Long-Term Trends in Container Shipping – the Revised Fourth Revolution[1]

The Development Process of Containerized Shipping

Evolution and Revolutions: Scale and Scope Economies

A conceptually-convenient way of depicting the history of liner shipping is as a combination of one, continuous evolution and several, successive revolutions. The evolution relates to the continuously increasing size of ships and ports in the pursuit of economies of *scale*. The revolutions relate to a series of technological breakthroughs, expanding the boundaries of the shipping system in the pursuit of economies of *scope*. The *first revolution* was the unitization of cargo, or *containerization*, focusing on the ship-to-shore transfer process and inducing the development of specialized ships and ports. The *second* was the expansion of containerization to land transport modes, or *intermodalism,* using the marine boxes for the entire ship-to-door transport process. This revolution was facilitated by the development of unit-trains with articulated, double-stack railcars, on/near-dock intermodal yards to handle them, domestic containers (in the US) and near-dock transloading terminals to transfer the content of marine boxes to domestic boxes, and hinterland "dry" ports, serving as extensions of the marine ones. The third revolution included the development of *transshipment*, or ship-to-ship transfer, linking together different shipping services and expanding the reach of container shipping to smaller ports.

The recently-completed *third revolution* marked the final stage of the scope expansion of container shipping. Hence, the forthcoming *fourth revolution*, unlike the previous ones, was not predicted to center on technological breakthroughs for further expanding the system, but on re-arranging the existing system. The Fourth Revolution was described by this author in a series of papers published in 1999 and updated in 2003[2][3]. The revolution, as depicted there, revolved around a far-reaching rationalization of the worldwide *service pattern* of shipping services intended to create a comprehensive, integrated network, defined there as the *global grid*. The core service pattern of this grid was cross-Panama, bi-directional (counter-rotating) equatorial round-the-world (**ERTW**), functioning as the "ring road" for the major east/west trades, with the service only calling at six or seven global "pure-transshipment ports" (**PTP**), strategically located at the intersection points with north/south routes. Complementary north/south services would have the dual role of handling their own traffic and feedering the east/west traffic. Additional feeder services might be needed for the final regional distribution to smaller ports. Accordingly, the total origin/destination trip might involve a total of up to five different services and four transshipments, two of which at the ERTW's PTPs. The main advantage

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[1] This paper is an expanded version of a previous one published in *Port Technology International*, Fifty-Fifth Edition, October 2012, pp. 77 – 93. See: http://*www.porttechnology.org/technical_papers/the_fourth_revolution_long_term_developments_of_containerize_shipping*

[2] Ashar, A., The Fourth Revolution, *Containerization International*, December 1999 and January 2000. See: *www.asafashar.com.*

[3] Ashar, A., Revolution #4, *Containerization International*, December 2006. See: *www.asafashar.com*.

of this service system would be much more effective use of mother and feeder ships; its main disadvantage would be the *multi-level* handling of boxes (transshipments).

ERTW and PTPs

The two main components of the above-depicted Fourth Revolution are the circular service pattern, the ERTW, and its hub ports, the PTPs. The peculiarity of a circular service pattern is the continuity of route, without end-points and respective switch-backs of ships at these points. The circularity also eliminates the need for double-calling at ports at the end regions (e.g., eastbound and westbound), resulting in a better utilization of ships' space and shorter transit times. The round-the-world rotation consolidates the traffic of multiple trades into one, high-volume service which, in turn, provides for the deployment of the world's largest and most cost-effective ships. The employment of counter-rotating services also provides for better adjustment of ship-size to the uneven directional flow of traffic volumes. It was estimated that the ERTW-based shipping system could handle about half of the total world's east/west trade.

The second component of the Fourth Revolution, PTPs, is critically important for the transshipment-intensive ERTW and the respective shipping system. Since these PTPs are expected to only handle transshipment or ship-to-ship transfer, it was predicted that they would be based on a specialized handling system resulting in a much higher productivity and lower cost than in existing ports.

Obstacles to the Fourth Revolution

The Fourth Revolution, despite its radical name, seemed to be the logical next stage in the evolution/revolutions development path of liner shipping. The 2014 expansion of Panama Canal was expected to serve as its trigger. However, as early as 2006 it was observed that the Revolution might be stalled because of two obstacles:

- The emergence of ships substantially larger than the new Panama locks; and
- The failure to develop cost-effective, specialized PTPs.

The New Post-Panamax (**NPX**) ships defined by the new and expanded Panama locks, with 13,200 TEUs, are almost three times larger than the typical 4,500-TEU Panamax. But Maersk's new 18,000-TEU, Triple-E ships, soon to be deployed on the Asia / Europe trade route, are almost 50% larger than the 13,200-TEU NPX. Moreover, it is quite likely that the continuing evolution in ship size will not stop at 18,000 TEUs and larger ships might emerge within a few years (see discussion below). A second expansion of the Canal to accommodate larger-than NPX ships is not envisioned for many years and, perhaps, might even be technically infeasible. Hence, the ERTW would not be able to employ the largest and most cost-effective ships of the future. Likewise, the massive transshipment to be generated by the Fourth Revolution could not be efficiently handled by existing ports, which are geared toward handling gateway (domestic) traffic. Altogether, it seems that the bold concept of consolidating a large chunk of the world's east/west trades in a single, comprehensive ERTW service pattern is unlikely to be realized.

Continuation of Direct Services

The Fourth Revolution predicted a transformation of the current service pattern, mainly based on direct calls by mainline (mother) ships, into a pattern mainly based on indirect calls by feeder ships with extensive use of transshipment. Presumably, such a transformation should have taken place as a "natural" consequence of the substantial increase in ship size, even without the Fourth Revolution and its ERTW-based global grid. Larger ships promote transshipment by: (a) allowing better exploitation of scale economies stemming from the size differentials between mother and feeder ships; and (b) eliminating calls at ports that either have limited facilities and/or limited traffic.

Interestingly, despite the introduction of larger ships, no meaningful transformation in service pattern has taken place thus far. The service pattern of the shipping services on the world's largest trade route, Asia/Europe, is still based on direct calls at all major regional ports as it has been when ships were much smaller. Moreover, Maersk Line's AE10 service, which employs the largest ships presently in operations, the E-class with 15,000 TEU, has even extended its route by adding a long "detour" into the Baltic Sea. This service's rotation (summer 2012) includes direct calls at 14 ports (!), instead of 10 ports by the more common Asia/Europe services. Likewise, most recently, the G6 alliance has announced an extension of its Asia / Europe service to Gothenburg. As a result, this mid-size remote port, which previously was only served by feeders, now has 2 direct weekly calls by Asia/Europe mainline services.

