1. Spaces, Networks and Flows in a Global Economy

What is behind the process of globalization? This is certainly a dimension that has been discussed in length and from many different perspectives. Among the most common factors identified are those related to the exploitation of comparative advantages, mainly in terms of labor, information and telecommunication technologies, foreign direct investments and technology transfers. All these have helped create a clustered and spatially diffused global economy, particularly in terms of production and consumption. A very powerful and widely acknowledged trend in recent years has been the rapid industrialization of Pacific Asia, particularly China, and the enduring growth in the consumption of foreign goods in North America and Europe. Global trade is thus steadily growing so does the distance of trade relations. Parallel to this growth, the need to reconcile spatially diverse demands for raw materials, parts and finished goods has placed additional pressures on the function of freight distribution and logistics.

Freight distribution is a physical activity where the transportation component is of prime importance. Paradoxically, transportation often appears to be taken for granted. Because of its efficiency, freight transportation is almost invisible to the end consumer. In previous work (Rodrigue, 2006), I suggested that this fallacy is mainly due to the consideration of transportation solely as a derived demand which states the transport exists because of the requirements of the activities it services. Although this concept is fundamentally true, the emergence of global distribution has brought many nuances. The global economy is thus based on the backbone of freight distribution, which in turn relies on networks established to support its flows and on nodes that are regulating the flows within networks. Networks, particularly those concerning maritime shipping and air transportation, are flexible entities that change with the ebb and flows of commerce while nodes are locations fixed within their own regional geography.

2. The Emergence of a Nodal Space
The regulation of flows by nodes is particularly important, and we can summarize the emergence of the global nodal space in three major phases. The three phases presented are additive, implying that each one was built upon the previous.

**Phase 1: The Transshipment Node**

The first phase saw the emergence of transshipment nodes and concerns a conventional perspective on international trade that prevailed until the 1970s. Particularly, there is a level of mobility of raw materials, parts and finished products in a setting which is fairly regulated with impediments such as tariffs, quotas and limitations to foreign ownership. Trade mainly concerned a range of specific products (and very few services) that were not readily available in regional economies. Due to regulations, protectionism and fairly high transportation costs, trade remained limited and delayed by inefficient freight distribution. In this context, trade was more an exercise to cope with scarcity than to promote economic efficiency.

The nodal space thus concerns locations that are very constrained and where a load break is necessary. The transport systems they connect are fairly disjointed implying a lag that warehousing fulfills. Due to the importance of this load break function, important port facilities were built, many of which saw the accumulation of heavy industrial activities (port industrial complexes). Rail transportation also characterizes well this nodal space with the emergence of industrial clusters next to major yard facilities (grain processing, meat packing districts, paper).

Ports as locations where maritime and land traffic converges are crucial facilities in the global economy. There are more than commercial 4,500 ports around the world, but only a small share handle a significant amount of traffic. The geography of these ports conditions the global geography of trade and flows since they are locations that cannot be easily bypassed. Ports remain points of convergence and divergence of traffic and their location is constrained by the physical characteristics of their sites. The first physical constraint involves land access and the second concerns maritime access. Both must be jointly satisfied as they are crucial for port operations and the efficiency of the maritime / land interface. Thus, land and maritime access can impair port operations and port development. However, maritime access is the attribute that can be mitigated the least. Activities such as dredging and the construction of facilities such as docks are very expensive, underlining the enduring importance of a good port site, albeit inland access also endures as a factor of importance for maritime freight distribution.

**Phase 2: The Intermodal Node**

The second phase saw the emergence of the intermodal node. From the 1980s the mobility of factors of production, namely capital, became possible. The legal and physical environment in which international trade was taking place lead to a better realization of the comparative advantages of specific locations. Concomitantly, regional trade agreements emerged and the global trade framework was strengthened from a legal and transactional standpoint (GATT/WTO). In addition, containerization provided the capabilities to support more complex and long distance trade flows, as did the growing air traffic. Due to high production costs in old industrial regions, activities that were labor intensive were gradually relocated to lower costs locations. The process began as a national one, then went to nearby
countries when possible and then became a truly global phenomenon. Thus, foreign direct investments surged, particularly towards new manufacturing regions as multinational corporations became increasingly flexible in the global positioning of their assets.

The nodal space became a set of locations promoting the efficiency of different transport networks and offering a higher level of integration. Transport chains started to emerge. In simple terms, they include the functions of composition, transfer, interchange and decomposition (Figure 1).

### Figure 1 The Intermodal Node

- **Composition** is the process of assembling and consolidating freight at a terminal that offers an intermodal interface between a local / regional distribution system and a national / international distribution system. It is commonly referred as the ‘first mile’.

- **Transfer** involves a consolidated modal flow, such as a freight train or a containership (or even fleets of trucks), between at least two terminals, which happens on the realm of national or international freight distribution systems. The efficiency of a connection mainly derives from economies of scale, such as doublestacking or post-panamax containerships.

