TEXAS A&M UNIVERSITY GALVESTON CAMPUS

MANAGEMENT OF PORT FACILITIES AND INFRASTRUCTURE

6. Container Terminals

MARA 616

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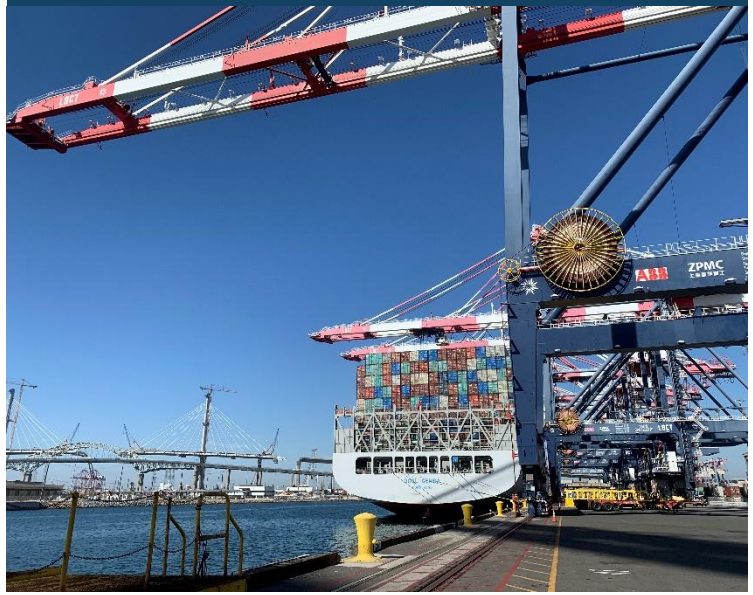


A. Ports and Container Shipping

Read this section

An Asset-Based Industry

- Container shipping industry
  - Shipping companies transporting containerized goods overseas.
  - Regular liner services as their core activity.
  - Transporting a limited range of standardized load units:
    - 20-foot dry cargo container or TEU.
    - 40-foot dry cargo container or FEU.
  - Liner service:
    - Fleet of ships, with common ownership or management.
    - Provides a fixed service, at regular intervals, between designated ports.
  - Container shipping contributes to about 16% of the volumes carried by maritime shipping and more than 50% of the value carried.

An Asset-Based Industry

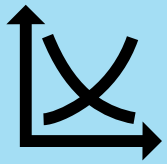
- Asset management program for the fleet they own or operate
- Vessel lifecycle management:
  - Includes the procurement, acquisition, deployment, and disposal of container vessels.
- Fleet capacity management:
  - Complex issue given the inflexible nature of vessel capacity in the short run.
  - Fixed timetables, seasonality and cargo imbalances effects in the shipping business.

Asset Management Domains in Container Shipping

LIFECYCLE MANAGEMENT

- Ship and container assets
- Purchase / ordering
- Deployment
- Performance measurement
- Maintenance
- Disposal (second-hand market, scrapping)

COST MANAGEMENT



- Total cost of ownership and operation
- Ship/box finance
- Depreciation / amortization
- Decision on flag state (ship registry)
- Operational, financial and fiscal accounting
- Location and modalities of ship management

CONTRACT MANAGEMENT

- Leases / charter parties (C/P)
- Warranties
- Service-level agreements
- Outsourcing of services

RISK MANAGEMENT

- Safety / security (assets, people, IT)
- Regulatory compliance

An Asset-Based Industry

- Adding capacity is not incremental
  - 11 to 12 ships are needed to operate one regular liner service on the Europe-Far East trade.
  - Each post-Panamax container vessel has a typical newbuilding price ranging from USD 120 to 170 million.
  - On average, container shipping lines charter about half of the vessels from third-party ship owners.
  - Ship chartering is a common practice for mid-size containerships in the range of 1,000 to 3,000 TEU.
- Container fleets
  - To support their operations and provide their customers with conveyances for their cargo.
  - A container carrier operating regular service on the Asia-Europe trade with ten vessels of 20,000 TEU needs a container fleet of at least 400,000 TEU to support the service.
  - Container shipping lines and other transport operators typically own 55% to 60% of the total global container equipment assets.
  - The remainder is leased from specialized companies.

Average Operating Margins of Main Carriers by Quarter, 2008-2024

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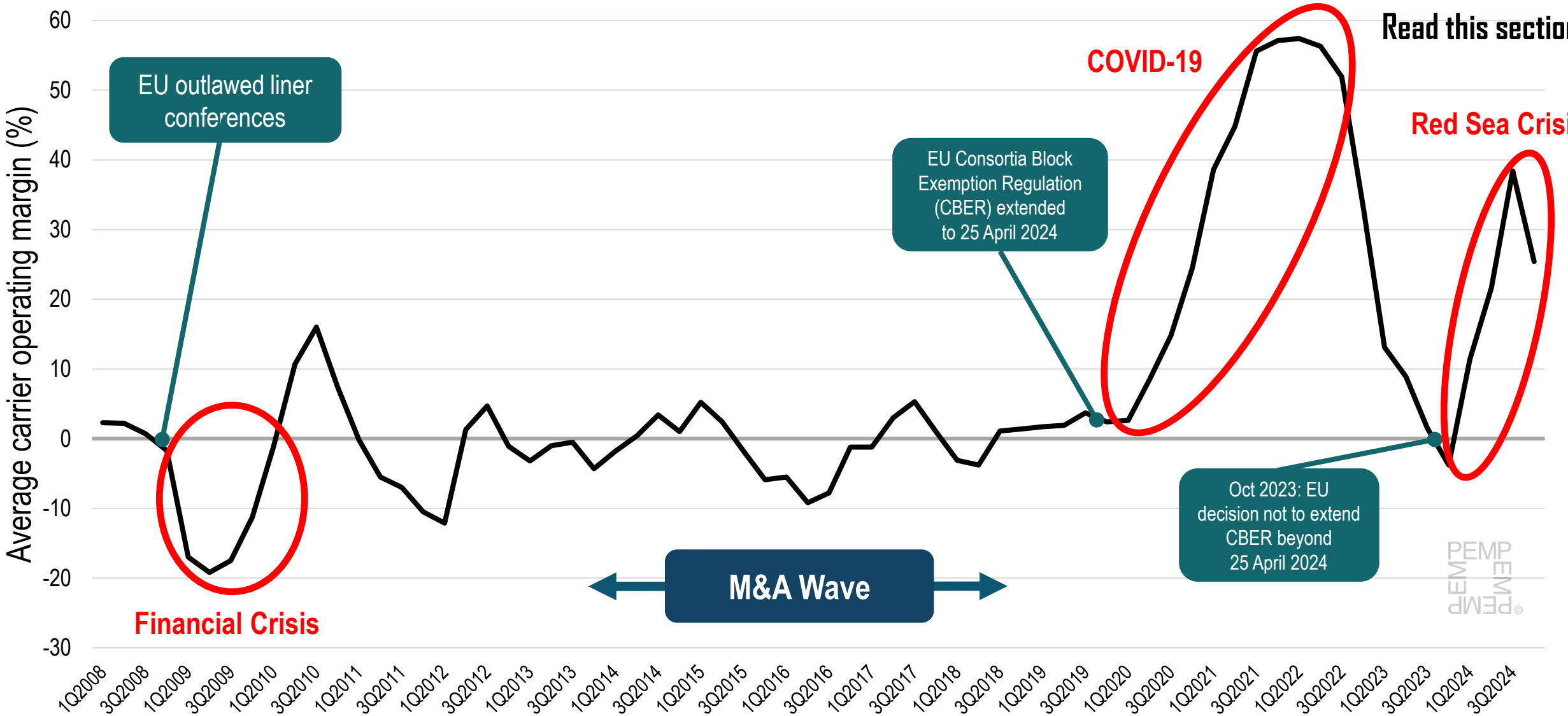

Scale Enlargement in Vessel Size

- Vessel upscaling
  - 1970s: First ships of over 2,000 TEU capacity.
  - 1990s: Panamax vessels of 4,000 to 5,000 TEU.
  - 1988: APL was the first shipping line to deploy a post-Panamax vessel.
  - 1996: Maersk Line introduced the Regina Maersk with a nominal vessel capacity of about 7,400 TEU.
  - 2006: Emma Maersk with more than 15,000 TEU and measured 397 m in length overall, with a beam of 56 m, and a commercial draft of 15.5 m.
  - 2010: vessel capacity beyond the 20,000 TEU.
- Cascading
  - Introduction of larger container vessels resulted in an overall upscaling across the main east-west trade routes.
  - Large vessels cascading to north-south routes.

The Largest Available Containership, 1970-2024

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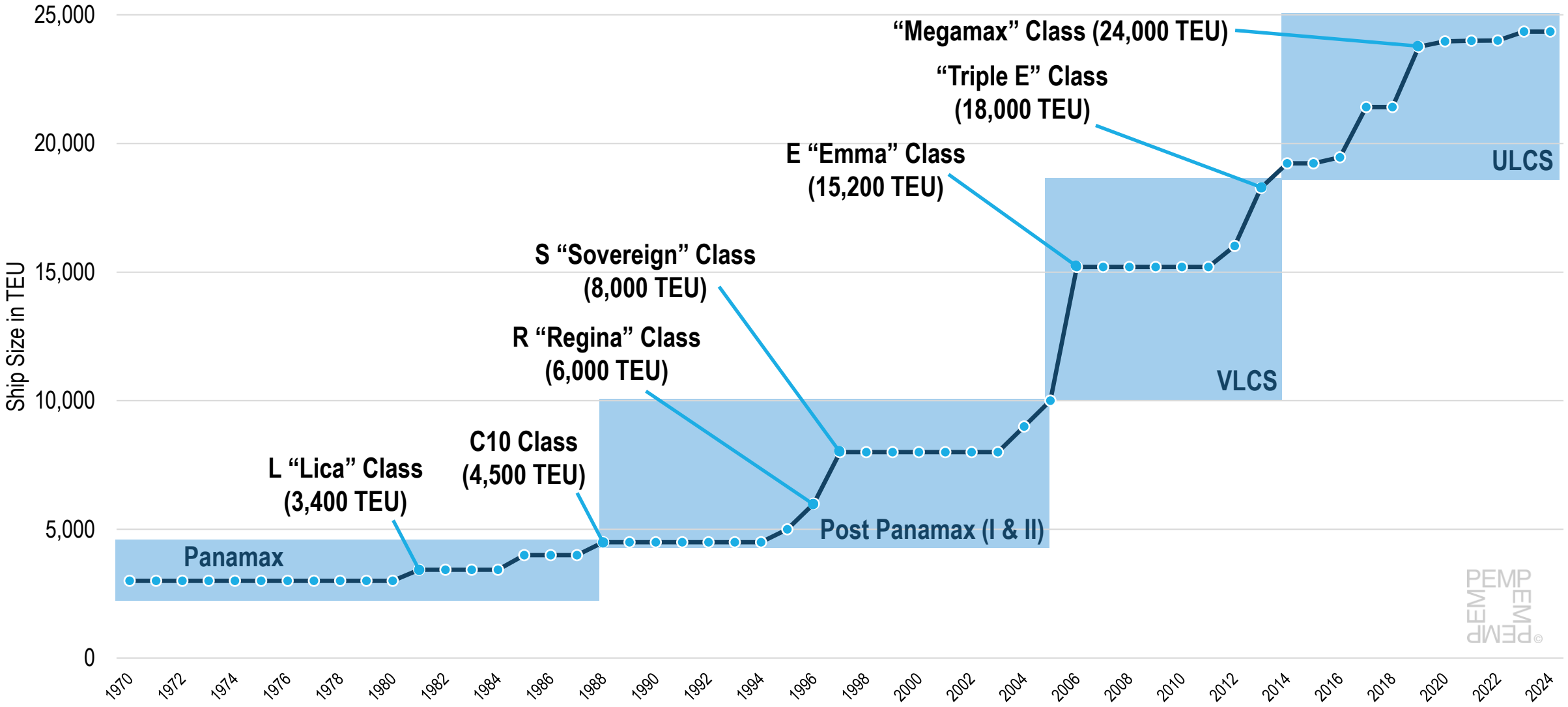


The Disadvantages of Scale in Maritime Shipping

Read this section

Maritime / Port Operations

- Fewer ports can accommodate larger ships.
- Reduction in ship call frequency.
- Capital dredging.
- Longer intra-port navigation.
- Longer berth space and berth time.
- Reduction in crane productivity.

Yard Operations

- Surges in yard haulage.
- Surges in yard storage.
- Surges in reefer slots usage.
- Security and customs inspection issues.

