The Dubai Metro, the World's Longest Fully Automated Metro Network

Transportation Systems Division

The Dubai Metro infrastructure was designed to support economic growth in Dubai, and is the first urban railway in the Gulf States.

Dubai has established its position as a leading hub for finance, logistics, and tourism in the Middle East. During this process, chronic traffic congestion became a serious social issue, stemming from the population increase that ensued from rapid economic growth. In order to alleviate traffic congestion, the Dubai Government decided an urban railway would be constructed. In 2004, the Dubai government asked for international tenders for the Dubai Metro Project and the following year placed an order with the Dubai Rapid Link Consortium (DURL), a five-company consortium lead by Mitsubishi Heavy Industries (MHI), with three other Japanese companies and one from Turkey.

DURL was responsible for delivering a fully automated driverless railway system including all related engineering and construction. The Civil Works including the design, engineering and construction of tunnels, elevated viaducts, and station buildings and depots were performed by our civil works partner, a joint venture consisting of Obayashi Corporation, Kajima Corporation, and the Turkish firm Yapi Merkezi.

MHI, in collaboration with Mitsubishi Corporation, was responsible for the design, manufacture, integration, construction and delivery of all railway systems including railcars, the automatic driverless control system, communications, operation control and SCADA systems, automatic fare collection, platform screen doors, depot equipment and facilities, the power distribution system and substation equipment, and the track facilities.

1. Railway system overview

The Dubai Metro rail network consists of two lines, which were delivered by DURL in two phases. The first phase scheduled for delivery was the 52.1 km Red Line, which runs from Dubai Airport to the coastal development area. This was followed by the Green Line, which runs for 22.5 km in the old town, near the Dubai Creek, scheduled for the second phase. Together these two lines form an urban transportation system with a total length of 75 km, configured for a minimum headway of 90 seconds. The Red Line is listed by the Guinness Book of Records as the world's longest railway with a fully automated driverless operating system (**Figure 1**).

Mitsubishi was responsible for the entire railway system including the individual subsystems outlined below and the overall interface and integration management for the project.

1.1 Signaling and operations control system

The Communication-Based Train Control (CBTC) moving block system chosen to enable high-density operation by minimizing the safest distance between trains, in accordance with their track positions and speeds. The operations control system, including the Operations Control Center (OCC) located in both the main and auxiliary depots, monitors and controls all lines (**Figure 2**).