- **Interchange** concerns the major intermodal function taking place at terminals whose purpose is to provide an efficient continuity within a transport chain. Those terminals are dominantly within the realm of national or international freight distribution systems, with ports being the most notable example.

- **Decomposition**. Once a load of freight has reached a terminal close to its destination it has to be fragmented and transferred to the local / regional freight distribution system. It is commonly referred as the ‘last mile’ and often represents one of the most difficult segments of distribution.

In all cases, the emergence of the intermodal node required entirely new terminal facilities either at new locations or through the reconversion of existing facilities. The outcome has been an increase in the velocity of the flows, not necessarily because of
improvements in modal speeds (which has been limited), but because of faster and less costly transshipments.

The emergence of landbridges is a good example of the setting of intermodal nodes along transport chains. Rail freight in the United States has experienced a remarkable growth since deregulation in the 1980s (Staggers Act) with a 77% increase in tons-km between 1985 and 2003. A significant share of this transformation concerns the emergence of long distance rail freight corridors linking the two major gateway systems of North America; Southern California and New York/New Jersey via Chicago. This represents the most efficient Landbridge in the world, which considerably reduces distances between the East and the West coasts. Thus, the North American landbridge is mainly the outcome of growing transpacific trade and has undergone the containerized revolution; container traffic represented approximately 80% of all rail intermodal moves. Landbridges are particularly the outcome of cooperation between rail operators eager to get lucrative long distance traffic and maritime shippers eager to reduce shipping time and costs, particularly from Asia.

With the North American landbridge, an alternative to freight shipments across Panama Canal or the Strait of Magellan is thus available (Figure 2). For instance, a container coming from Singapore takes 36 days to reach New York using the Panama Canal sea route. The same journey takes 19 days if the Landbridge is used (Double-stack rail transport using the Seattle-Chicago-New York rail chain). On average, transport services between the East Coast of the United States and Pacific-Asia are reduced from 6 days to 2 weeks depending on the case. The North-American Landbridge is also competing for a market share of the traffic between Europe and Asia. It requires for maritime shippers on average from 5 to 6 weeks to service the harbors of Tokyo and Rotterdam. With the Landbridge, this time is reduced to about 3 weeks with an 80 hours railway journey across North America.
With the landbridge service, several maritime companies abandoned the Panama Canal and were able to shift to post panamax class containerships. Their productivity and long distance shipping costs were reduced proportionally as maritime shippers were able to use larger ships with a higher level of frequency of services. A higher capacity can thus be achieved with the same number of ships. The North-American Landbridge also includes a Canadian (Vancouver-Montreal-Halifax) and a Mexican section (Salina Cruz-Coatzacoalos). As opposed to the Eurasian landbridge, the American landbridge has the advantage of providing a transcontinental link through a single country (Canada, USA or Mexico).

Phase 3: The Logistical Node

The emergence of logistical nodes went quickly and is the direct outcome of containerization and globalization. There is a growth in international trade, now including a wide variety of services that were previously fixed to regional markets and a surge in the mobility of the factors of production. Since these trends are well established, the priority is now shifting to the geographical and functional integration of production, distribution and consumption. Geographical integration implies using effectively the comparative advantages of space while maintaining the cohesion, capacity and efficiency of the freight distribution systems. Functional integration implies more effective relations within existing supply chains. “Just-in-time” and “door-to-door” strategies are relevant examples of interdependencies created by new freight management strategies. Both geographical and functional integration take place concomitantly. Transportation has become much more integrated in the production and retailing process, enabling several corporations to establish what can be called global production networks (Figure 3).
The outcome are complex networks involving flows of information, commodities, parts and finished goods have been set, which in turn demands a high level of command of logistics and freight distribution. Global production networks have been advocated as an adequate paradigm to represent and explain the current global setting (Coe et al., 2004; Henderson et al., 2002). In such an environment, powerful actors have emerged which are not directly involved in the function of production and retailing, but mainly taking the responsibility of managing the web of flows. In addition, entirely new nodal locations have emerged since geographical integration led to industrialization in new regions, significant changes in the routing of flows and well as new strategies to manage these flows.

There is an emerging geography of containerized maritime terminals (Figure 4). Aside from the conventional port clusters in Europe and North America many corresponding to older ports partly or wholly converted to containerization, new regions and new port clusters have emerged, mainly in Pacific Asia. Most major ports have been transformed to become container ports with the construction of new container terminals, often away from the initial port site. Ports unable to adapt to containerization have mostly declined. In other cases, often because of the insurmountable constraints of the existing port site or because of a surging new demand (such as in Pacific Asia), entire new facilities have been built. Several of the world’s largest container ports simply did not exist 20 years ago. Containerization has deeply challenged the conventional geography of ports, particularly because of its requirements for port operations. Ports are facing a growing level of sophistication brought by technical and logistical changes. From simple facilities offering wharves and berths to accommodate ships, terminal facilities have emerged where a complete range of maritime
(berthing, mooring, transshipment) and inland services (stacking / warehousing, customs, inland distribution) are provided. Containerized maritime terminals are the facilities in which these range of services are the most developed and extensive.