Gate / Hinterland Operations

- Surges in gate access.
- Increased local congestion.
- Supply chain adjustments (more lead time and inventory).
- Cargo risks (insurance).

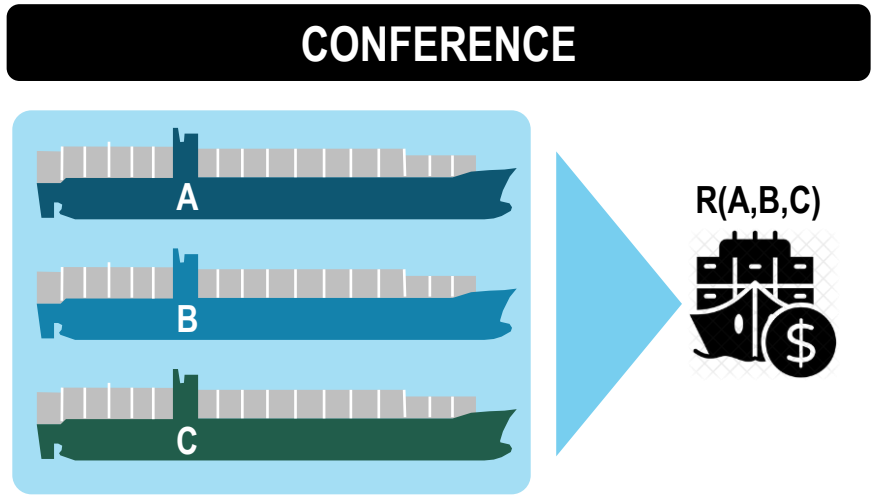
Horizontal Integration for Shipping Lines

- Horizontal integration dynamics
  - Cooperation an effective way with intense pricing pressure.
  - Based on mergers and acquisitions (M&A) and operational cooperation
  - Slot-chartering and vessel-sharing agreements to strategic alliances.
- Slot chartering agreement (SCA)
  - Contract between partners who buy and sell a defined allocation (space, weight) on a vessel.
  - On a 'used' or 'unused' basis at an agreed price and for a minimum defined time period.
  - Shipping lines may engage in a slot exchange agreement.
- Vessel sharing agreement (VSA)
  - Operate a liner service along a specified route using a specified number of vessels.
  - Partners do not necessarily each have an equal number of vessels.
  - Allocated capacity varies from port to port and depends on the number of vessels operated by the different partners.

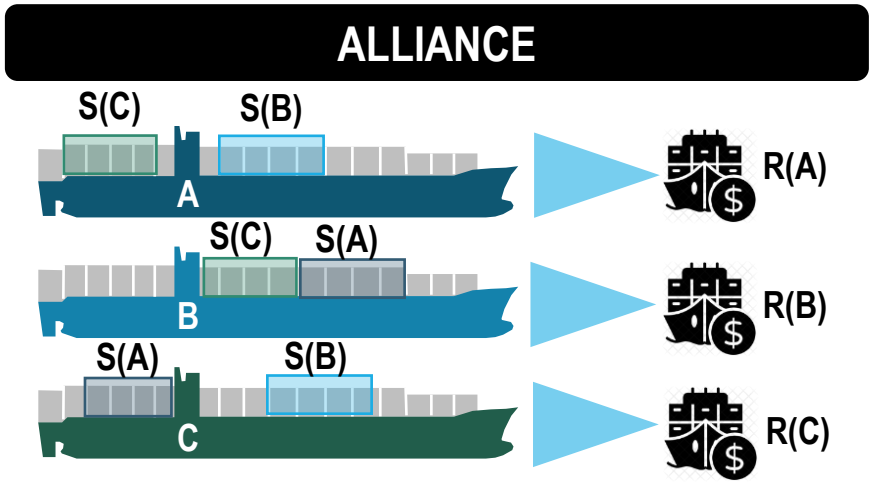
Horizontal Integration for Shipping Lines

- Alliance
  - Operating agreement between two or more carriers.
  - Joint fleet capacity management on a number of trade routes (typically the major East-West trade routes).
  - Alliance members retain their commercial independence.
  - Their introduction corresponds to larger ships.

Conferences versus Alliances in Maritime Shipping



- Regulate competition among carriers.
- Protect their markets from external competition.
- Common freight rates.
- Regulate their capacity (rate setting).



- Cooperative agreement between carriers.
- Regulate competition in selected markets.
- Individual freight rates.
- Share capacity (slot sharing).

Main Incentives for Carriers to be Involved in Alliances

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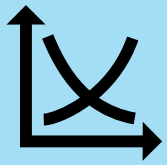
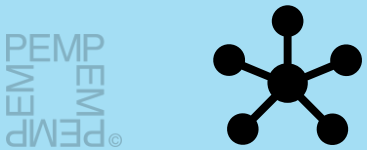
FINANCIAL

- Economies of scale.
- Economies of scope.
- Less capital requirement.



MARKET

- Increase service frequency.
- Expand network coverage.
- Stable freight rates.



OPERATIONAL

- Container utilization level.
- Capacity management.
- Extend logistics services.

TACTICAL

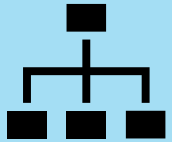
- Rationalization of service routes.
- Expand intermodal services.

STRATEGIC

- Entry into trade routes.
- Entry into gateways or hubs.
- Limit competition.

MANAGERIAL

- Better asset utilization.
- Improve managerial skills.
- Global service coordination.



Alliances in Container Shipping, 1996-2025

Critical juncture in Oct 2023: EU decision not to extend Consortia Block Exemption Regulation (CBER) beyond April 25, 2024

Q2 1996	Q1 1998	Q4 2001	Q4 2005	Q4 2009	Q1 2012	Q2 2015	Q2 2017	Q3 2023	Q1 2025
GLOBAL ALLIANCE APL MOL Nedlloyd OOCL MISC	NEW WORLD ALL. APL/NOL MOL HMM	NWA APL/NOL MOL HMM	NWA APL/NOL MOL HMM	NWA APL/NOL MOL HMM	G6 ALLIANCE APL/NOL MOL HMM Hapag-Lloyd NYK Line OOCL	G6 ALLIANCE APL/NOL MOL HMM Hapag-Lloyd NYK Line OOCL	THE ALLIANCE Hanjin MOL K-Line NYK Line Yang Ming Hapag-Lloyd	THE ALLIANCE ONE Yang Ming HMM Hapag-Lloyd	PREMIER ALLIANCE ONE Yang Ming HMM Feb 2025 - Feb 2030 Slot chartering with MSC on Asia-Europe route
GRAND ALLIANCE Hapag-Lloyd NYK Line NOL P&OCL	GRAND ALLIANCE II Hapag-Lloyd NYK Line P&O Nedlloyd OOCL MISC	GRAND ALLIANCE II Hapag-Lloyd NYK Line P&O Nedlloyd OOCL MISC	GRAND ALLIANCE III Hapag-Lloyd NYK Line OOCL MISC	GRAND ALLIANCE IV Hapag-Lloyd NYK Line OOCL		CYKHE Hanjin K-Line Yang Ming COSCO Evergreen	OCEAN ALLIANCE CMA CGM COSCO OOCL Evergreen	OCEAN ALLIANCE CMA CGM COSCO/OOCL Evergreen	OCEAN ALLIANCE CMA CGM COSCO/OOCL Evergreen 2017-2027 Extended to 2032
	CYK ALLIANCE K-Line Yang Ming COSCO	CYKH Hanjin K-Line Yang Ming COSCO	CYKH Hanjin K-Line Yang Ming COSCO	CYKH Hanjin K-Line Yang Ming COSCO	CYKH Hanjin K-Line Yang Ming COSCO	2M ALLIANCE MSC Maersk Line	2M ALLIANCE MSC Maersk Line	2M ALLIANCE MSC Maersk Line Jan 2015-Jan 2025	
	UNITED ALLIANCE Hanjin Cho Yang USAC				MSC/CMA CGM MSC CMA CGM	OCEAN THREE CMA CGM China Shipping UASC			GEMINI COOPERATON Maersk Line Hapag-Lloyd Feb 2025 -
Maersk Sea-Land	Maersk Sea-Land								

MAIN CARRIERS NOT PART OF AN ALLIANCE

MSC CMA CGM Evergreen	MSC CMA CGM Evergreen	Maersk SeaLand MSC CMA CGM Evergreen	Maersk Line MSC CMA CGM Evergreen	Maersk Line MSC CMA CGM Evergreen	Maersk Line Evergreen	MSC

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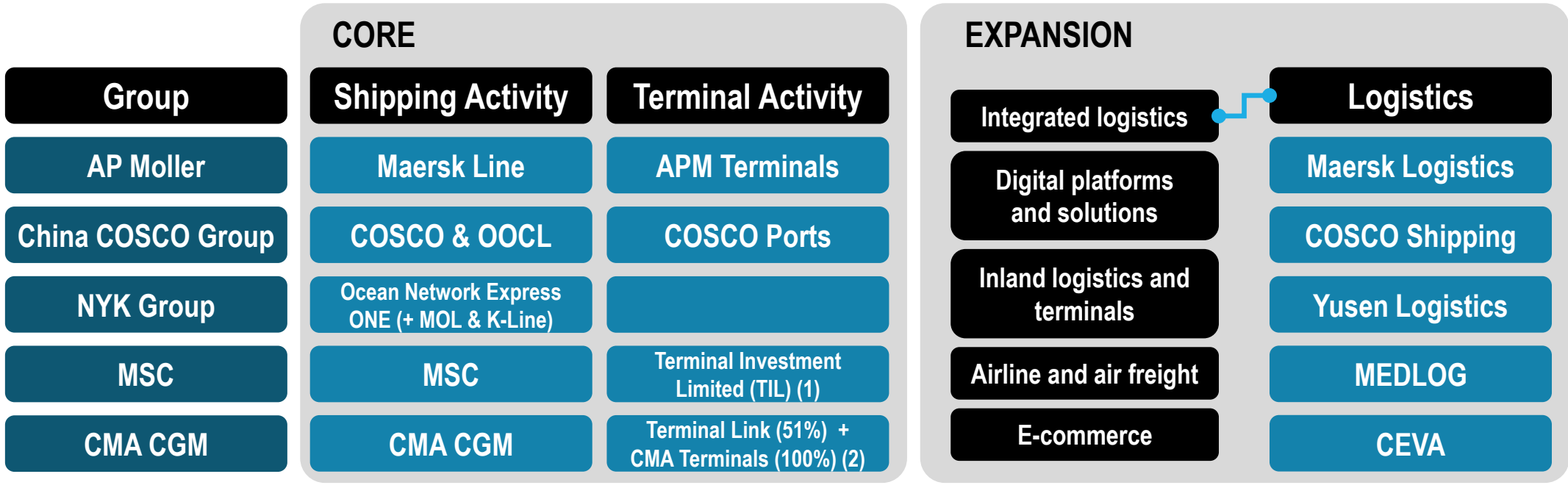
Vertical Integration: Extending the Scope of Operations

- Context
  - Low margins in shipping.
  - Customer demand for door-to-door and one-stop shopping logistics services.
  - Shipping lines may extend the reach of their activities to other parts of the supply chain.
  - Largest container lines have shown a keen interest in developing dedicated terminal capacity:
    - Control costs and operational performance.
    - Improve profitability.
    - Measure to cope with poor vessel schedule integrity.
- Scope
  - Beyond terminal operations to include inland transport and logistics.
  - Developing door-to-door services based on the principle of carrier haulage.
  - Coordination with independent inland transport operators and logistics service providers.

Vertical Integration by Carriers: Beyond Shipping Agencies and Terminals



Past: Waves in logistics integration (invest vs. divest) with continued interest in terminals
Present: Transition from carrier to logistics integrator; large differences among carriers remain

(1) Fully owned by MSC till 2013, stake brought to 60% in May 2019. Other shareholders are Global Infrastructure Partners (GIP) and GIC Private Limited, a Singaporean Sovereign Wealth Fund.
(2) Terminals controlled by CMA Terminals were transferred to Terminal Link in late 2019.

Container Services and Networks

- Container service network patterns
  - Trade-off between the requirements of the customers and operational cost considerations.
  - Higher demand for service segmentation adds to the growing complexity of the networks.
  - Shippers demand direct services between their preferred ports of loading and discharge.
  - Carriers prefer more indirect services to capture as much cargo as possible.
  - Demand side exerts strong pressure on the service schedules, port rotations, and feeder connections.
  - Design networks to optimize ship utilization and benefit from scale economies in vessel size.
  - Rationalizing the coverage of ports, shipping routes, and transit time according to direct routes and strategic passages.
- Bundling
  - Bundling within an individual liner service.
  - Bundling by combining two or more liner services.

