Feature

Tokyo's New Waterfront Transit System

Kazuaki Iwata

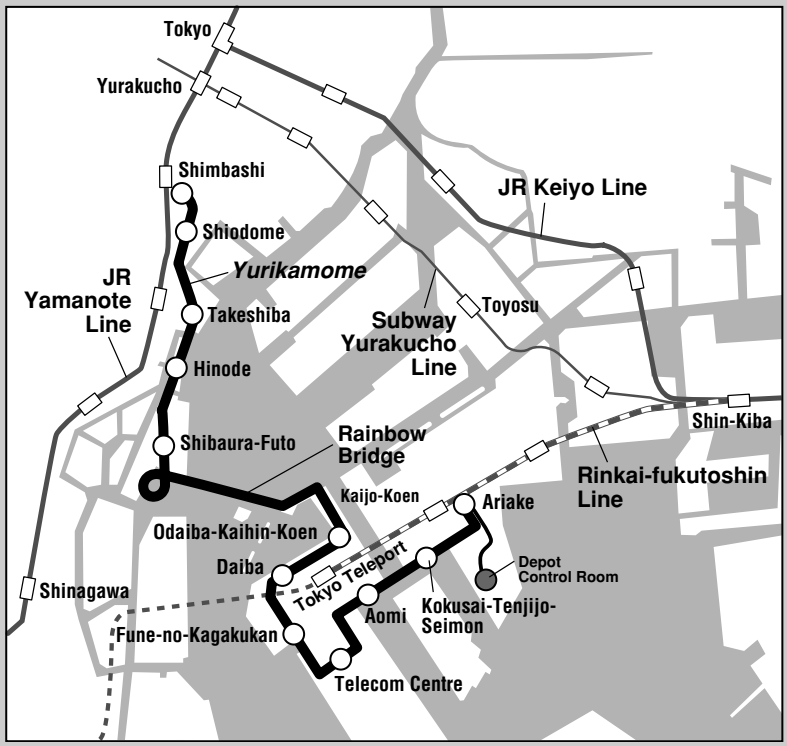
Overview

Yurikamome—Tokyo's new waterfront transit system, is a medium-capacity, automated guideway transit (AGT) system connecting the centre of Tokyo with a new subcentre on the Tokyo Bay waterfront. It takes its name, *Yurikamome*, from the black-headed seagull, Tokyo's officially-designated bird, seen widely around the waterfront area.

The 12-km line with 12 stops starts at Shimbashi, crosses Tokyo harbour on the double-deck suspension Rainbow Bridge with an overall length of 3.75 km linking the man-made islands of the waterfront with Tokyo, and ends at Ariake. The journey takes 24 minutes.

Before the inauguration of *Yurikamome*, the current operator, Tokyo Waterfront New Transit, Inc., was worried that the line would not be profitable, because the initially projected scope of the new waterfront subcentre had not been achieved due to lingering economic stagnation. However, since its inauguration in November 1995, the number of passengers has steadily increased with more-and-more commuters, visitors, and sightseers. This is attributed to the opening of new waterfront facilities, holding of events, and the widespread popularity of the pleasant *Yurikamome* ride with its magnificent views of the Tokyo waterfront. Despite the initial worries, the operators are now busy increasing capacity to meet demand, especially when large events are held in the waterfront area, and the future of *Yurikamome* looks bright.

Figure 1 Route of *Yurikamome* AGT from Shimbashi to Ariake



(Tokyo Waterfront New Transit, Inc.)

Note: The currently closed Shiodome Station will open after redevelopment of the former JNR Shiodome freight terminal.

Waterfront Project

As part of a plan to decentralize Tokyo into urban subcentres (*JRTR* 13, pp. 4–11), in 1985, the Tokyo Metropolitan Government (TMG) started a project to develop an international information centre in the waterfront area on 448 ha of reclaimed land, 6 km from the city centre. The daytime workforce was expected to be 110,000 with a night-time population of 60,000.

Yurikamome was planned to serve as the major mode of access to the subcentre. Construction proceeded towards completion in 1995 along with the subcentre's other facilities including roads, railways, utility tunnels, lifelines, the Rainbow Bridge, etc.

AGT System

Yurikamome is Japan's 10th AGT; it is unmanned and runs on a dedicated, elevated track using dual lateral guides. The carriages run on rubber tyres at a maximum speed of 60 km/h with a normal operating speed of 30 km/h.