Emerging Bi-Regional Shuttles Services

While the overall pattern of direct-call by the Asia/Europe services has been kept unchanged for many years, an interesting modification has recently taken place, the elimination of en-route ports of call. The traditional multi-trade services commonly referred to as *pendulums*, have been gradually converting into single-trade, bi-regional *shuttle* services. For example, a few Asia (Far East)/ (North) Europe services have eliminated en-route calls in South Asia, the Middle East and the Mediterranean, limiting their calls to ports in the two end-regions. The en-route ports, in turn, are also served by dedicated bi-regional shuttle services such as Asia (Far East)/Mediterranean, or South Asia/ (North) Europe. The latest addition to this trend is the Southeast Asia/Middle East dedicated service announced by UASC (AGX). This transition from multi-trade to single-trade services was triggered by the general growth in trade volumes and, especially, the recent creation of "super" alliances, producing sufficient traffic volumes between end-ports to fill large ships.

Revised Fourth Revolution based on Bi-Regional Shuttle Services

The Revised Fourth Revolution, the subject of this paper, is based on the same principles of the original Fourth Revolution, except that the ERTW is replaced by bi-regional shuttles as the core service pattern. The principle guiding both revolutions remains the same: comprehensive rationalization of the service pattern. In fact, the need for such rationalization is more urgent today, when ship size is reaching 18,000 TEUs, than in 1999, when the largest ship was Maersk's S-class with nominal capacity of "only" 6,600 TEUs.

The *Revised* Fourth Revolution is based on further transformation of existing bi-regional shuttle services. The present shuttles are *multi-port*, with the mother ship calling directly at several ports at each end-region. In contrast, the envisioned shuttles of the Revised Fourth Revolution will only call at a *single* PTP in each end-region, whereby *the entire ship is turned around* and the regional distribution is provided by feeder services. The revised revolution exploits the economies of the "classical" hub & spoke concept to their full extent, with its mother ships only calling at 2 ports and the rest of the ports served by feeders. This, indeed, is the most cost-effective service pattern available -- assuming the cost of transshipment at hub ports can be substantially reduced. Also, the single-hub shuttles do away with the multi-level transshipments of the original Fourth Revolution. Another advantage is that most of the transshipment is concentrated in specialized PTPs instead of being distributed over gateway ports as is presently the case (see below).

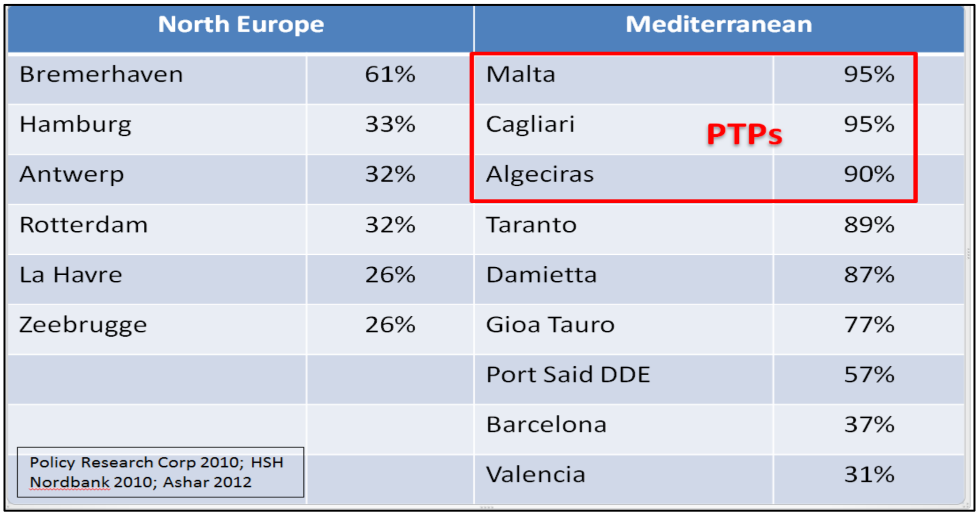
The revised Fourth Revolution, very much like the original one, is dependent on the development of specialized PTPs to quickly and efficiently turn around 18,000-TEU (and larger) ships, which cannot be accomplished by existing handling technology. Hence, both revolutions mandate the development of a specialized handling technology for PTPs.

Transshipment in Present Terminals

Mixing Gateway and Transshipment Traffic

Most of the transshipment traffic is currently handled by ports primarily designed to handle domestic (gateway) traffic. The gateway traffic is to a large degree captive and therefore can be charged full cost. In contrast, transshipment is "foot loose" and can easily shift to competing ports, including those located far away. Therefore, transshipment is usually only charged marginal cost and, accordingly, treated as secondary to the primary gateway traffic. Figure 1 presents indicative data on the share of transshipment in a sample of North European and Mediterranean ports. As shown there, all major ports of North Europe and the Mediterranean handle significant volumes of transshipment traffic; this also is the case in most ports worldwide, with the exception of the US. It is unlikely that these ports will develop a specialized handling system for transshipment, considered by them as secondary. It also is interesting to observe that transshipment exceeds 90% only at 3 ports (inside the red frame), justifying their definition as Pure Transshipment Ports (PTPs).

Figure 1 Share of Trannshipment Traffic



North Europe		Mediterranean	
Bremerhaven	61%	Malta	95%
Hamburg	33%	Cagliari	95%
Antwerp	32%	Algeciras	90%
Rotterdam	32%	Taranto	89%
La Havre	26%	Damietta	87%
Zeebrugge	26%	Gioa Tauro	77%
		Port Said DDE	57%
		Barcelona	37%
Policy Research Corp 2010; HSH Nordbank 2010; Ashar 2012		Valencia	31%

Ship-to-Ship vs. Ship-to-Shore Handling System

There are important operational differences between handling systems of transshipment and gateway traffic, or between ship-to-ship and ship-to-shore transfer:

- ***Land Interface*** – Ship-to-ship transfer does not require gate processing of trucks, pre-gate parking for trucks, on-dock intermodal yard for trains, and road/rail access to the terminal;
- ***Selectivity*** – Ship-to-ship, or mother-to-feeder transfer, involves *groups of containers* sharing the same origin and destination ports, while ship-to-shore transfer involves a single container;
- ***Control*** – In ship-to-ship transfer the entire handling process is under the control of a shipping line while in ship-to-shore transfer, the shore-side is controlled by cargo owners; and

- ***Dwell Time*** – In ship-to-ship transfer the dwell time between mother and feeder is shorter than in ship-to-shore transfer, since there is no need for clearing Customs, paying freight and port charges, arranging for land transport, etc.