Types of Inter-Range Maritime Routes

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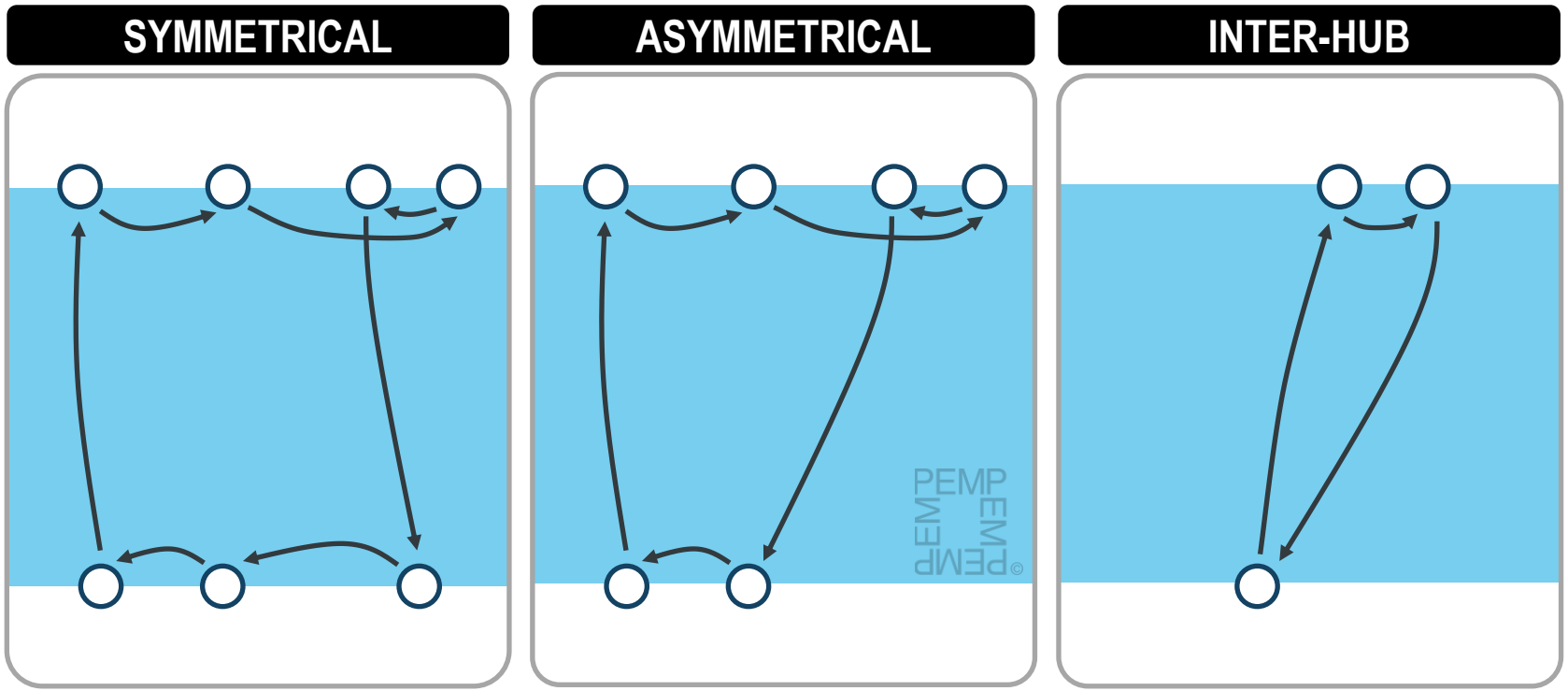

Three Major Inter-Range Routes Serviced by Maersk

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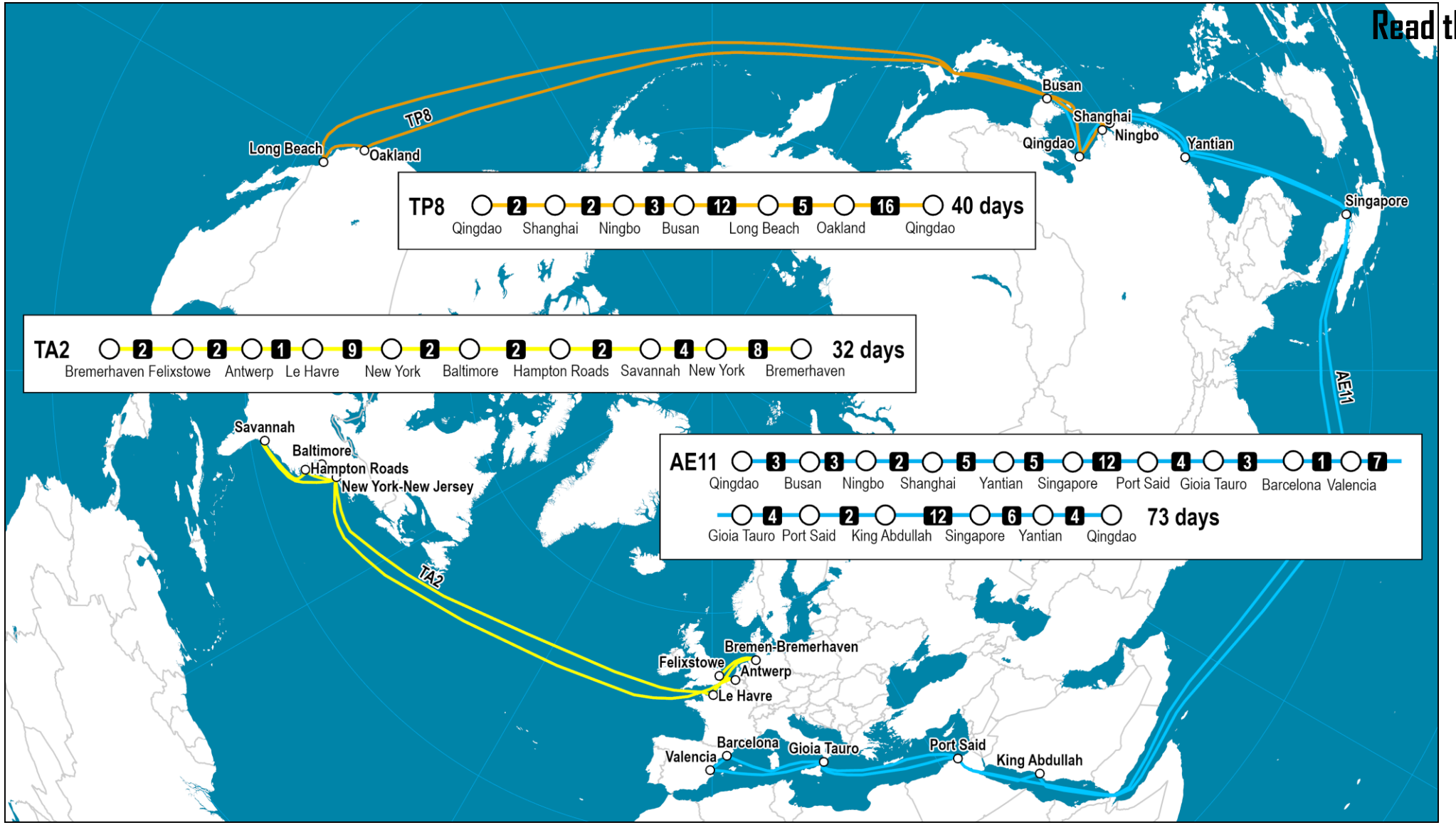

Container Services and Networks

- The role of transshipment hubs
  - Bundling container cargo by combining two or more liner services.
  - The three main cargo bundling options:
    - Hub-and-spoke network (hub/feeder).
    - Interlining/intersection.
    - Relay.
  - Hub port development
    - Crossing points of trade lanes.
    - Emerged since the mid-1990s within many global port systems.
    - Freeport (Bahamas), Salalah (Oman), Tanjung Pelepas (Malaysia), Gioia Tauro, Algeciras, Taranto, Cagliari, Damietta, Tanger Med, and Malta in the Mediterranean.

Selection Factors for a Transshipment Hub

Read this section

LOCATION

- Proximity to major shipping routes (low deviation).
- Intermediary location connecting feeder and deepsea services.
- Hinterland access (local cargo capture).

INFRASTRUCTURE

- Greater depth (>13.5 meters) to accommodate post-Panamax ships.
- Large yard area for the temporary storage of containers.
- High-capacity equipment.

OPERATIONS

- Lower costs.
- High berth productivity.
- Reliability (service level).

The Insertion and Location of Transshipment Hubs

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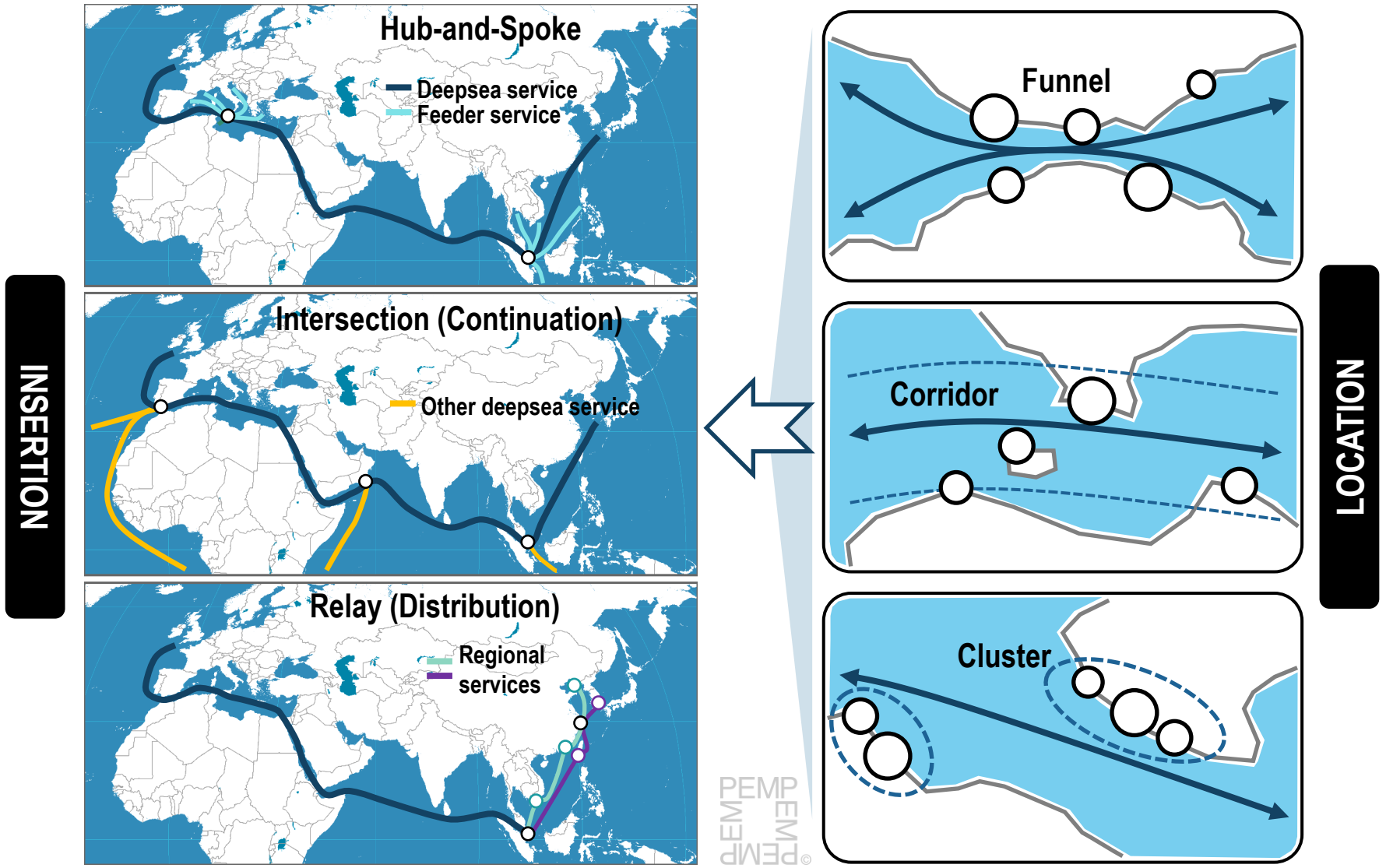

