As the world population keeps growing, the demand for using cars traveling in transportation system becomes outstripping the current limited supply of road facility. Although there are many transportation modes that are recognized as the key of the future sustainable transportation system, bus system plays an important role because of its flexibility, easy navigation and low costs. It an be said that improving bus service to attract more bus users switching from private cars to buses is an indispensable trend to relieve traffic congestion, traffic accident as well as excessive dependence on car mobility in the current overpopulation society.

Although current bus priority systems can perform well its functionality, there are some weak points needed to be improved to enhance convenience for users as well as to encourage more users of the public transportation. For example, the huge delay that a traffic system has incurred due to priority calls at signalized intersections, the reduction in road capacity for cars in the cases of bus priority lanes, etc are problems related to negative effects of priority treatment. In this research, the author investigates into bus lane operation and proposes improved models for bus signal priority for the sake of enhancing the efficiency of bus service. The scope of the study covers not only isolated intersections, arterial roads with multi-intersections but also traffic networks. The details are presented as follows.

For bus lanes, the research firstly comparatively analyzes the operation of three popular bus lane types including ordinary lane, exclusive bus lane and bus priority lane in Japan. The result of a case study shows that although the exclusive bus lane type can improve bus service, its negative impacts on other types of vehicles are significant. Meanwhile, because of the flexibility in choosing lane in the scenario of bus priority lane, the bus priority lane can reduce bus travel time and relieve negative effects on other types of vehicle simultaneously. Converting all the delays to passenger delays, the research conducts a sensitivity analysis in choosing bus lane types under various conditions of the main traffic volume and the number of passengers in buses. The analysis concludes the roles of main traffic volume and the number of passengers in buses in determination of the bus lane type. More specifically, the increase in the number of passengers in buses decides the tendency of choosing exclusive bus lanes. Meanwhile the increase in the main traffic volume benefits the decisions on ordinary lanes. The tendency of choosing bus priority lanes plays an intermediate role that finds rooms between the choice of exclusive bus lanes and that of ordinary lanes.

The research secondly investigates the behaviour of passenger cars under bus effects in the scenario of bus priority lane by proposing a new car lane-changing model. Unlike any previous car lane-changing model, this model consists of three steps: looking-back threshold determination, gap acceptance model and execution model. These three steps are represented for the philosophy of a lane-changing manoeuvre of passenger cars under the influence of oncoming buses. The estimation result confirms the compulsory lane-changing behaviour of cars under bus priority-lane effects. As soon as a car recognises oncoming buses, it would rather pay attention to the speed of the lag vehicle than concern that of the lead vehicle in finding acceptable gaps. Because of the compulsory lane changing behaviour in this situation, the research would like to send
a message on warnings of traffic accident to car drivers when changing lane to give space to buses.

After investigating the proposed car lane changing model, the research thirdly integrates the proposed model into simulation models and evaluates the effect of bus priority lanes in comparison with that of exclusive bus lanes based on the current ordinary lane in Nagaoka traffic network. The results show that the bus priority lane and exclusive bus lane can reduce the bus travel time on the treatment segment significantly. However, in terms of entire the bus routes, the bus priority lane and the exclusive bus lane may benefit some bus routes and bring disadvantages to several ones as well. In terms of the effect intensity of exclusive bus lane and bus priority to the traffic network, the research suggests that bus priority lanes should be considered as a transitional treatment before the exclusive bus lane deployments.

For bus signal priority at isolated intersections, the research firstly proposes a prediction model to predict bus arrival time. The proposed model that utilizes the measured data from image processing sensor and signal database can improve the accuracy of the prediction on bus arrival time. Based on the proposed prediction model, the research investigates the intersection performance under different schemes of bus priority, including bus signal priority, bus preemption without exclusive bus lanes, and bus preemption with exclusive bus lanes. The result shows that the more increase the bus priority level is, the more decrease the bus travel time is and the more negative effect on non-bus vehicles is. In terms of delay reduction at intersections, the bus priority level is directly proportional to the role of bus occupancy in this study. The research secondly proposes an improved genetic algorithm (GA) for optimization in adaptive bus-signal priority control at isolated signalized intersections by applying the compensation rule between signal cycles in adaptive control. The proposed algorithm can increase the convergence rate to reach the optimal solutions compared with conventional ones. The time saving is important to the smooth running of any simulation model as well as real time control systems.

For bus signal priority in arterial roads with multi-intersections, the research proposes a model to improve the efficiency of bus service. The model involves the coordination between bus speed guidance and signal timing techniques to give priority to buses in arterial roads. The coordination allocates the proper recommended bus speed as well as minimizes the traffic delays simultaneously. The results show that the proposed model which be integrated into simulation models is more efficient than the conventional one in terms of delay reduction.