오보헤드 셔틀 시스템을 사용한 자동화 컨테이너 터미널에 대한 시뮬레이션 연구

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Pusan National University
Logistics System Laboratory

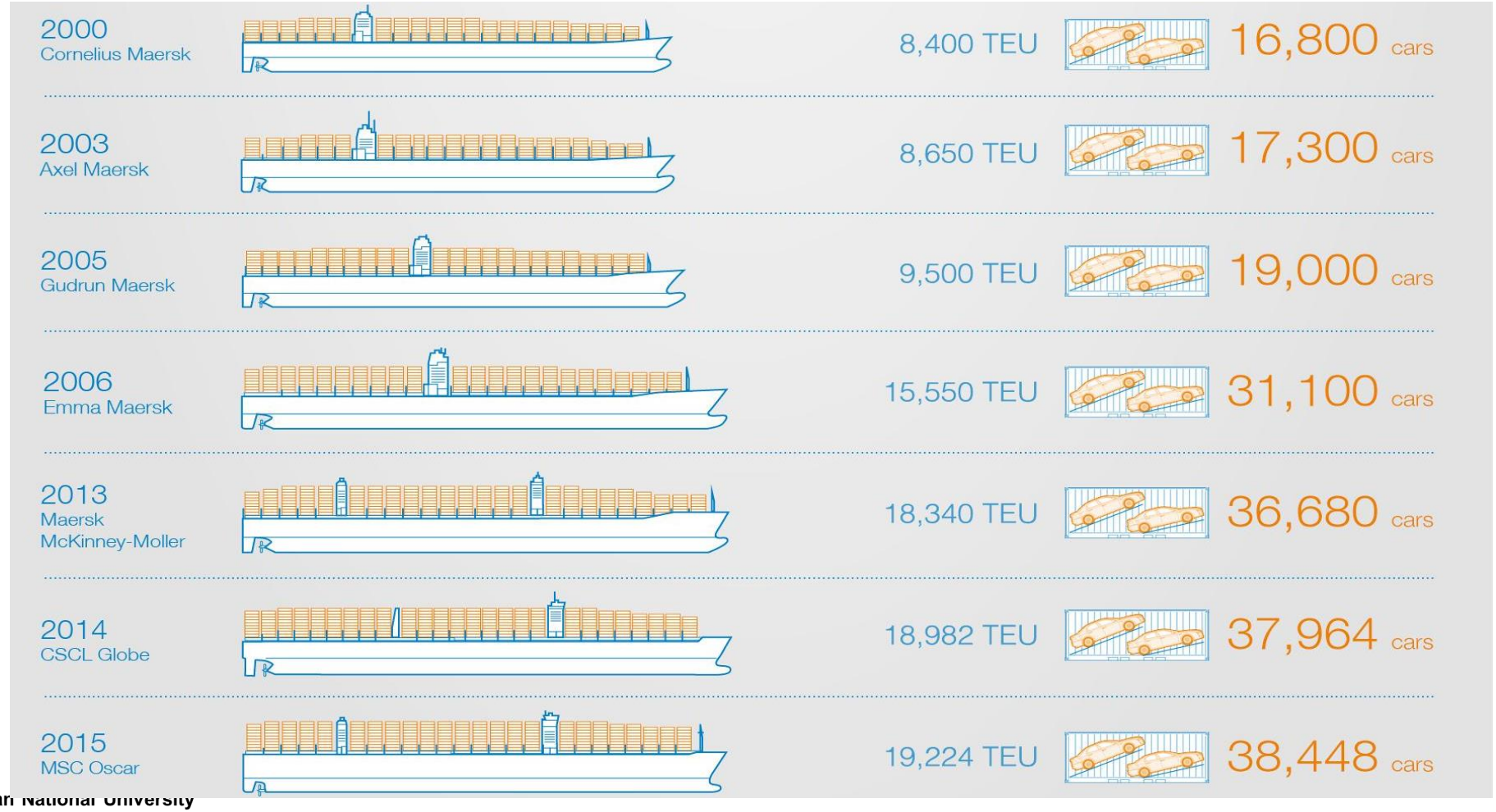
Date: 2 June, 2017
Location: aT센터 (서울 양재동)

Contents

- Background
- New Conceptual ACT
- Simulation Structure
- Operation Scenario and Rules
- Numerical Experiments
- Conclusions and Future Works

Background

- The capacity of the current world's largest container ship has seen an increase of almost 229% in 15 years



Source: http://new.abb.com/turbocharging/maritime-cargo-vessels---is-bigger-better

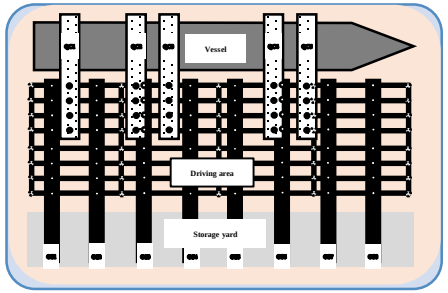
Background

- Ship liners
  - wish to decrease the makespan in terminals

- Container Terminals
  - wish to speed up the operation time
  - wish to increase yearly throughput

Need to develop a high performance automated container terminal!

