

# The Bimodal Tram with Automated Guidance System

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**ABSTRACT:** The bimodal tram is one of the public transportation systems with a new and innovative concept to provide the passengers with the high quality service of mobility. It is a rubber tired tram with two or three carriages. It is driven by electric power and operated on the track with magnets inserted into the ground by automated guidance system. Its electric power comes from engine generator. It was designed to provide railway service without rails and overhead wires. The bimodal tram is currently powered by hybrid of CNG engine generator and lithium battery for practical use. The automated guidance system enables its precise docking to the station at the distance of 5 centimeters so that the passengers on wheel chair or with stroller can have easy access without any barrier. Many key components are localized in Korea. High capacity lithium battery and its management system were developed and tested successfully in the bimodal tram. The body shells and floor panels are composite materials. The bimodal tram project was performed along with its infrastructure project to secure safety and reduce construction period as well as cost. It is possible to construct the infrastructure gradually depending on the traffic demand and the planned route, which can effectively reduce the initial cost to launch the bimodal tram service. The bimodal tram was developed to provide the advantages of subway as well as bus to the passengers like on-time performance and flexibility of the lines.

## 1 THE BIMODAL TRANSPORTATION SYSTEM

The bimodal tram is a new type of public transportation featured with on-time performance of the train as well as flexibility of the bus. It runs by automatic operation mode on the dedicated track and by manual mode on the normal road.

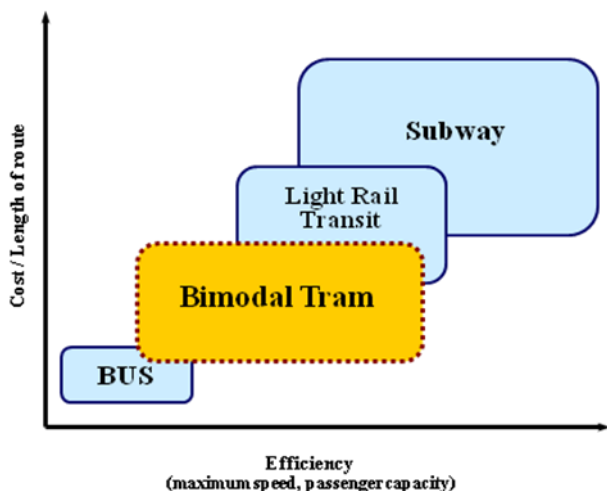


Figure 1. Position of the bimodal tram in public transportation

Its capacity is between those of bus and of LRT(Light Rail Transit), respectively. One of the advantages for construction of the infrastructure is that initial cost can be saved with gradual construction of the route depending on the demand. Thus, the bimodal tram is expected to play a role to realize the public transportation system of low cost and high quality.

But, bimodal tram can be used as bus or light train depending on how it is operated by managing institute. The development concept of the bimodal tram is not just to carry more passengers but to provide high quality service like train mode. When the driving mode is dependent upon driver's character, passengers feel uncomfortable due to inconsistent acceleration and deceleration patterns. In order to get the full benefits from the bimodal tram, auto mode driving is necessary. The bimodal tram was developed to provide the service like train with economic investment. When it is operated with normal buses on the busway, it provides only the service like bus and is overinvestment. The bimodal tram runs with the program of optimum operation mode. Acceleration, deceleration and constant

velocity are controlled as programmed so that the passengers onboard can expect the driving mode.

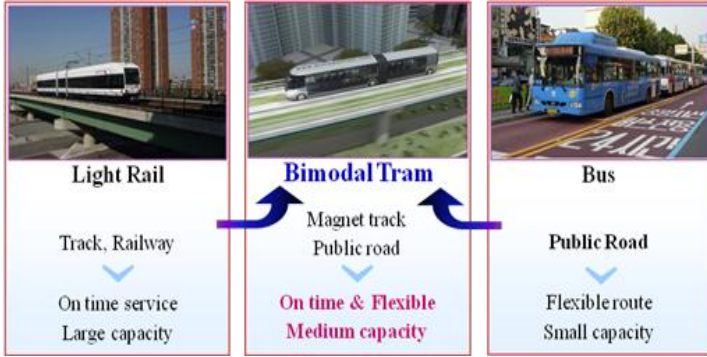


Fig. 2. The bimodal tram with on-time performance and flexible operation

The bimodal tram makes precise docking to the station within the distance of five centimeters. Since the bimodal tram approaches to the station very closely, screen doors are installed at the station to secure the safety of the passengers waiting for the tram. Climate control works inside the station for a pleasant environment. The waiting time for the tram at the station is regarded as a part of the travel in the concept of the bimodal tram system. Thus, station should be kept comfortable and safe. As long as dedicated tracks are used for the bimodal tram, the passengers arrive at the destination at the expected time even at rush hour.