Terminal Automation and Transshipment

Despite the differences between the handling systems of transshipment and gateway traffic, most of the transshipment is presently handled in terminals designed for handling gateway traffic. Because of shortage in waterfront land, these terminals are often created through costly, deep-water reclamation. Indeed, the main objective of the recently-introduced automation of yard operations is to reduce the amount of terminal land through densification of the storage area, along with reducing labor cost and increasing productivity. Figure 2 presents a typical layout of an automated terminal based on automated stacking cranes (**ASC**), with two optional yard arrangements, based on stacks aligned parallel and perpendicular to the berth. The arrows in this figure depict the 3 main transfer processes performed at the terminal berth: (a) ship-to-yard (import); (b) yard-to-ship (export); and (c) ship-to-ship (transshipment). For illustration, the transshipment is presented in this figure by a double-headed arrow between mother and feeder, as if boxes are moving directly between these ships. Such a direct move is unconceivable in automated terminals whereby the dock area is exclusively used for traffic lanes and no interim storage is allowed. In reality, transshipment in automated terminals is handled exactly like gateway traffic: the discharged box is transported from ship-side to the yard for storage, to be later retrieved and transported back to the ship-side for loading onto the ship. Accordingly, transshipment, or a ship-to-ship transfer in automated terminals, involves *double handling* exactly as it is done in conventional terminals, except that the transport and storage operations are performed by automated machines.

A second problem of handling transshipment at today's automated terminals relates to the low utilization of these terminals' most precious resource -- waterfront land. Most of the transshipment is presently handled in terminals designed to handle domestic traffic, since it is by far the most important traffic component. In these terminals, as seen in Figure 2, about 40% of the area is devoted to the land-interface. While this area is critically important for handling gateway traffic, it has no use for transshipment.

Productivity of Automated Terminals

A third, and perhaps the most critical problem of automated terminals, is their relatively-low productivity. The productivity of the automated terminal shown in Figure 2 is constrained by their yard system. The yard needs to simultaneously support both the ship-side and land-side operations, limiting the number of yard cranes that can be allocated to the ship-side. This limitation is most severe in the more-popular perpendicular-yard arrangement, even when using nested yard-cranes (Hamburg's CTB). Another constrain on productivity is the traffic congestion in roadways between ship and yard, especially in larger terminals with longer-distance traveling, where bulky shuttle-carriers (small straddle carriers) are used to transport containers between yard and ship. It could well be that automated terminals may eventually reach berth productivity averaging 300 moves/hour (e.g., 7-8 cranes x 40 moves/hour). However, at this productivity level turning around an 18,000-TEU ship, as mandated by future shuttle services, would take 3 - 4 days -- undermining the feasibility of the entire shipping system. Altogether, it seems that the present kind of automation is not applicable for PTPs.

Floating Pure Transshipment Terminals

Barges for Storage and Transport Containers

As demonstrated above, automated terminals, designed for handling gateway traffic, are not designed to serve the extensive transshipment traffic of the Revised Fourth Revolution's PTPs. These PTPs require a specialized handling system, taking advantage of the main characteristic of transshipment traffic -- moving *groups* of containers between ships. This, in turn, cannot be performed on land but only by water, using barges. Accordingly, future, specialized PTPs could be based on *floating yards,* or barges, for storing and moving containers.

Figures 3 & 4 depict a section and an elevation of the proposed design of a floating PTP. Figure 5 presents the overall layout of this terminal, using the Port of Algeciras as an example (the proposed layout and location of this terminal is the sole opinion of this author and is brought here only as an illustration for the concept).[4] As seen in Figures 3 & 4, the ship-to-shore (**STS)** crane is similar to conventional gantry cranes used in land-based terminals, except that the roadways between crane legs are designed for barges instead of trucks.[5] The floating terminal's yard is not land-based but water-based, whereby boxes are stored on barges. These barges have a *dual role,* serving as: (a) horizontal-transport vehicles of boxes between mother and feeder ships; and (b) intermediate, inter-ship storage "rack" for boxes. The main advantage of barges is their ability to move groups of boxes together. This indeed is the case in ship-to-ship transfer, where one mother ship is typically "broken-down" into several feeder ships. For example, in the case of 18,000-TEU mother served by five feeders each calling five ports, the average number of boxes moving between the mother and each of the 25 ports is 720 TEUs in each direction (18,000 / 25).

The barge configuration in the above figures is based on that of common, square-shaped Mississippi River "Jumbo" barges, with 10 x 4 x 4-TEU stowage and a total of 160 TEUs/barge (about 2,000 dwt). Accordingly, a full discharge of an 18,000-TEU ship requires 112 barges (18,000 / 160). The ship-to-barge gantry cranes are conventional, although with a wider gauge of about 50 m, not much different than the 42 m of recent cranes. The cranes also have a cantilever of about 35 m, allowing a total of 8 rows of barges. This arrangement seems sufficient to provide the required selectivity, with each barge destined for a specific feeder and, desirably, specific end port. Barges are moved along the mother ship by a special pulley system, similar to that used in the Mississippi River's grain terminals. The barges are stored (parked) according to end-ports in a protected water area, referred to in the US as *fleeting area*. For the shuttling between the fleeting area and the dock, barges destined to the same ship are tied together, forming a train (called *tow* in the US) and moved by a push-boat. Figure 6 presents an aerial picture of a typical fleeting area in the Mississippi River with barges sorted according to feeder-ports, based on the example of Algeciras. Figure 7 presents the handling of the tow at a deep-water port using a gantry crane. Figure 8 presents a picture of a tow of barges in the Mississippi River. The use of Mississippi River barges here is only for illustrating the floating-yard concept; it could well be that larger and deeper barges (6–wide, 240-TEU) would be more stable and better suited especially if triple-tandem STS cranes are used. An operational simulation is required to determine the optimal size of barges, including the possibility of using a modular, flexible design, e.g., allowing for two smaller barges to be tied, with their combined size similar to a larger barge, etc.