![Image: Map of the world showing container ports]

Figure 4 Traffic at the 50 Largest Container Ports, 2003

The most substantial growth took place along the Tokyo – Singapore corridor, where economies have followed the export-oriented model, producing consumption goods highly prone to the use of containerization and bound for the global market.

3. **Nodes as Central and Intermediate Locations**

*Gateways and Hubs*

In the emerging nodal space, gateways and hubs are playing a crucial role. The transport system is subject to remarkable geographical changes even if many of its infrastructures are fixed. Flows, origins, destination and the modes used can change rather rapidly. What remain relatively constant are gateways, which can be seen as semi-obligatory points of passage.

A gateway is a location that promotes the continuity of circulation in a transportation system servicing supply chains. It is the interface between different spatial systems that includes terminal facilities, but also the numerous activities linked with freight circulation such as distribution centers, warehouses and even insurance and finance. Gateways reap advantage of a favorable physical location such as highway junctions, confluence of rivers,
seaboards, and have been the object of a significant accumulation of transport infrastructures such as terminals and their links. A gateway generally commands the entrance to and the exit from its catchment area. In other words, it is a pivotal point for the entrance and the exit of merchandise in a region, a country, a continent. The emergence of intermodal transportation systems reinforces gateways as major locations of convergence and transshipment and has modified their geography with increased locational flexibility. While major terminals have expanded and relocated to more peripheral locations, namely port facilities, many distribution centers have relocated even further away along corridors.

A hub is a central point for the collection, sorting, transshipment and distribution of goods for a particular area. This concept comes from a term used in air transport for passengers as well as freight. It describes collection and distribution through a single point such as the “Hub and Spoke” concept. A hub is thus the outcome of commercial decisions linked with a desired level of service in terms of frequency. System-wide the delays imposed by transshipments at the hub (instead of direct services) are compensated by higher frequencies of services between all points.

While a hub is a central location in a transport system with many inbound and outbound connections of the same mode, a gateway commonly imply a shift from one mode to the other (such as maritime / land). Thus gateways tend to be intermodal entities while hubs tend to perform transmodal (within a mode) operations. Transport corridors are commonly linking gateways to the inland. Gateways also tend to be most stable in time as they often have emerged at the convergence on inland transport systems while the importance of a hub can change if transport companies decide to use another hub, as common in the airline industry. The functions of centrality and intermediacy are particularly relevant to the emergence of a global nodal space since one focuses on nodes as an origin or destination of traffic while the other focuses on nodes as intermediate locations where transshipment is performed. While central locations obviously correspond to large metropolitan areas, intermediate locations have developed a rather unique geography.

The Terminal and Logistical Zones

Many gateways are linked to a specific mode, but the largest tend to have a combination of modes. Modal gateways can be classified in three categories each expressing its own nodality:

- Land gateways commonly have a simple transit function, since they are obligatory points of passage, with in some cases logistics and manufacturing activities. When a border is concerned, this involves a concentration of custom related activities, such as document preparation, inspection and clearance. For instance, the lengthy US/Canada border has several gateways imposed by the local geography (e.g. along the St. Lawrence and Great Lakes) or by the necessity to restrict entry at a few specific locations (e.g. along the Great Plains). If there are important differences in the level of economic development between both sides of the land gateway, there is often a specialization of function where one side will concentrate on manufacturing (the side where labor costs are advantageous) and the other on logistics. The Maquiladoras
Intermodal Transportation and Integrated Transport Systems

exemplify this situation along the US – Mexico border, as Shenzhen does for Hong Kong (SAR) and China.

- Air gateways are linked with important metropolitan areas with regional air or road connections. They tend to have more inland locations as they are not bound to strong transshipment constraints. Air gateways are jointly the outcome of their respective centrality or intermediacy. A significant trend in recent years has been a growing divergence between passengers and freight air gateways. Due to the flexibility of their operations, specific freight gateways and hubs have emerged.

- Maritime gateways are large terminals with high capacity inland connections (rail and road). Due to congestion and lack of space for logistical activities near maritime terminals, the emergence of satellite terminals or inland freight distribution centers appear to be a significant trend, well developed in Europe.

