Maritime Economics & Logistics (MEL)

P3: Maritime Management:

(Containerization and Hub-and-Spoke Systems)

Port & Maritime Organization – I.R. Iran
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Recommended Reading

1. UNCTAD *Review of Maritime Transport* (various years); freely downloadable from www.UNCTAD.org
2. Haralambides: Determinants of Price and Price Stability in Liner Shipping
3. Haralambides: Structure and Operations in the Liner Shipping Industry
4. HE Haralambides: Special Handout
5. HE Haralambides: Works on http://eur.academia.edu/HerculesHaralambides
6. HE Haralambides: Works on https://www.researchgate.net/profile/Hercules_Haralambides

Liner Shipping: Definition

C. Ernest Fayle, in an effort to distinguish tramp from liner shipping, describes a **liner service** as one implying '...a fleet of ships, under common ownership or management, which provides a **fixed service**, at **regular intervals**, between named ports, and offer themselves as **common carriers** of any goods or passengers requiring shipment between those ports and ready for transit by their sailing dates. A **fixed itinerary**, inclusion in a regular service, and the **obligation to accept cargo** from all comers and to sail, **whether filled or not**, on the date fixed by a published schedule...' In contrast, he defines a tramp ship, a 'seeker' or a 'general trader' as one '...which can be hired as a whole, by the voyage or the month, to load such cargo and to carry it between such ports as the charterer may require...' (C. Ernest Fayle, "A short history of the world's shipping industry").

Advantages of Liner Shipping

To maintain a stable sailing schedule, so that importers/exporters (shippers) can plan the transportation of their cargoes with less concern about the lack of services and/or delays

Ability to transport small amounts of cargo at a reasonable price (no need to contract a whole vessel as is the case in bulk shipping)

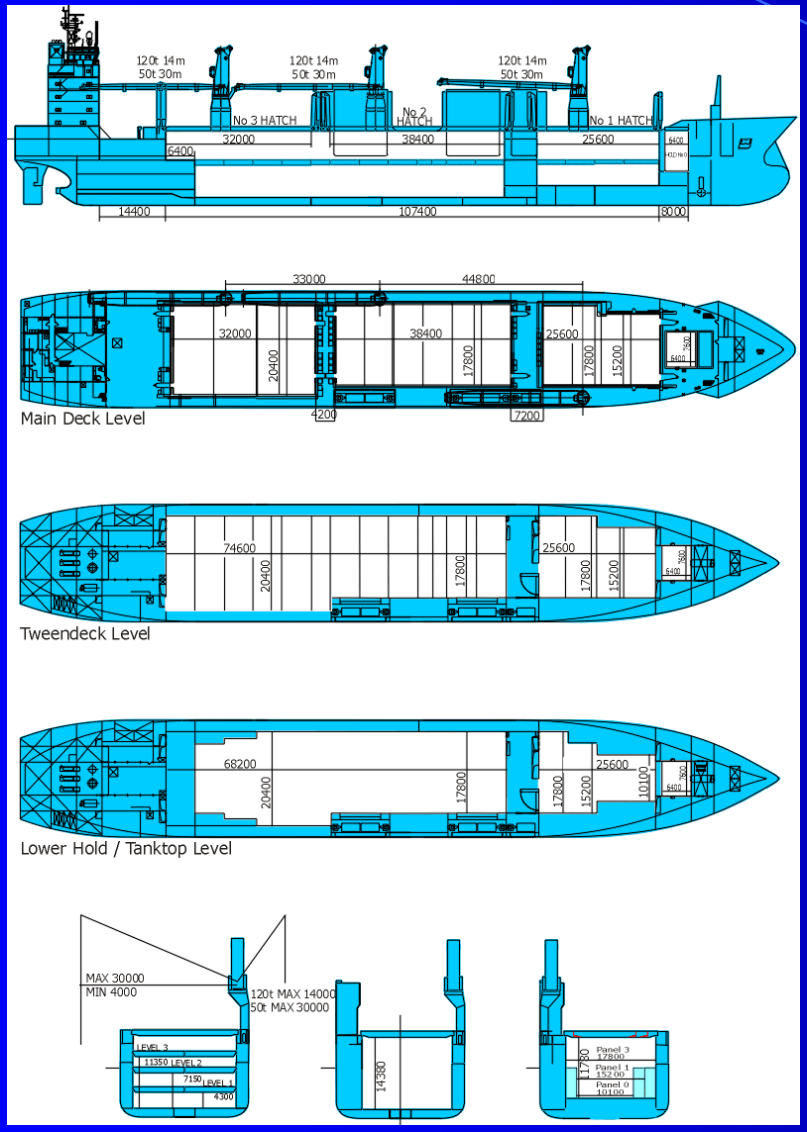
The advantage of liner shipping is in its reliability, predictability, and reasonable cost to shippers (important conditions to encourage international trade)

Liner Shipping: the Early Days

Cargo carried by liner shipping has come to be known as '**general cargo'**. Up to the beginning of the 1960s, such cargo was transported, in various forms of packaging (pallets, boxes, barrels, crates), by relatively small vessels, known as general cargo ships. These were twin-deckers and multi-deckers, i.e. ships with holds (cargo compartments) in a shelf-like arrangement where goods were stowed in small pre-packaged consignments (parcels) according to destination. That was a very **labour intensive** process and, often, ships were known to spend most of their productive time in port, waiting to load or discharge. And although seafaring was great fun in these days [sic] **congestion** was a chronic problem in many ports, raising the cost of transport and hindering the development of trade. Equally importantly, such **delays in ports made trade movements erratic and unpredictable**, obliging manufacturers, wholesalers and retailers to **keep large stocks**. As a consequence, warehousing and **carrying costs** were adding up to the cost of transport, making final goods more expensive and, again, hindering the development of international trade.