Background

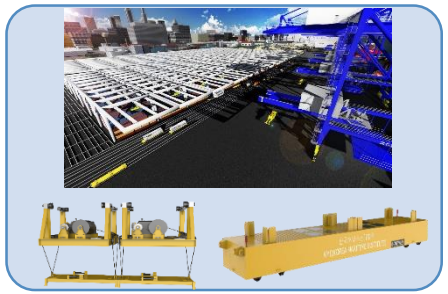


Conceptual Design

- Layout design
- Throughput calculation

Simulation Modeling

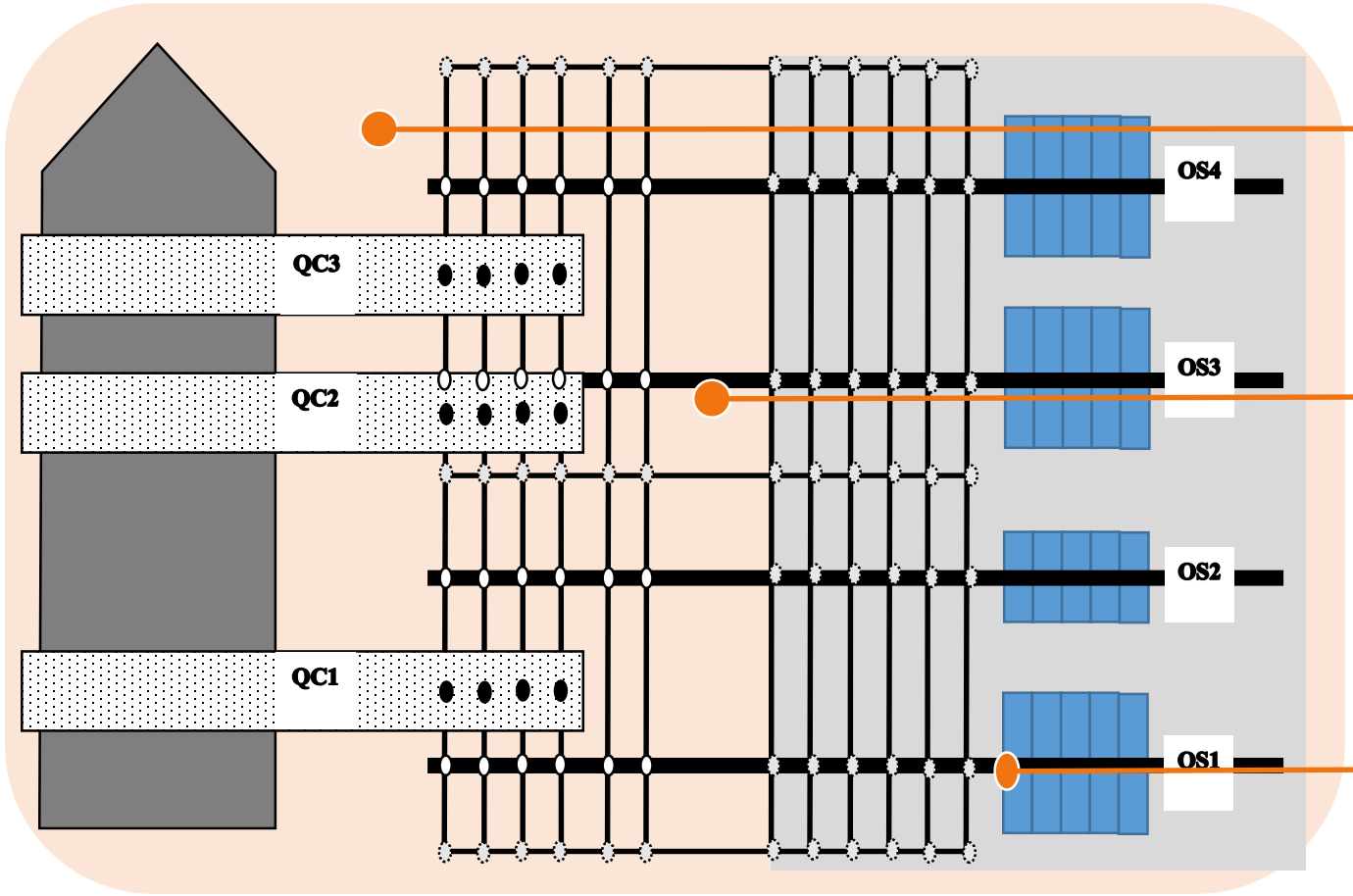
- Equipment & Logics
- Strategy & Technical & Operation
- Considering real situation



Actual Building

- Hardware & Software
- Civil engineering
- Cost engineering

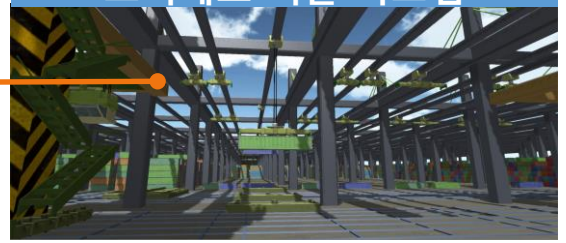
New Automated Container Terminal (ACT)



