Solving the Pickup and Delivery Problem in Semiconductor Supply Chain

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Abstract – Taiwan’s semiconductor supply chain has been constructed comprehensive and the performance of this industry is very significant. With the comprehensive supply chain, transportation and distribution activities emerge as one of the central issues owing to their complexity and costs. Since the pickup and delivery problem in semiconductor supply chain (PDP-SSC) involves constraints on pickup and delivery, product/vehicle compatibility, multiple-priority, and vehicle capacity constraints, it is more difficult to solve than the classical pickup and delivery problem. In this study, we consider the PDP-SSC and formulate the PDP-SSC as an integer programming program to minimize total traverse time. An example is used to illustrate the performance of the proposed formulation.

Keywords – integer programming, transportation schedule, semiconductor manufacturing, supply chain.

I. INTRODUCTION

In Taiwan’s semiconductor manufacturing industry, the supply becomes widespread and the competition pressure is very fierce. Due to the relative magnitude of the transportation and distribution cost being associated with the routing and scheduling vehicles, a semiconductor manufacturer needs to integrate and manage distribution in supply chain networks effectively and efficiently in order to increase their competition edge and profitability [1] [2].

A supply chain is an integrated manufacturing process wherein raw materials are converted into final products, then delivered to customers. Basically, a supply chain consists of two processes, one is the production planning and inventory control process and the other is the distribution and logistics process [3], where PDP-SSC belongs to the latter. The distribution network of semiconductor supply chain consists of mask houses, wafer fabs, IC packaging plants, and warehouses. Sites among each other are connected by transport. Distribution activities (hereafter referred to as requests) arise from wafer-delivery among fabs due to capacity backup, mask-delivery from mask house to fabs, material-delivery from warehouses to fabs, wafer-delivery to packaging plants, finished-goods delivery to warehouse, etc. Note that, at the die bonding in the assembly stage, a lot flowing into the die bonding area is in the form of a complete wafer, and it flow out of this area in the form of a die on leadframe.

A vehicle route is a sequence of pickup and/or delivery points which the vehicle must traverse in order, starting and ending at a depot or domicile. A vehicle schedule is a sequence of pickup and/or delivery points together with an associated set of arrival and departure times [4]. One of the importance classes of vehicle routing and scheduling problems is pickup and delivery problems, in which commodities or people have to be collected and distributed [5]. In the pickup and delivery problem, a set of routes has to be constructed in order to satisfy transportation requests. Each transportation request specifies the size of the load to be transported, the locations where it is to be picked up and the locations where it is to be delivered. Each load has to be transported by one vehicle from its set of origins to its set of destinations without any transshipment at other locations [6]. Very often, the pickup and/or delivery are imposed by time interval within which the operation must begin, in which the problem is known as pickup and delivery problem with time window (PDPTW).

Real-world application directly related to the PDPTW include: dial-a-ride problem, airline scheduling, bus routing, tractor-trailer problems, helicopter support of offshore oil field platforms, and logistics and maintenance support [7]. The survey papers [5] [8]-[10] provide a comprehensive review of the literature on PDPTW.


The PDP-SSC in this study is investigated by taking into account pickup and delivery, product/vehicle compatibility, multiple-priority, and vehicle capacity constraints. The objective is to find a set of routes and schedules for the vehicles in order to accomplish a set of requests at minimum total traverse time satisfying priority restrictions while without violating vehicle capacity constraints.