Major Shipping Bottlenecks and Intermediate Hubs, 2019

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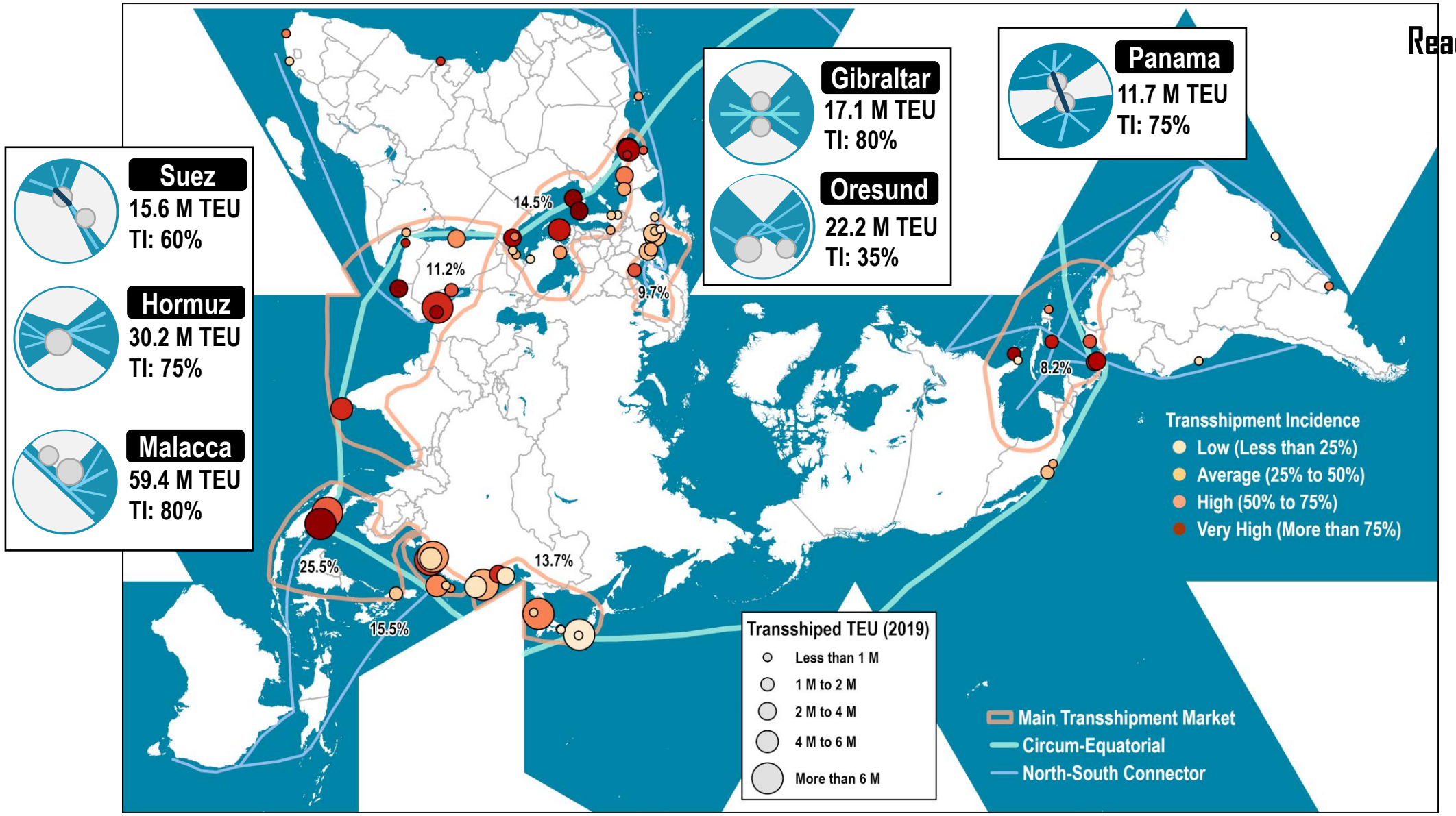

Port and Terminal Selection by Container Shipping Lines*

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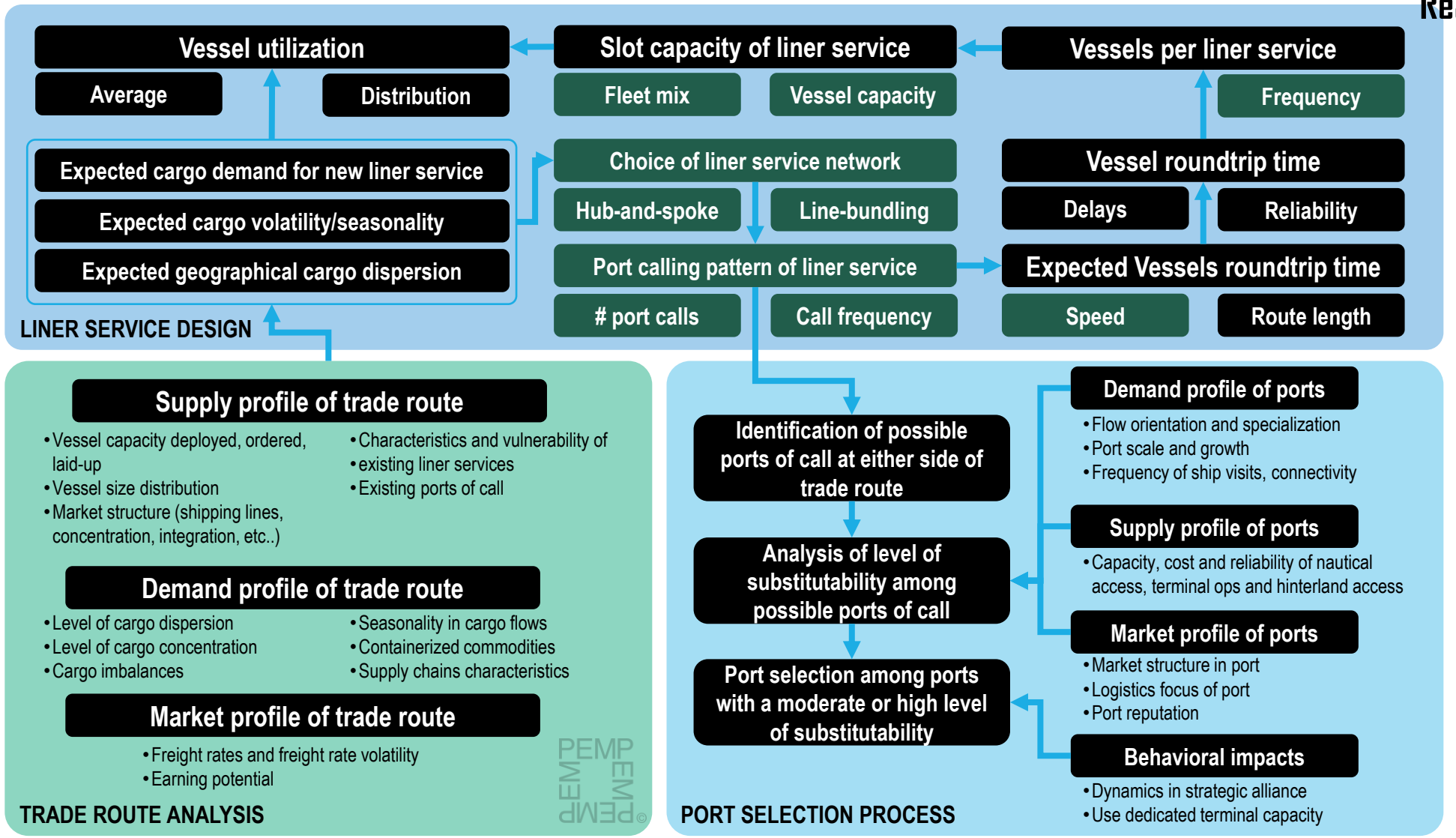

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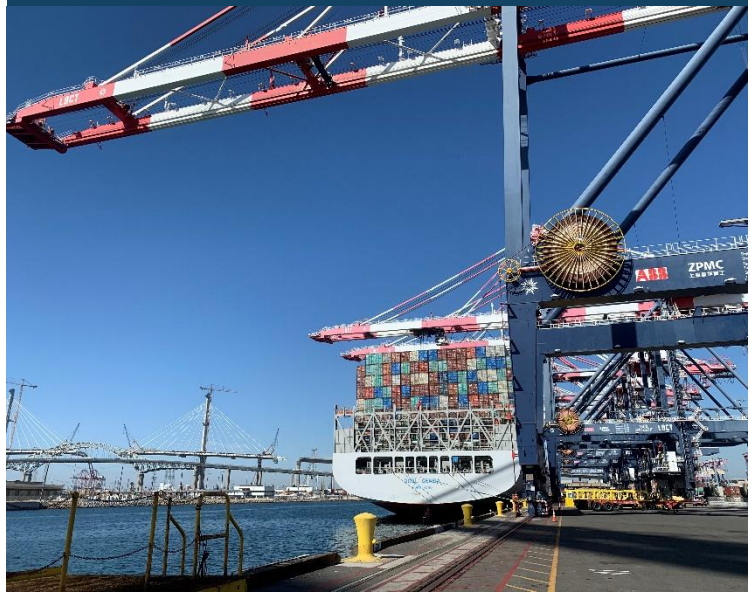

B. The Box and Chassis Markets

Read this section

The Box Market

- Ongoing demand for new containers
  - About 1.5 to 2.5 million TEUs worth of containers are manufactured each year.
  - 90% made in China, taking advantage of its containerized export surplus.
- Dry containers
  - Most important market.
  - Standard containers used to carry general cargo.
- Refrigerated containers (reefers
  - Niche market.
  - Specially insulated containers to transport temperature-sensitive goods.
- Tank containers
  - Niche market.
  - Specially designed containers to carry food-grade liquids (wine, vegetable oil, juice) or chemicals.

Composition of the Global Fleet of Containers, 2012

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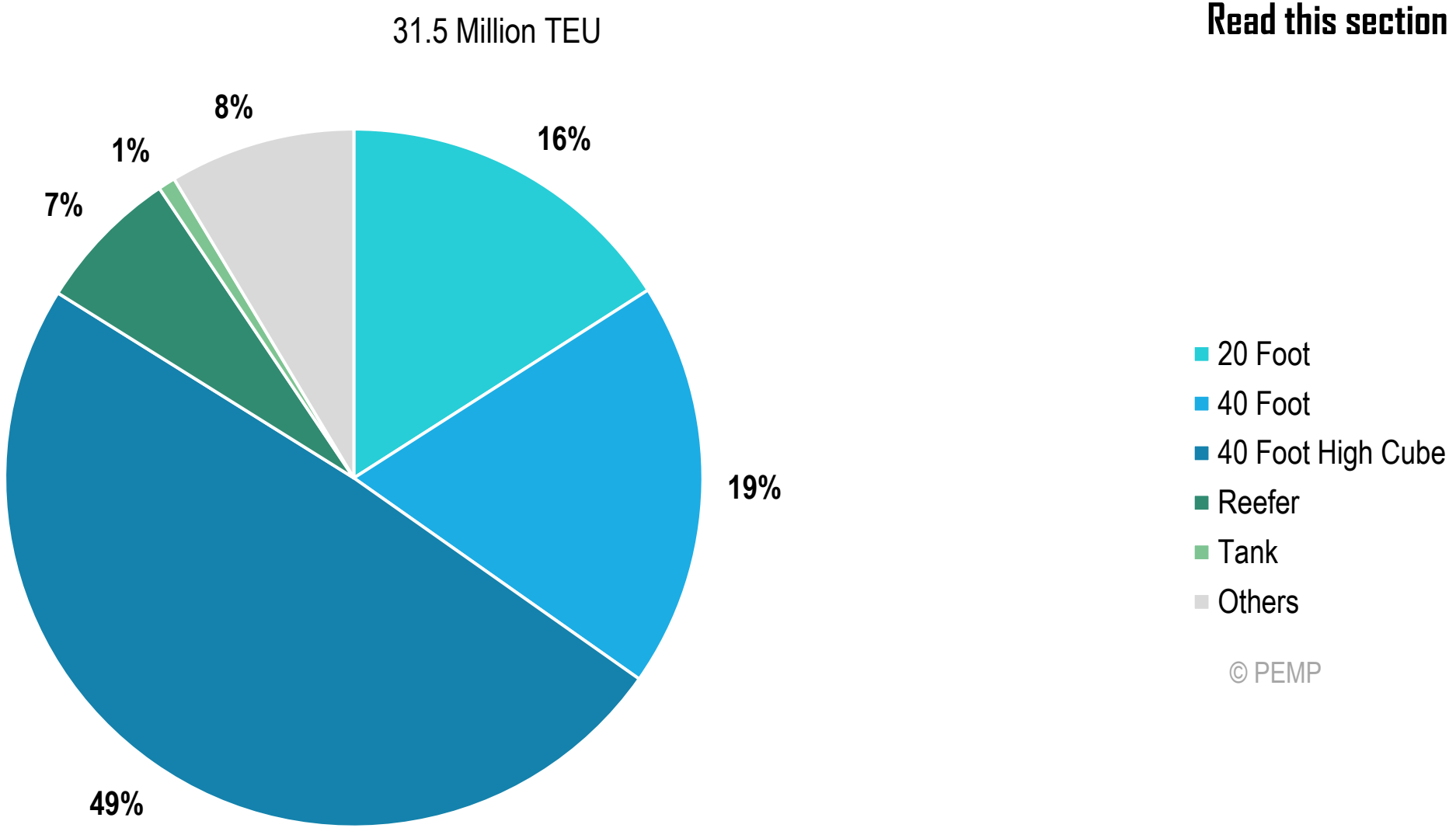


