There are many issues we have to take on to achieve improvement of customer satisfaction in our railway business. Most of all, moving up a gear in improvement of the quality of the transport service in the Tokyo metropolitan area —our revenue base into the future— is of particular importance.

The Research and Development Center of JR East Group thus has undertaken a project on the next-generation railway operation system in the Tokyo metropolitan area that covers the area within 50 km from central Tokyo to solve the issues in our business field. The aim of the project is to innovate transport service in the Tokyo Metropolitan Area.

2.1 Expected Situation and Viewpoint on Efforts

In considering the situation in short-distance transport in the Tokyo metropolitan area for next 10 to 20 years, we should pay particular attention to the following points.

1) Impact on transport demand of the change of population structure in the Tokyo metropolitan area by an aging society with fewer children, the tendency to marry later, decrease of working and producing population and influx of foreign people

2) Impact on transport characteristics of the change of social structure demonstrated by diversified working and studying styles and lifestyles such as increased inner-city living

3) More sophisticated customer needs in security and safety (higher safety and ensured security), convenience (barrier-free access) and service and hospitality (higher service quality), due to changing user manners and public morals and advanced social services

4) Impact on transport modes of worsening global environmental problems and fuel price fluctuation

In order to set the concept for the new Tokyo metropolitan area railway system and appropriately advance research and development for that, it is essential to always pay attention to the aforementioned changes, keeping up with environmental and situational changes. We have to continue to keep an eye on future changes in the situation caused by the significant economic downturn since autumn 2008. Still, in the efforts for the next-generation railway operation system in the Tokyo metropolitan area, we need to more quickly deal with growing customer needs at this stage while keeping present transport capacity.

Furthermore, we should realize that our strategy is shifting from individual lines to an enhanced network that takes into account mutual through service and parallel lines. That can be seen in our measures to expand through service such as with the Tohoku through line and the mutual through service with Sagami Railway.

2.2 The Ideal Railway System

A railway operation system is a large-scale total system using rolling stock, wayside equipment and a large staff including maintenance personnel. Traditionally, we have developed separate systems per field, such as “transport management and transport operation control” for train scheduling and operation, “signaling and communications” for control of signals and point machines and information control and “train control” for control of train and vehicle components. These systems work together with partial coordination.

Each system has been separately developed, incorporating needs and technologies of the times. So looking at them individually, they may have good workings locally. But they may develop into a not-
In the process of reallocation of functions, more control conventional framework are:
of safety, reliability and convenience, along with cost reduction and functions, we are aiming for a railway that can achieve improvement
next-generation IP networks. By building an information network
radio such as digital train radio, general-purpose radio including
trains. Those systems will be organically connected via dedicated
for stations and “next-generation train control and monitoring” for
operation control” for dispatch, “next-generation route control”
key fields: “next-generation transport management and transport
system in the Tokyo metropolitan area, the system consists of three
In the development concept of the next-generation railway operation
coordination.

2.3 Overall Image of the Next-Generation Railway
Operation System in the Tokyo Metropolitan Area
In the development concept of the next-generation railway operation system in the Tokyo metropolitan area, the system consists of three
key fields: “next-generation transport management and transport operation control” for dispatch, “next-generation route control”
for stations and “next-generation train control and monitoring” for
trains. Those systems will be organically connected via dedicated
radio such as digital train radio, general-purpose radio including WiMAX (Worldwide Interoperability for Microwave Access) and
next-generation IP networks. By building an information network
that takes into account optimal allocation of wayside/onboard system functions, we are aiming for a railway that can achieve improvement
of safety, reliability and convenience, along with cost reduction and lower environmental burden (Fig. 1). Main differences of this development concept from the
conventional framework are:
1) In the process of reallocation of functions, more control
functions will be transferred to onboard equipment by making
use of technologies such as train separation control by radio, thus
eliminating track circuits, signals and other wayside facilities. We
will therefore reform the conventional system fields of “transport management and transport operation control”, “signaling and communications” and “train control and monitoring”, into
new fields of “transport management and transport operation control”, “route control” and “train control and monitoring”,
where functional reallocation will be more easier to review.
2) With the change in the transport strategy, we will introduce the
optimized system as a whole in the future.

