Development of Dual Mode Vehicle (DMV) and its Practical Use

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Introduction

Currently, JR Hokkaido covers the total railway route length of approx. 2,500km. Notably, a section comprising one third of the entire route (about 800km) is characterized by an extremely small number of passengers below 500 a day. This yearly declining use of local railways has continued even after JR private enterprises were launched amid difficult financial circumstances, along with loss-making route bus services.
This problem is attributed to the following social circumstances.

(1) Increasing local depopulation attributable to dwindling birthrate and aging society combined
(2) Serious financial situations due to deregulation of route bus services and reduction in government subsidies
(3) Strong demands for public transportation services by residents despite a higher rate of individual private cars

Consequently, JR Hokkaido introduced various measures to improve the management of local lines such as

(1) Abandonment of debt-ridden local lines
(2) Driver-only operation
(3) Review of office operations
(4) Review of station operations

This cost-conscious effort, however, has failed to achieve a sufficient level of management improvement. Amid these circumstances, JR Hokkaido has developed a new technological concept to produce Dual Mode Vehicle (DMV), aimed at improving the management of local lines. The specific technological advantages are described as follows.

(1) It is to cut down on vehicle's initial and running costs by introducing small and light-weight vehicles (e.g. converted minibuses) capable of transporting small- and medium-amount of passengers according to transport volume.
(2) It is to reduce operational costs by focusing on more efficient use of basic ground infrastructure such as rails and more compact designs, along with the use of GPS.
(3) It is to provide barrier-free transport services to cope with aging society and contribute to regional revitalization by introducing more convenient buses capable of running both on the railway and road.

In order to attain these objectives, JR Hokkaido performs DMV research and development.

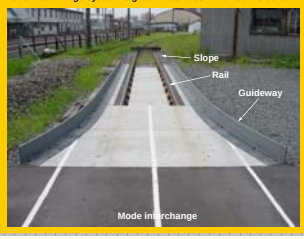
DMV system

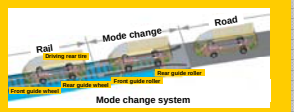
DMV is a bus capable of running both on the road and rail bi-directionally. With a rubber tire, this vehicle runs on the road like ordinary buses, and it runs on the rail, using guide wheels and a driving rear tire (inner wheel) in the front and rear parts of the vehicle. To "convert from the road to rail modes," the vehicle lifts a guide roller from inside by hydraulic transmission to approach the mode interchange section and run on the rails on the pavement along the guideway. Then, longitudinal guide wheels come down by hydraulic transmission, the front rubber tire will be raised and the steering will be fixed and guide roller will be stored in the vehicle body. This process takes only approx. 15 seconds. Meanwhile, to "convert from the rail to road modes," the steering is unfixed in the section with rails and pavement like a railroad crossing, and the front rubber tire comes down and the longitudinal guide wheels will be stored in the vehicle body to be ready for running on the road. This operation requires merely about 10 seconds.
The guiding of the vehicle on the rail by means of the guide wheel requires no steering operation. In fact, the vehicle, comprising merely accelerator pedal and brake pedal, can be operated more easily than an ordinary bus.

DTS (Dual-mode Transport System)

(1) DMV (Dual Mode Vehicle) System
The DMV vehicle comprises rubber tire driving system to run both on the road and rail, longitudinal guide wheel system which is guided by the rail for traveling and guide roller system to position the vehicle which will be transferred from the road to rail.

(2) Mode interchange system
Mode interchange system is ground facilities which convert the running mode from "road to rail" to "rail to road."



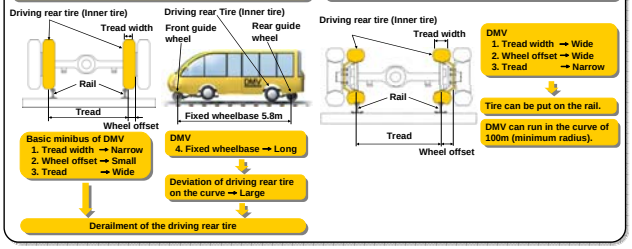


Mode change time

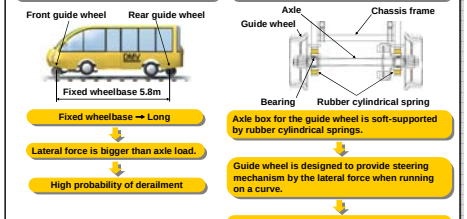
- Road→Railway (on rail) : about 15 seconds
- Railway→Road (off rail) : about 10 seconds

(3) Traffic control system
Traffic control system primarily consists of GPS-equipped operation system and train protection system.