The Box Market

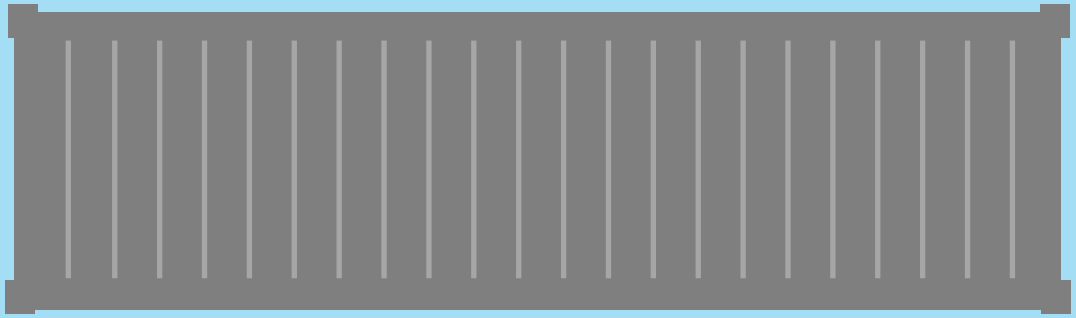
- Global inventory of containers
  - Around 37.6 million TEUs as of 2015.
  - 5 million containers are manufactured each year.
  - Approximately three TEUs of containers for every TEU of maritime containership capacity.
  - The container manufacturing market is highly volatile.
- Container usage
  - Owned either by maritime shipping companies or container leasing companies (50-50).
  - Clear brand recognition, particularly for shipping lines.
  - Asset that maritime shipping companies make available to service their customers.
  - Providing containers helps increase the utilization rate of containerships.
  - Growing level of intermodal integration.
  - Container leasing business less profitable.
  - Ocean carriers also have a greater ability to reposition empty containers.

The Chassis Market

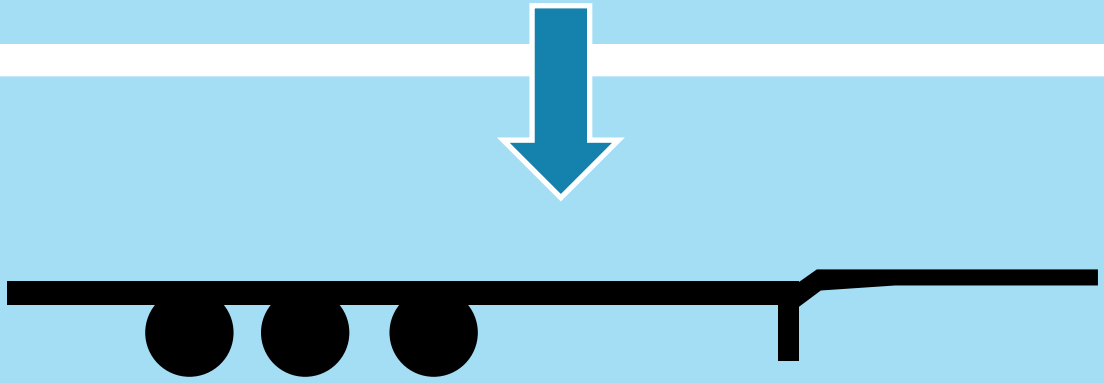
- Chassis fleets
  - Important element of the container market.
  - Necessary to carry containers by road and sometimes within terminals.
  - Chassis are designed to be interoperable.
  - Containers are international transport units:
    - Owned by ocean carriers or leased by container leasing companies.
    - Transport between international markets relies on separate regional chassis provision segments.
  - Separate ownership of containers and chassis.

The Container and Chassis Markets

CONTAINER MARKET



- Global intermodal transportation, particularly maritime shipping.
- Container owned by shipping lines or leasing companies (50/50).
- Interoperable and transferable across transportation markets.
- 20% of global container movements empty.



CHASSIS MARKET

- Regional and local intermodal transportation by truck.
- Can be used for terminal operations (container storage).
- Chassis owned by Intermodal Equipment Providers, shipping lines, and motor carriers.
- Interoperable, but cannot be easily transferred across markets.

The Chassis Market

- A derived demand of a derived demand
  - Chassis supply:
    - The provision of chassis to a regional drayage market.
    - Owned by carriers (motor carriers, ocean carriers, rail carriers).
    - Organized as pools by Intermodal Equipment Providers (IEP), which lease chassis through daily (spot) rates or through long-term contracts.
  - Chassis demand:
    - Using chassis for drayage by motor carriers or terminal operations at port and rail terminals.
    - Demand delimited to a regional area representing the usual distance the containers are carried from intermodal terminals to cargo owners.

Empty Container Flows

- A transport and production unit
  - Unit that moves as an export, import, or repositioning flow.
  - Once a container has been unloaded, another transport leg must be found.
  - Moving an empty container is almost as costly as moving a full container.
  - A container consumes the same amount of space and requires the same transport capacity.
  - Shipping companies need containers to maintain their operations and level of service along the port network they call.
  - Containers arriving in a market as imports must eventually leave, either empty or full.
  - The longer the delay, the higher the cost.
  - 10% of existing container assets and 20.5% of global port handling.

Empty Container Flows

- Trade imbalances
  - Most important source of the accumulation of empty containers in the global economy.
  - An import region will face the systematic accumulation of empty containers.
  - An export region will face a shortage of containers.
  - Repositioning of large amounts of containers will be required between the two trade partners, involving higher transportation costs and tying up existing distribution capacities.
- Repositioning costs
  - Combination of inland transport and international transport costs.
  - Low costs: trade imbalance without much impact as containers get repositioned.
  - High costs: container shortages may appear in export markets.

Types of Container Flows

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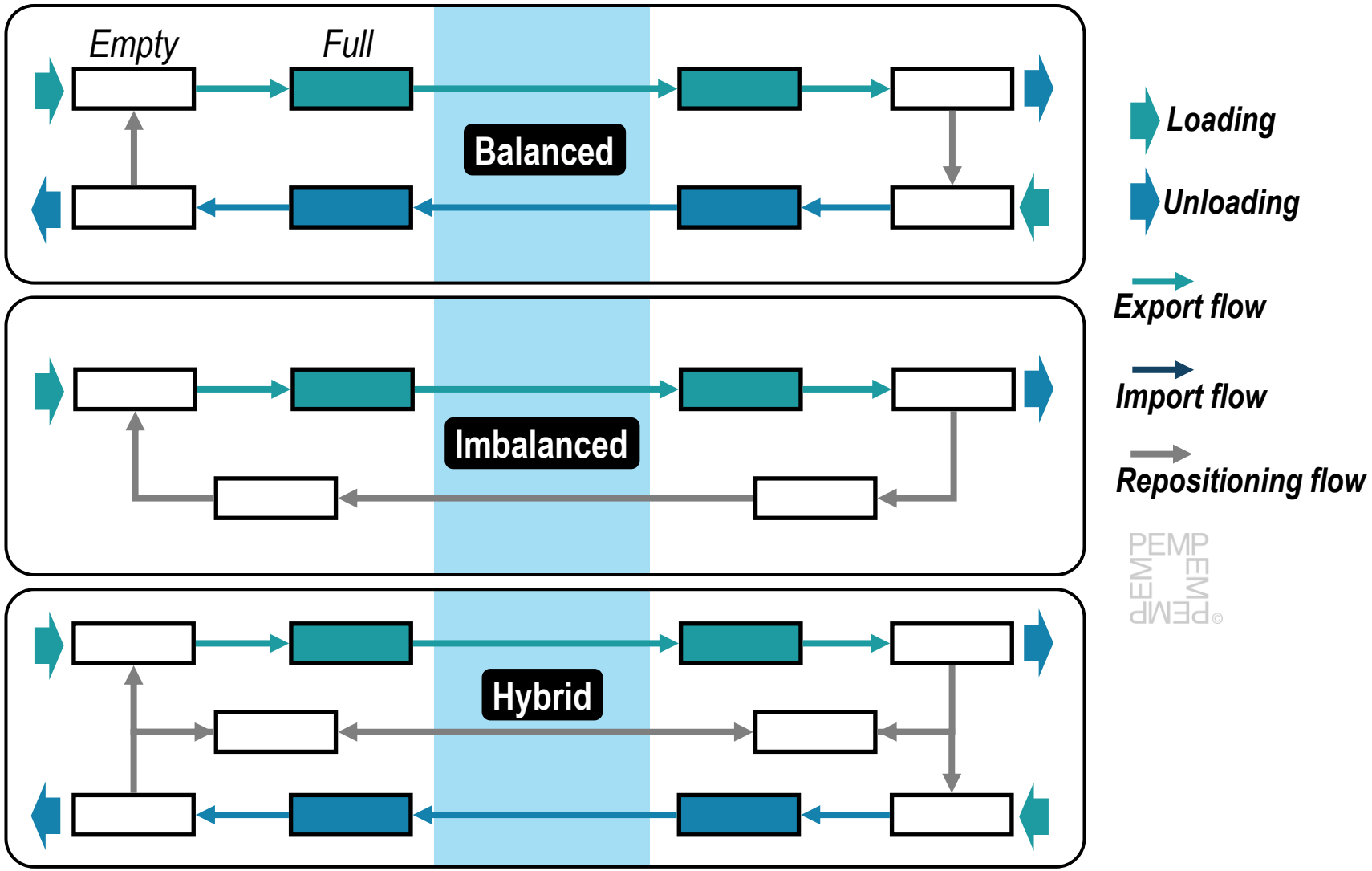

Empty Container Flows

- Revenue generation
  - Shipowners allocate their containers to maximize their revenue.
  - Shipowners often opt to reposition their containers back to export markets instead of waiting for the availability of an export load.
- Manufacturing and leasing costs
  - Cost of manufacturing new containers or leasing existing units can be cheaper than repositioning.
  - Higher manufacturing or leasing costs may favor the repositioning of empty containers.
- Usage preferences
  - Containers as brand and readily available capacity to their customers.
  - Challenging to establish container pools or introduce the 'grey box' concept.
- Slow steaming
  - Maritime shipping companies to reduce operational speed (21 knots to 19 knots).
  - Longer transoceanic journeys tie more container inventory in transit.

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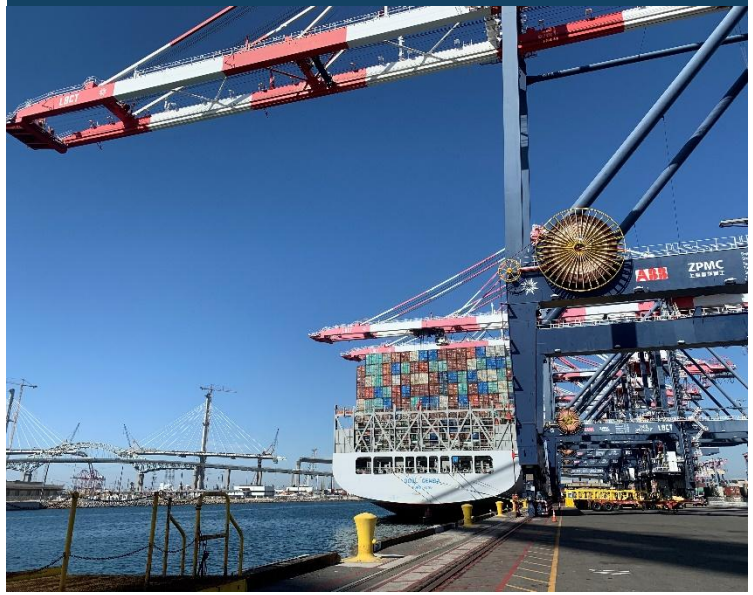

C. Container Terminal Design and Equipment

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The Design of Container Terminals

- Container terminal
  - Facility specializing in the transshipment, handling, and temporary storage of containers between at least two transportation modes.
  - Footprint including quays, yard areas, equipment such as cranes.
  - Support facilities, including administrative and maintenance buildings and warehouses.
- The footprint issue
  - Expansion of footprint.
  - A large container terminal occupies a substantial area, mainly because of storage requirements.
  - Storage is short-term, usually 3 to 5 days.
  - Early container terminals were created by converting existing general cargo terminals.
  - Outcome: variety of terminal configurations.
  - Many ports did not have enough available space to accommodate the footprint.
  - Setting of new facilities and new port areas.
  - New container terminal designs to improve operations.