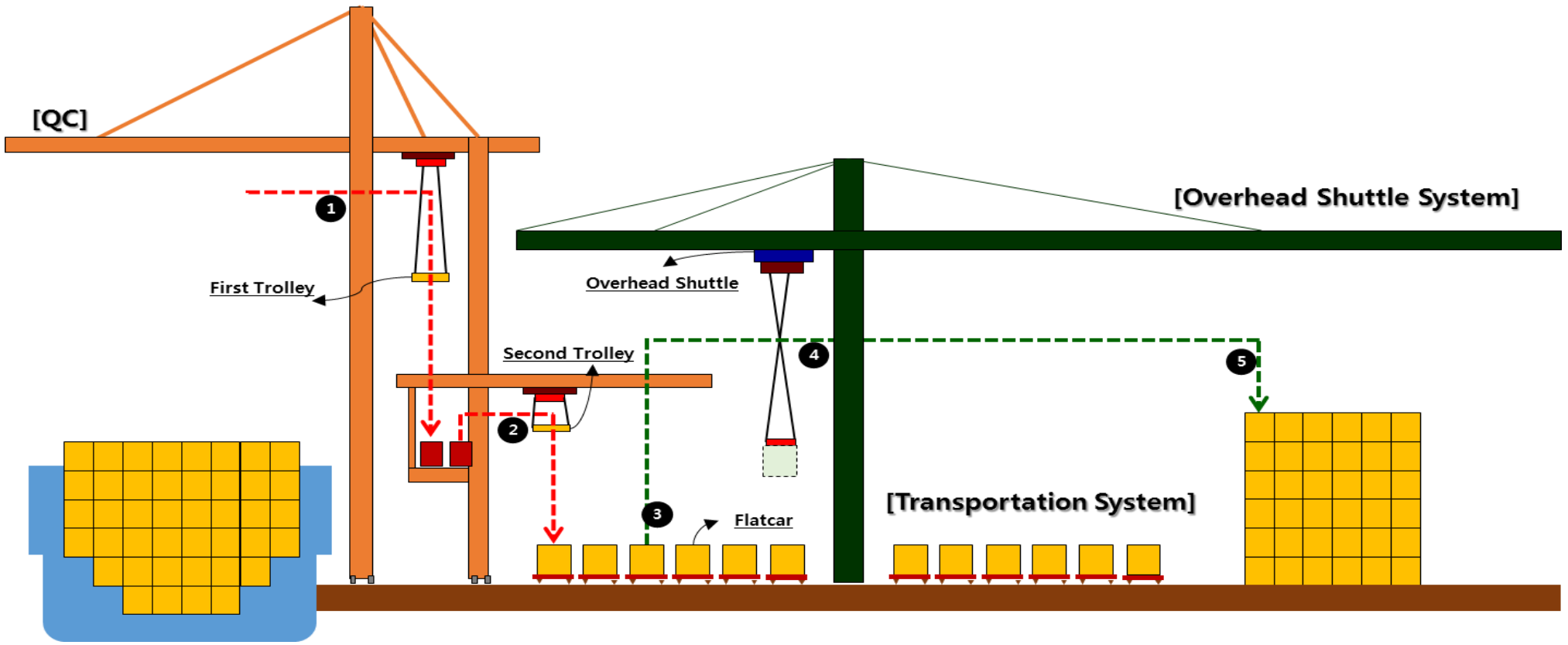
Quay Crane

플랫카 시스템

오버헤드 셔틀 시스템

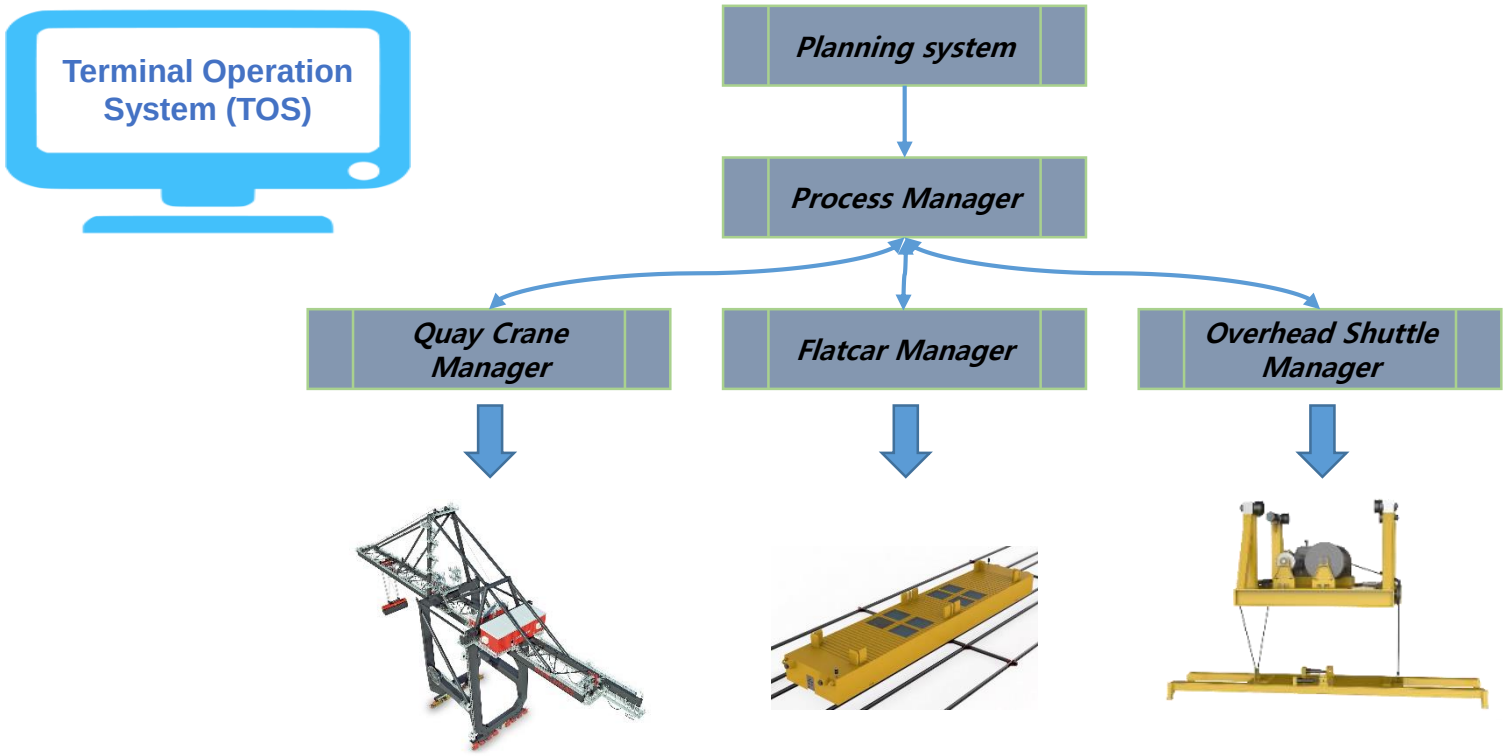


New Automated Container Terminal (ACT)