![Figure 5 Major US Modal Gateways, 2004](image)

Trade and physical flow imbalances are clearly reflected at major American modal gateways (Figure 5). Almost all the gateways—land, maritime and air alike—are characterized by traffic imbalances where inbound traffic far exceeds outbound traffic. This is particularly the case for maritime gateways linked with long distance international trade with Europe and more specifically Asia. The West Coast is notably revealing and is the most imbalanced both in the concentration and the direction of the traffic. Inbound traffic accounts for about 80% of all the traffic handled by ports. The ports of Los Angeles and Long Beach handled 75% of the total freight dollar value brought in through the West Coast. NAFTA land trade gateways tend to be more balanced, but still reflect a negative flow. A
similar pattern is observed for air gateways. What also characterizes North American gateways is their high level of concentration in a limited number of gateway systems; a set of modal gateways within a relatively defined region that acts as a functional system linking that region to international trade.

4. Integrated Transport Systems

From Fragmentation to Coordination

With improvements in the capacity, efficiency and reliability of freight distribution, integrated transport systems have become a leading paradigm. The conventional fragmented and sub-optimal freight transport systems have substantially been changed by intermodal transportation and the combination of several modes servicing commodity chains. The advantages of each mode and terminals, used in conjunction, create multiplying effects.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Cause</th>
<th>Consequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology</td>
<td>Containerization &amp; IT</td>
<td>Modal and intermodal innovations; Tracking shipments and managing fleets</td>
</tr>
<tr>
<td>Capital investments</td>
<td>Returns on investments</td>
<td>High costs and long amortization; Improve utilization to lessen capital costs</td>
</tr>
<tr>
<td>Alliances and M &amp; A</td>
<td>Deregulation</td>
<td>Easier contractual agreements; joint ownership</td>
</tr>
<tr>
<td>Commodity chains</td>
<td>Globalization</td>
<td>Coordination of transportation and production (integrated demand)</td>
</tr>
<tr>
<td>Networks</td>
<td>Consolidation and interconnection</td>
<td>Multiplying effect</td>
</tr>
</tbody>
</table>

Figure 6 Integrated Transport Systems: From Fragmentation to Coordination

A process of coordination of freight transport is taking place, from which substantial financial and operational benefits are derived (Figure 6). Several factors can be pondered in this development:

- **Technology.** Containerization is without any doubt the most significant technological factor behind a more efficient coordination of transport modes. Innovations from which additional capacity and efficiency are derived include modes, such as post-panamax containerships or double-stacking trains, but also intermodal equipment to handle significant transshipment demands. Hard (technical) assets require soft (management) assets. Information technologies have gone a long way to help improve the level of control over supply chains, which includes important aspects such as tracking shipments and managing fleets. The issue of e-commerce has also received attention as a technological dimension, improving freight distribution, particularly with a better interaction between suppliers and customers.
• **Capital investments.** Freight transportation is a capital intensive sector with high entry costs, particularly for the maritime and rail segments. Rail remains one of the most capital intensive of economic activities. For instance, rail has capital expenditures that accounted for about 18% of their revenue, while this share is about 4% for manufacturing (AAR, 2005). The amortization of modal and infrastructure investments, such as terminals, has to be spread over a significant time period, sometimes over more than a decade. This environment is prone to risks and many potential investors are unwilling to commit capital for infrastructure projects since potential returns are uncertain and may benefit one mode more than the other (I-95 Corridor Coalition, 2004). This is a reason why public interests are often been called to step in, either as sole investors or more often in partnership. Still, freight transport companies are dominantly private entities and must rely on capital markets to finance their ventures. If through a higher level of coordination with other elements of the supply chain a greater volume and stability in utilization can be secured, capital costs can be reduced and financial returns and risks improved. For modal operators such as railways that have vested interests on their network (monopoly or oligopoly) and high infrastructure costs, capital investments for intermodal projects is difficult to secure and remains one of the most significant issue in the development of these projects. The benefits of intermodal infrastructures in lowering capital risk need to be demonstrated.

• **Alliances and M&A.** Coordination also implies new forms of relationships between freight forwarders, such as joint ownership or more simply the potential to share modes and terminals. This was favored by a wave of deregulation of many transport modes in the early 1980s. The Aviation Deregulation Act (1979), the Staggers Act (1980), the Motor Carrier Act (1980) and the Ocean Shipping Act (1984) are among the most significant landmarks in this direction (FHWA, 2005). It became easier for different transport operators to establish contractual agreements and to price services based upon real costs. Mergers and acquisitions within the same mode started to take place, mainly in maritime and rail transportation, but also the emergence of modal and intermodal alliances. Global players managing large freight distribution systems (such as global port operators; Olivier and Slack, 2006) understand well that an integrated approach results in economies of scale and scope.