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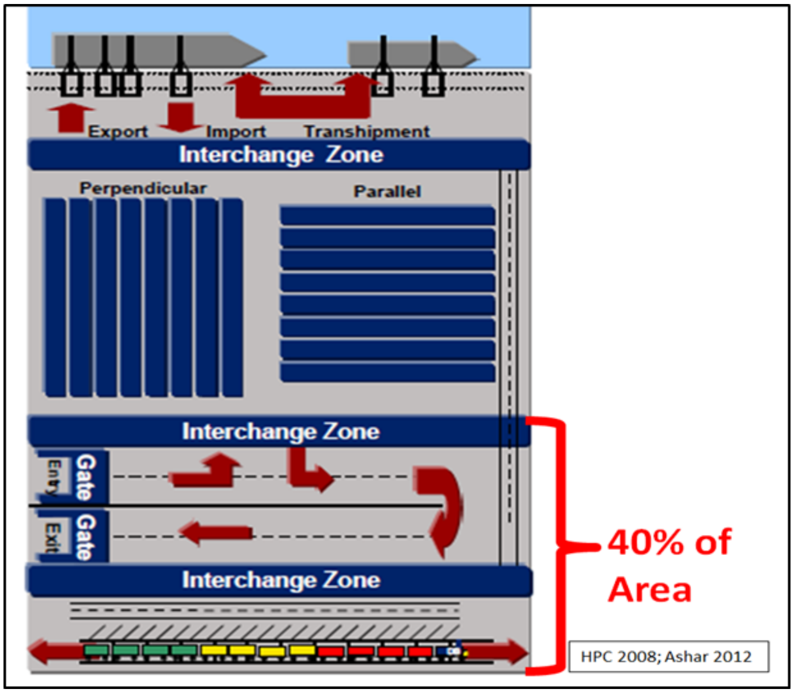
[4] The concept was first presented in a public seminar on long-term developments of liner shipping, which was part of the Port of Algeciras strategic plan.

[5] Michael Jordan of Liftech Consultants Inc. proposed a similar design. See: *www.liftech.net.*

The operation of the floating terminal is quite simple. The boxes from the mother ship are discharged onto barges according to their final destinations; the barges are towed away from ship-side to the fleeting area and parked there according to destination ports; when the feeder ship arrives, the barges are towed back to ship-side and the boxes are loaded onto the ship. Accordingly, the entire ship-to-ship transfer involves only two lifts, both performed by STS cranes, which can be remotely-operated or even automated.[6] In comparison, the full ship-to-ship cycle at a land-based, automated terminal based on shuttle carriers and ASCs, involves eight lifts: two by the STS, four by shuttle carriers and two by the ASCs. Some limited shuffling of boxes may be needed in the floating operation due to changes in box destinations while already en-route. These could be performed by floating cranes such as that shown in Figure 8. It could well be that, as is the case in Algeciras, a small percentage of the traffic will be gateway (domestic). The domestic traffic, much like the transshipment one, will be staged on barges, but instead of being towed to the fleeting area, it will be towed to a local, land-based barge terminal.

My preliminary calculation indicates that the cost of barges would be lower than the cost of respective land-based storage yard, especially in case of deep-water reclamation. There is also the savings due to the avoidance of yard equipment. Moreover, the operating cost of transshipment in the floating terminal is expected to be a fraction of that in a land-based terminal because of the elimination of the double handling. Still, the main saving in the floating design would be in ship cost, as will be seen in the following section on productivity.

Figure 2 Layout of automated Terminal



HPC 2008; Ashar 2012

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[6] A recently inaugurated slab terminal in Mobile, AL, USA applies direct ship-to-barge operations. See: *http://vimeo.com/26014564*.