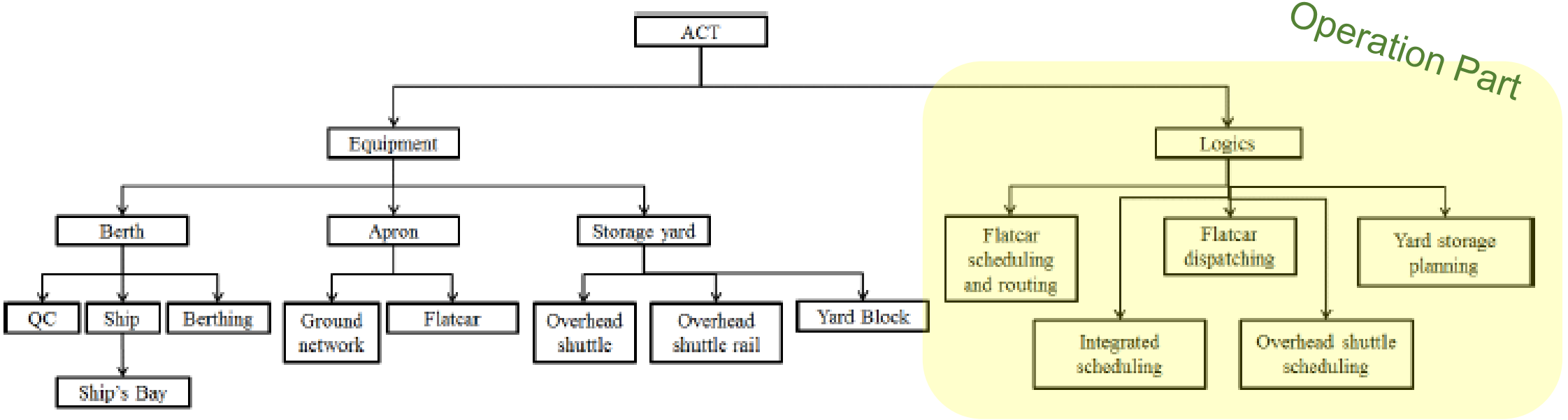
Terminal Operation System

- High performance of ACT

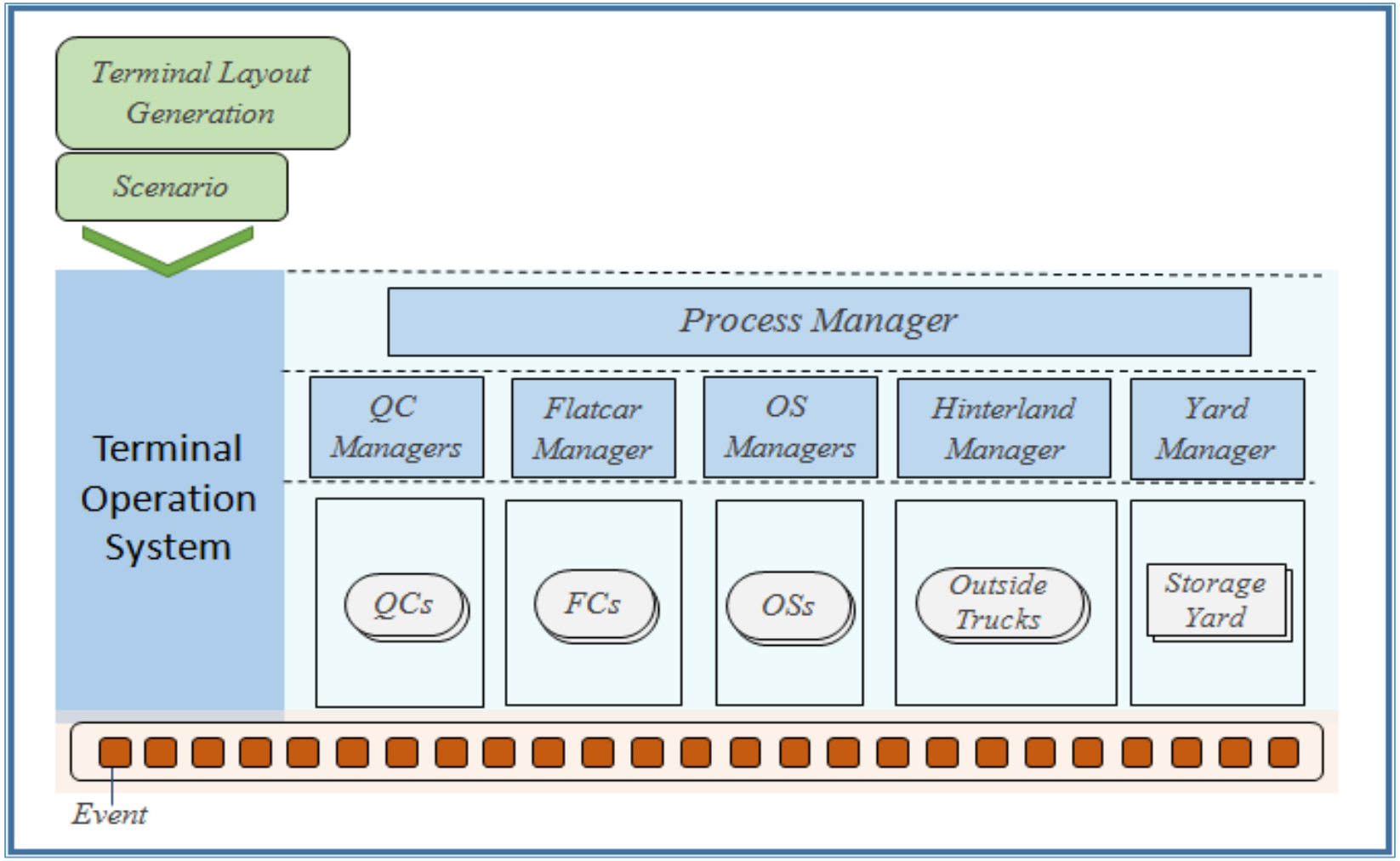


- Planning system
  : Stowage planning
  : Yard planning
  : QC scheduling
- Process manager
  : Integrated scheduling
  : Monitoring of other managers
- Quay crane (QC) manager
  : Quay crane movement control
- Flatcar operation
  : Flatcar movement control
  : Flatcar dispatching
  : Flatcar routing
- Overhead Shuttle (OS) manager
  : OS movement control

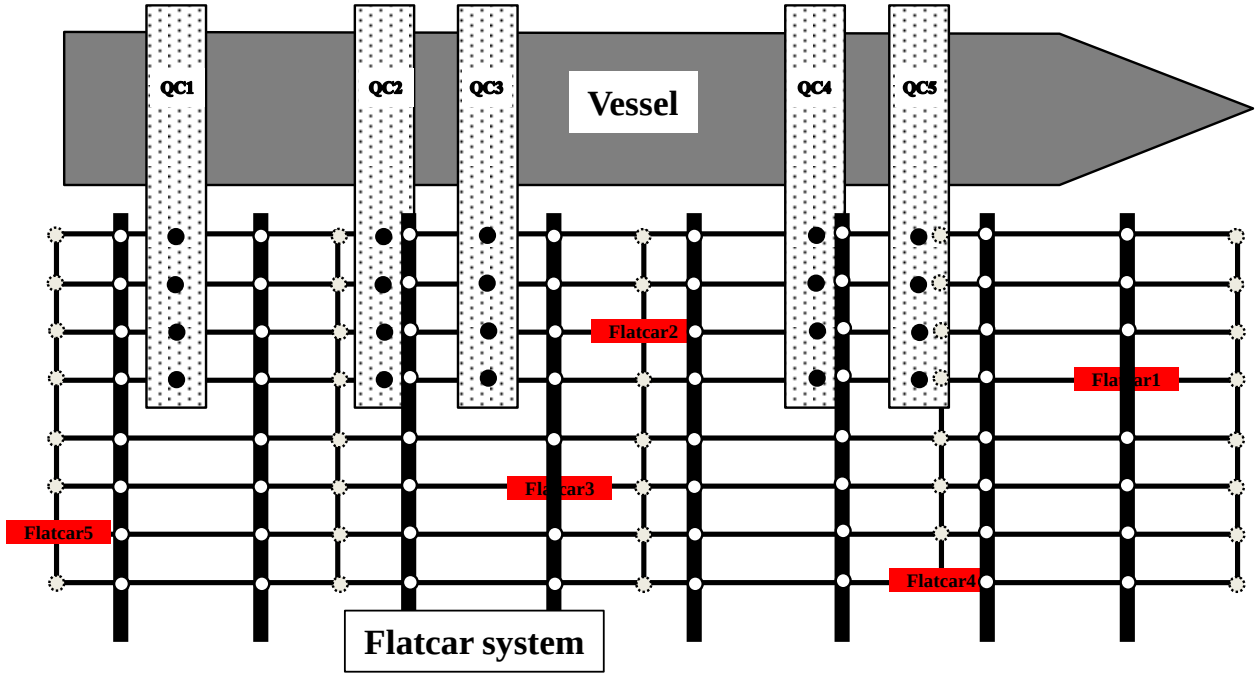
Hierarchy Structure for new Conceptual ACT