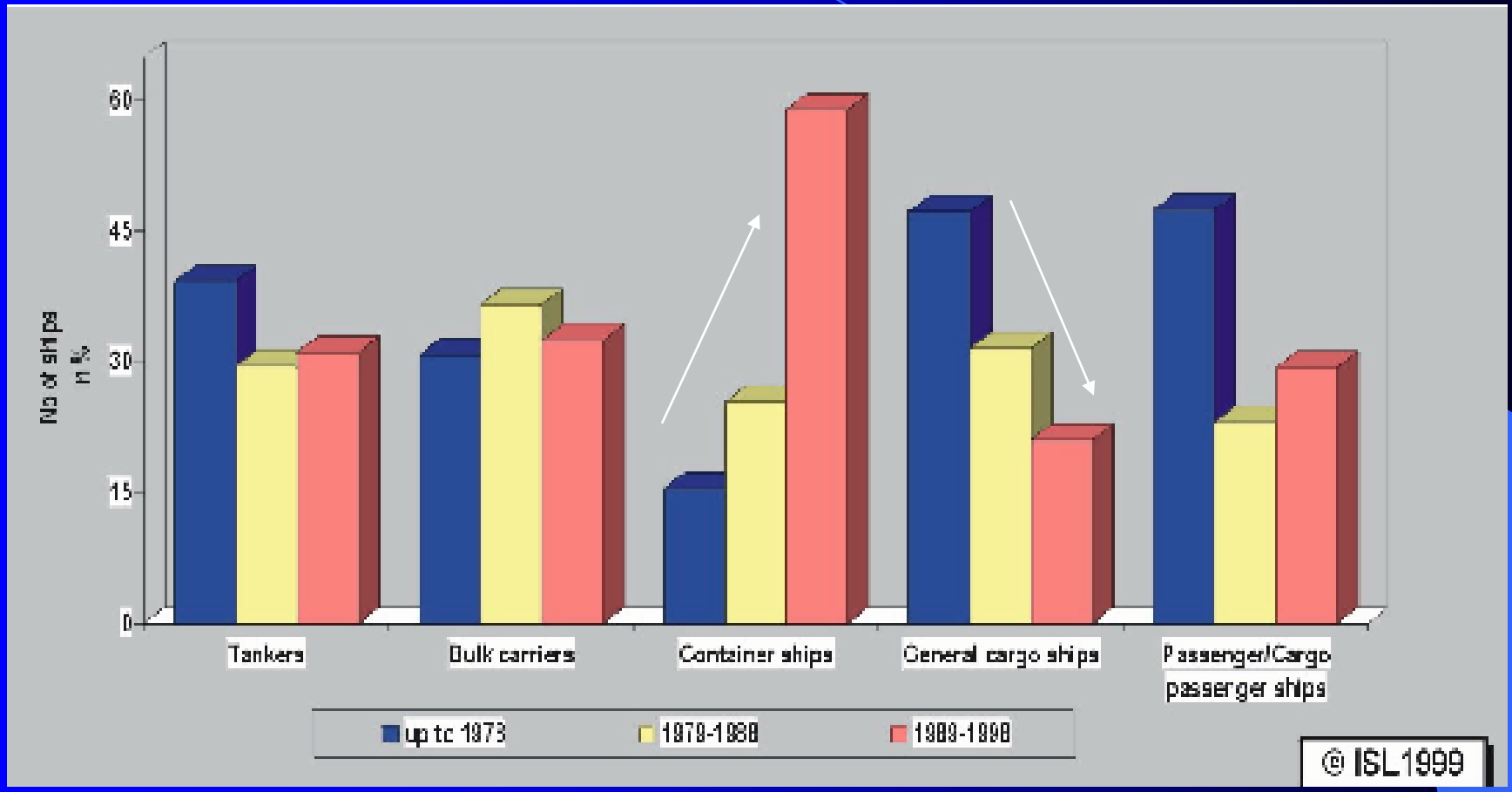
Multipurpose general cargo ships

Multi-purpose vessels



Multi-purpose vessels

Fleet Composition by Type of Ship



Liner Shipping: Containerisation

This situation started to change in the 1960s with the introduction of ‘containerisation’ in the trade between the United States and Europe, and subsequently in the rest of the world. Containerisation is often described as a **revolution in transport**. General cargo goods are now increasingly carried in steel boxes (containers) of standardized dimensions (most common is the 8x8x20 feet unit known as **TEU** – Twenty (feet) Equivalent Unit-, although containers of double this size (40 feet) are quite common, particularly in North America). The most important thing however is that now containers are packed (stuffed) and unpacked (stripped) away from the waterfront, either at the premises of the exporter (**consignor**) and/or the importer (**consignee**), or at Inland Container Depots (**ICD**), known also as ‘dry-ports’.

20- and 40-foot containers

20-Foot Equivalent Unit (TEU):

Length:	**20 ft**
Width:	**8 ft**
Height:	**8.5 ft**
Tare Weight:	**1.8 – 2.4 tons**
Rating:	**24 tons**

40-Foot Equivalent Unit (FEU):

Length:	**40 ft**
Width:	**8 ft**
Height:	**8.5 ft (standard)**
	9.5 ft (high cube)
Tare Weight:	**2.8 – 4.0 t (standard)**
	3.9 – 4.2 t (high cube)
Rating:	**30.5 tons**

Payload (technical) = Rating–Tare Weight

Liner Shipping: Productivity and Port and Ship Size

Expensive port labour is thus by-passed, pressure on port space relieved, and ship **time in port minimised**. These developments increased ship and port productivity immensely and allowed ships to become even bigger achieving economies of scale and low prices. Nowadays, containers are increasingly carried by specialised '**cellular'** containerships some of which able to carry more than 18,000 TEUs, while designs of even larger ships are already on the drawing boards of naval architects.

Containerisation, Just-in-Time and Make-to-Order Production

By-passing the waterfront in the stuffing and stripping of containers, and thus having them ready in port to be handled by automated equipment, increased immensely the **predictability** and **reliability** of cargo movements, enabling manufacturers and traders to **reduce high inventory costs** through the adoption of flexible **Just-in-Time** and **Make-to-Order** production technologies. *Inter alia*, such technologies have helped manufacturers to cope with the vagaries and unpredictability of the **business cycle** and plan business development in a more cost effective way.

Containerisation and Port Efficiency

Around the world, the port industry has invested a lot in order to cope with the technological requirements of containerisation. **Modern container terminals** –and suitable **cargo-handling equipment**- have been built and new, more efficient, organisational forms (including **privatisation**) have been adopted in an effort to speed up port operations. Operational practices have been streamlined, the element of uncertainty in cargo flows largely removed, forward planning has been facilitated, **port labour regularised** and **customs procedures** simplified. These developments took place under the firm understanding of governments and local authorities that ports, now, constitute the most important link (**node**) in the overall door-to-door transport chain and thus inefficiencies (**bottlenecks**) in the port sector can easily whither all benefits derived from economies of scale in liner shipping.