Figure 3 Floating Pure Transshipment Port (PTP) – Cross-Section

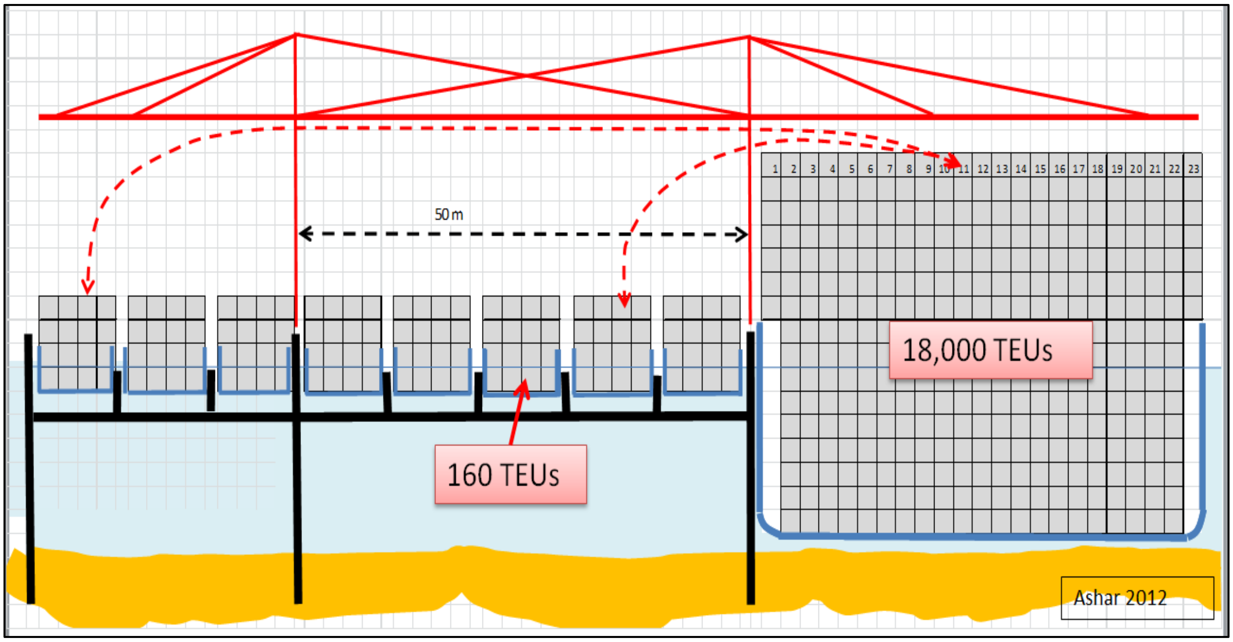

Figure 4 Floating Pure Transshipment Port (PTP) – Elevation

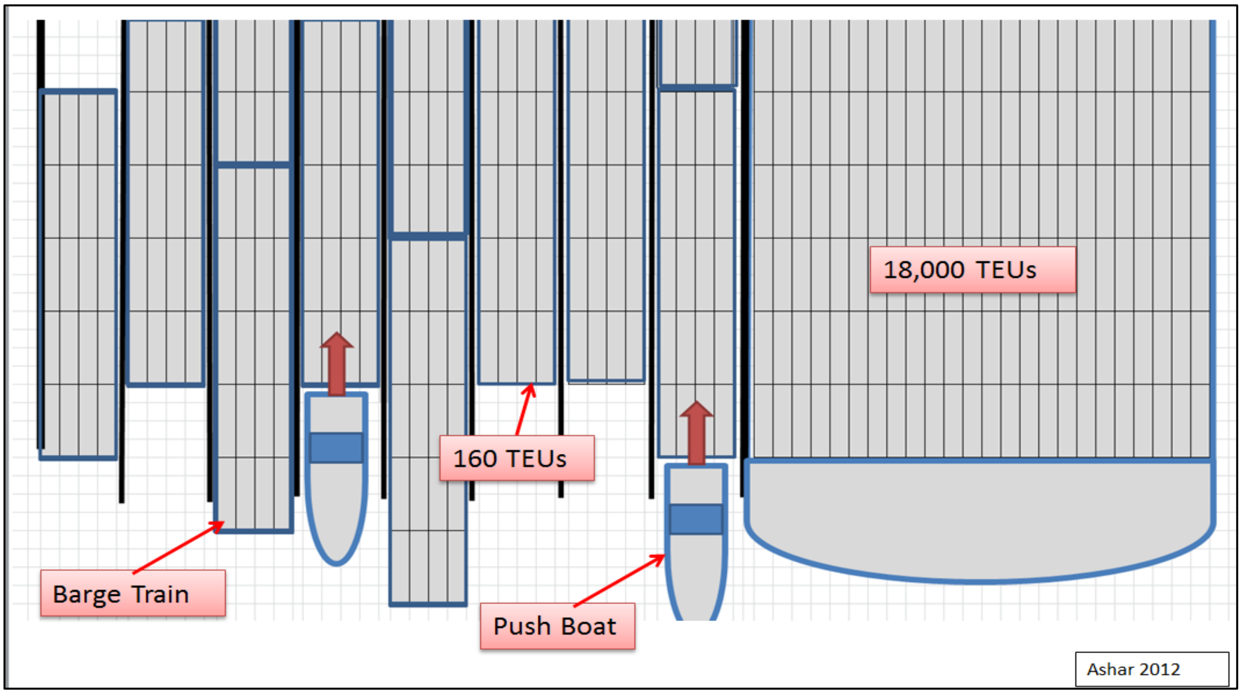

Figure 5 Algeciras' Floating Pure Transshipment Port (PTP)

