

# Step by step to a three-line network

Krasimir Krastanov\*

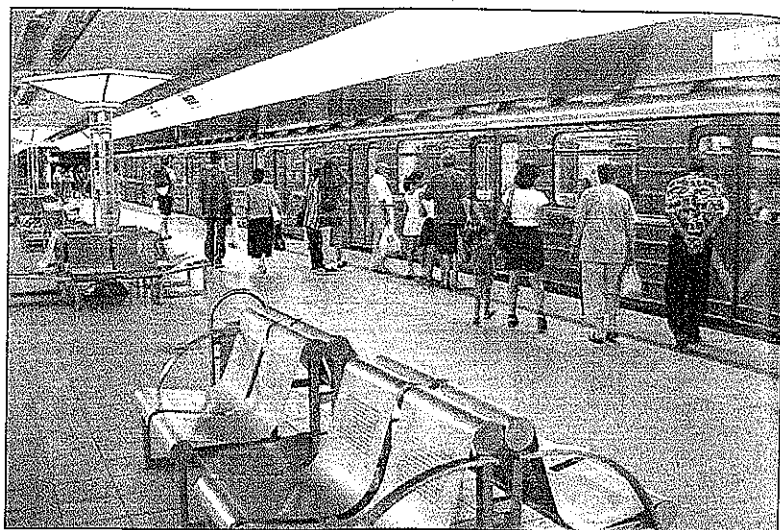
**A**T THE MOMENT Sofia has only one metro line, but plans call for a three-line network to be built, stretching to a total length of 52 km. When this is eventually completed, the network will have 47 stations, and traffic will amount to more than 1 million trips a day.

The Bulgarian capital has a population of about 1.25 million, living in an area of slightly more than 190 km<sup>2</sup>. Studies deemed it essential for the capital to have a metro network, and the municipality plans to complete this in stages based on a development plan drawn up for the period to 2020. This envisages that the metro will become the backbone of the capital's transport network, meshing with bus and tram services.

A technical and economic feasibility report published in May 1974 concluded that the first line should run for 21 km and have 17 stations. The second line is to be 18 km long with 15 stations, and the third line will be 15.8 km long with 15 stations. All three will meet in the central area, where they will form a triangle.

The report recommended an average distance between stations of 1 100 m, with trains running at up to 90 km/h. Capacity in each direction will be 50 000 passengers/h, the shortest headway being 90 sec thanks to the use of automation. Gauge is 1 435 mm and power is supplied by a bottom-contact third rail at 825 V DC.

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Trains on the Sofia metro are built to a standard Russian design

Although planning began as long ago as the early 1970s, construction of the first line is relatively recent. The first two stations and the tunnel between them formed part of the same project that saw the National Palace of Culture built in the city centre in 1992. Construction continued, and the first 6.4 km section with five stations opened in January 1998. Another station at Opalchenska was added in September 1999, taking the length of the line to 8.1 km with seven stations. Work on the most recent 1.8 km extension to Serdika began in October 2000, and the station was opened in early 2003. Construction of this section demanded special precautions because of the historic buildings in the central area. Most construction was undertaken using cut-and-cover techniques.

Design and construction of the first metro line was carried out entirely by Bulgarian companies. Control and

operational equipment was sourced from other countries, although Bulgarian software was used. Rolling stock was supplied from Russia, and ATO equipment was supplied by Bulgarian companies using Russian-made components matching the equipment installed on the cars.

Functional control systems include train radio and dispatching, information and fire alarm systems, ventilation, ticketing and visual information displays.

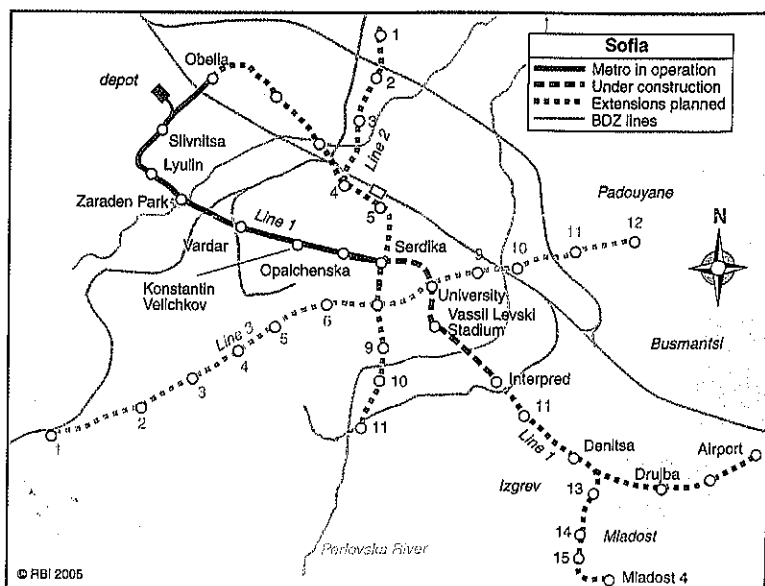
## Station design

The architectural design of the stations emerged as a major element in the urban environment, and in Sofia planners were conscious that station design on other metro networks generally represents the type of architecture that is popular during the period of construction – or is chosen to match specific features of the area through which the line passes.