• **Commodity chains.** The emergence of a globally oriented production structure, often labeled as global commodity chains or global production networks (e.g. Coe *et al.*, 2004) requires a high level of coordination between its elements, from the supply of raw materials to the final distribution to consumers. It is thus expected that global commodity chains impose a corresponding structure of distribution where coordination between modes and different transport systems is required. Under such circumstances, it has been argued that transport demand should increasingly be considered as integrated instead of derived (Hesse and Rodrigue, 2004).
• **Networks.** Integrated transport systems rely on the respective strengths of each transport networks. Since networks are expensive to build and operate, linking them promotes efficiency and a higher level of control. This can be considered as a multiplying effect where the efficiency of the whole intermodal network is greater than the sum of its parts. The hub-and-spoke structure of airline operations, transloading where the advantages of short distance trucking are combined with long distance rail, and containerized barge shipping are particularly relevant examples of the multiplying effects of combining transport networks.

**Intermodal and Transmodal Operations**

Integrated transport systems rely on two types of operations; intermodal and transmodal (Figure 7). Intermodal transshipments have received the bulk of the attention, particularly their port and rail terminals segments, as massive investments in those facilities were required to set global commodity chains. For instance, investments were made in port terminals so that a better connectivity could be established with inland road and rail transport systems. Large maritime container yards where trucks can pick of drop containers where built as well as on-dock rail facilities offering a better access to inland rail systems. However, intramodal transshipments are comparatively uncovered, the main reason being that until recently they mainly took place within fragmented and regulated national transport systems.

![Figure 7 Intermodal and Transmodal Operations](image)

**Three Emerging Nodal Spaces Supporting Transmodal Flows**

The three main modal dimensions include:

- **Transmodal road.** Mainly takes place at distribution centers, which have become strategic elements in freight distribution systems. It is probably one of the few cases where intramodal transshipments can be combined with added value activities, such as labeling and packaging. Although distribution centers were conventionally warehousing facilities in which commodities could be
stored while waiting to be sold to customers down the supply chain, this function has substantially receded. Time constraints in freight distribution impacted on road based distribution centers, whose function is increasingly related to transmodal operations and much less to warehousing. The true time-dependent intramodal facility remains the cross-docking distribution center (Gue, 2001; Gumus and Bookbinder, 2004).

- **Transmodal maritime.** Ship-to-ship transshipments mainly concerns off-shore hubs such as in the Caribbean, the Mediterranean or ship-to-barge activities. Although in many cases the containers are actually unloaded onto a temporary storage facility (commonly next to the piers), an off-shore hub is functionally a transmodal facility. They have emerged at intermediary locations by offering transshipment advantages in view of costs related to pendulum multiport services coupled with lower container handling cost related to transshipment-only terminals, in addition to economies of scale for feeder ships (Baird, 2002).

- **Transmodal rail.** Probably represents one of the least investigated segments of transmodal transportation. Most rail systems were built to service specific markets and were heavily regulated. It is only recently that containerization created the need for transmodal functions in rail transport systems, since rail transportation was “forced” to address a new variety of movements, many of them with international origins or destinations. Initially, rail developed greater intermodal efficiencies with maritime and road transport systems, particularly because this represented new market opportunities. The next step places a greater emphasis on developing transmodal efficiencies within the rail system itself, notably with a Thruport. This opportunity is not without challenges inherent to rail transportation, namely the spatial fixity of its infrastructures.

5. **Transmodal Transportation**

*Cross-Docking Distribution Center*

Cross-docking favors the timely distribution of freight and a better synchronization with the demand. It is particularly linked with the retail sector (often within large retailers), but can also be apply to manufacturing and distribution. Cross-docking is mainly dependant on trucking. Its particular advantages reside at the minimization of warehousing and economies of scale in outbound flows (from the distribution center to the customers). With cross-docking the costly inventory function of a distribution center becomes minimal, while still maintaining the value-added functions of consolidation and shipping (Figure 8). Inbound flows (from suppliers) are thus directly transferred to outbound flows (to customers) with little, if any, warehousing. Shipments typically spend less than 24 hours in the distribution center, sometimes less than an hour. In a conventional distribution system, goods are stored in a distribution center (or kept in inventory at the supplier) and wait until ordered by a customer. Under such a setting it is difficult to have shipments that are not less than truckload (LTL). With cross-docking, goods are already assigned to a customer. The distribution center receives goods from suppliers, sort them directly to be shipped to a...
consolidated batch (often including other orders from other suppliers) to the customers. Since there is for each supplier less shipments, most of them are full truckload (TL).

![Cross-Docking Distribution Center](image)

**Figure 8 Cross-Docking Distribution Center**

Cross-docking can be applied to a number of circumstances. For manufacturing, cross-docking can be used to consolidate inbound supplies, which can be prepared to support just-in-time assembly. For distribution, cross-docking can be used to consolidate inbound products from different suppliers which can be delivered when the last inbound shipment is received. For transportation, cross-docking involves the consolidation of shipments from several suppliers (often in LTL batches) in order to achieve economies of scale. For retail, cross-docking concerns receiving products from multiple suppliers and sorting them to outbound shipments to different stores. The world’s biggest retailer, Wal-Mart, delivers about 85% of its merchandises using a cross-docking system. The rest are direct deliveries done by large suppliers.