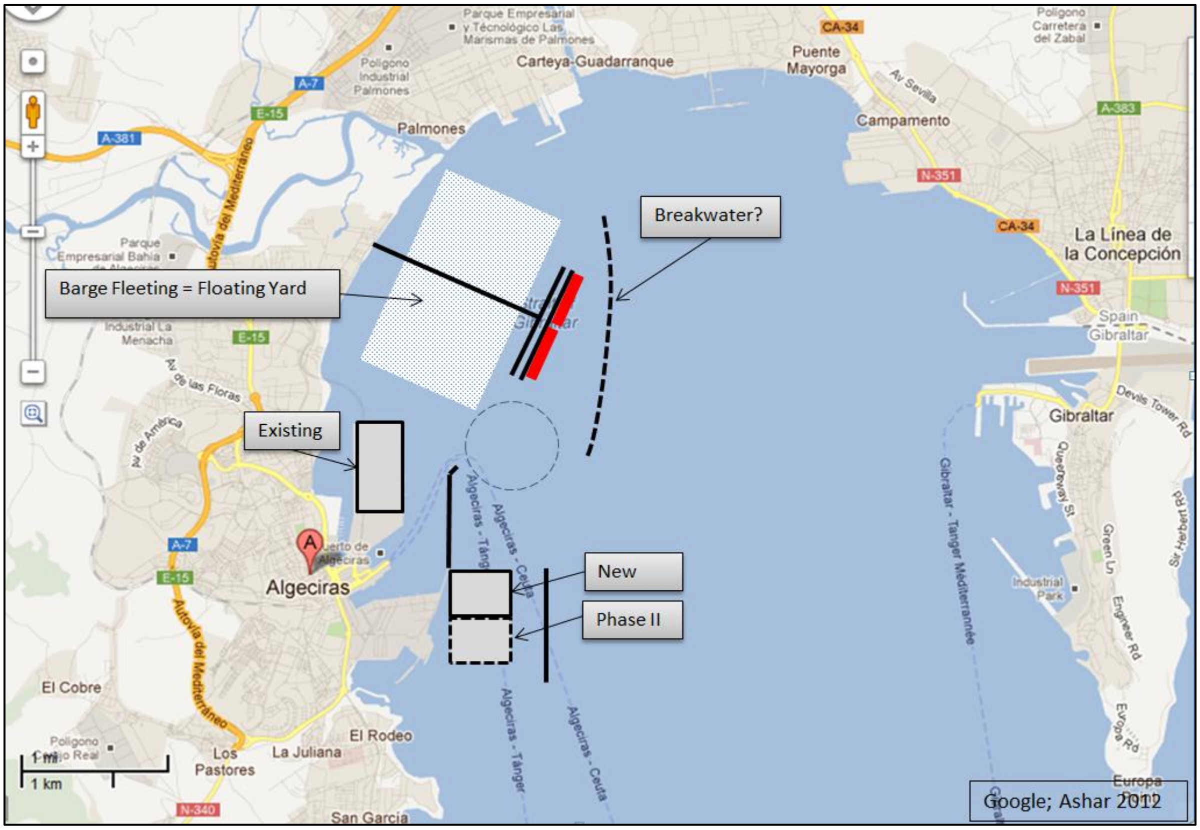

Figure 6 Mississippi's Container Barges

Figure 7 Handling Container Barges, Port of New Orleans

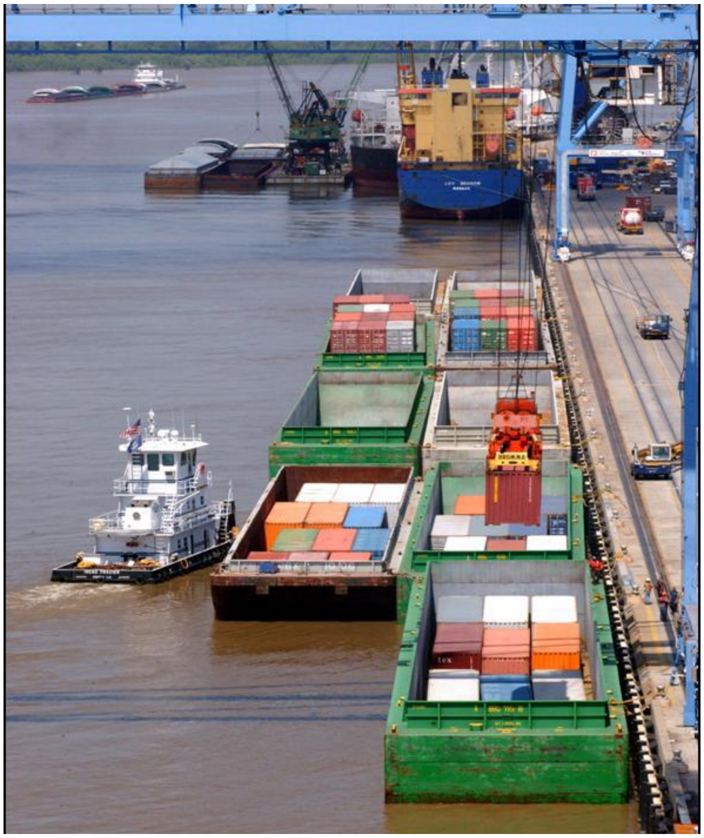

Figure 8 Mississippi's Fleeting Area

Figure 9 Floating Barge Crane

Productivity of a Floating PTP Terminal

The use of barges for horizontal transport of containers facilitates tandem and triple lifting for the transshipment, ship-to-ship transfer operation, where the matching of boxes is simple, since many boxes have the same destination. Likewise, “dumping” the entire mother ship at a single terminal simplifies ship handling, allowing the deployment of more STS s per ship and a higher percentage of dual-cycling, resulting in significantly higher productivity. For example, employing 9 STSs with tandem lift (4 TEUs) throughout the entire operation with 50% dual cycling, would result in productivity of 1,620 TEUs/hour (9 cranes x 30 moves/hour x 4 TEUs/move x 1.5); with triple lift, the productivity could reach 2,430 TEUs/hour. At these productivities, an 18,000-TEU ship can be turned around (2 x 18,000-TEU moves) within 1 day. A berth dedicated to handling such ships on a daily basis will have an annual throughput of 13 million TEUs (!). Such productivity and throughput levels are way beyond those achievable in land-based terminals.

Gibraltar / Singapore Shuttle

Figure 10 shows the service route of Maersk’s primary Asia/Europe service, the AE10 provided by Maersk’s largest, 15,000-TEU E-class ships (summer 2012). As shown in this figure, the AE10, as well as almost all current Asia/Europe services, includes long regional legs in both North Europe and the Far East. As a result, ships spend about *half* of their rotation time on these legs, most of it at regional ports. Accordingly, a typical Far East/North Europe rotation requires 10 ships; AE10 with its additional Baltic Sea requires 11 ships. Because of switch backs, as illustrated by the double-headed arrows, regional ports are either called once, resulting in long transit times for boxes moving in the opposite direction; or called twice, first for the inbound and second for the outbound traffic, resulting in waste of ship’s time and additional port costs. Altogether, the current “milk run” of large, motherships between five or more regional ports on each end is very costly.

The development of high-productivity, low-cost floating PTPs would induce a transformation of the current service pattern into a shuttle between two regional PTPs located in Gibraltar and Singapore (or other ports in the Malacca Straits).[7] A Gibraltar/Singapore (**Gib/Sig**) shuttle service would require about *half* the number of ships of a present Far East/North Europe rotation, or only five ships.[8] Hence, if Maersk dedicates its fleet of 20, 18,000-TEU on-order and present 10, 15,000-TEU ships to the Gib/Sig express services, Maersk could provide six daily services between Asia and Europe. The annual capacity of these services would be about 10 million TEUs and the respective traffic generated at each PTP 20 million TEUs. A wide network of feeder services should be developed to distribute this traffic both in Europe and Asia. Figure 11 depicts the Gib/Sig shuttle concept, including feeder connections at its two PTPs.

The Gib/Sig service could be extended via feeder to encompass the main North European ports and, perhaps, even some North and South American ports. Transit times between end-ports using the Gib/Sig will be similar to those currently provided by direct service or, perhaps, even shorter, since the

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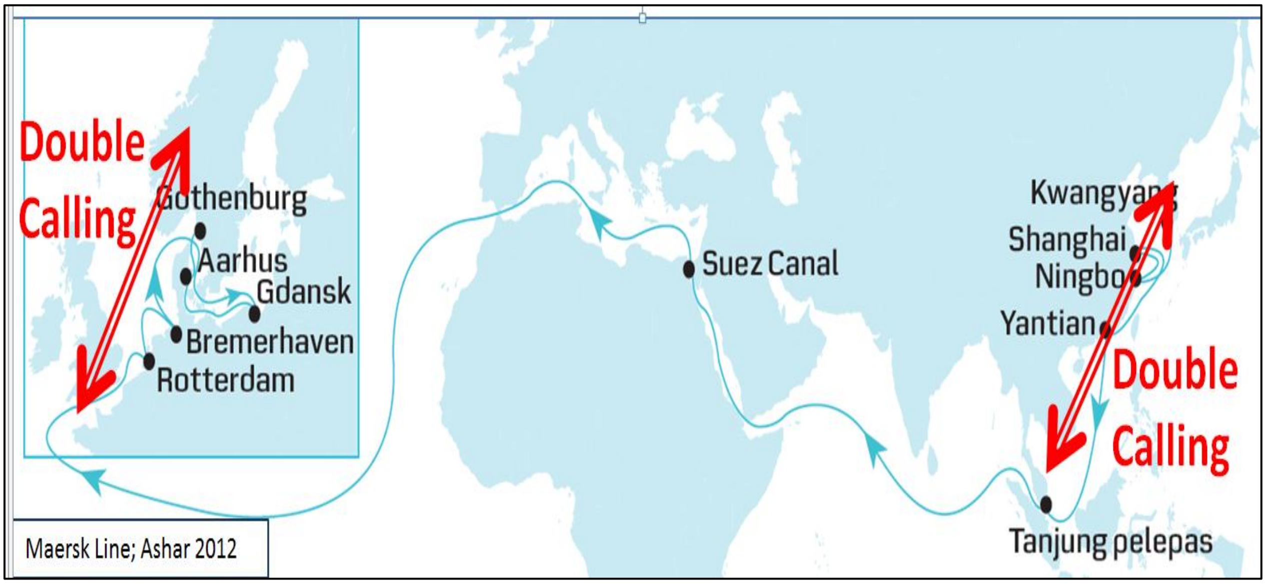
[7] Prof. Niko Wijnolst of Delft University studied a shuttle service by Malacca-max ships between Singapore and Rotterdam, although Rotterdam is mainly a gateway port. See: Wijnolst, N., *Malacca-max 2*, Container Shipping Network Economy, DUP Satellite, 2000. Capt. Yigal Maor presented a similar system based on a Mediterranean hub in TOC 2000.