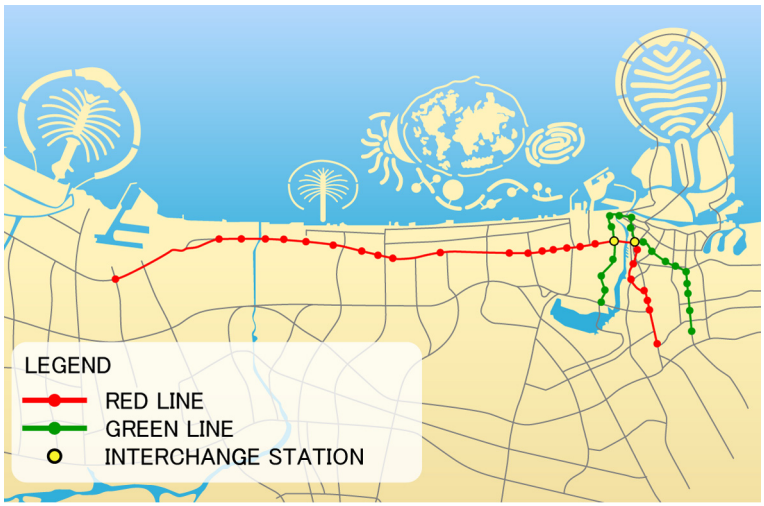

Figure 1 Railroad map

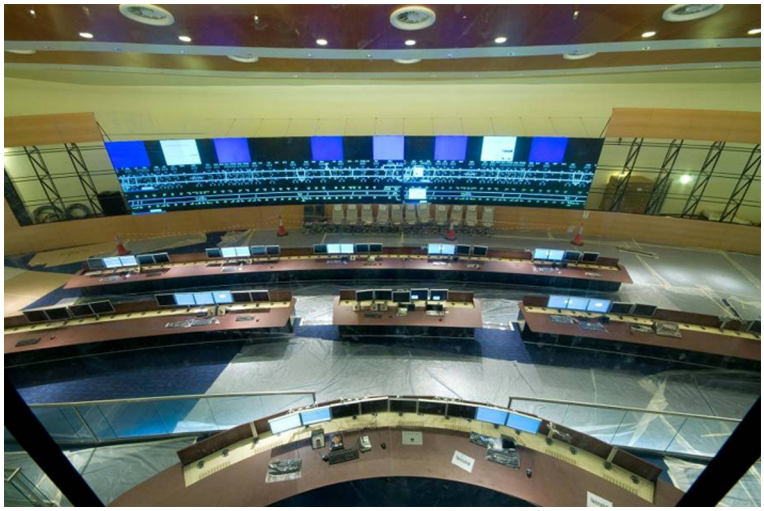

Figure 2 The Operations Control Center

1.2 Communications and integrated surveillance system

The core communication system uses optical data communication with a Transmission Control Protocol/Internet Protocol (TCP/IP) and an integrated communications network for audio and video data along the entire train line. The total length of the optical cable is about 500 km. By means of the cable, the optical communications system facilitates the voice service system, including telephones and station announcements, the railcar communication system, which enables audio-visual communication between facilities in the railcars and on the ground, and the visual communication system between the OCC and individual stations/depots, as well as the passenger information system, the emergency communication system, and so on. The Operations Control System (OCS) also enables surveillance and control of all the OCC subsystems.

1.3 Power supply

The traction power feeding system uses a third rail powered at 750 V DC. The Dubai Electricity and Water Authority provides high-voltage power at 132 kV, which is converted into 33 kV at the Main Power Substation. From there, it is transmitted to individual Traction Power Substations located along the railway lines. The power is converted into 750 V DC at the Traction Power Substations to supply railcars via the third rail and to supply the facilities at individual stations with 400 V AC.

1.4 Track

The railway track is standard 1,435 mm gauge plinth track, using a seamless long rail for all lines, in order to achieve a comfortable train ride with less noise and vibration.

1.5 Station equipment

All stations have floor-to-ceiling platform screen doors, for passenger safety and to maintain the efficiency of the interior air-conditioning.

The fare collection system uses contactless cards, enabling seamless use between other forms of public transportation, including buses and the Abra water buses that cross Dubai Creek.

1.6 Depots and maintenance equipment

There are two main depots and one auxiliary depot. The main depots have facilities for heavy maintenance and the auxiliary depot is designed for light maintenance. The operation of railcars at depots, such as entering and dispatching, is also fully automated. Regarding maintenance and management, the Maintenance Management System (MMS) collectively manages individual subsystems with respect to maintenance planning, maintenance logs, preparing maintenance work orders, and maintaining assets.

2. System integration

In order to establish a safe, reliable railway system, it is important to achieve an integrated system that comprehensively controls individual subsystems throughout the entire process, including design, manufacturing, procurement, installation, testing and commissioning. The biggest selling point of the MHI transportation system is its level of systems integration.

The Verification & Validation method, achieved when implementing Taiwan High Speed Rail, is used for system assurance, the linchpin of system integration, to ensure system quality by conducting in-depth validation of each process, including whether the system meets its requirements or is built to specifications.

Before shipping the railcars, MHI first conducted rolling stock and signaling system integrated test running on a test line located at the Wadaoki Plant, to confirm and verify the proper interface functionality was configured and performing correctly between these safety critical train control systems. Following the completion of this vital series of activities, the trains were shipped to Dubai and underwent further vigorous test running on a designated 10-km test-drive section on site, before being extended to the entire length of the Red Line for comprehensive test running on a fleet wide, multiple train basis enabling gradual, efficient system validation in accordance with international standards.

The construction work met the client's schedule, and the Red Line, built in the first phase, was inaugurated as planned on September 9, 2009, the delivery date promised in the contract. The fact that it opened 49 months after the contract was signed is considered remarkable, especially with regard to the construction of a fully automated driverless operation system on this scale.

After the line opened to the public, MHI has undertaken the major maintenance services for the railway system, including the railcars, greatly contributing to the stable operation of the line since it opened.

3. Future prospects

The system continues to consistently maintain high levels of availability and punctuality above the target levels, offering reliable and safe service to its users, and winning high praise and trust from the client. The Emirate of Dubai commended the affiliates involved in the construction project for successfully completing the construction. MHI takes pride in achieving the highest level of customer satisfaction.

The number of passengers has been increasing steadily. Since opening the Green Line, the number of passengers has increased, with approximately 290,000 users per day and more than 125 million passengers having used the Dubai Metro to date. The railway has earned kudos from citizens and tourists, and the number of users is expected to increase.

A number of new railway network projects are being planned for the Middle East, including projects in Qatar, Abu Dhabi, and Saudi Arabia. Based on the achievements of the Dubai Metro, MHI will continue to approach and address all these new challenges in an innovative and proactive manner and looks forward working together closely with client organizations and other stakeholder parties to ensure the continued successful delivery of railway networks in the Middle East.