The UPS Willow Springs facility in Chicago (opened in 1994) is the largest land transport distribution center in the United States and the largest package sorting facility in the world. It acts as a large cross-docking facility sorting about 1.3 million parcels per day, which is roughly 10% of the UPS daily ground volume. It consolidates traffic bound for the East and the West coasts. The facility is linked to a BNSF intermodal terminal, which will handle about 40% of the traffic processed by the distribution center. Trucks can deliver inbound traffic at one of the 126 inbound doors, which is then sorted and brought to one of the 1,000 outbound loading bays. 15 minutes is all of what is required for the sorting to take place if the package is of standard size such as an envelope or a small box. About 11,000 people work at the facility. Packages bound for UPS distribution facilities located less than 400 miles away are trucked while for destinations greater than 400 miles, the trailer is likely to be loaded on a train.

*Rail Transmodal Operations: The Thruport*
A Thruport is designed to accommodate fragmented markets, supply chains and ownership, notably when this fragmentation takes place at a large scale (Figure 9):

- **Market Fragmentation.** The first rationale behind trans-modal transportation is market fragmentation, particularly for the retailing stage. Since retailing leans heavily on global production and national distribution, the system depends on gateways forwarding freight along long distance rail corridors. The gateways (ports for the most part) are limited in number and the markets are excessively diverse. This thus represents a distributional setting in which the Thruport acts as a hub where the containers are shuffled to their respective unit trains bound to specific markets. The market however needs to be large enough to justify this level of shipments. The efficiency of gateways to accommodate intermodal traffic would thus be linked with the efficiency of the Thruport. In some cases, the efficiency of ports and inland freight transportation can promote imports more than regional manufacturing, especially if the later relies on a different and less efficient distribution channel. In a situation of labor costs differences, this may create a multiplying effect making imports even more advantageous since they would offer cost as well as time benefits. On Figure 5, a Thruport can improve the efficiency of long distance distribution by acting as a location where containerized freight can be fragmented and assembled in batches (unit trains) bound for specific regional markets. In the first case, the volume is sufficient enough to simply be a matter of fragmentation. However, it is more likely that a Thruport would be the assembly and redistribution point of freight coming from several gateways.

- **Ownership Fragmentation.** Rail companies have their facilities and customers and thus have their own markets along the segments they control. Each rail system is the outcome of substantial capital investments occurring over several decades. Interchange is a major problem between segments controlled by different rail companies, particularly since many networks were built to gather market share and regional control over rail freight services. Until the last two decades, this did not present too many difficulties since transmodal operations were comparatively small. However, with a surge of transcontinental rail shipments, rail operators are bound to further address transmodal issues. In this context, the Thruport creates multiplying effects. The distribution potential of each operator is expanded since they have better access to the freight markets of their competitors, creating a situation of complementarity. An analogy can be made with network alliances that took place in the airline industry. The outcomes were increased revenue, costs reductions (shared services and facilities), a better level of service and a wider geographical coverage. Rail networks are obviously much more constrained in this process since they have a high level of spatial fixity – by far the highest of any mode. This is the reason why mergers and acquisitions is a more common expansion strategy. They have added numerous efficiencies to the rail system, notably a more centralized control and the reduction of duplicated facilities (e.g. maintenance). Only 7 Class 1 carriers remained in the United States as of 2003, down from 39 in
1980. It is unlikely that additional mergers will take place, mainly due to the size the networks have achieved (diseconomies of scale) and an oligopolistic situation that could trigger anti-monopolistic interventions from the Federal Government. A Thruport would thus appear to be the next step in this trend since ownership fragmentation will remain in North America.

![Figure 9 Thruport and Market and Ownership Fragmentation](image)

Transmodal Rail Operations in North America

Continuity within the American rail network is far from being practical as major regional markets are serviced by specific rail operators (Figure 10). Mergers have improved this continuity but a limit has been reached in the network size of most rail operators. The issue of ownership fragmentation is thus particularly important and dictates much of the locational rationale of a Thruport. Because of the geography of rail ownership, there are six major locations that appear suitable to begin the foundation of a Thruport system supporting a rail freight distribution system in North America. These locations correspond to changes in rail ownership, imposing an interface between different segments of the continental rail network. Chicago, Minneapolis / St. Paul, Kansas City, St. Louis, Memphis and Dallas / Fort Worth are particularly suitable locations since they are interface nodes in the rail system. Each Thruport is positioned to act as a gateway, collecting, sorting and redistributing the containerized freight along major rail corridors.
Offshore Hubs: A New Nodality