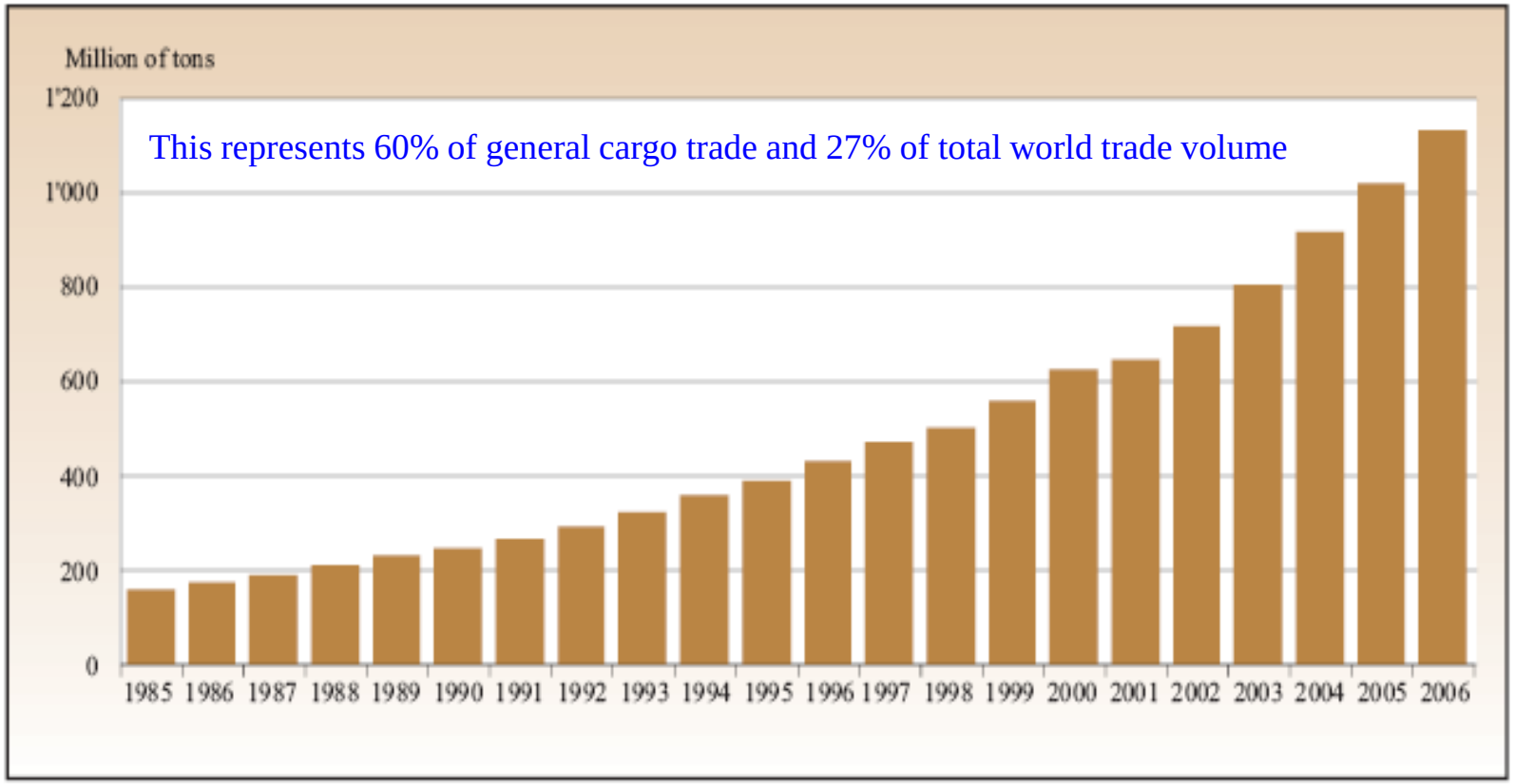
Port Work-Hours and Tons Handled in the US West Coast

Year	Work Hours (million)	Tons Cargo (million)
1960	29	29
1990	15	175

Productivity increased by more than 12 times!

International containerized trade growth, 1985–2006

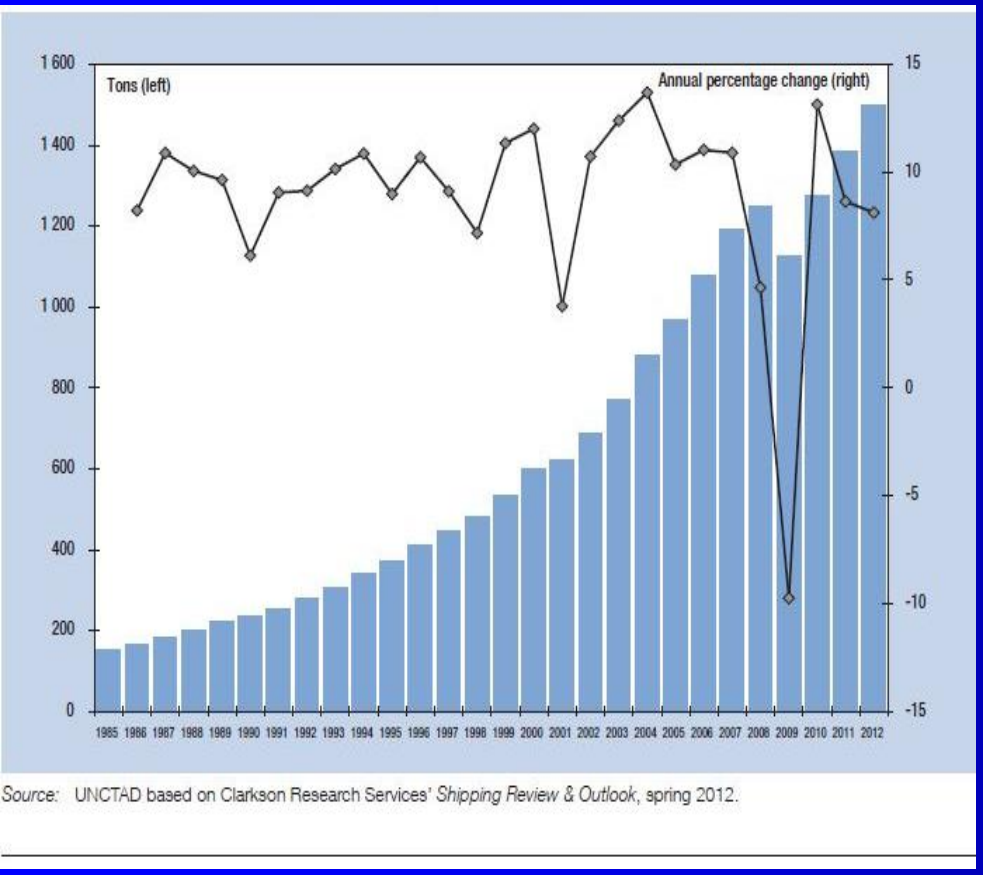
(Million tons)



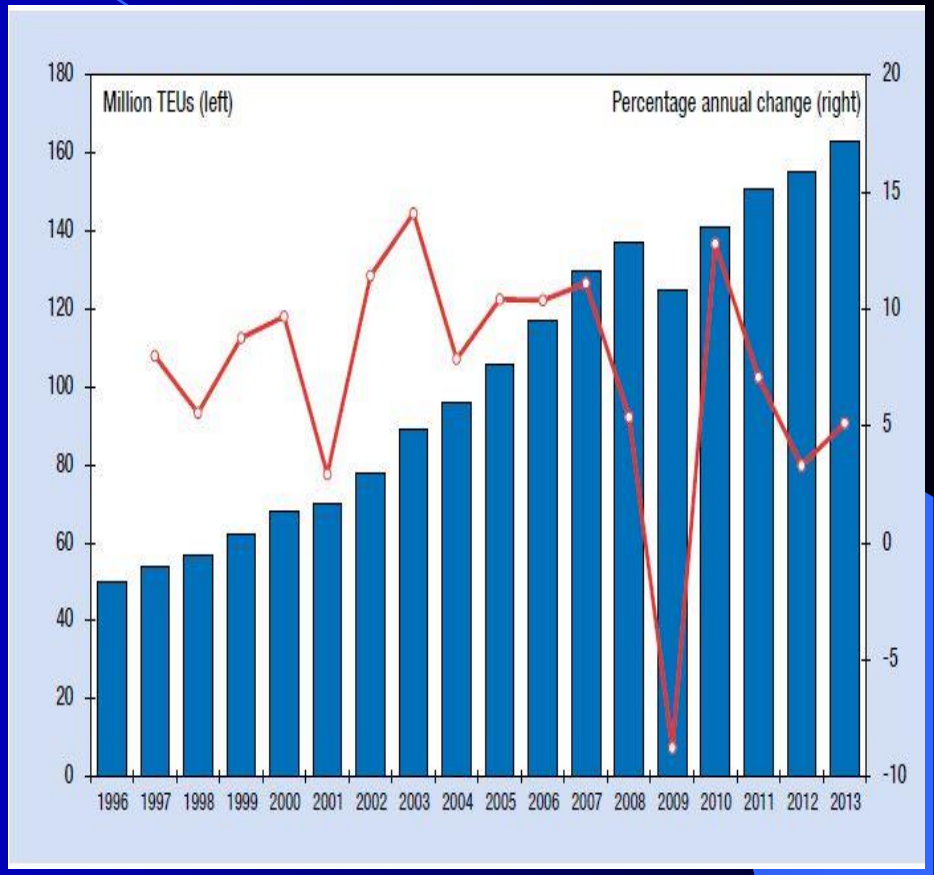
Source: Clarkson Research Services, Shipping Review Database, Spring 2007, p. 101.