Operation System Architecture



Flatcar Dispatching



- **Flatcar select QC with weight table**

.Models...mFlatCarSelectCCWithWeight.CCListTF

File Edit Format Navigate View Tools Help

	object 1	integer 2	integer 3	real 4	real 5	real 6
1	*.OSS.AOL.Facilities.CC.CC:1	2	1339	0.05	0.30	0.06
2	*.OSS.AOL.Facilities.CC.CC:2	2	631	0.05	0.14	0.05
3	*.OSS.AOL.Facilities.CC.CC:3	2	395	0.05	0.09	0.05
4	*.OSS.AOL.Facilities.CC.CC:4	2	159	0.05	0.04	0.04
5	*.OSS.AOL.Facilities.CC.CC:5	2	77	0.05	0.02	0.04
6						

- an adaptation of the inventory-based dispatching method
- after a vehicle completes performing an unloading task, the next target QC is selected
- based on the weighted estimated horizontal distance and the current number of assigned vehicles to the QC

Flatcar Routing

1. Vertical travel first

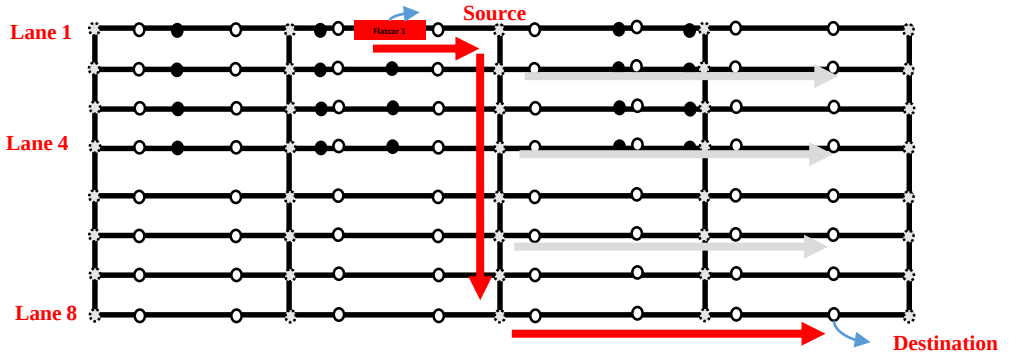
- TP determination by considering workload
- TP determination at each Vertical lane

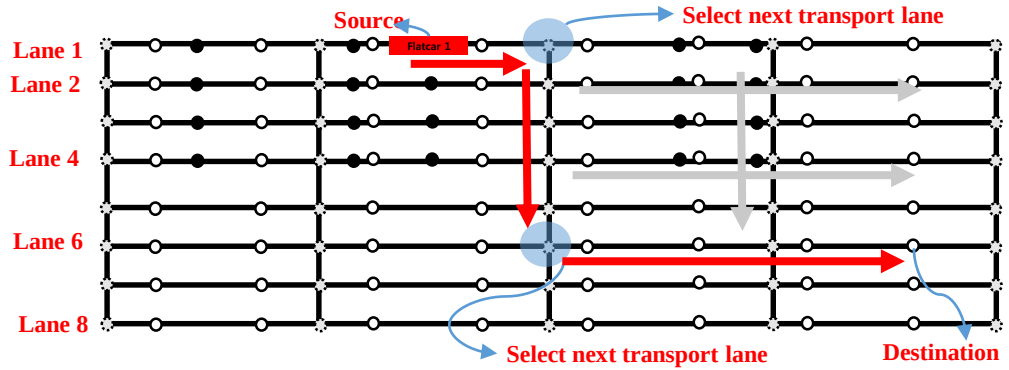
2. Postponed TP determination

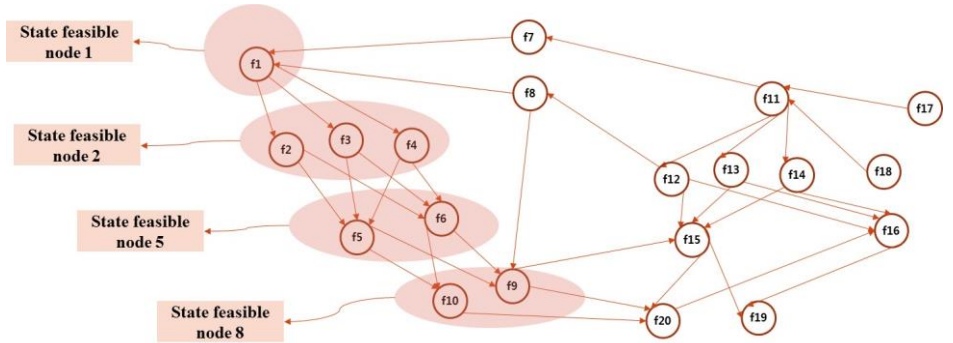
- TP determination by considering workload
- TP determination at latest moment

3. Shortest time path routing algorithm

- A flatcar has to **reserve multiple resources (transfer points and intersections)** simultaneously at any moment during its travel.
- A travel-scheduling algorithm for conflict-free routing based on **Dijkstra's algorithm** is suggested by using **the concept of time-windows**.