[8] Assuming: 20 k, 2 days for Suez, 2 days for PTPs handling and 1 day for slack.

Gib/Sig eliminates en-route ports of call and the PTPs shorten the port time of ships. The reduction in transit times may even be more substantial for smaller North European ports presently feedered via North Europe ports, since the Gibraltar-based feeder services, using ships of 3,000 - 6,000 TEUs, will be able to directly call at these ports. This would also apply for the Baltic ports, including the most remote ones such as St. Petersburg, Tallinn and Helsinki, which could be served directly from the Gibraltar's hub. All these ports will also be able to enjoy from daily services, now confined to the major North European hubs. Altogether, the Revised Fourth Revolution is expected to substantially lower transport costs and improves level of services to most ports. The main losers are the dethroned present hub ports, which will lose their transshipment traffic to the new PTPs. However, transshipment is not the primary traffic of these ports.

Similar PTP-based shuttle services to the Gib/Sig could be developed between other pairs of world's regions. Possible PTPs could be developed in Prince Rupert and Melford, Canada[9]; Freeport, Bahamas; Kingston, Jamaica; ports at entrances and near Panama Canal and Suez Canal; Shanghai (Yangshan); and others. The two pre-requisites for PTPs, in addition to a strategic location, are a deep channel and, especially, a large, protected body of water for barge fleeting. Eventually, a global network of specialized PTPs and shuttle services connecting them will evolve, similar to the global grid of the original Fourth Revolution, but without the ERTW.

Figure 10 Maersk Line's Asia / Europe AE10 Service



Maersk Line; Ashar 2012

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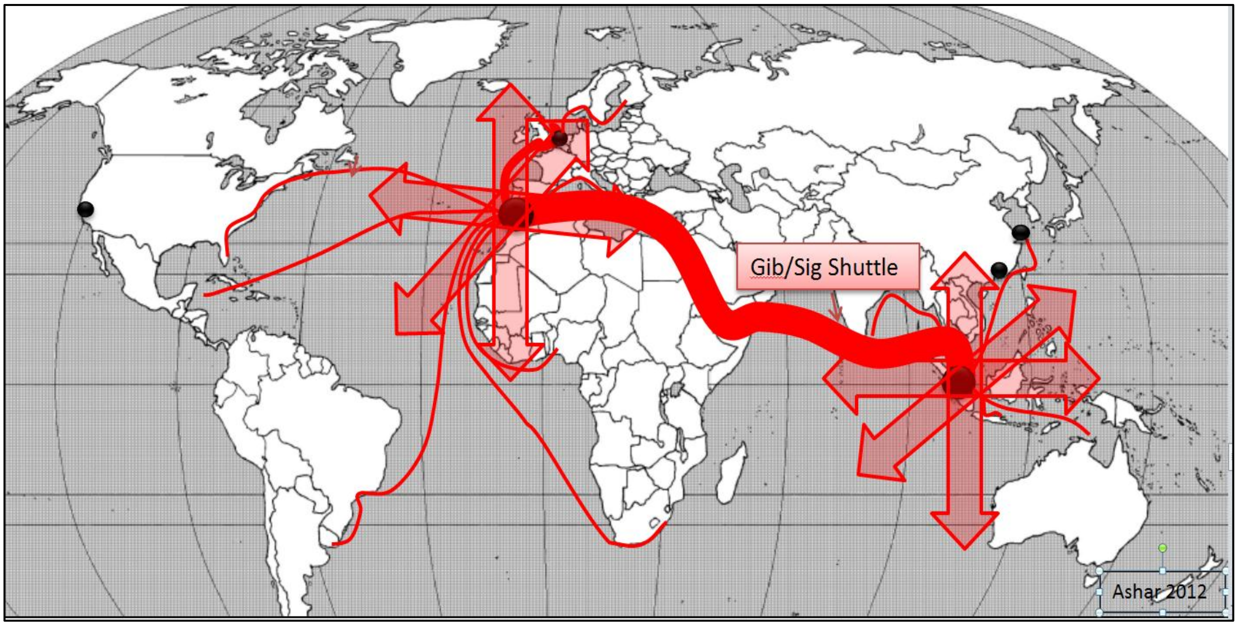
[9] An interesting application of the floating design will be for a barge-to-rail transfer terminal.

Figure 11 Gibraltar / Singapore Shuttle



30,000-TEU Malacca-Max Ships

The Gib/Sig shuttle service is a dedicated service between 2 specialized PTPs; both could be based on a floating design. The floating design allows locating the PTPs in deep water, since there is no need for land reclamation, with crane rails supported on piles or, more probably, caissons. For example, Algeciras' PTP, as shown in Figure 5, is located in a naturally-deep water of 30+m.

The availability of deep-water in both PTPs raises the possibility of employing *dedicated* deep-draft ships for the PTP-to-PTP shuttle service.[10] In the case of Gib/Sig service, the ships' draft would be defined by the Straits of Malacca, or the largest ships could be Malacca-Max (**MalMax**). These MalMax ships could have similar dimensions to Maersk's Triple E, except for their deeper draft. Accordingly, the MalMax dimensions could be 400 x 60 x 21 m, resulting in 245,000 dwt, 36% larger than the 180,000 dwt of the Triple E, and an equivalent container capacity of 24,500 TEUs (18,000 x 1.36)[11] – almost twice the size of the 13,200-TEU NPX. With an additional 60-m midsection the capacity of the MalMax could reach 28,000 TEUs; adding one row of containers athwart will bring the dimensions to 400 x 63 x 21 m and the capacity to about 30,000 TEUs, or 2.3 times the size of NPX. Figure 12 presents the main dimensions and stowage arrangement of the various "generations" of containerships.