Global container trade 1985-2012 (left: million tons) and 1996-2013 (right: million TEU)

(right axis: annual (%) change)



Source: UNCTAD based on Clarkson Research Services' *Shipping Review & Outlook*, spring 2012.



NB: 1.6 billion tons / 160 million TEU means, on average, 10 tons of cargo per container. Moreover, container port throughput has exceeded 600 million TEU; i.e. each container is handled 4 times. This is called transhipment and transhipment costs…

Things you should be able to understand from the previous graph

- Global container shipments: 1.5 billion tons, or 151 million TEUs. This means average container payload = 10 tons.

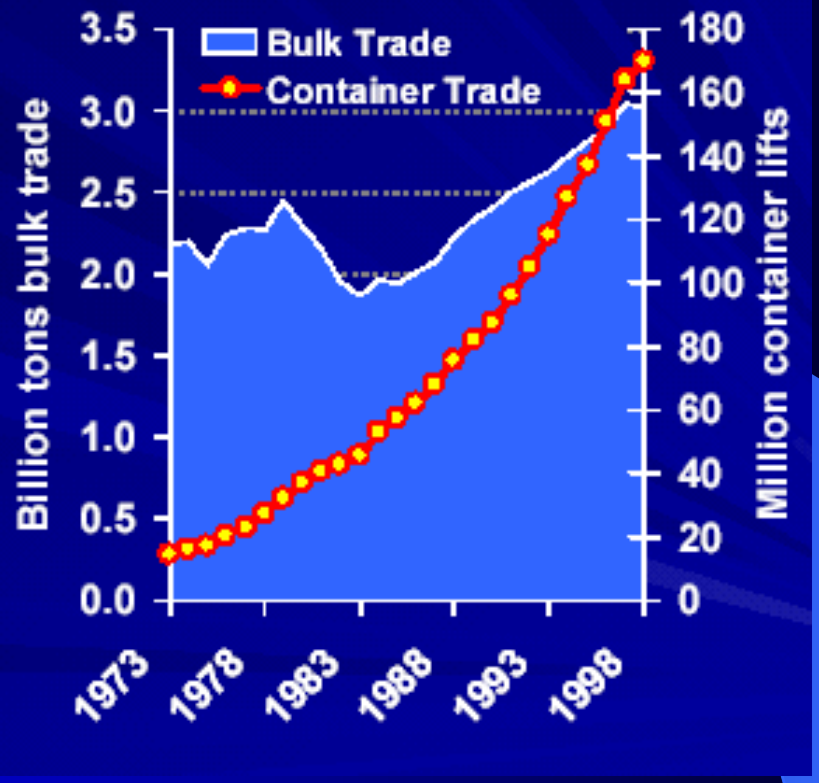
- This is: 62% of world general cargo trade (container penetration) and 16% of world trade (8.7 billion tons).

- These two percentages were 60% and 27% respectively, 5 years ago. This means that a) container penetration has increased; b) bulk trades have increased much more mostly due to the iron ore and oil imports of China.

- Global port throughput reaches 600 million TEUs. Thus, the ratio of port throughput to container exports reaches 4:1. This used to be 3:1 a few years back. This means that each export container is transshipped two times. This is the result of concentration in the port sector and the predominance of hub ports. In spite of the benefits of the hub-and-spoke system in liner shipping, transshipment costs time and money and penalizes peripheral ports. This is something we should not forget in our, often enthusiastic, advocacy of hub ports.

Growth of container and bulk trades

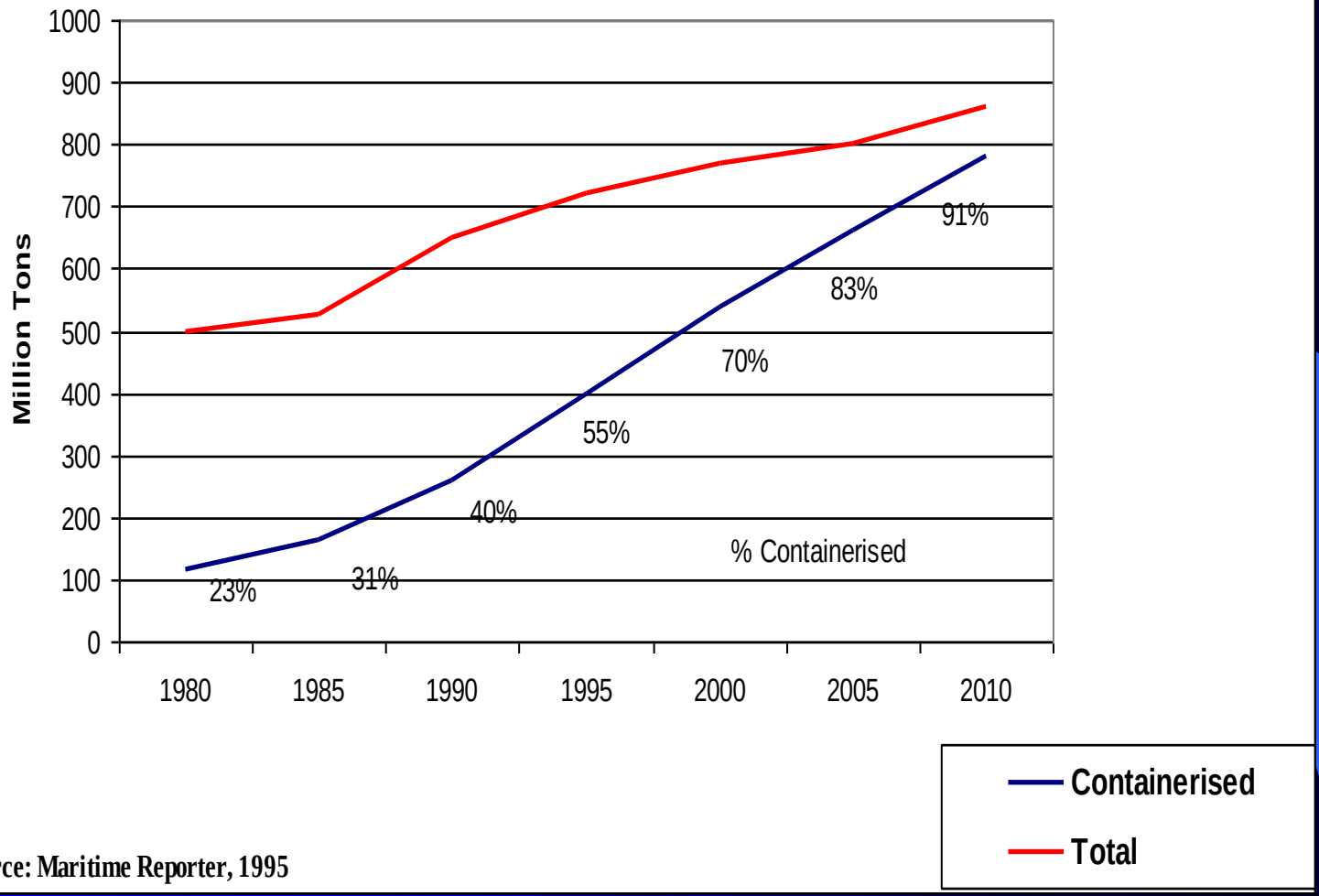
- Container trade has been expanding rapidly
- Average growth rate 8% compared with 2% pa for the bulk trades
- Future growth assumed to be 6% pa