Reasons for choosing AGT

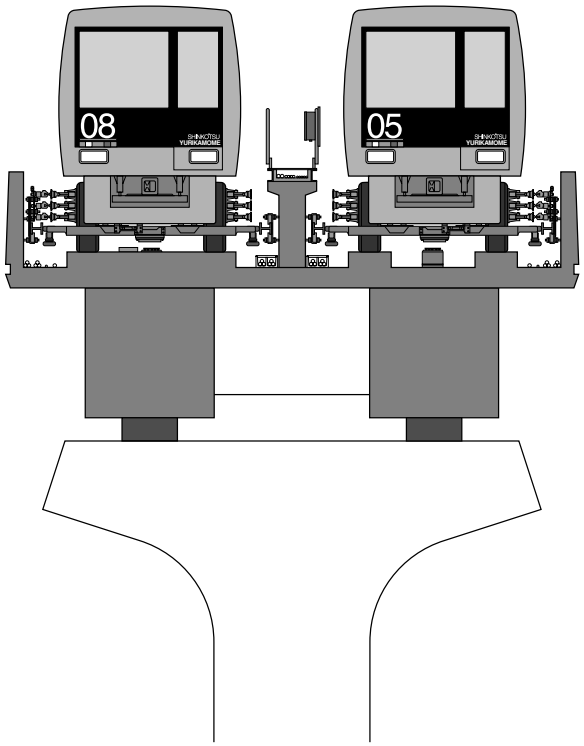
The AGT was chosen for the following reasons.

- The reclaimed land where the subcentre was to be developed offered plenty of space, making an elevated guideway a lower-cost option than a subway.
- The compact, lightweight train is ideal for crossing a suspension bridge.
- Unmanned operation matches the concept of a future subcentre with round-the-clock activities.

Specific advantages

Yurikamome has the following specific advantages.

Figure 2 Layout of *Yurikamome* Elevated Guideway and Train Car



(Tokyo Waterfront New Transit, Inc.)

- Unmanned, automatic operation offers flexible scheduling and an increased number of trains.
- The rubber tyres and elevated track ensure a quiet smooth ride for passengers and are environment-friendly.
- The 2.47-m wide and 8.5-m long two-door carriages are slightly larger than the standard AGT size.
- Large, curved-glass windows and booth seats enable passengers to enjoy the splendid view.
- Space for wheelchairs inside carriages as well as elevators, escalators, etc. at stations, enable people with physical disabilities to use the services easily.

Construction

The TMG built the main elevated structure and infrastructure using national government subsidies. In 1988, the TMG established the Tokyo Waterfront New Transit Inc., a third-sector enterprise to operate the entire AGT. The company handled the construction of the operation and maintenance centre, electrical facilities, guideways, etc., finishing and furnishing of stations, and building of carriages. Construction started in 1988 and was completed in 1995 after overcoming various difficulties. The total cost was ¥170 billion, ¥115 billion for infrastructure and ¥55 billion for everything else; this works out at ¥14 billion/km, which seems comparatively expensive for an AGT. However, the cost-effectiveness is high considering the scale and quality, as well as the number of passengers. Moreover, this cost was still only 50% of that required for a subway.

In an effort to make the ride as comfortable and pleasant as possible, enormous care was taken over the level of the track, which was finished mechanically to a precision of better than ±2 mm. All in an effort to ensure passenger comfort, indentations in girder joints were levelled with acrylic resin mortar and finished by a specially designed, diamond-cutter/grinder vehicle.

Reappraisal of Waterfront Project

In June 1995, Yukio Aoshima—Tokyo's newly elected governor—decided to follow through on his election campaign pledge and cancelled hosting the World City Exposition Tokyo '96, planned for the subcentre by his predecessor. This was followed by cancellation and suspension of commercial construction projects in the subcentre due to the lingering stagnant business conditions. The anticipated fall in passenger traffic cast serious doubts over the *Yurikamome* project.

With more than ¥1 trillion already invested in the subcentre's infrastructure, the TMG re-appraised the project in relation to the changes in the economy. The 1996 revised plan cut the daytime workforce to 70,000 and the night-time population to 40,000; the development period was extended by about 10 years, and more diversified use of the land, including amusement facilities, was permitted. It was also decided to call the area 'Rainbow Town'.

This revised plan has been in progress ever since.

More Passengers than Expected

Yurikamome officially entered service on 1 November 1995 as a forerunner of the waterfront development project, despite anxiety over its future and criticism as 'aerial transport through a wilderness'.

The waterfront development attracted media attention, causing an influx of far more passengers than predicted right from the opening day. On 3 November 1995, a national holiday, the platforms were

completely packed with waiting passengers and extra trains had to be run on an altered timetable. From November 1995 to March 1996, the daily average of passengers was 27,000—very close to the original estimate of 29,000.

