cellnex
driving telecom connectivity

DAS
case study
“Milan Metro Line M5”

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1 What is a DAS installation for?

A **Distributed Antenna System (DAS)** makes it possible to increase cellular capacity and coverage in places with large numbers of people needing intense mass simultaneous traffic. The **DAS** system is implemented when signal levels arriving from external macrosites are very low or, even where levels are sufficient, when a large number of network requests need to be served, which entails increasing system capacity to ensure that everyone in the area has a good connection.

2 Architecture of the DAS system in “Milan Metro Line M5”

Line M5 of the Milan Metro crosses the city from the north east (Bignami terminus) to the west (San Siro Stadio terminus). Built as a light metro with tunnels and trains smaller than the three pre-existing Milan metro lines, it is also known as the “**purple line**” on account of the colour used to represent it on maps and also the principal colour of its stations and trains. It was opened in 2015 and is the latest of Milan’s metro lines. **Line 5** is equipped with an innovative automatic driving system: it is in fact a **driverless** metro: the platform’s vehicles have no driver’s cab and offer high levels of performance, comfort and safety.

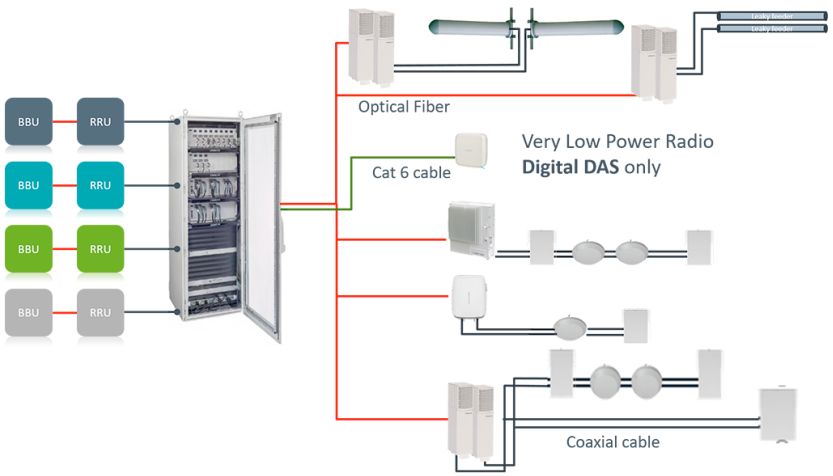
The automatic driving system of **Metro5** is controlled directly from the control room of the **Central Operations Post (PCO)**. The **PCO** monitors the smooth operation of the line and allows operators to devise scenarios that guarantee passenger safety at all times in coordination with service and maintenance personnel and stewards.

Some facts and figures about the line: it is **12.9 km long with 19 stations** and has a total transport capacity of **10,720** passengers an hour and boasts an average of **134,075** passengers carried per working day.

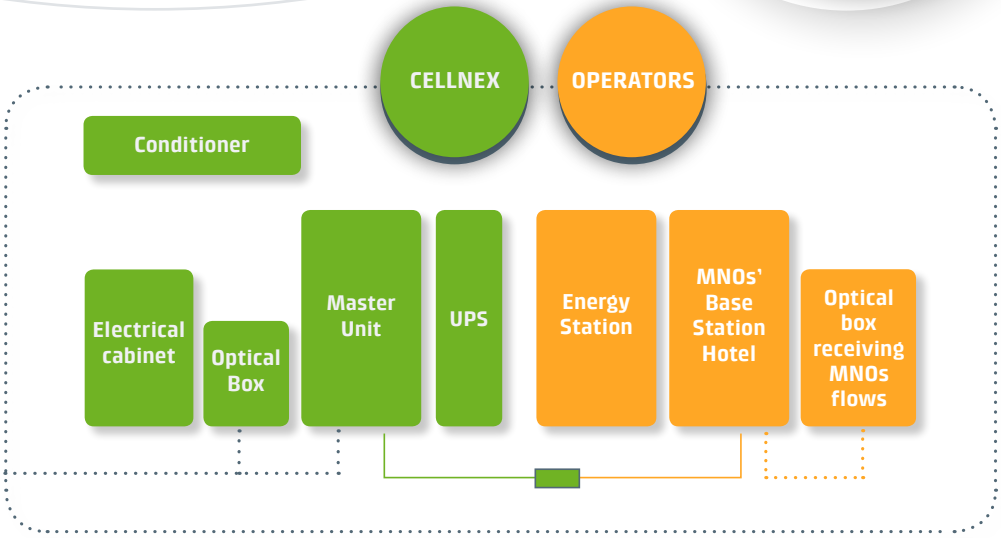
A **multi-operator DAS** solution was required to guarantee all passengers travelling on Line5 a simultaneous connection for sharing images and videos and browsing the web.