One of the reasons for such isolation is that replacement timing is
different between systems, with each system inheriting its previous
workings. Another reason is that we have developed systems without
paying due consideration to integrity of the total system, specifically,
coordination and interaction of systems and attention to later
functional addition and improvement.

Such systems also have problems in terms of being able to flexibly
and quickly deal with changes in the environment and needs.

For the next-generation Tokyo metropolitan area railway system, it
is important to optimally allocate functions where individual
systems can contribute to rational system work as a whole in good
coordination.

Fig. 1 Image of the Next-Generation Railway System

concept of looking at transport service as a network including
elements such as parallel lines instead of as line sections.
3) We will study a system that is based on large-capacity data
transmission from onboard to wayside terminals. That will
include operation monitoring of onboard devices and railway
infrastructure by trains in service.

The key technology of particular importance that will allow
onboard and wayside function allocation is radio communications
technology. Fig. 2 shows the long-term expectations in the
development of radio communications technology. We should
actively introduce the results of that mobile radio communications
technology, provided that they produce higher speed and larger
capacity communications.

For example, when communicating control information between
onboard and wayside terminals, transmission via dedicated radio
such as digital train radio is expected to see double-digit increases in
transmission capacity and speed compared to existing track circuit
transmission.

By transmitting information between onboard and wayside
 terminals via broadband radio communication service such as
WiMAX, transmission capacity and speed see triple-digit or greater
increases compared to transmission via train radio. At such a level, we
will be able to transmit information such as that for regulating trains
or passenger guidance directly from a dispatcher's office to a train.
Furthermore, on-train monitoring and maintenance information
including images and other large-volume data can be immediately
transmitted to the dispatcher's office and the maintenance depot.

Fig. 2 Developments in and Outlook for Radio Technology

Next, I will present a brief overview of the three key fields of the next-
generation railway operation system in the Tokyo metropolitan area.

3.1 Development of Next-Generation Transport
Management and Transport Operation Control System
In the future Tokyo metropolitan area transport, two things will
continue to be important for improving customer satisfaction. Those
are flexible transport according to the passenger flow and appropriate
and timely information to passengers, both in normal operation
and in operation disruption. To achieve those, the next-generation
transport management and transport operation control system should
meet the following requirements (Fig. 3).

1) System for accurately identifying situation
When performing work such as train regulation to recover from
operation disruption, we have to do that while providing information
we will work to enhance the railway traffic operation management
monitoring systems. 

departments concerned, route control systems and train control and 
will allow us to transmit the latest operation schedule to internal
immediately inform of such arrangement. An information network
Quick arrangement requires a means of communication to
line sections.

through services, transport management will shift from management
previously mentioned data on passenger flow to that system. Along
arrangement up to schedule recovery. In the future, we will add the
management support system that can make suggestions for total
into consideration scheduling of cars and crews. So, we are now
is necessary to employ the know-how of skilled dispatchers, taking
large-capacity communication network to enable dispatcher’s offices to
obtain information such as ever-changing passenger flow data (as well
expectations for the near future) and real-time image information in
locations such as in the cabin.

(2) System for supporting quick arrangement
To make quick arrangement in cases such as operation disruption, it
is necessary to employ the know-how of skilled dispatchers, taking
into consideration scheduling of cars and crews. So, we are now
proceeding with the development of a railway traffic operation
management support system that can make suggestions for total
arrangement up to schedule recovery. In the future, we will add the
previously mentioned data on passenger flow to that system. Along
with changing to a strategy with features such as expanded mutual
through services, transport management will shift from management
of line sections to network management taking into account parallel
line sections.

(3) System for quick transmission of information to departments
concerned and passengers
Quick arrangement requires a means of communication to
immediately inform of such arrangement. An information network
will allow us to transmit the latest operation schedule to internal
departments concerned, route control systems and train control and
monitoring systems.

We will also use information displays at stations and in cabins to
promptly provide information to passengers. For the time being,
we will work to enhance the railway traffic operation management
suggestion function, with an aim at
introducing that in the planned deployment of the Autonomous
decentralized Transport Operation control System (ATOS).