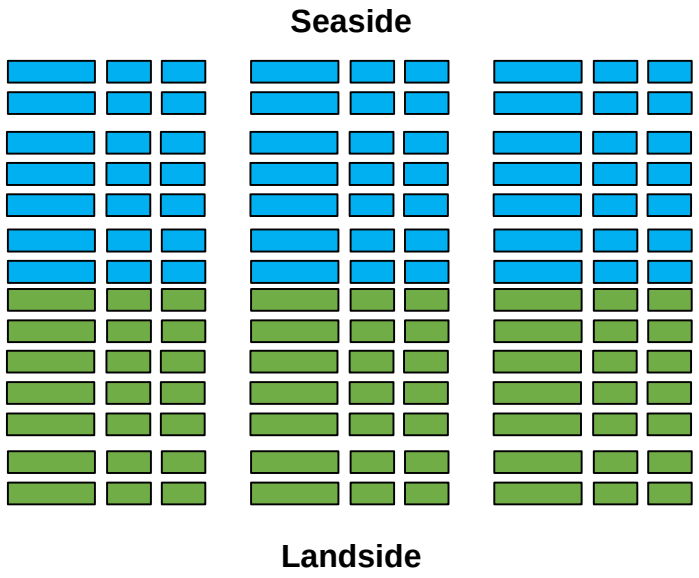




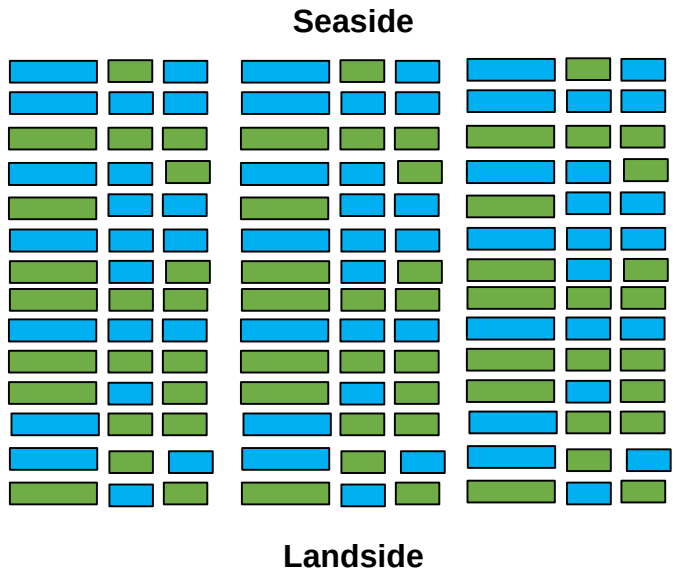


Storage Planning

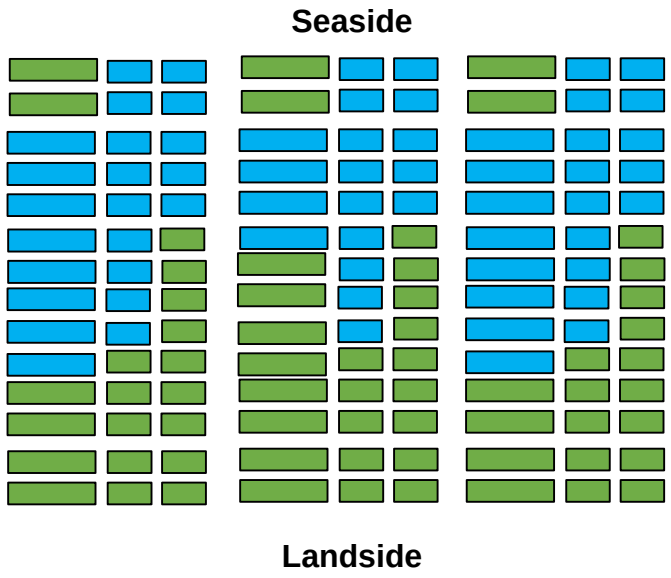
1. Uniformly yard allocation strategy



2. Randomly yard allocation strategy



3. Weighted yard allocation strategy

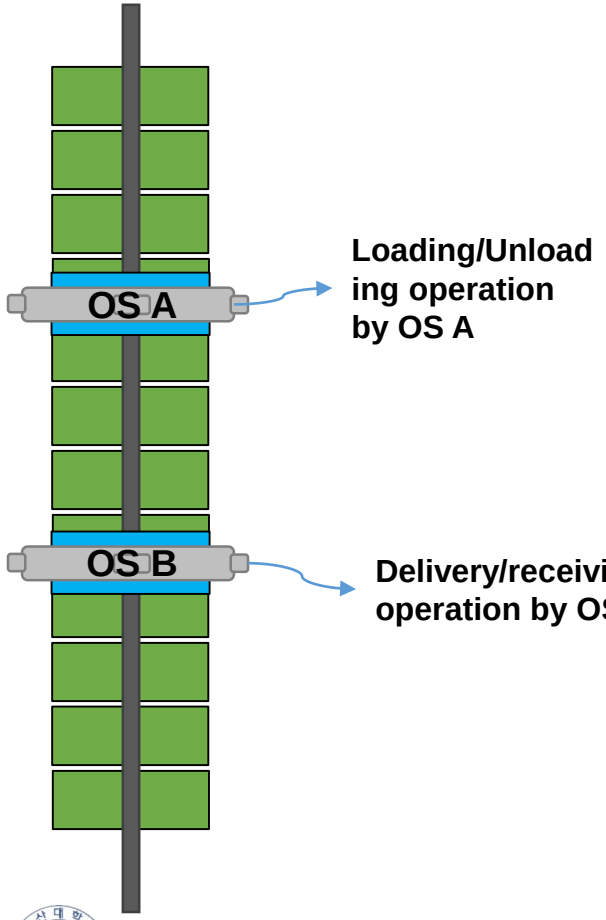


: outbound container

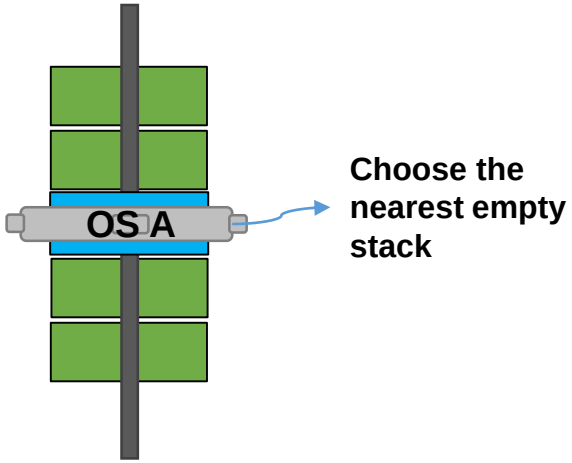
: inbound container

OSs Dispatching

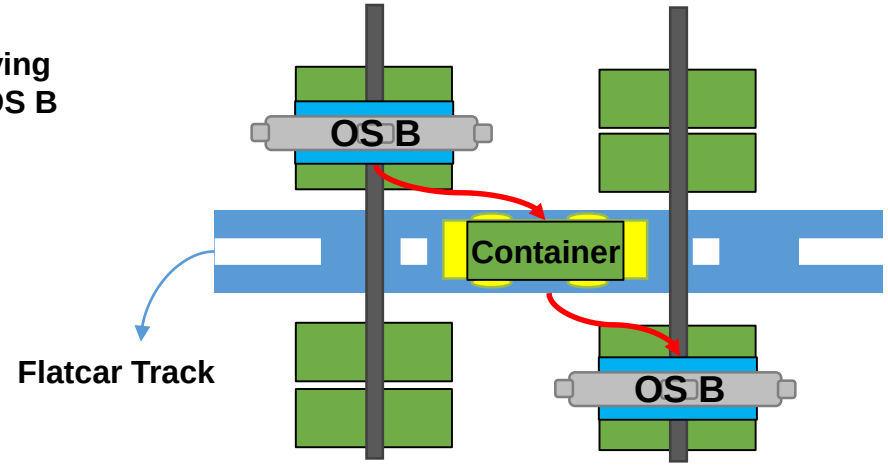
1. Separated OS operation



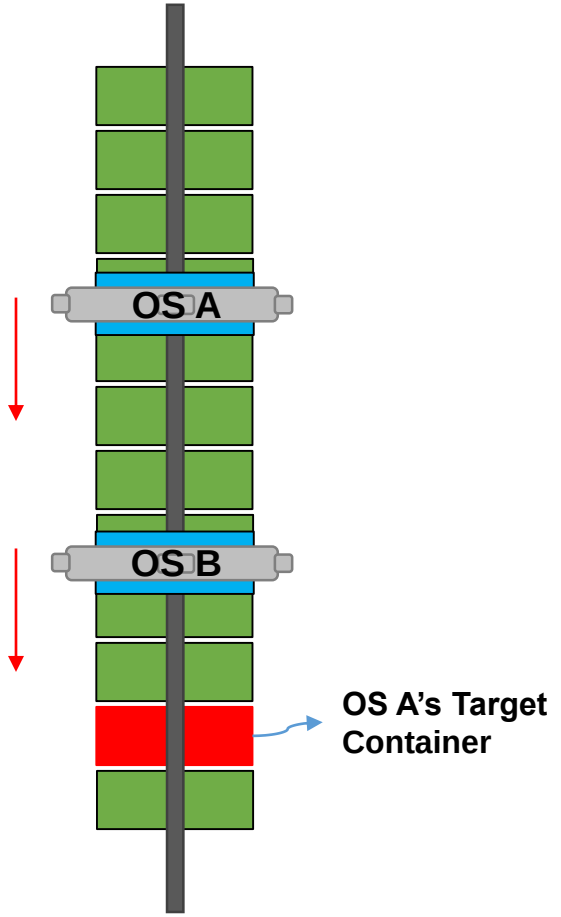
2. Re-handling operation



3. Re-marshaling operation

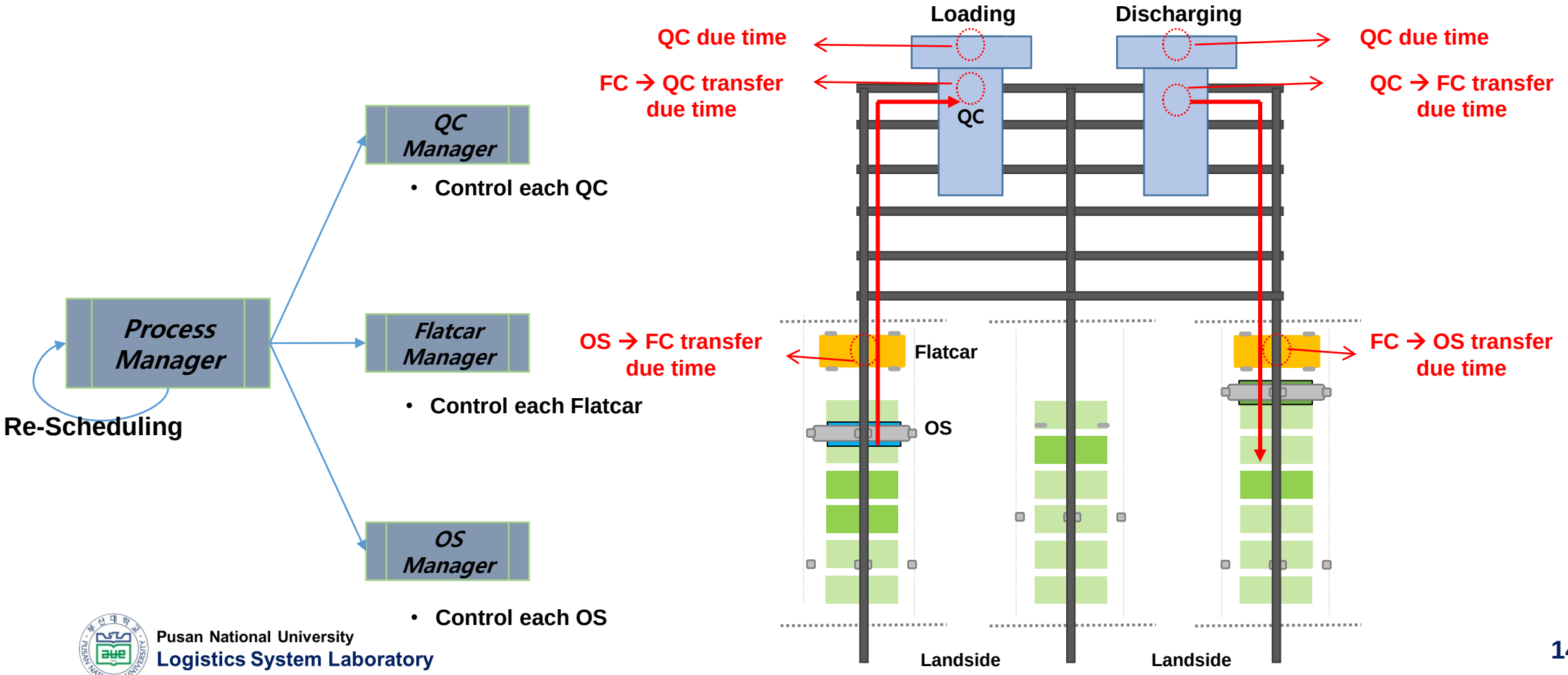


4. Loading/Unloading OS is first strategy

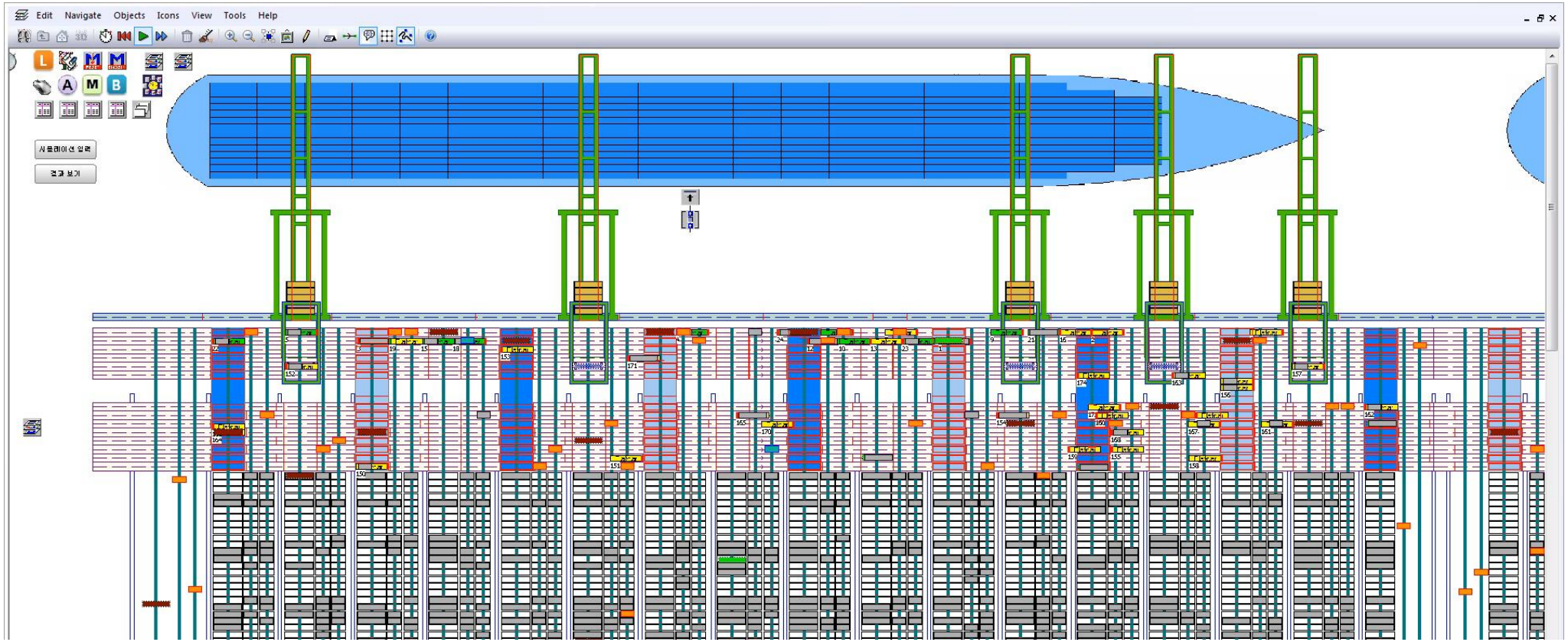


Integrated Scheduling

- Integrated scheduling
- Re-scheduling of QC & Flatcar& OSs operation



Simulation Video



Input Data

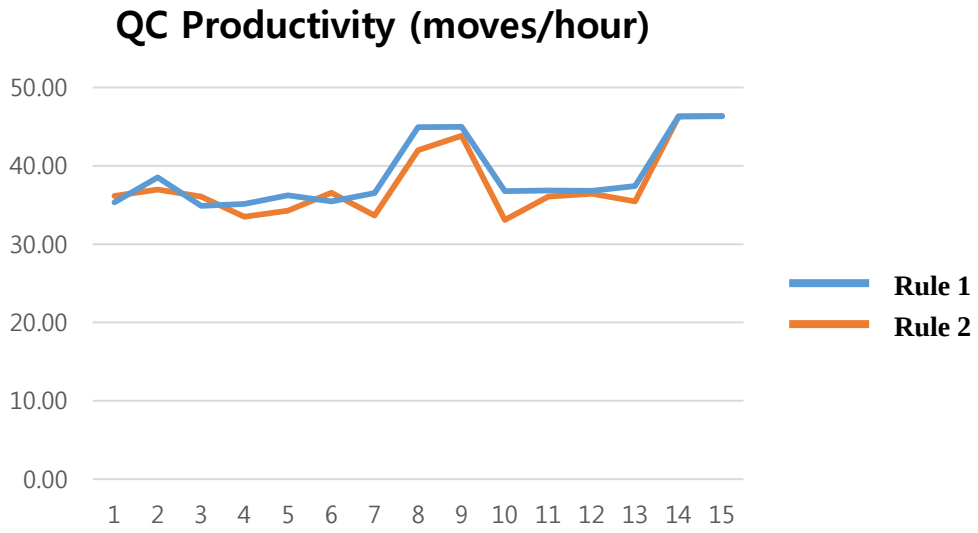
Vessel Size (TEU)	Arrival Ratio (%)	# Containers (TEU)	Vessel Length (m)	# 40ft Bays	# QC
0 ~ 1,000	19.4%	296	127	7	3
1,000 ~ 2,000	7.9%	450	166	9	4