## 2 MAIN FEATURES

The bimodal tram is powered by a serial hybrid system of CNG engine and high capacity lithium battery. Two or three carriages are available depending on the demand, the lengths of which are 18 and 24 meters, respectively.

In order to meet the on-time performance, automatic operation is essential on the dedicated track, but manual operation is necessary in case of emergency. All wheels are independently steered and its minimum turning radius is 12 meters. Automated guidance system controls the overall operation of the bimodal tram on the dedicated track. It recognizes the magnets on the ground and collects the information on the positions. It automatically travels while continuously communicating with magnetic markers laid under the dedicated tracks through the sensors installed under the bottom of the tram.



Fig. 3. Appearance of the bimodal tram vehicle

All the information on the route is input into the system in the control center. The bimodal tram approaches to the station platform by crab walk. All the wheels automatically face inward to reduce the distance leading to the exact platform positions from the drive way. The space between the tram and the platform is less than five centimeters, and the position error along the platform is less than  $\pm$ ten centimeters. Since it's a low-floored tram, the passengers need no steps when they get on and off.

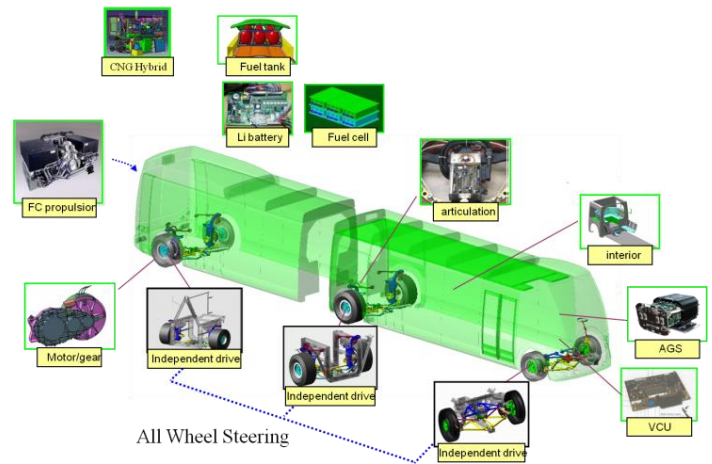


Fig. 4. Major components in the bimodal tram

It makes wheel chairs and strollers accessible without any barrier like subway train system. The fastener for a wheelchair and a baby carriage is available. Thanks to the precision docking and the low-floored system, it can provide more convenience and better mobility for the mobility handicapped

people corresponding to about a quarter of the whole nation.

Table I. The feature of the bimodal tram

total length	18 meters/24 meters
width	2.5 meters
height	3.1 meters
floor height from ground	34 centimeters
weight(18 meters)	16.8 tons(empty)/23 tons(full)
electric propulsion	CNG engine and Li battery hybrid
automated guidance	magnets
slope	10~13 %
max. speed	80 km/h

Control center and infrastructure designed for the bimodal tram are necessary to make the best use of the system to secure safety and ensure efficiency and convenience for the passengers. The environment-friendly dedicated tracks make the city more beautiful and reduce the urban heat island effect and traffic noise. The only tracks that wheels are in contact with are covered with concrete while the other parts of them are covered with grass.

The vehicle body made of composite materials is light and looks elegant. Also since it is driven by an electrically propelled hybrid system where the internal combustion engine and the batteries are combined, its noise and exhaust gas are much more reduced than those of the existing bus, and its fuel efficiency is more improved as well.



Fig. 5. Dedicated lanes covered with grass between left and right wheels

### 3 CONCLUSIONS

The bimodal tram is expected to provide low-cost and high quality public transportation with the on-time performance of the train by combining economical efficiency and flexibility of the bus. Also, through the establishment of the environment-friendly, low-cost, and highly efficient public transportation system, it will upgrade public transportation service. It features precise docking to the platform within five centimeters for horizontal stepping on and off the tram. The bimodal tram is expected to play a significant role in the public transportation system in addition to subway and LRT in many cities in the near future.

### 4 REFERENCES

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