The Design of Container Terminals

- Constraints
  - Available land footprint that will limit terminal capacity, particularly yard storage.
  - Nautical profile of the site that will command the maximum ship size and the number of ships that can be serviced at a given time.
  - Needed infrastructures and superstructures and their capital investments.
  - Available transport infrastructures supporting the connectivity of the terminal with its hinterland.

Terminal Footprint, Selected Container Ports

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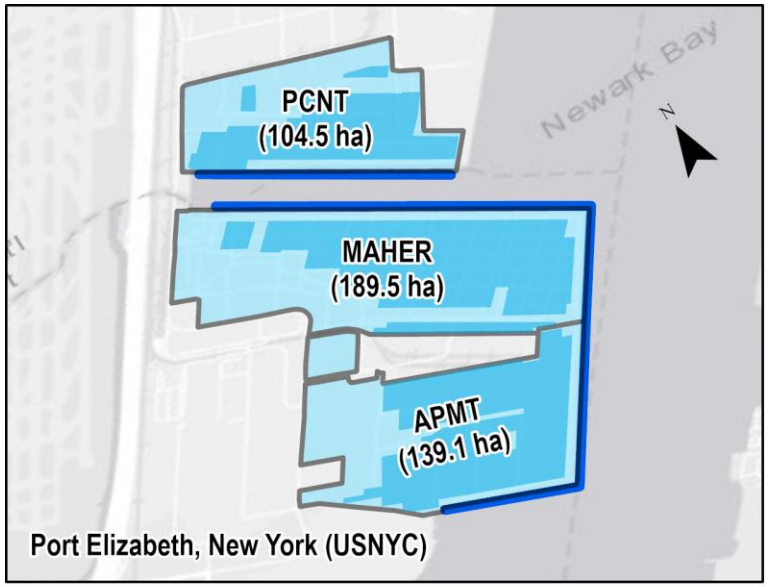

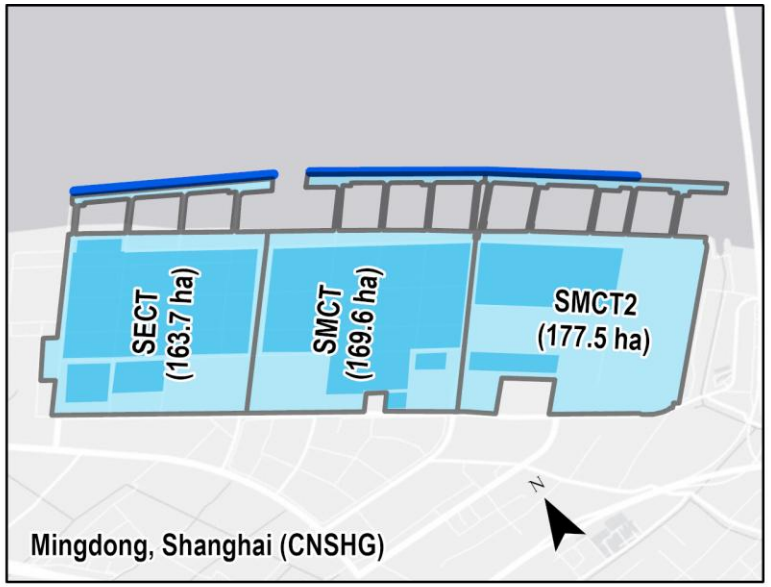

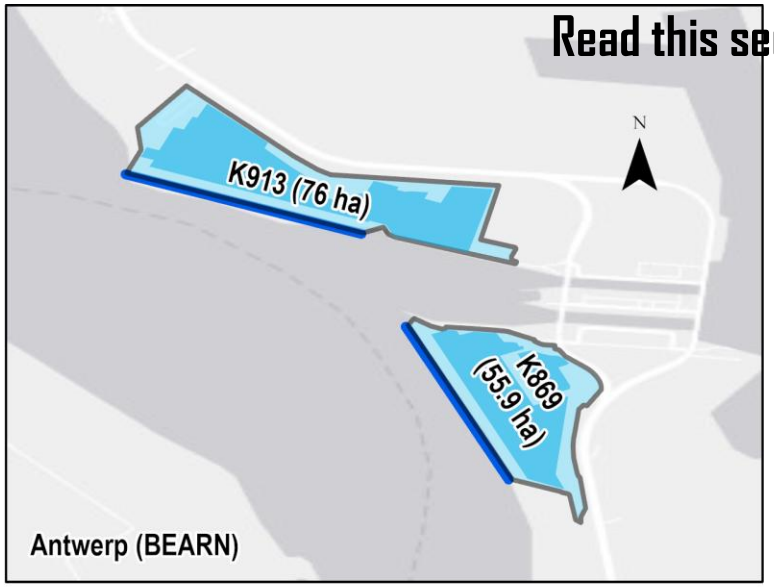

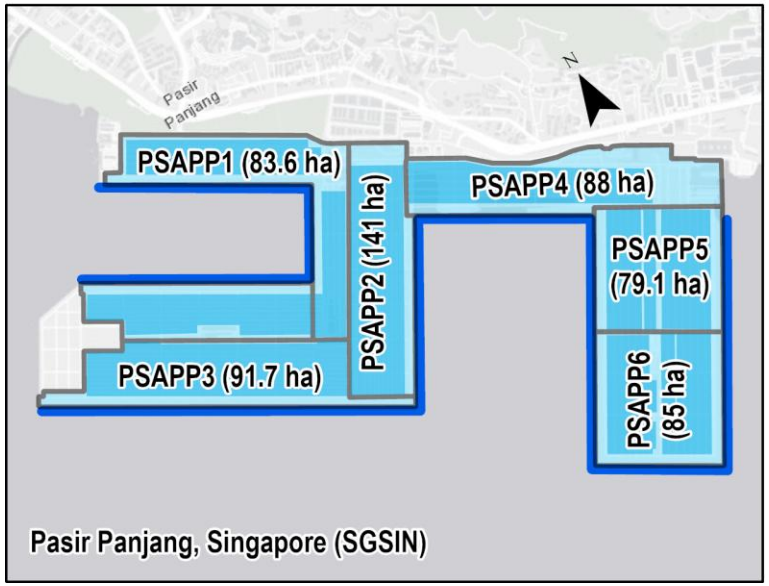

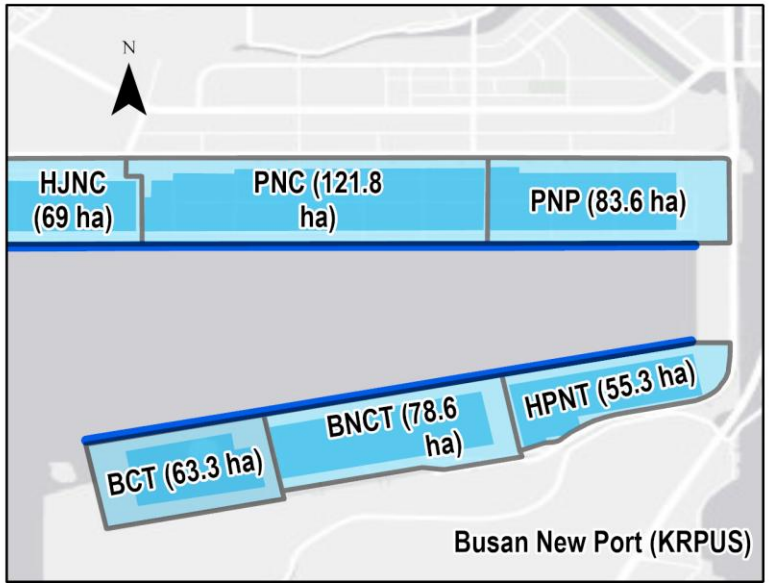

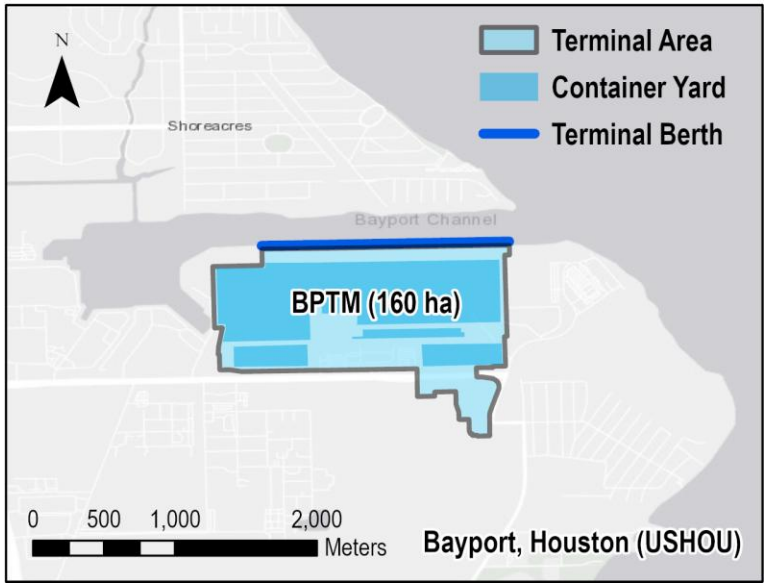

Container Terminal Equipment

- Intermodal equipment
  - Equipment mix is related to a number of factors in terms of capital investment, volume, stacking density, and productivity.
- Forklift
  - Basic piece of intermodal equipment.
  - Can handle only loaded 20-foot containers or empty containers of other dimensions.
  - Not suitable for intermodal operations but can be occasionally used.
- Holster truck
  - Move containers loaded on chassis or bomb carts within terminals.
  - A bomb cart is a heavy trailer designed to hold containers with side guides.
- Straddle carrier
  - Flexible piece of equipment.
  - Loading/unloading railcars and trucks and stacking containers up to three in height.
  - Stacking density may vary between 500 and 700 TEU per hectare.
  - Often used to move containers from piers to stacks.

Container Terminal Equipment

- Front-end loader
  - Restricted piece of equipment that can reach stacks of up to three full containers.
  - Used for double-stack intermodal rail operations.
  - Manage empty stacks by reaching up to eight empty containers in height.
- Reach stacker (also known as a side loader)
  - Flexible piece of equipment for rail and trucks, as well as for container stacking.
  - Can support a stacking density of 500 TEU per hectare.
  - Used in intermodal rail terminals and maritime terminals for specialized moves (e.g. reefers).
- Rubber-tired gantry (RTG)
  - Mobile equipment used for loading and unloading railcars from trucks in high-density terminals.
  - Can span up to four rail tracks or six containers.
  - Manage densities of up to 1,000 TEU per hectare.
  - Stacks of up to four full containers or five empty containers.
  - Higher acquisition costs but lower operational costs.