Source: Clarksons

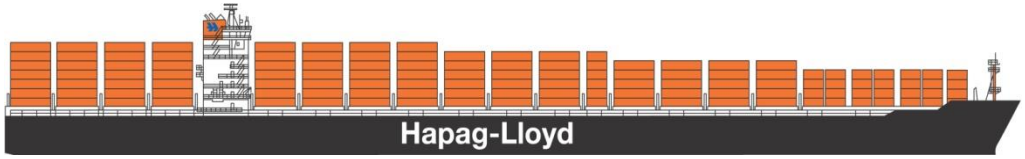
Note: bulk transport relates to production (GDP) that grows much slower than trade (containers)
Also, containerization starts from a low base (1960s)

Container penetration of General Cargo Trades

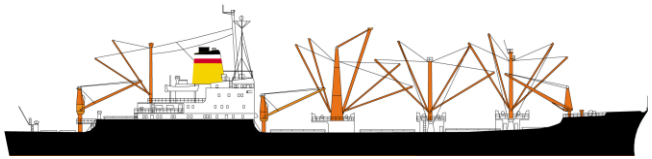


Source: Maritime Reporter, 1995

One of the reasons for the success of the container can be seen in the increase of vessel productivity and a reduction of cargo handling times



6 round voyages
Annually = approx. 800,000 t



4 round voyages
Annually = approx. 80,000 t

Capacity Comparison Europe-Asia Trade

	Length	Breadth	Capacity (tdw)	Speed	Engine	Crew
Containership	320 m	43 m	100,000 t	25 kn	68,640 kw	22
Freighter	160 m	22 m	13,000 t	21 kn	18,400 kw	42

Labor Productivity Evolution in Shipping

(Europe – Asia Trades)

	Round V/year	Annual cargo	Speed	Crew	Ton/year /pers.	Pr-tivity Index
Conventional ship **(12,000 dwt)**	**4**	**80,000 t**	**19 kn**	**42**	**1,905**	**1**
Container ship **(100,000 dwt)**	**6**	**800,000 t**	**25 kn**	**19**	**42,105**	**22.1**

Improvement in the quality of service

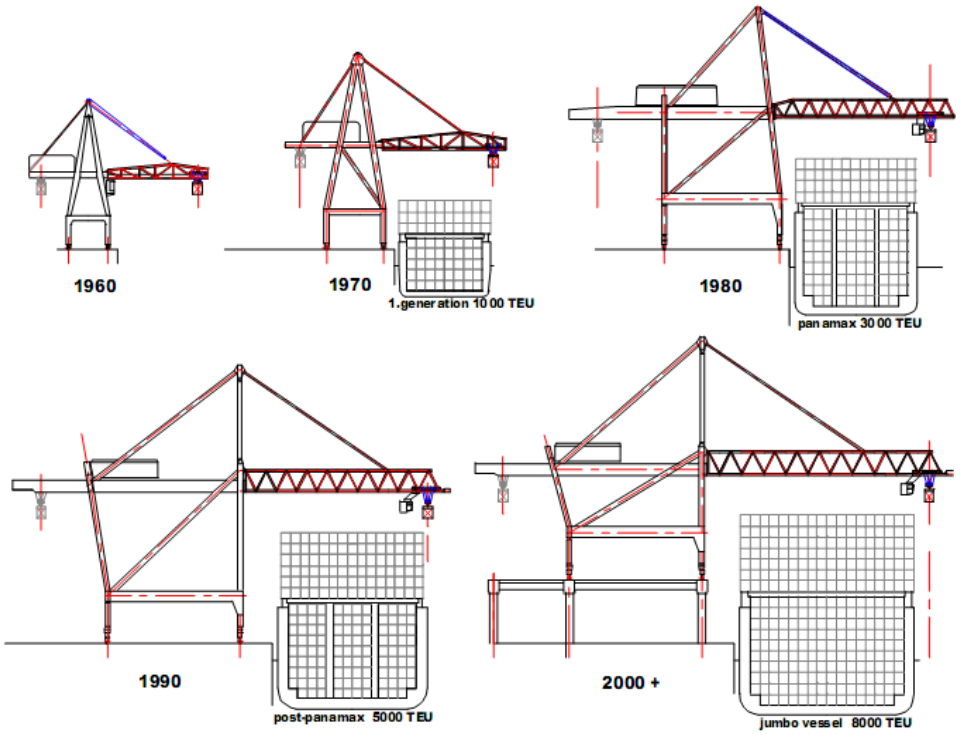
- Quicker transit time (50% faster than before)
- High service frequency
- Better punctuality, reliability, safety, information services

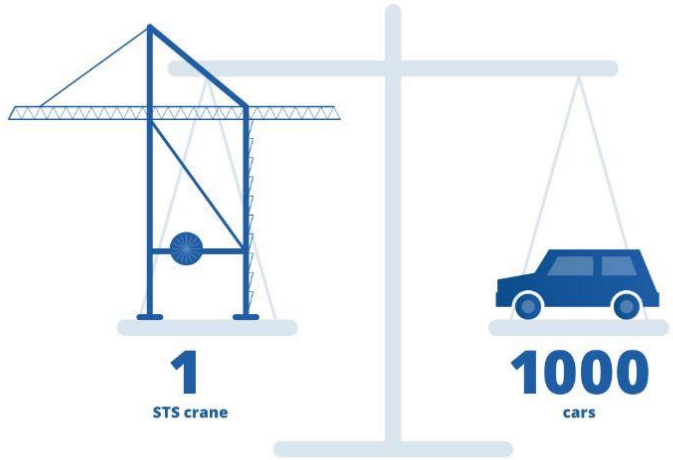
Containership Generations and their Characteristics