Despite the fact that the architecture of the stations absorbs a mere 3% of the total cost, it has a major aesthetic impact on passengers, with the potential to create a feeling of comfort and to encapsulate the overall image of the metro. In Sofia design and implementation was developed in joint efforts by the design staff for each metro station and the investor, and in most cases the final version was selected from a range of alternatives.

## Line 1 extensions

Work is already getting underway on the next extension of Line 1, which will add a further 2.4 km and three stations. In 2002 Bulgaria signed a loan agreement with Japan to fund this extension. The Japan Bank for International Co-operation has agreed a credit worth US\$104m with a term of 30 years



before repayments are due.

Japanese contractors were awarded a contract for construction of the 2.4 km extension from Serdika to Interpred, which is scheduled to open in October 2007. The contract includes the construction of two stations serving Sofia University and the Bulgarian National Radio building; a third is being funded separately by the municipality. When this extension is completed, Line 1 will run for 15 km with 11 stations, and will carry an estimated 35 million passengers a year.

The extension will run in two parallel single-track bores. The new station under construction at the University of Sofia will be one of the busiest on the network, as it will provide interchange with several of the principal surface routes. The second new station lies at a considerable depth below the surface, because the extension must pass under the Perlovska river and the adjacent sewers. There will be three underground levels between the surface and the station tunnels, and here an underground car park with 300 spaces is envisaged.

After this station, the line will run beneath one of the city's main boulevards, climbing at a relatively steep 3.7% gradient up from the river crossing. Interpred station will also be underground, but after this the route will run onto the surface, where the reversing crossovers will be located.

Engineering design is now in hand for another 6 km extension with six stations that will take the line to the business park and residential suburb of Mladost on the outskirts of Sofia. The municipality is currently looking for funding in parallel with the design work, which is expected to be completed by the end of this year.

Construction will start in 2007 and should be completed in 2009, although Mayor Stefan Soflanski said recently that it is possible that the metro could open in 2008. The work is likely to be split into two sections, with Interpred – Denitsa opening in 2008 and the final section to Mladost the following year. This would bring Line 1 to a total length of 21 km with 17 stations. End-to-end journey time will be 30 min compared with the present

trip by tram and bus which takes 1 h 20 min because of the severe traffic congestion in the city centre.

#### Line 2 under construction

Work has also started on the second line, although the initial section is just 1.2 km long. The first station will provide an interchange to Line 1 immediately in front of the National Palace of Culture, and the single-track tunnel taking the line to a station in front of the Hotel Hemus will be completed by the end of 2005.

The municipality is also planning to extend the metro to the airport, where a new terminal is now under construction. The intention is to apply for accession funding after Bulgaria joins the European Union in 2007.

The airport branch would diverge from Line 1 at Denitsa and run via Drujba. It would be around 9 km long, with construction expected to take five or six years. This accords with the timescale envisaged in Sofia's recently-adopted general town planning strategy, which assumes as a worst case that the metro will open to the airport by 2020.

Although implementation of the Sofia metro plan in stages has been approved by the municipality, the funds needed to continue construction of the second line and to start the third have not yet been secured. Despite this, plans are being prepared to continue work during the period from 2010 to 2020. Once the

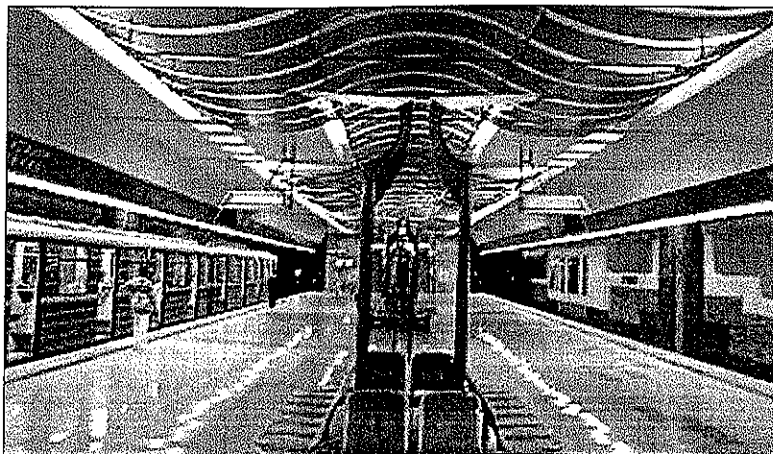
three lines are complete, most important parts of the city will be served, in particular those which currently suffer from heavy traffic. The municipality expects the length of the metro to reach 25 km by 2012 and 42 km by 2020.

For the moment the metro has a 3% share of the trips taken within the city. Despite heavy investment, this is not much to show for the cost and the effort, and the traffic of about 90 000 passengers per day or 29 million a year is a long way from the forecast of 52 million passengers a year anticipated when the first line is complete. However, with construction of the final section in prospect, the perspectives are excellent, and current figures suggest that the number of passengers carried will quadruple by the end of 2007.

Daily patronage is expected to increase to 600 000 by 2020. According to the municipality, after completion of the first two routes the metro will be carrying about 25% of all rush-hour trips.

A flat fare equivalent to €0.25 is charged, generating about €7.2m a year. Additional revenue is generated by advertising sales and rental of numerous cafes and shops at the stations. Operating costs amount to around €10.1m a year, with the difference being covered by the municipality. ■

*Serdika station serves the city centre, adjacent to the National Palace of Culture; it will provide interchange with Line 2 from 2007*



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