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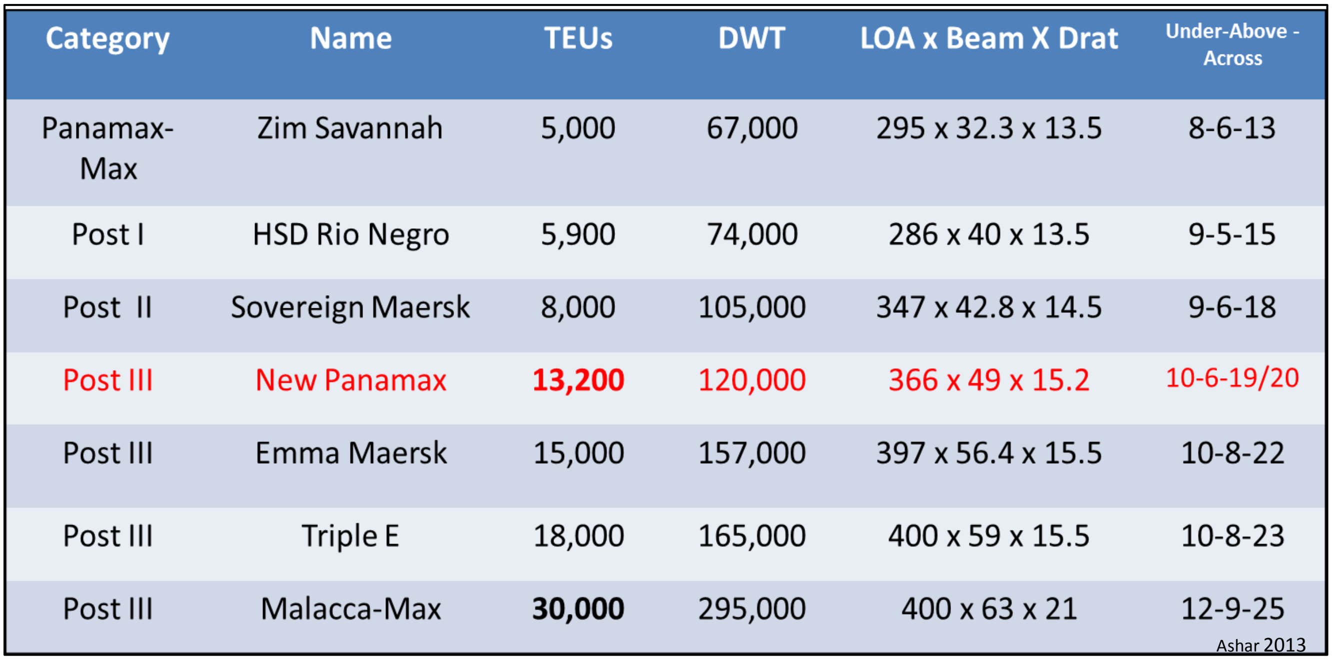
[10] The dedicated, 2-port service raises the option of constructing LNG-fueling installations to allow the deployment of LNG-powered ships.

[11] The permissible draft of Suez Canal is 66 ft (20.1m) and the largest allowed ship is 240,000 dwt. The Canal plans further deepening to attract large tankers.

Figure 12 Containerships' Generations



Category	Name	TEUs	DWT	LOA x Beam X Drat	Under-Above - Across
Panamax-Max	Zim Savannah	5,000	67,000	295 x 32.3 x 13.5	8-6-13
Post I	HSD Rio Negro	5,900	74,000	286 x 40 x 13.5	9-5-15
Post II	Sovereign Maersk	8,000	105,000	347 x 42.8 x 14.5	9-6-18
Post III	New Panamax	**13,200**	120,000	366 x 49 x 15.2	10-6-19/20
Post III	Emma Maersk	15,000	157,000	397 x 56.4 x 15.5	10-8-22
Post III	Triple E	18,000	165,000	400 x 59 x 15.5	10-8-23
Post III	Malacca-Max	**30,000**	295,000	400 x 63 x 21	12-9-25

Ashar 2013

Summary Observations

Original vs. Revised Fourth Revolution

Making predictions for the volatile liner shipping industry is risky for the short term; it is immeasurably riskier for the long term, the subject of this paper. A case in point is my 1999 prediction of a forthcoming Fourth Revolution, a sweeping change in the global service pattern, revolving around of a new, inclusive ERTW service and a multi-level transshipment. The revolution was expected to be triggered by the 2014 expansion of Panama Canal and the related introduction of large post-Panamax ships. The irony in this prediction is that the size of the recently-emerged ships has already surpassed the expanded Canal and because of it the ERTW and the revolution which is dependent on are unlikely to materialize. Moreover, despite the dramatic increase in ship size, there has been no meaningful change in service pattern thus far; direct calling and multi-porting still dominate Asia/Europe, the world's major trade route.

I believe that this dominance is the result of a short-term excess in ship supply and, mainly, the inability of existing terminals, even the most technologically-advanced ones, to provide cost-effective transshipment due to their focus on gateway traffic. But, I also believe that in the long-term the principles underlying the original Fourth Revolutions, comprehensive rationalization of service pattern into a highly-effective integrated network of mother and feeder services, will prevail.

While the principles of the original revolutions are still valid, there is a need for a revision of the revolution's components. The Revised Fourth Revolution described in this paper replaces the inclusive ERTW of the original Fourth Revolution with a system of bi-regional, dedicated shuttle services between specialized PTPs, with each service tailored to the specifics of the trade lane served by it. The various shuttle services are linked together at these PTPs, forming a *global grid* of shipping services similar to that envisioned by the original Fourth Revolution but, again, without the ERTW. Replacing the ERTW with a system of bi-regional shuttles also does away with a need for multi-level transshipment.

The recent increase in ship size, the emergence of dedicated regional shuttles in the Asia/Europe trade lane and the formation of “super alliances” appear to prepare the ground for the revised revolution. The present regional shuttles are still multi-port. The revised revolution involves further conversion of these shuttles to focus on a single regional ports, fully exploiting the hub & spoke concept. Turning around large motherships at a single port requires a radical change in this port’s handling system. Hence, as was the case with the original revolution, the revised one is critically dependent on the development of specialized PTPs, such as the floating design presented in this paper.

A New “Specie” of Liner Shipping

The essence of both the original and revised revolutions is a comprehensive rationalization of the present service pattern of liner shipping, turning it into an integrated, worldwide network of mother and feeder services defined as a *global grid*. However, the change in service pattern in the revised revolution could also set off related changes in ship and port technology and even in the cargo unit itself. Since the global shuttle services of the Revised Fourth Revolution are not constrained by Panama Canal's locks, they could give rise to increasing ship size to 30,000 TEUs and beyond (Figure 12 above). These ships and the massive transshipment traffic generated by them would be too big to handle by conventional land-based ports, even the most automated ones which, in turn, would give rise to a new type of ports specializing in transshipment, based on a floating design. The unique feature of transshipment traffic, moving *groups* of containers, could also give rise to a new multi-container cargo-unit, possibly similar to the Sea Shed.[12] At this point, the three components of the emerging liner shipping system, the cargo unit, the ship and the port, would have completed an extensive process of specialization and differentiation, setting the stage for a new shipping system -- apart from the present one. A new “specie" of liner shipping would have evolved.

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[12] The Sea Shed is a metal frame developed by the US military to handle 3 FEUs or other outsize cargo units in container ships.