The DAS solution includes an extender, or **remote access** facility, a system designed to extend mobile telephone services within specific places. To this end, the system not only extends coverage but also performs network functions, providing **radio coverage** inside the metro as agreed with the operators.

Architecture of the DAS facility



Logical Scheme and Technical Room



This design of this extender system is adapted to the structure of the areas to be covered and has the following architecture:

Outgoing radio signals

The outgoing signals of the **2G, 3G and 4G** systems are managed by the operators, who set up a technical interface with the **DAS** installation, delivering the signals to be distributed in the agreed places. The interface between the operators' source devices and the **Cellnex remote access system** is housed in the plant room where the **Master Unit** is also installed.

Plant room

To ensure optimal distribution of the operators' signals, two Plant Rooms were installed in spaces provided by **Metro5**, of a suitable size to accommodate all the equipment needed for the proper operation of the system. In addition to the **Cellnex** equipment, the rooms also house the equipment installed by all the mobile telephone operators needing to distribute their signals within the Metro system via the **Master Unit (MU).**

In addition to all this pre-installed equipment, the operators then placed their cabinets in the plant rooms. These cabinets contain the radio section of their chosen systems to be repeated through the system as envisaged by the project. It should be noted that the number of operators' devices depends on the number of sectors/systems that each of them has decided to repeat within the structure.

Remote unit

Remote Units (RUs) are optical repeaters, powered at 230V, which convert the optical signal received by the **Master Unit** into a radio signal and feed it into coaxial cables for final distribution to the antennas.

53 High Power and Low Power RUs were used to provide coverage to all areas of the metro (stations and tunnels) with an output power for each system of **20 W (40 dBm) and 1 W (30 dBm)** respectively. Considering that each of these **Remote Units** can consume up to **1 kW** at full capacity, a standard single-phase circuit breaker must be provided to power them.

The breakers were installed in positions selected in cooperation with **Metro5**, whose full understanding of the purpose of a **DAS** system allowed **Cellnex** to offer the best solution in terms of both technical and aesthetic criteria.

Optical fibre distribution to the Remote Units

Appropriately sized fibre-optic distribution cables connect the **Master Unit** with each of the **RUs** distributed within the metro and hence transmit the operators' signals.

Passive RF network distribution

This is an **RF network** composed of 1/2'' semi-rigid coaxial cables and passive RF components (directional couplers and splitters) to connect each individual RU to all antennas suitably positioned in the points envisaged by the radio project to guarantee the expected coverage levels.

Antennas

The antennas chosen for the coverage inside the stations and tunnels are passive types (omnidirectional, panel and circular) and were sited to achieve a very low visual impact. The system employs a total of **508 antennas** distributed to reduce electromagnetic emissions to the minimum while guaranteeing multi-operator cellular coverage within each individual area.

Here it is worth remembering that the underground railway environment is very sensitive to direct or induced electromagnetic fields which, if allowed to become too strong, would cause even the simplest equipment inside the trains to malfunction. The very low electromagnetic impact of a **DAS** installation is therefore the best possible solution for providing coverage while safeguarding all electronic assets. In the case of the Milan **Line5**, this compatibility has also been certified by appropriate tests that have shown that the cellular repeater system does not cause any interference with the devices on board the trains, notably those that control the automatic driving system.

Multiple sectors

Sectors are used to adapt and specify the coverage based on the architecture of the entire metro line and particularly the needs of the passengers using it every day.

This system has been designed and specified with up to **14 sectors.**

Each of these sectors forming part of the structure has been set up to allow all mobile telephone operators to repeat up to **three frequencies (1800 MHz, 2100 MHz and 2600 MHz)** and more specifically:

2G/4G: 1800MHz	**3G/4G:** 2100MHz	**4G:** 2600MHz

In any case, there is already provision fort multiple sectors for **4.5G**, since it allows users to utilise both **4G** bands simultaneously, in **SISO** configuration, and actually perform what is known as "**carrier aggregation**" to achieve the highest possible download speeds on this standard.

It was therefore possible to provide a very high level of service to everyone within the entire **Line 5** of the metro using this multi-operator system to implement up to:

14 sectors in total, including 11 for each of the **2 systems** and 3 sectors for **3 systems** of **4 operators** with a total of **124 sectors** dedicated to guaranteeing very high performance for each passenger taking the underground every day.

More recently, during the Covid-19 pandemic emergency, Cellnex was also able to help increase coverage capacity in some areas identified by Metro5 in support of a praiseworthy initiative by the Metro company: providing space free of charge to the Buzzi Children's Hospital in Milan for a free flu vaccine campaign for children aged 2 to 6.

The entire DAS coverage system described above operates with **24/7 supervision** by the **Cellnex Network Operations Centre (NOC)** equipped with all the necessary hardware and software, and appropriately staffed for the control of the system.

Network Operation Centre, Cellnex

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