Rubber-Tired Gantry Crane

Stacking Density of Container Yard Equipment

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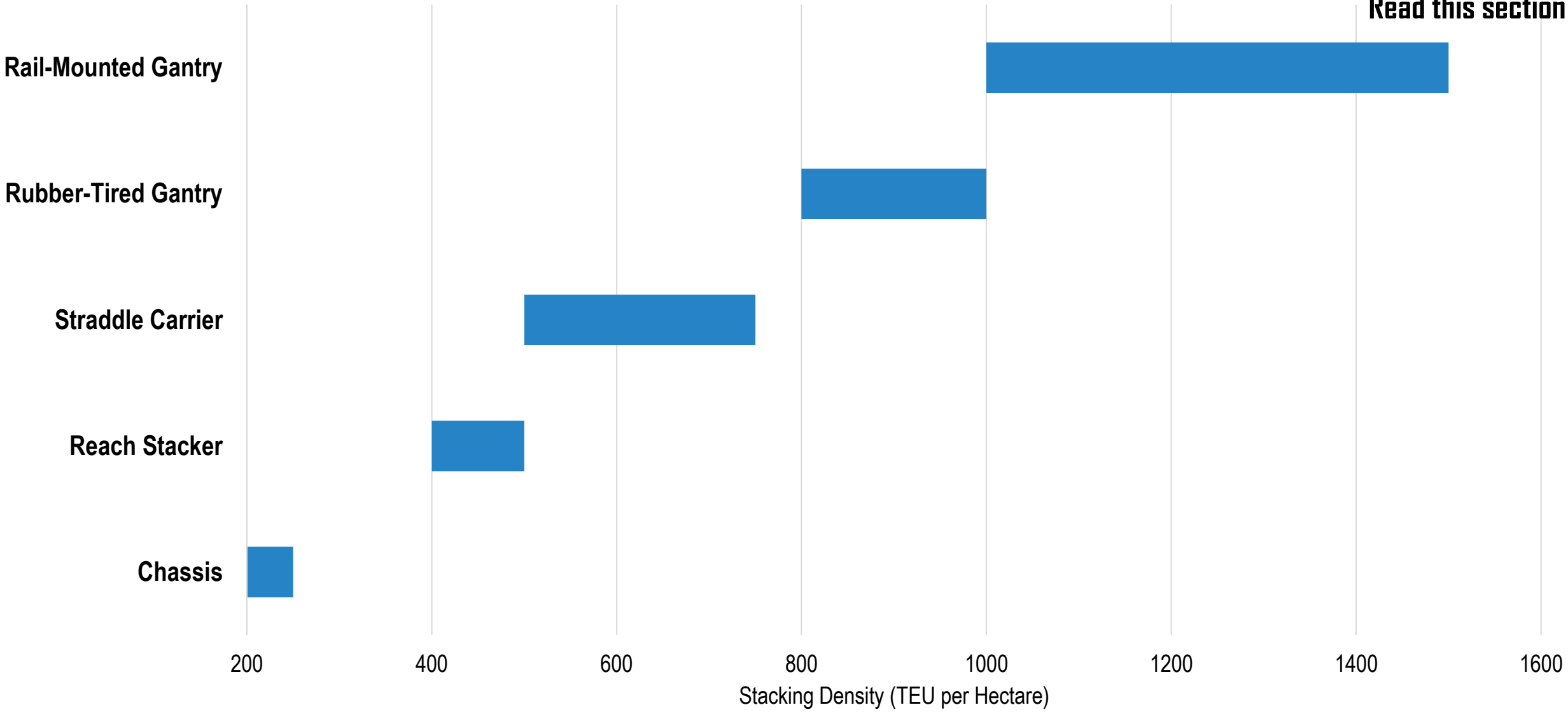

Container Terminal Equipment

- Portainer or ship-to-shore crane (STS)
  - Strictly used to load and unload containerships.
  - Comes in different sizes based on the ship class they can accommodate.
  - Portainer classes:
    - Panamax (13 containers alongside).
    - Post-Panamax (16 containers alongside).
    - Ultra Post Panamax (Latest generation of containerships of 24,000 TEU; 24 containers alongside).
    - Latest cranes can lift more than 150 tons at a time (6 to 8 containers).
  - Containers brought to the portainer by holsters using chassis, bomb carts, or straddle carriers.
  - Spreaders:
    - Have twist locks on each corner to secure the container during hoisting.
    - Spreader technology evolved: portainers able to perform twin and tandem lifting.
  - Ongoing automation of terminal equipment.

Conventional Intermodal Port Terminal Equipment

STRADDLE CARRIER

- Circulate over container piles.
- Can go over stacks up to 3 containers.
- Density of 500 to 750 TEU per hectare.

RUBBER-TIRED GANTRY

- High storage densities (1,000 TEU per hectare).
- Difficult moving between stacks.
- High acquisition; low operating costs.

FRONT-END LOADER

- Use top container anchor points.
- Handle most containers.
- Can reach stacks up to 3 containers in height.

RAIL-MOUNTED GANTRY

- Highest storage density (wide span; +1,000 TEU per hectare).
- Lowest operating costs.
- Fixed to rail tracks.

REACH STACKER

- Flexible side loaders.
- Can reach stacks up to 3 full or 5 empty containers.
- 500 TEU per hectare.

PORTAINER

- Load and unload containerships.
- Various sizes (Panamax and Super-Panamax).

Maritime Operations

- Ship turnaround times
  - Expected to be short.
  - Accommodate the schedule integrity of shipping lines.
- Technical specifications of the docking area
  - Length and draft.
  - Under pressure as the size of containerships increased, demanding longer piers and deeper drafts.
  - Post-Panamax containership of 8,000 TEU: 325 meters of docking space and a draft of about 45 feet (13 meters).
  - Neo-Panamax class (12,500 TEU): 370 meters and a draft of 50 feet (15.2 meters).
  - Pier length of 400 meters to accommodate most of the containerships.
  - Largest container vessels have a length overall (LOA) of some 400m, requiring a berth length of 450m.

The Port Performance Continuum

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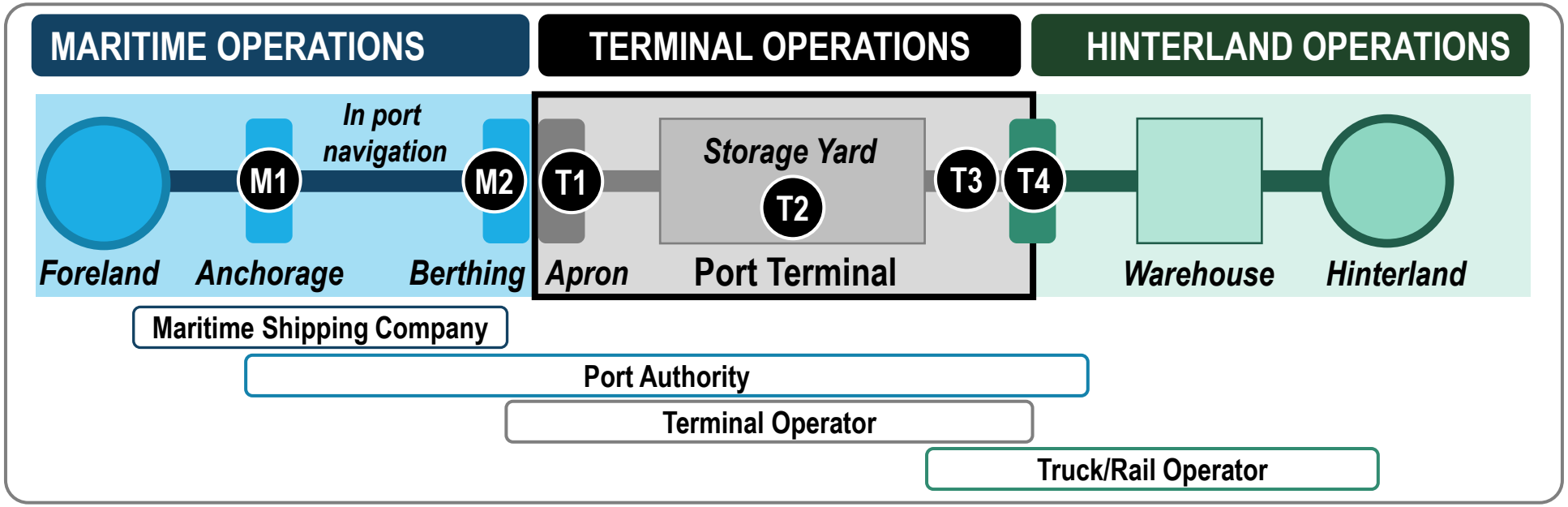


Key Performance Indicators

M1: Average anchorage time
M2: Average ship turnaround time

T1: Average number of crane movements per hour
T2: Average yard dwell time
T3: Average truck or railcar turnaround time
T4: Average gate waiting time (trucks)

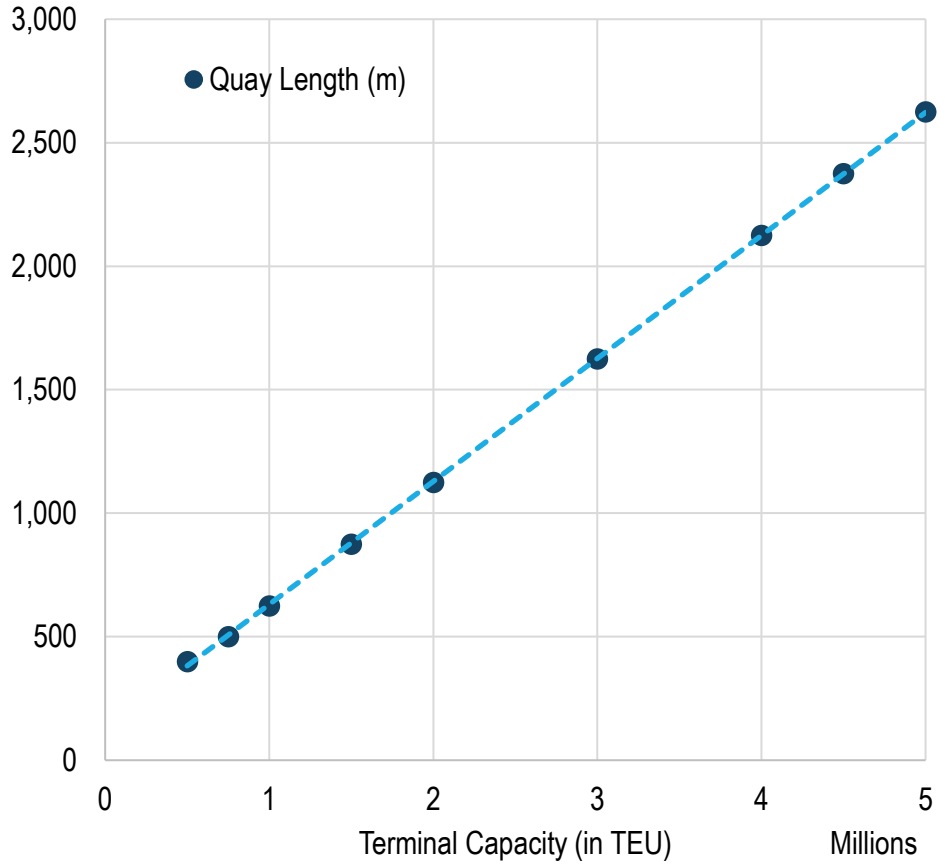
Maritime Operations

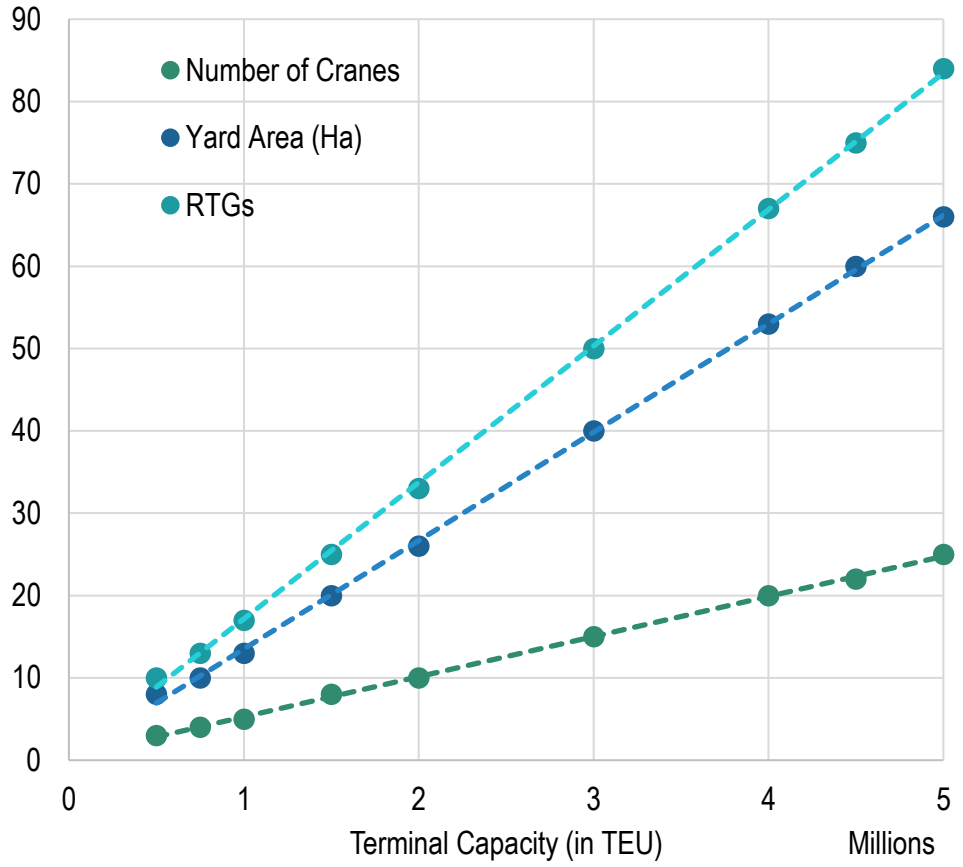
- Aprons (Loading/unloading areas)
  - Areas directly adjacent to the piers and under the gantry cranes (portainers).
  - Interaction between the cranes and the storage areas.
  - Containers are either brought in to be lifted on the containership or unloaded to be immediately picked up and brought to storage areas.
  - Straddlers (containers are left on the ground).
  - Holsters (containers are loaded from or unloaded to a chassis or bomb cart).
  - Terminal automation has seen the introduction of automated holsters that carry containers from the dockside to stacking areas.

