Integrated Optimization of Vehicle and Driver Scheduling in Public Transport
Shyam Sundar Govinda Raja Perumal, Industrial PhD project

Current planning process of public bus transport systems
Providing a bus service involves solving several planning problems. Public authorities define timetabled trips, where the arrival and departures times at all bus stops in a city network are determined. Transport companies then typically implement a sequential approach, where the buses are first scheduled to cover all of the trips (Vehicle Scheduling Problem, VSP) and then drivers are assigned to the scheduled vehicles (Driver Scheduling Problem, DSP). However, it is well known that solving a single optimization problem as a sequence of smaller optimization problems does not preserve global optimality. Integrating the problems could therefore lead to cost reductions and efficiency gains for the transport systems.

Challenges of integrating the scheduling problems
The VSP and the DSP are in their own right computationally hard problems to solve. They are well investigated in the operations research (OR) literature and huge progress has been made. However, integration of both the scheduling problems has proven much harder to solve. Increased complexity of formulating and handling the scheduling problems simultaneously, and immense computational time required to solve the problem are the primary reasons for the integrated approach receiving little attention. Therefore the research question for this project is, What and how optimization techniques could be used for large-scale integration of vehicle scheduling and driver scheduling problems?

Method
Decomposition methods (Column Generation and Branch & Price) will be the main tools for accomplishing the solution of integrated problems. The possibility of utilizing a Benders decomposition approach will also be explored. This project will initially establish a sequentially integrated approach where the solution methods for VSP and DSP iteratively constructs a feasible high-quality solutions and in the final phases of the PhD project, the two problems will truly be merged into one single entity.

Expected results
• Development of a decision support tool that produces optimal/high-quality solutions for vehicle and driver schedules.
• The underlying optimization model is expected to help the transport companies in efficiently utilizing their assets and reducing overall operating cost.
• Produce solutions in reasonable computation time since it is an important parameter for transport companies to plan quickly.

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