In a conventional pendulum container service, a maritime facade could involve several port calls. If the volume is not sufficient, this may impose additional costs for maritime companies that are facing the dilemma between market coverage and operational efficiency. By using an offshore hub terminal in conjunction with short sea shipping services, it is possible to reduce the number of port calls and increase the throughput of the port calls left. Offshore terminals can thus become effective competitive tools since the frequency and possibly the timeliness of services can be improved. While in theory offshore hubs do not have an hinterland, but a significant foreland, the impact of feedering (mainly be short sea shipping) confers them a significant indirect hinterland. Feedering combines short sea and deep sea containerized shipping at a hub where traffic is redistributed. The usage of larger containerships has lead to the concentration of traffic at terminals able to accommodate them in terms of draft and transshipment capacity. Smaller ports, particularly those well connected to inland transport systems, become feeders through the use of short sea shipping. Offshore hubs particularly owe their emergence to the following factors:

- **Location.** Offshore hubs have emerged on island locations or on locations without a significant local hinterland to fulfill a role of intermediacy within
global maritime networks. They are close to points of convergence of maritime shipping routes where traffic bound to different routes can be transloaded. Offshore hubs tend to be located nearby major bottlenecks in global maritime networks ( Strait of Malacca, Mediterranean or the Caribbean) as they take advantage of the convergence effect.

- **Depth.** Offshore terminals tend to have greater depth since they were built recently in view to accommodate modern containership drafts, placing them at a technical advantage over many older ports. Their selection often involves a long term consideration of growing containership drafts and the future capacity, in terms of transshipment and warehousing, of the hub to accommodate such growth.

- **Land availability.** The sites of offshore terminals tend to be less crowded and outside the traditional coastal areas that have see a large accumulation of economic activities. They often have land for future expansion, which is a positive factor to help securing existing and future traffic.

- **Labor costs.** Labor costs tend to be lower, since offshore terminals are located at the periphery and they tend to have less labor regulations (e.g. unions), particularly if it concerns a new terminal facility.

- **Hinterland access.** Limited inland investments are required since most of the cargo is transshipped from ship to ship with a temporary warehousing on the port facilities. The footprint offshore terminals have on the local or regional transport system is thus limited. In addition, the port operator does not have to wait for local/regional transport agencies to provide better accessibility to the terminal, which is often a source of conflict between the port and the city/region.

- **Ownership.** Most terminals are owned, in whole or in part, by port holdings or carriers which are efficiently using these facilities and are free to decide future developments or reconfigurations. Offshore terminals are avoiding a legacy of governance structure controlled by port authorities. They thus tend to be responsive and adaptable to market changes.

In an initial phase offshore terminals solely focus on accommodating transshipment flows and many have a transshipment share exceeding 80% of their container volume. As the transshipment business remains highly volatile, offshore hubs can eventually develop services that add value to the cargo instead of simply moving containers between vessels. This strategy could trigger the creation of logistics zones within or in the vicinity of the port area, in many cases implemented as Free Trade Zone. This potential capture of added value could change port competition.
The world’s leading offshore hub is the port of Singapore, where about 91% of its 19.1 million TEU volume was transshipped in 2004 (Figure 11). Its large volume is mainly attributable to its strategic location at the outlet of the Strait of Malacca, the world’s most heavily used shipping route that transits about 30% of the world trade. Other major offshore hubs are Freeport (Bahamas), Salalah (Oman), Tanjung Pelepas (Malaysia) or Gioia Tauro (Italy), Algeciras (Spain), Malta, Taranto (Italy) and Cagliari (Italy).

6. **Global Port Operators: Using Nodes to Control Global Flows**

   **A Change in Emphasis**

   From a strategic perspective, the recent years have seen a gradual but significant shift in emphasis about what constitutes control and the generation of wealth it entails. The conventional perspective can be derived from a long standing view where military and commercial interests are interrelated, namely through colonial empires and geopolitical alliances such as those that prevailed until the end of the Cold War. Controlling strategic maritime routes is a very expensive endeavor in terms of military deployment. The emerging perspective relies more on accessibility to global markets through carefully selected locations that handle flows. It is based on the identification and capture of commercial opportunities.

   A significant trend in container port operations has been the increase of the role of private operators where major port holdings have emerged with the purpose to manage a wide array of terminals, the great majority of which are containerized. Such a strategy aims at controlling terminals and the major gateways of the global economy. This mainly entails the setting of alliances with maritime and inland freight forwarders as well as investing in the development and expansion of terminals at strategic locations, particularly through
leasing agreements. Wealth is derived from the added value that is extracted from global flows with the emergence of a “nodal strategy” where stake holding is based on locations along major commodity chains.

**Horizontal Integration**

As of 2005, global port operators accounted for over 58% of container port capacity and 67% of global containerized throughput. An horizontal integration structure is being set up as port holdings acquire the management of transport terminals in a wide array or markets. The main rationale behind the emergence of large port holdings includes:

- **Financial assets.** Port holdings have the financial means to invest in infrastructures as they have a wide variety of assets and the capacity to borrow large quantities of capital. They can use the profits generated by their efficient terminals to invest and subsidize the development of new ones, thus expanding their asset base and their operating revenues. Most are listed on equity markets, giving the opportunity to access global capital, which realized in the last decade that the freight transport sector was a good source of returns driven by the fundamentals of a growth in international shipments. This financial advantage cannot be matched by port authorities even those heavily subsidized by public funds.