Vessel size	TEU range		Vessel characteristics (meters)						(1)/ (2)
	TEU	TEU	LOA	Beam (1)	Draft	Tiers on deck	Tiers below deck	Rows (2)	
Panamax	3000	3400	250	32	12.5	5	6	13	2.46
Panamax Max	3400	4500	290	32	12.5	6	8	13	2.46
Post Panamax	4000	5000	285	40	13	5	9	15	2.67
Post Panamax Plus	6000	8000	300	43	14.5	6	9	17	2.53
New Panamax		12500	366	49	15.2	6	10	20	2.45
Post New Panamax		15000	397	56	15.5	8	10	22	2.55
Triple E		18000	400	59	15.5	8	10	23	2.57

Source: http://www.skyscrapercity.com/showthread.php?t=1514993&page=18

Quay Crane Developments

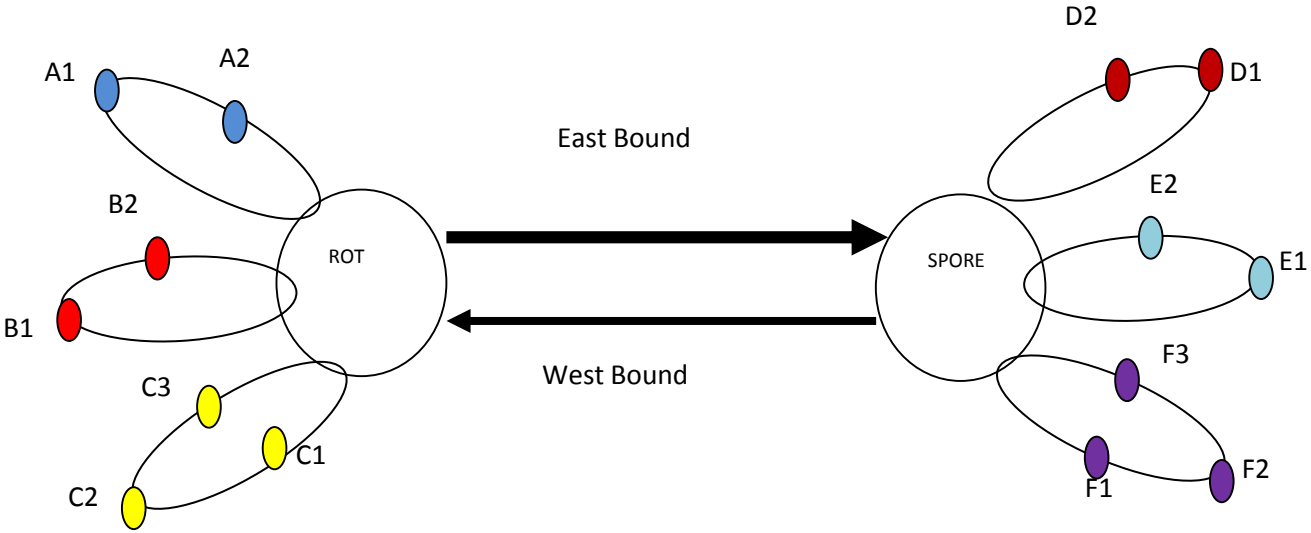




Containerisation and Hub-and-Spoke Networks

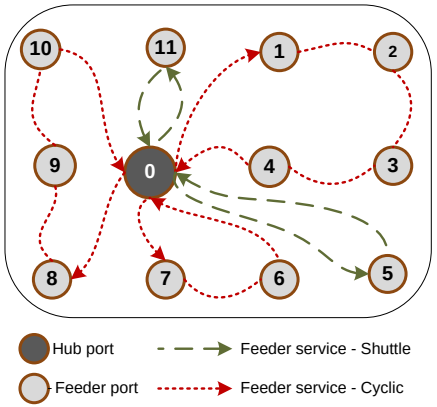
Mammoth containerships, such those of today, can cost anything in excess of **100 million US dollars** and it could take up to **9** of them to run a weekly service between Europe and the Far East. The capital intensity of these ships –the equivalent of a jumbo jet in aviation- obliges them to limit their ports of call at each end to a minimum of 'hub' ports or '**load centres'** such as Singapore, Hong Kong and Rotterdam, from where huge surges of containers are further forwarded (**feedered**) with smaller vessels to regional and local ports. A complex '**hub-and-spoke**' network(s) has thus developed whose fine-tuning and optimisation bears directly on the consumer's pocket.

Hub-and-Spoke Network

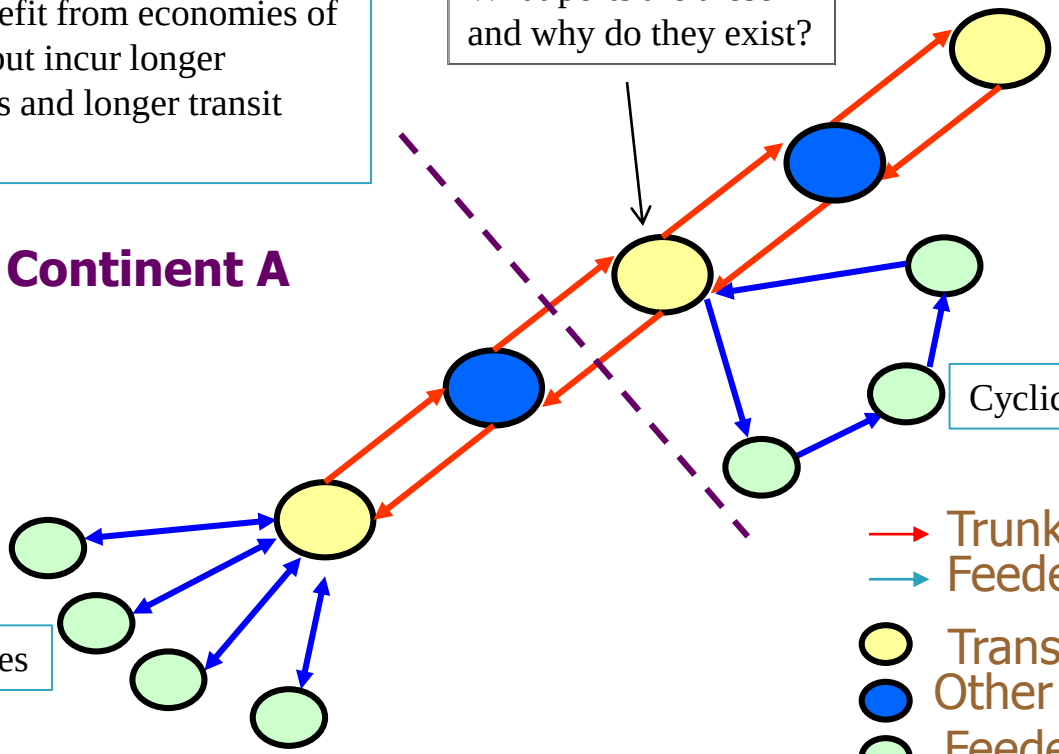


Shuttle routes are usually established between ports showing a relatively high transportation volume. They offer the lowest transit time, but typically require more and smaller feeders, while cyclic routes are more appropriate for feeder ports with lower transportation volume. Cyclic routes benefit from economies of feeder ship size, but incur longer shipping distances and longer transit times.