In 1996, following the successive openings of The International Exhibition Center, Hotel Nikko Tokyo, and other facilities, the daily passenger traffic grew to 60,000 in April to June. In July 1996, restaurants, game centres, and other amusement facilities were completed and the passenger traffic increased again to 78,000 a day. On the occasion of a fireworks display on Tokyo Bay, as many as 100,000 people swamped the system and ticket issuing had to be suspended from time-to-time at some stations. As a result, the average passenger traffic in the April 1996 to March 1997 period was 64,000 a day, or 1.5 times the predicted daily volume of 43,000.

In 1997, when the Fuji Television Network (Fuji TV) moved its operation to the subcentre, the number of passengers increased by 25% over 1996. On 4 May, during the 'Golden week' national holidays, the trains were so jam-packed that many people had to give up taking them and the day marked the record of 130,000 passengers. Since 1997, the daily average passenger traffic has exceeded 70,000, and in the 27 months since opening until February 1998, more than 50 million people have taken *Yurikamome*.

More Sightseers

Saturdays are peak traffic days for *Yurikamome*. Since many office buildings in the waterfront area are still vacant, passengers using season tickets and fare coupons account for only about 25% of the total, which is still roughly 75% of the target volume. On the other hand, there are 1.8 times more sightseers and visitors to events or amusement facilities in the area than originally forecast. As many as 20% of the passengers take *Yurikamome* for the pleasure of riding it, viewing the landscape, and enjoying the night view of the illuminated Rainbow Bridge and the Tokyo skyline.

Morning rush hours are made up of office workers; groups of housewives take the *Yurikamome* to enjoy the ride and sights during the day. Both office workers and sightseers contribute to the evening rush, while groups and couples take the train in the other direction into Rainbow Town for evening entertainment. On Sundays, there are all kinds of passengers as well as more children. *Yurikamome* is even now a feature of many Tokyo sightseeing tours.

Yurikamome crossing double-deck Rainbow Bridge *(Tokyo Waterfront New Transit, Inc.)*

Passengers prefer *Yurikamome*

Seventy percent of people going to the subcentre use *Yurikamome*, instead of cars. Their reasons are as follows:

- Good views and comfort
- Excellent accessibility to facilities, most of which are directly connected to stations
- Convenient starting point in downtown Tokyo

The panoramic view from the elevated track and the sight of the Rainbow Bridge have turned this modern urban transit system into a popular pleasure line. Although it was difficult to predict the high demand for *Yurikamome* based on sightseeing, the trend seems to be here for good.

More Trains and Higher Frequency

Yurikamome started operations with 13 trains operating at a headway of 6 minutes during the rush hours and 10 minutes at other times. With a capacity of 352 passengers per train, the system could

carry 5300 passengers per hour; during the rush hours, the load factor was 150%. Since early 1996, the rush-hour congestion spread into the daytime operations, requiring scheduling of extra trains, which was easy as long as free trains were available, thanks to the fully automatic unmanned operation. In July 1996, the timetable was revised to run at an 8-minute headway in the daytime, and two additional trains were ordered. In December, another three more trains were ordered along with reinforcement of power sub-station supply capacities.

When Fuji TV and other businesses opened offices in the subcentre in 1997 and further congestion was anticipated, the timetable was revised for a second time to allow a 5-minute headway during a 30-minute period in the morning rush. As soon as the two newly ordered trains were delivered in July, they were put into service and the timetable was revised a third time to allow a 5-minute headway in the morning and evening rush hours, providing a capacity of 6300 passengers per hour; daytime operation was at a 7-minute headway.

The next three new trains entered service in March 1998, allowing the timetable to be revised for a fourth time to permit a headway of 4 minutes during rush hours, carrying 8000 passengers per hour, and a 6-minute interval during daytime operation (5-minute intervals if required).

Use of an extra 10-ha piece of land in the subcentre for car showrooms, exhibition/entertainment hall, etc., was recently decided, with a projected annual influx of nearly 10 million visitors, starting in early 1999. Three more trains were ordered in November 1997 to cope with this anticipated demand.

Renovation & Extension

In principle, the AGT stations are unmanned, but part-time workers are sometimes mobilized to relieve congestion by guiding passengers, etc. Since congestion is conspicuously worse at the terminal stations, the ticket-issuing facilities and platform stairways are to be renewed early this year. The present semi-temporary facilities at Shimbashi Station are scheduled to be rebuilt as a fully fledged station for 16,000 passengers per hour to achieve operations at 2-minute intervals.

