A Hierarchical Multimodal Public Transit Network Design for Large Urban Networks: Algorithms and Implementations

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Problem Statement
In many cities, the public transit systems are unable to fully satisfy the varying mobility demands of urban commuters due to many reasons, such as slow evolution of public transit networks over many decades or rigid public transit network with lack of spatio-temporal adjustment and coordination among different public transit layers. Local improvements in the public transit network do not offer significant improvements instead they result in overall network level deterioration.

These problems can be addressed by planning a multimodal public transit network. Through such a planning mechanism and by reconfiguring the whole or a fraction of public transit network, issues faced by agencies (low ridership, higher operating costs), passengers (longer travel time and waiting time) and authorities (bad image, less coverage) can be reduced.

Motivation
The main aim is to come up with a hierarchical public transit network design, composed of route hierarchies such as trunk and feeder, with reduced network redundancy. Moreover, the resultant network should be able to satisfy the viewpoints of passengers, agencies and authorities. Apart from that, the proposed methodology should be able to tackle actual size public transit networks with satisfactory quality in acceptable time.

Methodology
The proposed methodology consists of four main components [1]:

1) Transit Route Creation  
In this module, first shortest path algorithms such as Dijkstra and Yen’s algorithms are utilised to create the feasible paths and later these routes are categorised into feeder and trunk routes.
2) Transit Network Construction
In this module, the hierarchical transit network is constructed by using route overlap concept. Initially, the trunk routes are created with least amount of network overlap. Later, feeder routes are created to feed the trunk routes with higher route overlap to capture more demand.

3) Transit Demand Assignment
In this module, the demand is assigned to the created routes to generate travel time components and schedules. This information is later used to evaluate different aspects of the transit system.

4) Solution Quality Evaluation
In this module, the created transit network is subjected to a holistic evaluation, composed of performance indicators, representing viewpoints of all stakeholders.

**Implementation**
The proposed methodology is planned to be implemented on several transit networks including benchmark and real-world networks. The benchmark networks will be compared with other related studies which used the same networks. In case of the real transit network, the methodology will be implemented on the transit network of Singapore. Moreover, the resultant network will be compared with the existing transit network.

**Fig. 2:** Singapore’s transit network.

**Outlook**
The proposed solution methodology will be able to assist transit planners to create high quality multimodal transit networks, that can satisfy the varying needs of the passengers, agencies and authorities. Moreover, the initial results suggest that the methodology seems promising in dealing with large urban networks.

**References**