3.2 Development of the Next-Generation Route Control System
With the next-generation Tokyo metropolitan
area railway system, one of our objectives
is improvement of reliability by making
the system simple. Simplified and reduced
wayside facilities by function allocation will contribute to reducing operation disruptions
caused by failures of facilities, and will also
reduce maintenance work and cost.

With the next-generation route control
system, we are planning to develop in steps
logic controllers that control signals, points, crossings and other
signaling equipment. The goal in that is simplification of wayside
signal equipment.

As the first step, we are organizing and rebuilding control logic that
has undergone function-oriented development such as the station
interlocking system and ATS-P system, and we are simplifying the
process of communicating control and feedback. This includes
physical development, where we aim to integrate and standardize
equipment as a signaling logic controller for station yards (station yard
LC). With this control logic, we are remaking the data structure of
control and feedback information into a device-oriented data structure
such as signals and switches. And we are conducting development
with a goal of building control logic that can determine and minimize
the area affected in work such as improving linearity of tracks. (Fig. 4)

As the next step, we envision integrating those station yard LCs
and the functions (train position detection, train tracking, train
control, etc.) of ATACS (Advanced Train Administration and
Communications System using radio communication), which is
now planned to be introduced to the Senseki line. We call this
integration “ATACS interlocking”. By integrating these functions
and equipment, we can come closer to a vehicle-drive train control
system, and we can also reduce wayside facilities including signals and
track circuits. Consequently, that will lead to reliability improvement
and cost reduction of the total system. Our final goal is to develop

Fig. 3 Next-Generation Transport Management and Transport Operation Control System

Fig. 4 Signalling Logic Controller for Station Yards (Station Yard LC)
an integrated signaling logic controller that integrates functions of interlocking, route control and information to passengers (station timetable management) (Fig. 5).

For the time being, we plan to develop by fiscal 2010 a signaling logic controller for station yards that works as a station interlocking device. We further aim to introduce signaling logic controllers for station yards as successors to electronic interlocking devices now used with ATOS, and we aim to apply ATACS interlocking to the Tokyo metropolitan area ATACS.

3.3 Development of Next-Generation Train Control and Monitoring System

The next-generation railway operation system in the Tokyo metropolitan area requires a system to safely and efficiently operate trains. Specifically, it needs a train control function to control running and braking and a device control function to control vehicle devices.

More functions than with the current system are expected to be transferred to the trains themselves with the next-generation train control and monitoring system. Further reliability will thus be required for onboard systems.

In the light of that, we are planning to conduct development in two phases for the next-generation train control and monitoring system. In the first phase, we will integrate functions of the train control and monitoring system to reduce the number of components. At the same time, we will also aggregate functions of the software with an aim of improving reliability of the total train control and monitoring system. The onboard network is made of the the following four components: (1) control network that handles control information, (2) status monitoring network that handles status information, (3) information network that handles passenger and crew support information and (4) wayside facilities monitoring network that handles status monitoring information of wayside facilities. The aim of that is separate network according to the importance, transmission frequency and volume of the information. That will allow us to improve in-train service such as information provision to passengers and security. It will also let us achieve deterioration diagnosis of onboard devices and quicker reaction to failures of those and monitor condition of wayside facilities using trains in service. Development of that new car control system is proceeding with an eye on introducing that to the next new commuter EMU that will succeed the E233 series.

In the second development phase, we will aim to shift to a vehicle-drive train control system. In that system, a train will receive the latest operation information from the transport management and operation control system, informing the route control system of its route by recognizing relative position to other trains. In the second phase, we will also work to develop economical train operation methods. Those include power consumption peak control by avoiding simultaneous startup of trains in a single substation area and predictive control to reduce irregular train stops just short of congested stations.

4 Conclusion

We are now proceeding with development of many elemental technologies for innovation of the Tokyo metropolitan area railway system. Some of the tests, evaluations and verifications of those technologies will be carried out with the Mue-Train (MULTipurpose Experimental Train).

Innovation of the next-generation Tokyo metropolitan area railway system is expected to be a long-term project, lasting around 10 years due to nature of railways and the need for technology development. On the total road map, we will appropriately introduce the intermediate results of development at the opportunity provided by implementation of measures.

And we will continue to make bold strategic moves for the future to meet customer expectations.

Reference: