Yard storage assignment problem

1. General Setting

The setting we consider involves a port terminal quay along with its container yard, as shown in Figure 1. Vessels are scheduled to arrive at the port on a weekly basis and must be assigned a berthing position at the quay for the duration of their stay. Each vessel arrives carrying a number of containers which must first be discharged by Quay Cranes. These discharged containers must then be stored at storage locations in the yard, where they are transferred to by special carrier vehicles. The suitability of storage locations depends on the content type of containers along with their final destination. After this intermediary storage phase, containers are either transshipped and loaded onto other vessels or they are transferred to other areas of the yard to be processed internally or depart via land-based transportation. Similarly, containers which arrive via land-based transportation must first be stored in the yard before they are loaded into and depart with a vessel. **For the purposes of this problem we consider all Berth Allocation and Crane assignment -related decisions as known, denoted as BAP.**

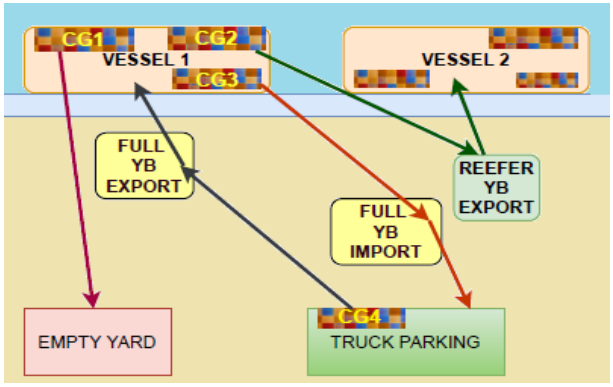

Figure 1: Setting configuration.

Within vessels cargo is separated into Container Groups (CGs) depending on their incoming and outgoing location, which might be the berthing position of a vessel or a point of interest in the terminal. All CGs are connected to at least one vessel, to arrive or depart from the terminal. Each CG has specified time window to be processed within, which is defined by the vessel's arrival or departure time, when a vessel is involved, or by a known time that it has to be transferred to or retrieved from another location.

A **Yard Block (YB)** z is a location within the yard where containers are stored during their stay. It consists of a tuple $< o_z^{max}, TYPE_z, CTYPE_z >$, where:

- o_z^{max} the maximum occupancy of z, which defines the maximum number of containers that may be stored within the YB at any timeslot,

- $TYPE_z \in \{IMPORT, EXPORT\}$ and
- $CTYPE_z \in \{FULL, REEFER\}$.

The set of terminal locations L contains all the vessels and parts of the terminal where a container may arrive and depart from.

A **Container Group (CG)** g consists of a tuple $< TYPE_g, CTYPE_g, n_g, \ell_g^{in}, \ell_g^{out}, t_y^{in}, t_y^{out} >$, where

- $TYPE_g \in \{IMPORT, EXPORT\}$,
- $CTYPE_g \in \{FULL, REEFER\}$,
- n_g its number of containers,
- ℓ_g^{in} and ℓ_g^{out} its incoming and outgoing locations to/from the terminal, respectively, and
- t_g^{in} and t_g^{out} its incoming and outgoing timeslots, respectively.

When a vessel $v \in V$ is involved, i.e., $\ell_g^{in} = v$ or $\ell_g^{out} = v, v \in V$, the corresponding incoming (outgoing) location corresponds to the quay position which is assigned to v under the current Berth Allocation schedule. For the rest of the cases, the incoming (outgoing) location is known.

A **Yard Assignment (YA)** y consists of a tuple $< g_y, z_y >$ which defines for CG $g_y \in G$ its assignment to the YB z_y for the time between $t_{g_y}^{in}$ and $t_{g_y}^{out}$. A YA y is valid when

i) $CTYPE_g = CTYPE_z$ and

ii) $TYPE_g = TYPE_z$ and

A set Y^G of valid YAs is complete for a set of CGs G when $\forall g \in G$ there exists exactly one $y \in Y^G$ such that $g_y = g$. Given a valid set Y^G of YAs, the yard-in time $t_g^{yard,in}$ of a CG g is equal to the start time t_y^{in} of its assigned YA y, with $g_y = g$. Similarly to yard-in time, the yard-out time $t_g^{yard,out}$ of a CG g is equal to the end time t_y^{in} of its assigned YA y, with $g_y = g$