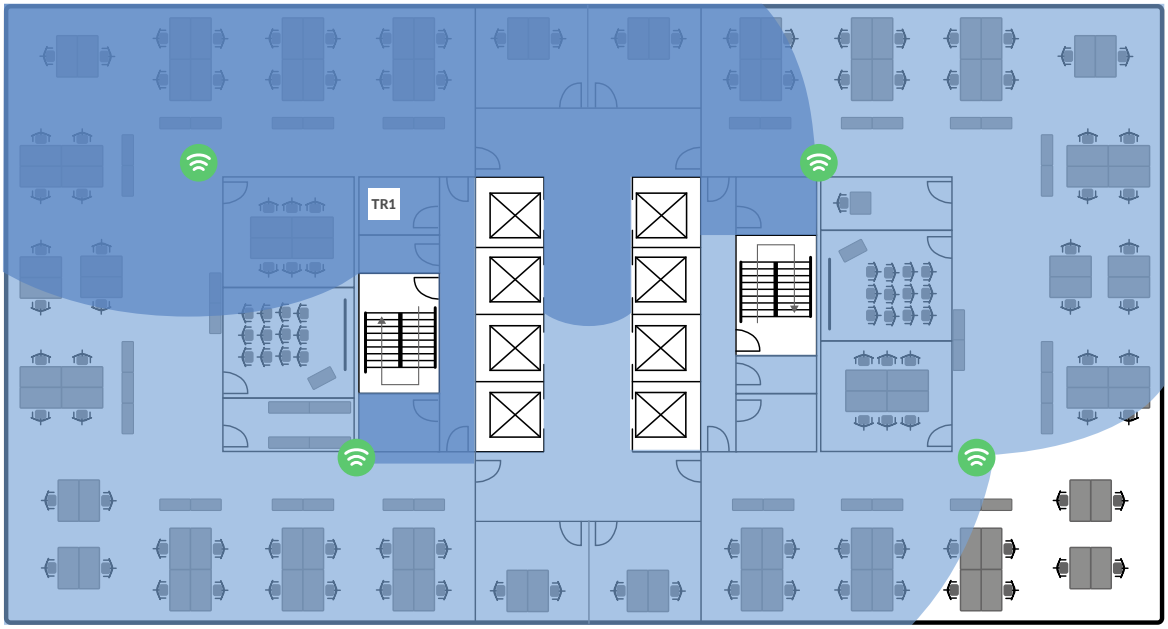


Figure 7: 24 m and 50 m zone with one floor distributor TR1 (telecom room)

Using the 50 m zone around TR1 allows coverage for 92 work spaces from a total of 100 and all WAP. Only 8 work places are not covered.

With modern office buildings for upscale standards often several floor distributors are projected. This enlarges the amount of connections in the 24 m zone significantly.

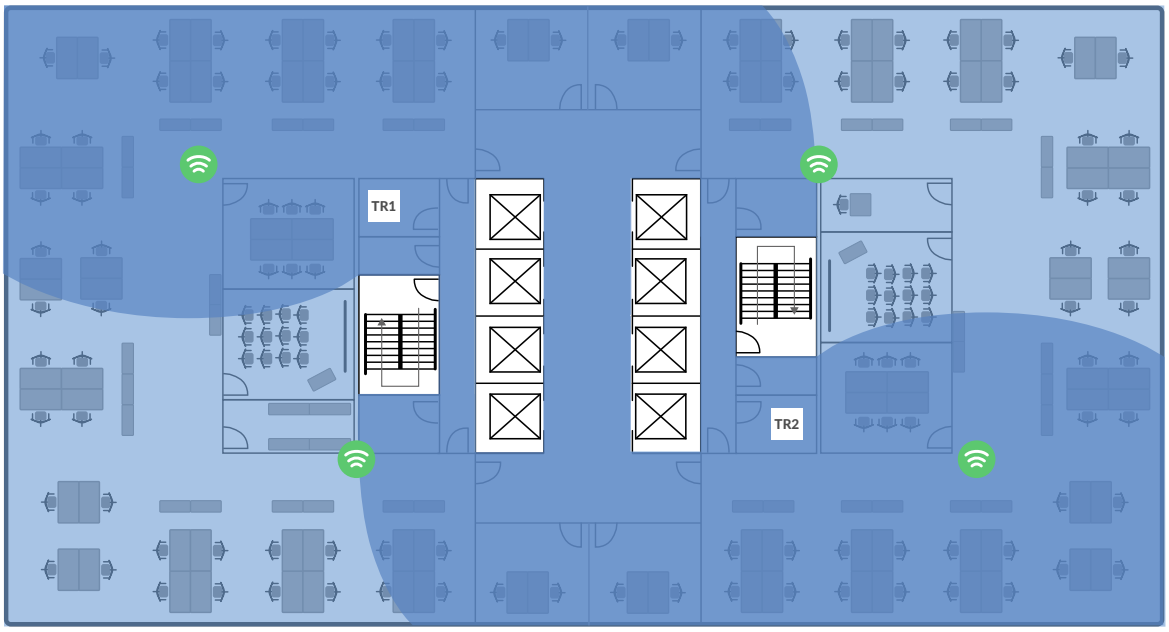


Figure 8: 24 m and 50m zone with two floor distributors (TR1 & TR2)

With 2 telecom rooms 58 work spaces are covered in the 24 m zone and all WAP. All remaining work spaces are within the 50 m zone.

Summary when using Cat.8.1 cabling:

| | 40G | 25G | 10G |
|---|---|---|---|
| 1TR, WP | 30 % | 62 % | 8 % |
| 1TR, WAP | 75 % | 25 % | - |
| 2TR, WP | 58 % | 42 % | - |
| 2TR, WAP | 100 % | - | - |

This example shows, in modern office buildings a significant amount of access points can often be connected with higher bandwidth when using Cat.8.1 cabling. Applying adequate planning and execution of Cat.8.1 cabling one can realise the next level in data transmission.