There is a plan to extend the line by the year 2005 to Toyosu, 2.8 km beyond the present terminus, connecting with the Subway Yurakucho Line. The plan is designed to augment the transportation capacity and accessibility to the waterfront area; it is in the final planning and environment assessment stage.

Current Financial Status

¥11 billion of the total construction expenditure of ¥55 billion borne by Tokyo Waterfront New Transit Inc., is capital investment; the rest is bank loans to be repaid from the train fare revenues. The first profitable year will be in 10 years and all the accumulated losses will be recovered 20 years after the opening. It is currently loss-making after depreciation, but making some profits before depreciation. It will be profitable when the number of passengers exceeds 80,000 per day.

The company future is quite bright considering the passenger growth, low number of employees (140) thanks to unmanned operations, and current low interest rates. Another great advantage is the passenger diversity throughout the day. Commuters, businesses, and residents have made strong requests for lower fares, and further discounts are coming into effect for season tickets and coupon fares from April 1998.

Unmanned Operation

Passengers on *Yurikamome* often wonder where the driver is, how it operates, and how precisely it stops. Various automated guidance technologies have been available for more than 10 years on other transportation systems. Most of the *Yurikamome* functions are computerized using the latest technologies based on lessons learned from other systems.

The unmanned operation is controlled from a control centre (*JRTR* 7, p.44) in the system operation and maintenance centre. A wide range of information required

Test run of Yurikamome *(Tokyo Waterfront New Transit, Inc.)*

Glassed-in platform with interesting roof design provides good view of neighbourhood *(Tokyo Waterfront New Transit, Inc.)*

Interior of Yurikamome with panoramic windows *(Tokyo Waterfront New Transit, Inc.)*

to handle train and station operations, marshalling, and power supply, etc., as well as current train positions, wind speed and direction, irregularities, and earthquake information is collected.

Station platforms have doors at the track side to keep people away from the track and are monitored so the train can be stopped if a passenger gets trapped in a door. The platform and carriage doors have touch-sensitive switches, to reopen the door if it is touched while closing.

Inquiries via the intercoms at ticket vending machines and barriers are answered by staff at the control centre. When a passenger presses the intercom button, the monitor at the control centre is switched automatically to the closed-circuit TV at the location; the centre receives an average of 300 inquiries a day.

The train is stopped instantly if a breakdown occurs, an emergency button is pressed, a door is not closed or opened, or the train touches an obstacle. For earthquake safety, if the seismometer at the operation and maintenance centre indicates a ground wave of 150 gal (5 on the Richter scale), the automatic emergency system instantaneously stops all trains. Another automatic system temporarily limits train speeds within a range of 5 to 40 km/h during track maintenance or strong winds.

ATC Backup

When a train is stopped due to a breakdown, etc., one drawback is that a driver must be dispatched to the train, requiring some time to resume operation. Although there was a series of early breakdowns, the system stabilized after 8 months of operation. The automatic train operation system is backed up by an automatic train control (ATC) system.

The rubber tyres used by *Yurikamome* tend to compact snow on the track, which then becomes difficult to remove and creates a slippery or bumpy ride. Operation had to be shut down for half a day for snow removal in the winter of 1996 and again in the early spring of 1998.

Current snow countermeasures include automatic speed control, snow ploughs, snow melting agents, and road heaters at grades and junctions. However, there is no perfect countermeasure to heavy snowfall.

Conclusion

The *Yurikamome* AGT system is an ideal urban transit system if there is space for constructing the elevated track, because it generates no disturbing noise or vibration. However, it is a medium-load transit system suitable only for lines with transport demand of less than 15,000 passengers per hour.

Yurikamome is highly evaluated as a transit system for the future and is now carrying far more passengers than predicted thanks to the delightful views that it provides of the waterfront area, as well as the pleasant and comfortable ride.

Although the project was originally targeted at providing transport for business commuters in a new development subcentre, an unexpected recreational function has led to far greater numbers of passengers than anticipated.

Yurikamome is an exciting example of how transit facilities can contribute to the shaping of a new urban area. The continuing growth of Rainbow Town is certain to attract more people, increasing the need to expand the current capacity.

Based on the experience of the *Yurikamome* AGT, there is no doubt that this unmanned system is destined to be the future of urban transportation. ■

Kazuaki Iwata

Mr Iwata is Director of the Planning Department of Tokyo Metropolitan Subway Construction Company. After graduating in civil engineering from Tokyo Metropolitan University, he joined the Tokyo Metropolitan Bureau of Transportation, holding important posts in construction. In 1993, he was appointed Director of the Engineering Dept. at Tokyo Waterfront New Transit, Inc., responsible for the construction and first operation of *Yurikamome* until he moved to his current post in 1997.