Yard and Auxiliary Operations

- Container storage
  - Temporary buffer zone:
    - While the assigned containership is available to be loaded
    - While waiting to be picked up for inland distribution.
  - Larger containerships require large container storage yards.
  - Arranged by shipbound (export) and landbound (import) stacks of containers.
  - For shared terminal facilities, stacks can even be subdivided according to shippers.
  - Stacking density varies depending on the selected equipment and the yard configuration.

Container Terminal Capacity and Terminal Configuration





Yard and Auxiliary Operations

- Linear layouts
  - Containers stored on a chassis (rare for port terminals but more common for rail terminals).
  - Linear stacks of two or three containers in height that straddle carriers can circulate over.
- Block layouts
  - Rubber-tired gantry cranes or by rail-mounted (wide span) gantry cranes.
  - Higher storage density of at least four containers across (seven or eight for a wide span crane)
  - Five full containers in height.
  - Higher stacking densities are linked with additional repositioning and rehandling of containers.
  - Requiring effective yard management systems.

The Configuration of Container Yards

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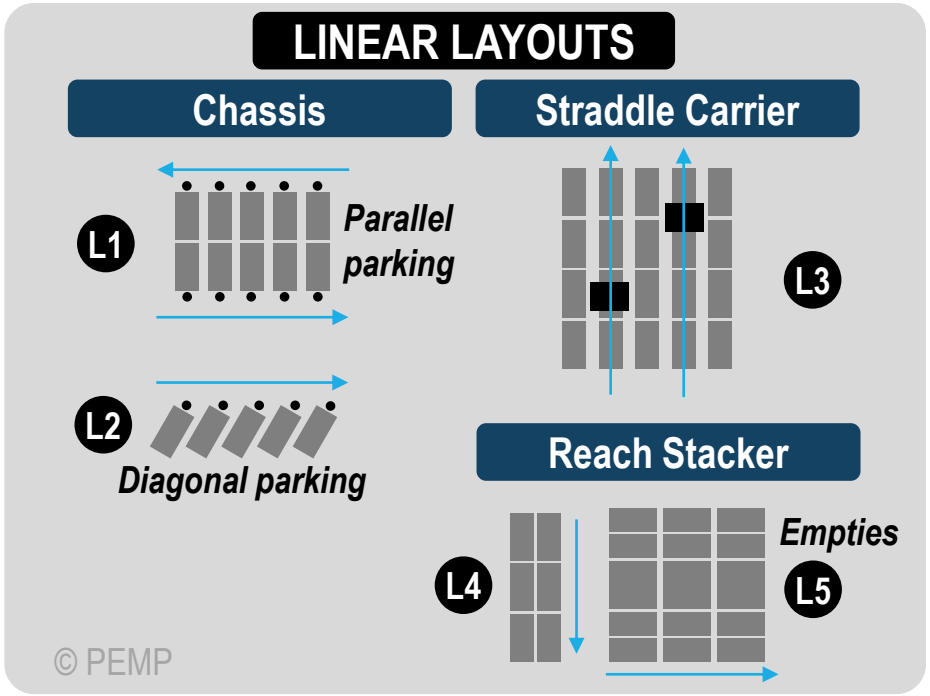
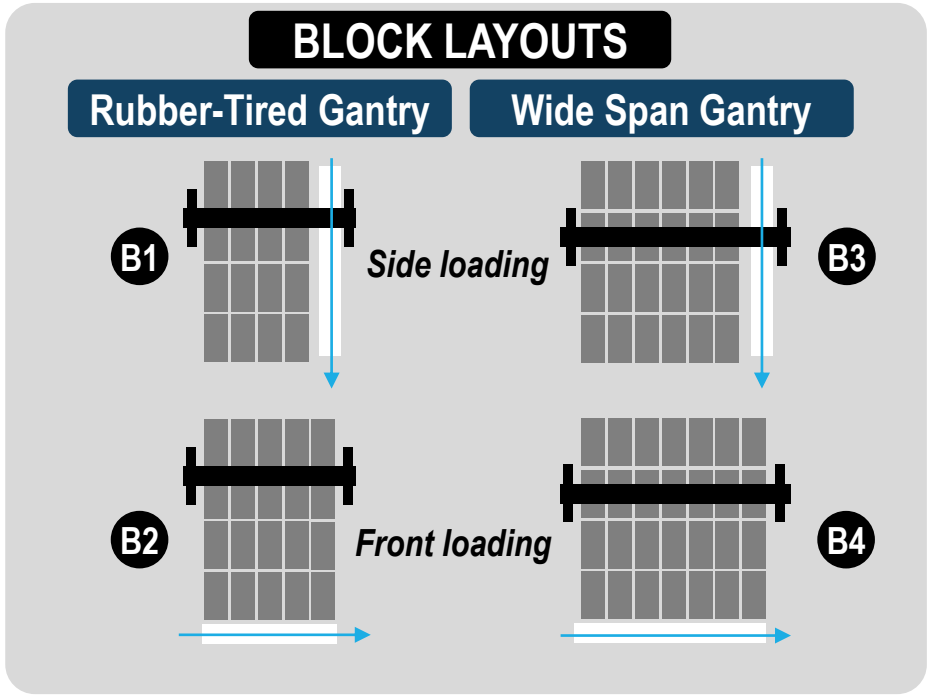
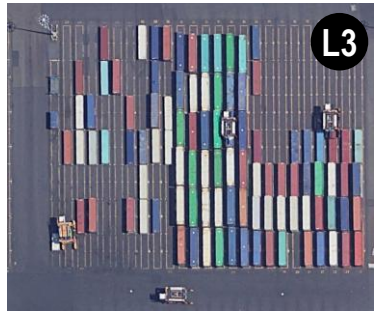
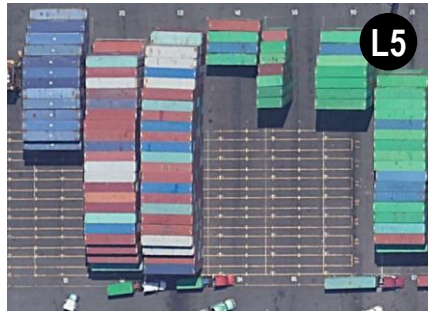








Yard and Auxiliary Operations

- Reefers (refrigerated containers) storage areas
  - Plugged in power.
  - About 5% of a terminal's stacking area.
- Empty storage areas
  - Can be stacked up to seven or eight containers in height due to less stringent weight limitations.
  - Easily distinguishable from loaded container stacks because of different stacking configurations.
  - Empty stacks are higher and denser.
  - Usually stacked by container ownership.
  - For terminals facing capacity pressures, the tendency has been to have empty container depots outside terminal facilities.

Empty Containers Stacking Area, Maher Container Terminal, Newark

Hinterland Connectivity

- Connecting the terminal to the hinterland
  - The gate is the entry and exit point.
  - Truck drivers present proper documentation (bill of lading) for pick up or delivery.
  - Most of the inspection is done remotely with cameras and intercom systems.
  - Remotely see the container identification number and verify if it corresponds to the bill of lading.
  - No longer require paperwork since all the documentation is kept in an electronic format.
  - Verify the identity of the truck driver, the truck, the container, and the chassis, which are all registered.

Remote Verification of Container Identification at a Port Terminal Gate

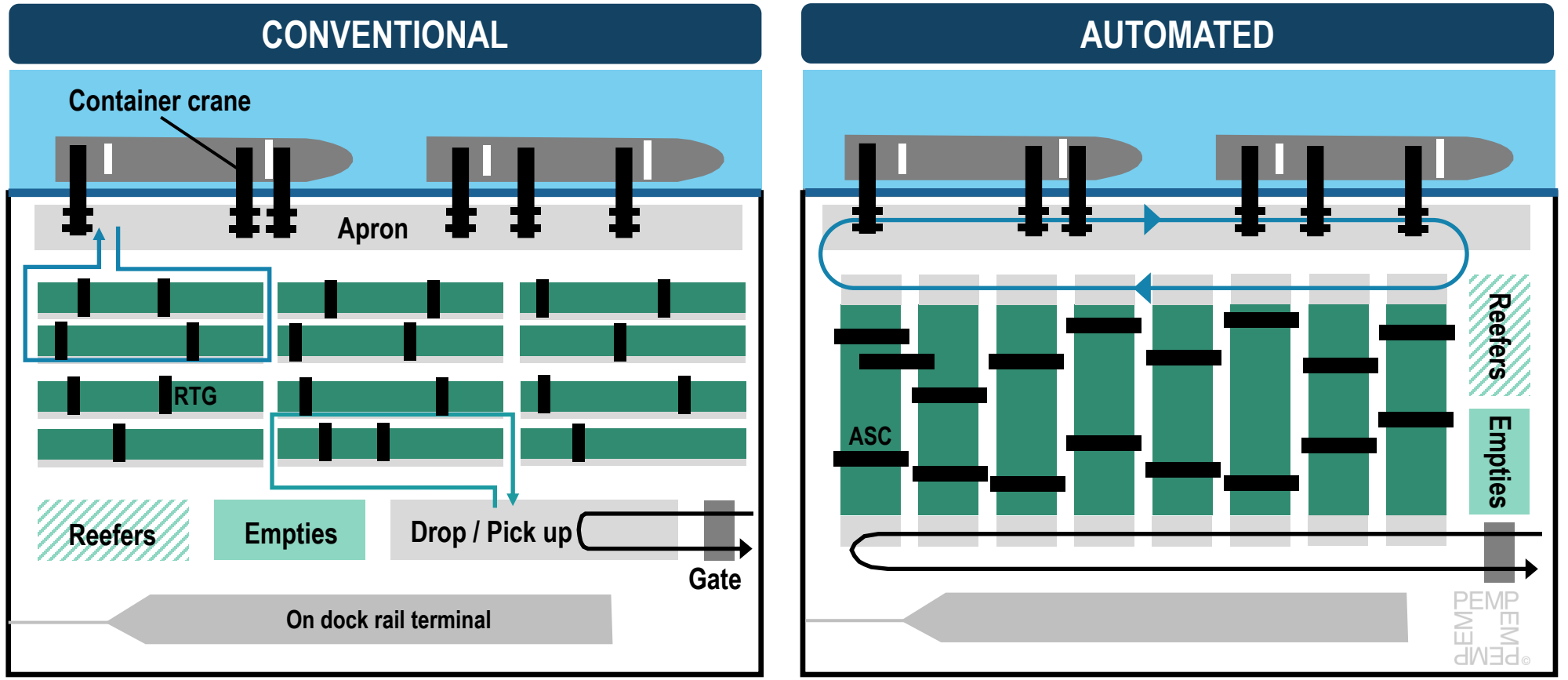
Hinterland Connectivity

- Pick up / Drop off areas
  - Delivery:
    - Truck is assigned to a specific slot at the truck drop/pick up area.
    - Chassis holding the container left to be picked up by a holster, a straddle carrier, or a gantry crane for more recent terminal designs.
  - Pickup:
    - Truck assigned to a slot in a waiting area.
    - Container picked up from a storage area, put on a chassis and brought to a pickup point.
    - Head out of the terminal, be inspected to ensure that the right container has been picked up, and head inland.
    - The container should be available for pick up (on a chassis in the truck drop/pick up area).
    - Pick-up delays can be significant (hours) when a large containership calls, and there is a “rush” to be the first to pick them up.

Conventional vs. Automated Terminal Configuration

- Conventional terminal
  - Block layouts are usually parallel to the pier when RTGs are used.
  - Perpendicular to the pier when stacking relies on straddle carriers.
  - Containers are brought to a pickup/drop-off area.
  - Moved to the stacks by a holster truck or a straddle carrier.
  - Brought to the quayside by another holster truck or straddle carrier when ready to be loaded onto a ship.
- Automated terminal
  - Block layouts that are perpendicular to the piers with automated stacking cranes (ASC).
  - On the gate side, stacks are serviced by trucks that have their containers picked up by an ASC.
  - On the pier side, containers are retrieved by straddle carriers or automated guided vehicles.
  - Reduces horizontal ground movements and removes vehicles from the stacking areas, enabling a higher stacking density.

Conventional and Automated Container Terminal Configurations



Conventional and Automated Container Terminal Configurations: Busan New-Port