- **Managerial expertise.** Port holdings excel in establishing procedures to handle complex tasks such the loading and unloading sequence of containerships and all the intricacies of port operations. Many have accumulated substantial experience in the management of containerized operations in a wide array of settings. Being private entities, they tend to have better customer service and have much flexibility to meet the needs of their clients. This also includes the use of well developed information systems networks and the capacity to quickly comply with legal procedures related to customs, clearance and security.

- **Gateway access.** From a geographical standpoint, most port holdings follow a strategy aimed at establishing privileged positions to access hinterlands. Doing so they secure a market share and can guarantee a level of port and often inland transport service to their customers. It can also be seen as a port competition strategy where a “stronghold” is established, limiting the presence of other competitors. Gateway access thus provides a more stable flow of containerized shipments. The acquisition of a new port terminal is often accompanied by the development of related inland logistics activities by companies related to the port holding.

- **Leverage.** A port holding is able to negotiate with maritime shippers and inland freight transport companies favorable conditions, namely rates, access and level of service. Some are subsidiaries of global maritime shippers (such as the A.P. Moller group controlled by the shipper Maersk) so they can offer a complete logistical solution to international freight transportation. They are also better placed to mitigate pressures from port authorities to increase rents and port
fees. The “footloose” character of maritime shippers has for long been recognized, with a balance of power more in their favor than of the port authorities they negotiate with.

- **Global perspective.** Port holdings have a comprehensive view of the state of the industry and are able to interpret political and price signals to their advantage. They are thus in position to influence the direction of the industry and anticipate developments and opportunities. Under such circumstances they can allocate new investments (or divest) to take advantages of new growth opportunities and new markets.

A concentration of ownership among five major port holdings is observed; APM Terminals (controlled by the Danish maritime shipper Maersk), Dubai Ports World, Hutchison Port Holdings (Hong Kong), Peninsular & Oriental Ports (P&O; United Kingdom) and the Port of Singapore Authority (PSA) (Figure 12). Several other port holdings exist, owned by specialized private companies or ocean carriers, but their focus is mostly regional. In 2006 Dubai Ports World acquired P&O further consolidating its global holdings. The outcome will be a landscape of four major container terminal operators, each managing about 40 port terminals.

7. **Conclusion: Emergence of a Global Nodal Space**
Within the framework of the global economy, a structured global nodal space is emerging with a reliance on integrated freight transport systems. In such a system, logistical nodes act either as central or intermediate locations. Depending on geographical conditions, those locations take the form of gateways if they perform intermodal operations or hubs if they perform transmodal operations. Many obviously do both. The logistical node is an essential element supporting the geographical and functional integration brought by the emergence of global production networks. Geographical integration has led to the extension and more complex supply chains while functional integration has favored a high level of control and synchronization of flows along supply chains. The logistical node thus effectively captures and adds value within global supply chains, but is also facing intensive competition with other nodes when they service similar markets and even within nodes when several terminal operators and freight forwarders are present. There are thus many challenges and opportunities for the logistical node. Among the most notable are:

- Congestion is a conventional problem faced by many transport modes and terminals. In addition to the usual responses based on providing additional capacity, there has been an array of nodal strategies to cope with congestion. For maritime transportation, this involved the setting of offshore hubs redirecting transshipment flows to new and much less constrained locations. A better access to the market areas of terminals is also looked after, particularly since this area is the object of competition between several terminals to capture flows. Port regionalization has been a strategy used in many cases to deal with congestion by going inland through high priority freight corridors using less congested modes such as rail and barges.

- Since supply chains are closely integrated entities, freight transportation systems are increasingly reflecting this reality. The challenge remains about improving intermodal as well as transmodal movements. While the intermodal issue received a lot of attention, transmodal imperatives have somewhat been neglected in spite of their strategic importance. Although several aspects of this integration can be considered as capital investment issues, others require a higher level of modal collaboration. In many ways, globalization has forced many transport providers to adopt a wider perspective that goes beyond the freight distribution segments they control.

- The increase in energy prices, particularly petroleum, appears to be a long term trend that will significantly impact transport systems. In view of additional frictions in logistics, a new modal balance is likely to be achieved where each mode will be used in it most cost effective way while abiding to time constraints of contemporary freight distribution.

- Last and not least, the global economy and its arbitrage in terms of labor costs, has led to acute trade imbalances that transport systems have to cope with. International trade flows currently reflect significant disequilibrium in the global geography of production and consumption. In such a context, many logistical nodes will be hard pressed to cope with traffic imbalances while capturing and adding value to the flows they handle.
References