2,000 ~ 3,000	5.6%	604	223	12	5
3,000 ~ 4,000	4.6%	758	257	15	6
4,000 ~ 5,000	4.0%	913	283	17	6
5,000 ~ 6,000	3.7%	1,067	276	17	7
6,000 ~ 7,000	3.4%	1,221	294	18	7
7,000 ~ 8,000	3.3%	1,375	307	18	7
8,000 ~ 9,000	3.1%	1,529	330	20	7
9,000 ~ 10,000	3.0%	1,683	340	20	8
10,000 ~ 11,000	2.9%	1,837	339	20	8
11,000 ~ 12,000	2.9%	1,992	364	22	8
12,000 ~ 13,000	2.8%	2,146	366	22	9

Vessel Size (TEU)	Arrival Ratio (%)	# Containers (TEU)	Vessel Length (m)	# 40ft Bays	# QC
13,000 ~ 14,000	2.7%	2,300	366	22	9
14,000 ~ 15,000	2.7%	2,454	366	22	9
15,000 ~ 16,000	2.7%	2,608	398	23	9
16,000 ~ 17,000	2.6%	2,762	398	23	9
17,000 ~ 18,000	2.6%	2,916	398	23	9
18,000 ~ 19,000	2.6%	3,071	399	24	9
19,000~20,000	2.6%	3,225	423	26	9
20,000~21,000	2.5%	3,379	431	26	9
21,000~22,000	2.5%	3,533	438	27	9
22,000~23,000	2.5%	3,687	445	27	9
23,000~24,000	2.5%	3,841	452	28	9
24,000~25,000	2.5%	3,995	459	28	9
25,000~	2.4%	4,150	466	28	9
합계	100.0	OSS 선석당 처리량 2,235,315 TEU 적용 및 환산			

Numerical Experiments

Experiment	Description
Rule 1: Integrated scheduling	Flatcar Dispatching: Earlier Due time Dispatching (EDD) OS Dispatching: Earlier Due time Dispatching (EDD)
Rule 2: Independent scheduling	Flatcar Dispatching: Inventory based Dispatching OS Dispatching: First In First Out (FIFO)

- **Result**



❍ Rule 1: QC Average Throughput 38.84 move/hour

❍ Rule 2: QC Average Throughput 37.78 move/hour

❍ Increase Ratio: 2.9%

Conclusions and Future Works

Conclusions

- This study proposes a simulation model for the automated container terminal (ACT) system which is developed using an object-oriented approach and Plant-Simulation tool.
- For analyzing the performance of the new conceptual container terminal system, we constructed a simulation model in which many operation logics and the performance measures for the ACT are provided.

Future Works

- It is necessary to verify and validate the developed simulation model for the ACT.
- This simulation program may be used for improving the design of the ACT and various operation rules in the model.

"Thank you for your attention"

Thank you