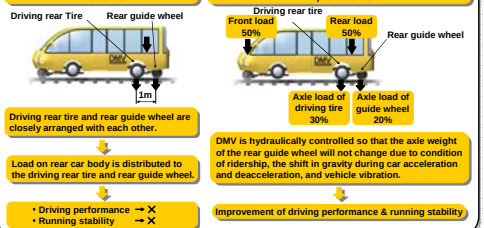
Problem 1 / Improvement 1



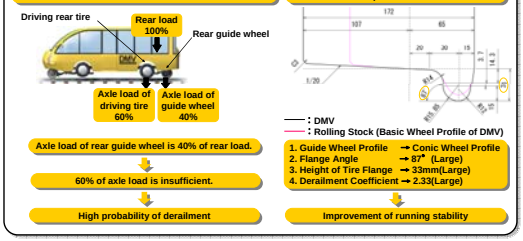
Problem 2 / Improvement 2



Problem 3 / Improvement 3



Problem 4 / Improvement 4



Mode interchange system

Shorter-time vehicle switch between on-rail and off-rail

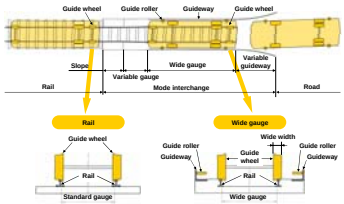
1. Easy mode interchange
To perform mode interchange from the road to rail in a short period of time, the centers of the vehicle and track should correspond to each other, regardless of the driver's operational skills. To meet this objective, JR Hokkaido developed the following mode interchange system.

- Ground side
  Mode Interchange system comprising Guideway, rails and pavement.
- Vehicle side
  Guide roller system capable of positioning the vehicle using the guideway at the ground side.

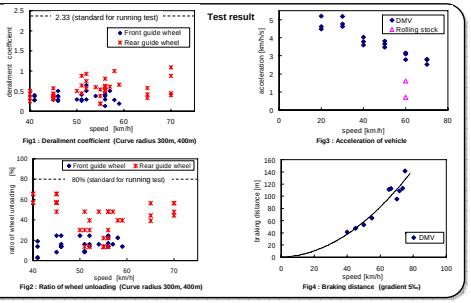
2. Reliable mode interchange
The mode interchange must be designed to assuredly change the road to rail modes even though there are wrong sizes on parts such as rails, guideway and guide rollers, based on the following approaches.

- Ground side
  The track gauge in the mode interchange part was increased by 70mm to 1137mm.
- Vehicle side
  To widen the track gauge, the width of guide wheel rim was raised by 47mm to 172mm.

3. Operability of guide wheel
To achieve swift operation of guide wheel at an appropriate position, the system adopts hydraulic control system.



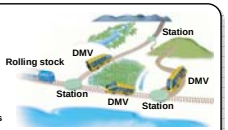
Test result



Effects expected

1. Low operational expenses
By comparing this type of vehicle with the rolling stock, the following cost reductions can be fully achieved.
(1) Vehicle purchase cost: cut by about 1/7
(2) Vehicle maintenance cost: cut by about 1/8
(3) Power cost : cut by about 1/4

2. More seamless transportation by railway and road
The railway is means of "linear" or inter-city connecting transportation, while the road is a means of "plane" or locally-networked transportation. However, there are non-seamless parts between these different means of transportation. Our DMV can eliminate such inconvenience for commuters and allow passengers to directly reach their destinations. Therefore, this system will provide DMV users with an easier access to destinations and DMV stops and more barrier-free and convenient services. Furthermore, it can greatly contribute to regional revitalization.



Seamless transportation by railway and road

3. Creation of new demands
DMV is expected to not only improve the management of local lines but also to create new demands such as "airport access," "replacement method of urban transportation LRT" and "replacement route of longer railways" serving as new transportation system.

4. Others
(1) Solving traffic congestion
With the ability to run on the rail in the railway section, the DMV system can allow users to promptly reach a destination compared to those traveling on the congested road, characterized by railway's punctuality and reliability.
(2) Achieving high mobility
In addition to the advantage of meeting various users' demands, the system can provide many possible travelable routes, one of which can be selected in case of a disaster with a high mobility.

Future plans

1. Development of prototype vehicle
Currently, JR Hokkaido develops 2-car-linkable prototype vehicles, aimed at increasing passenger capacity, facilitating mode interchange and achieving cost reduction and light-weight vehicles for commercial use and performs running tests to construct the system.

2. Identification and coordination of issues in ordinances regarding system's practical use
In this DTS, it is important to efficiently utilize current level of infrastructure and achieve low-cost transport services. Toward this goal, we identify and coordinate issues in ordinances with regard to the system's practical use by focusing on the safety.