Hub-&-Spoke Systems



What ports are these and why do they exist?



Continent A

Continent B

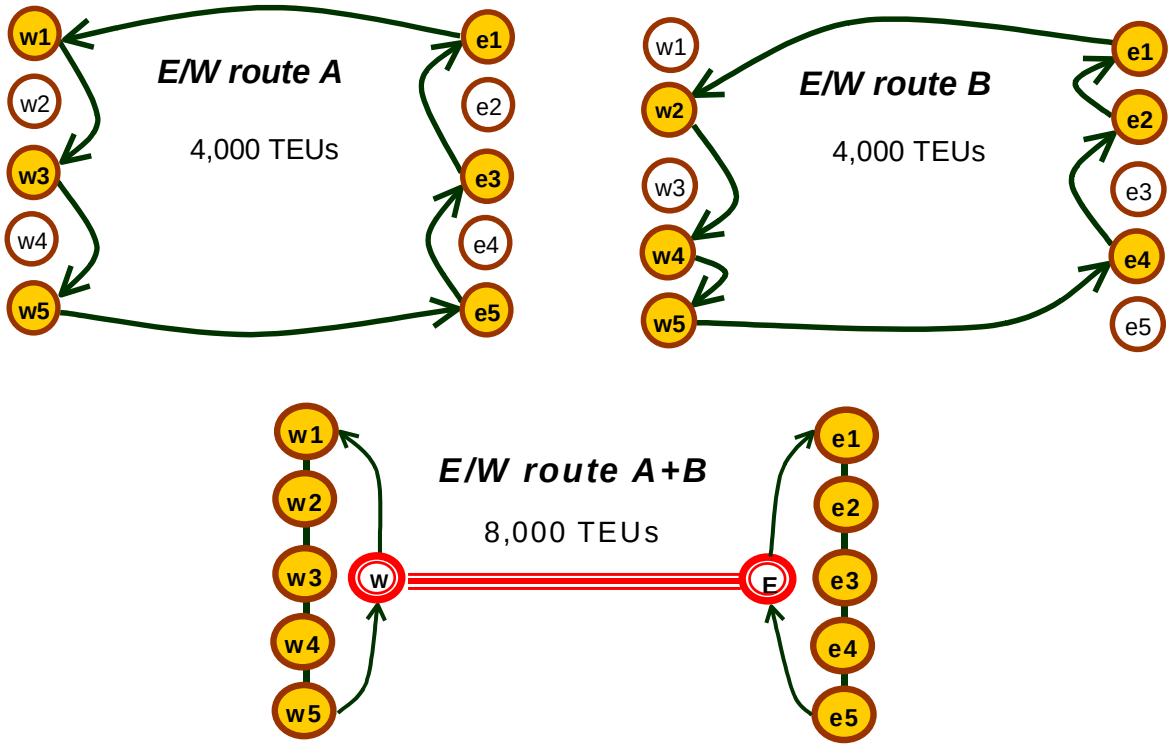
Cyclic feeder route

Shuttle feeder routes

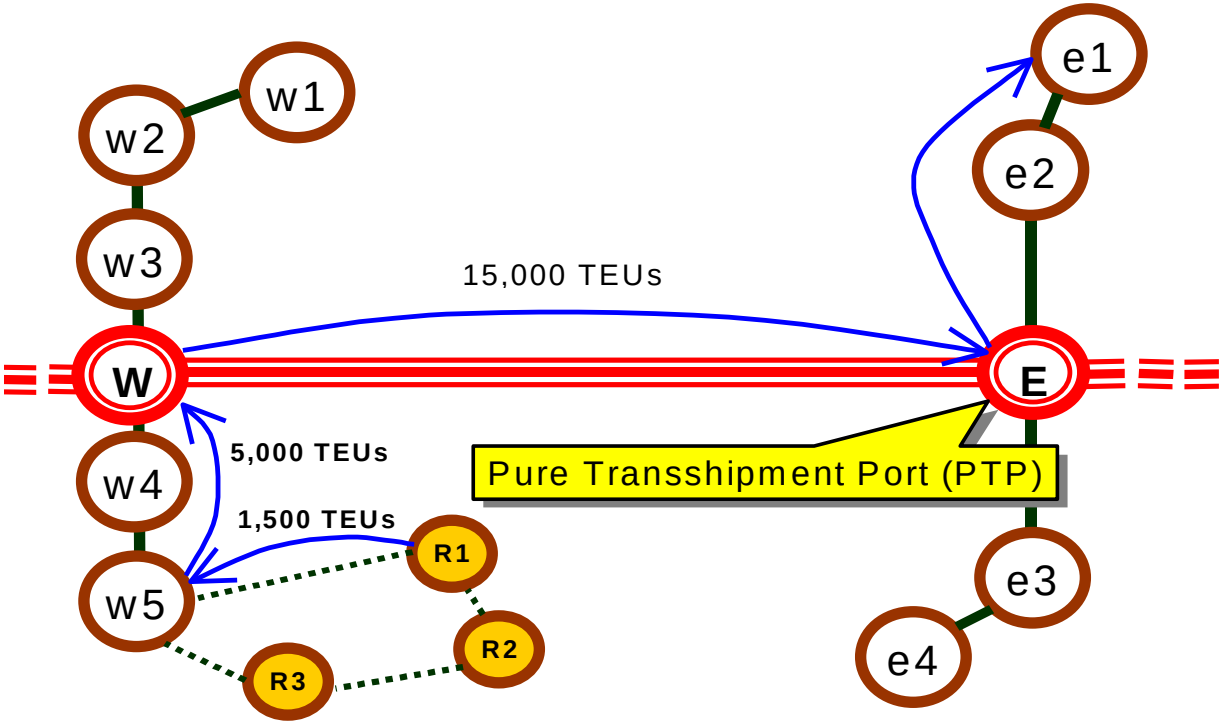
Trunk Route
Feeder Route

Transhipment Hub
Other port along the trunk
Feeder Port

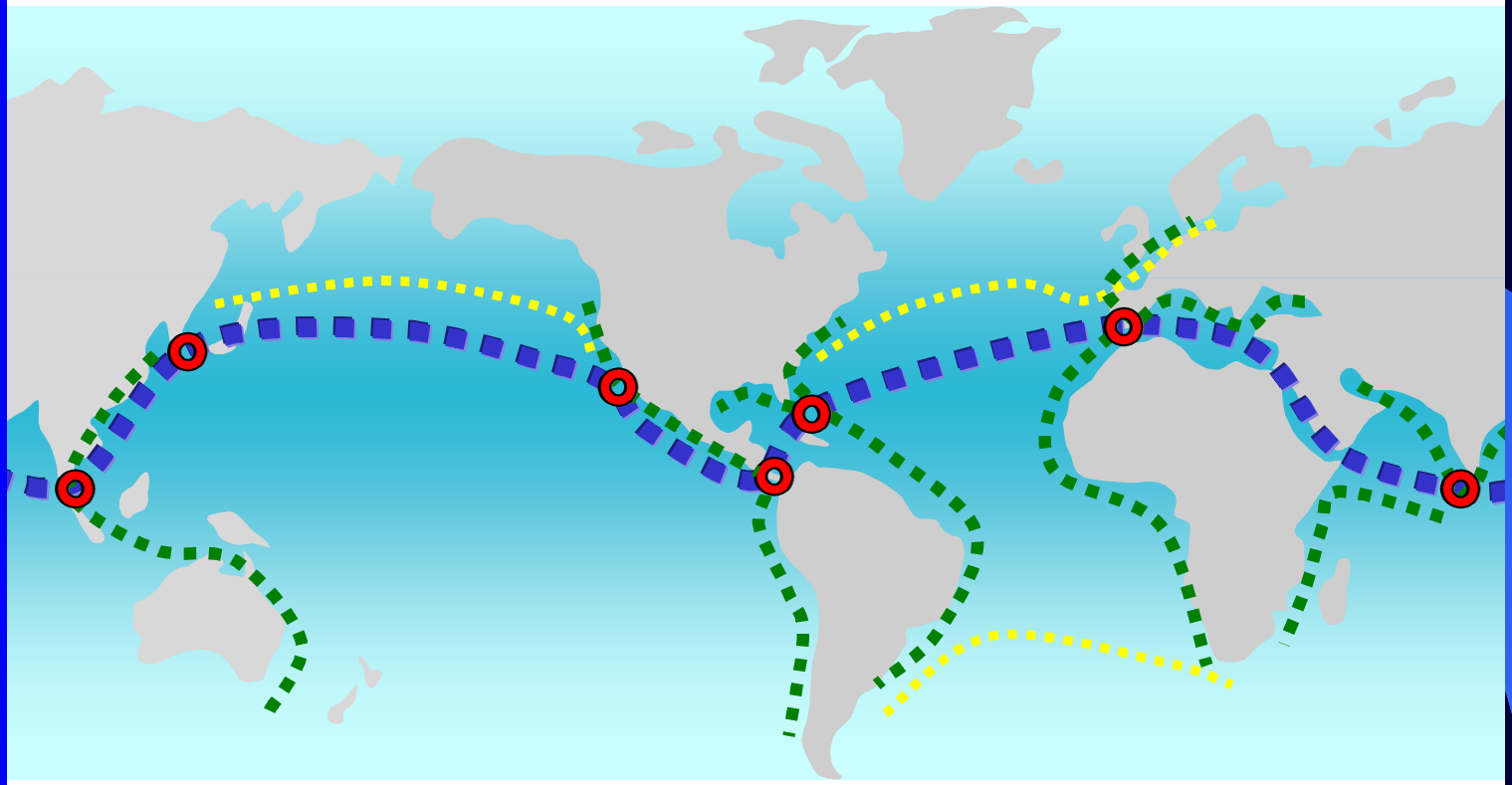
Hub-and-Spoke and Decoupling



Hub-and-Spoke, Feedering and Regional Trades



World Service Patterns



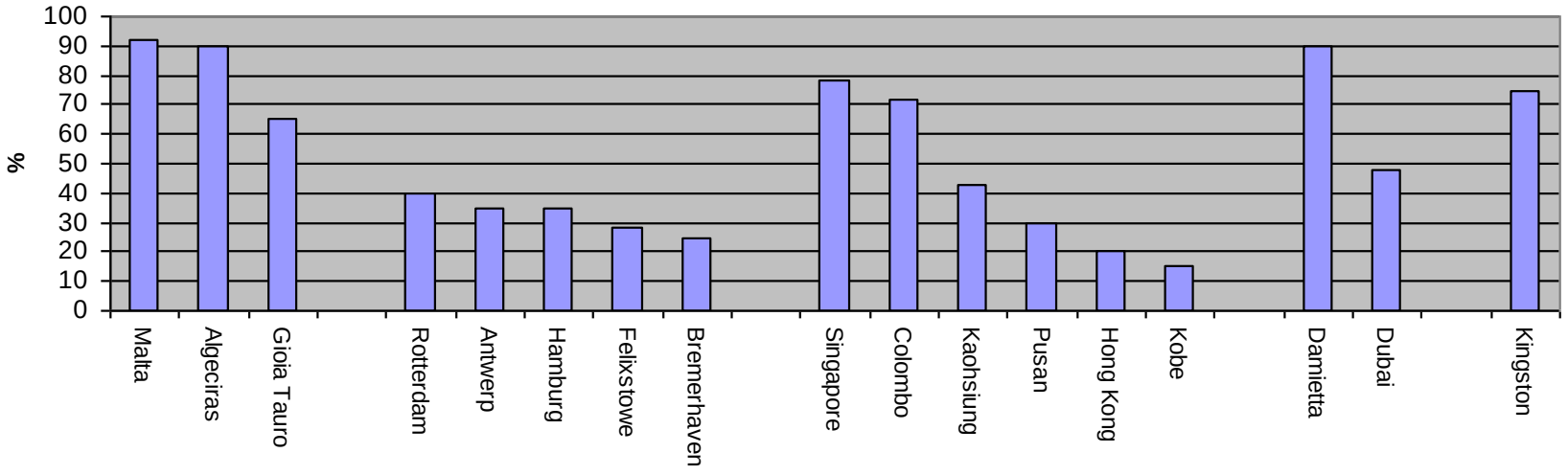
Pure Transshipment Hubs

We call them wayports and they are mostly pure transshipment hubs. They are ‘freed’ from local cargo and thus their location does not matter so much. They are the result of growing regional trade and north-south trade. Examples include Malta; Algeciras; Gioia Tauro; Singapore; Colombo; Damietta; Salalah; Kingston.

North South Feedering Across the Pacific Route

Source: http://www.maerskline.com

Proportion of Transhipment to Total Throughput in Major Ports



Source: Hoffmann, J., 1999

Success Factors for a Regional Hub

- Strategic location and connectivity to transport networks
- Minimization of overall, generalized, transport costs
- Regional competition with other hubs
- Port dues and productivity
- Sufficient land and nautical infrastructure and space for future development (including processing and storage)
- Generous government incentives for successful PPPs and creation of a maritime/industrial cluster
- Information Technology (logistics)
- Modern cargo-handling equipment
- Highly skilled, educated and multilingual labour force
- Excellent business culture and institutional framework
- Political stability and sound economic policies

Port Selection Criteria

(shippers: importance on a scale 0-100)

	US	Canadian	European
Number of sailings	93	83	83
Inland freight rates	85	75	83
Proximity of port	62	46	61
Congestion	43	54	44
Possibility of intermodal links	27	54	72
Port equipment	45	42	33
Port charges	35	38	33
Quality of customs handling	14	21	33
Port security	16	21	17
Free time	25	13	16
Size of port	8	13	0

Rotterdam: Number of Weekly Calls