TECHNICAL REPORT – STUDY / SERVICES

SUPPLY CHAIN ANALYSIS

Submitted to:

SPAWAR Systems Center San Diego
53560 Hull Street, Code 2206
San Diego, California 92152-5001

Attention:
Mr. Mark Tukeman, Code 2712
(619) 553-1510

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based on the High Speed Ship/Agile Port Concept

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Prepared and Submitted by:
Center for the Commercial Deployment of Transportation Technologies
California State University, Long Beach Foundation
6300 State University Drive, Suite 220 • Long Beach, CA 90815 • 562.985.7394

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Operational, Economic and Financial Evaluation of a Logistics Solution Based on the High-Speed Ship/Agile Port Concept

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Supply Chain Analysis

Prepared by:

Manalytics International
301 Howard Street, Suite 1320
San Francisco, CA 94105

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Executive Summary

This segment of the evaluation of the High-Speed Ship/Agile Port (HSS/AP) concept builds on earlier analyses of the market, deployment and infrastructure of the HSS/AP system. It looks at the broad supply chain for the transpacific trade and present estimates of so-called extended supply chain impacts. First-order estimates of the impact of HSS/AP, derived in previous studies in this series, were based on the assumption that all aspects of the logistics network would stay the same after the introduction of HSS/AP. The present study relaxes that assumption and distinguishes between first-order and extended impacts. Impacts examined include:

- Relocation or reallocation of production and distribution to locations in closer proximity to the HSS/AP deployment
- Further segmentation of cargo by value and other key logistics characteristics, such as perishability, to take advantage of HSS/AP benefits
- Further speed advantages of HSS/AP due to superior terminal efficiency
- New commodities entering the trade
- Intermediaries influencing a further shift of volume to HSS/AP service by substituting it for air service

Although the cumulative effect of these extended supply chain effects is difficult to judge, it seems reasonable to conclude, based on the estimated impacts and our experience in similar supply chain reengineering efforts for shippers, that HSS/AP volume would increase by at least 20 percent beyond the estimated volume for the base case. This increase in demand would enable the operators of the HSS/AP system to increase profitability, either through increasing volume at the same price premium or by holding volume constant and increasing price.

Background and Objectives

Manalytics developed a supply chain analysis for evaluation of the High Speed Ship/Agile Port (HSS/AP) concept. This analysis builds on recent work on infrastructure analysis, and on logistics and operations simulation of HSS/AP. This earlier work developed several scenarios of real-world implementation of an HSS/AP system as part of a major international trade lane, the transpacific. It provided estimates of the amount of cargo that could be diverted from conventional air or ocean service to HSS/AP, assuming speed/price combinations that could be achieved under realistic operating conditions and constraints.

The present study considers the broader supply chain context in which the HSS/AP system operates and considers the long-run impact, beyond immediate cargo diversion. The idea here is that as the HSS/AP system becomes established, supply chain participants -- mainly shippers and consignees, but also logistics intermediaries – might make changes in their operating structures to take further advantage of the new services. This could involve, for example:

- Changing the location of production and distribution closer to the origin and destination points of the HSS/AP vessel deployment to maximize time saved and/or to minimize transportation costs.

- Introducing new commodities into the transpacific trade.

- Entering the transpacific trade or further penetrating new or existing geographic markets within the trade.

- Shifting from slower speed conventional ocean service to improve overall supply chain performance; particularly reducing the probability of lost sales, late penalties or markdowns without having to resort to expedited air service.

Logistics intermediaries, such as freight forwarders and third party logistics companies (3PLs) may also have a significant role in the diversion of cargo to HSS/AP. These intermediaries purchase transportation on behalf of their shipper/consignee clients, often with significant discretion on the choice of transport mode and carrier. The existence of a new transpacific service such as HSS/AP that is midway between ocean and air in terms of speed and price provides intermediaries with additional options to meet their customer requirements for delivery reliability with new opportunities for more profitable pricing of their services.

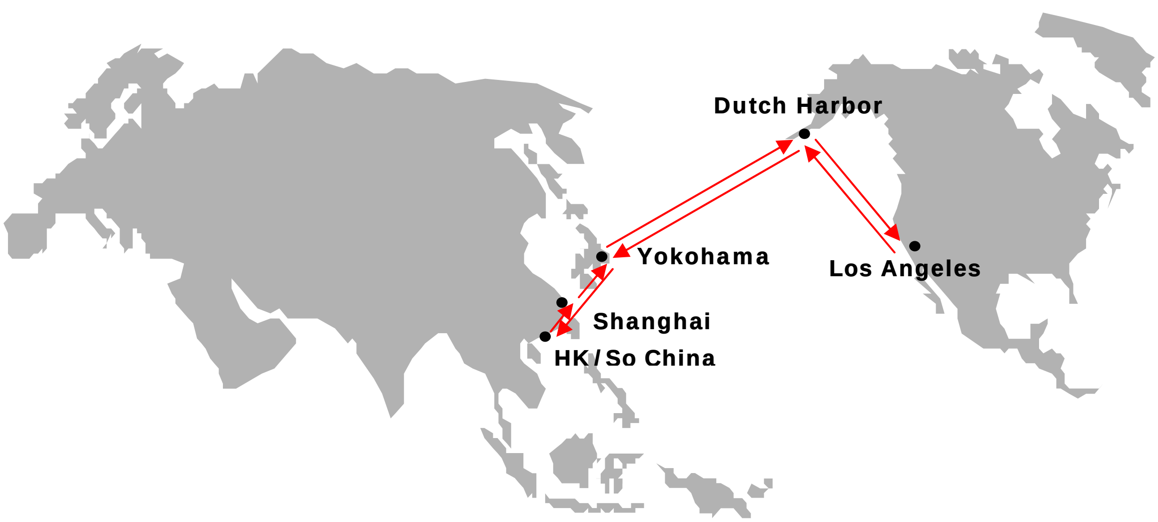
These impacts were explored in an earlier study and summarized in a report entitled "Analysis of the Impact of HSS/AP on Commercial Supply Chains in the Transpacific Trade" (December 2001). In that study, in - depth interviews were conducted with 30 representative shippers and consignees to identify the various types and magnitude of long run supply chain impacts and the rationale for each. However, this analysis was conducted based on an "unconstrained" version of HSS/AP service; i.e., with the service equally available to all origins and destinations in the transpacific trade. The present study utilizes follow – up interviews with shippers and consignees, new interviews with logistics intermediaries, and a specific deployment for HSS/AP (port rotation, frequency, capacity, speed of vessels and port operations) to develop realistic, constrained supply chain impacts.

Base Case High-Speed Ship/Agile Port Deployment and Infrastructure

Structure of the Base Case Deployment and Rationale

The base case transpacific deployment for HSS/AP involves a three – times weekly service with one port of call on the West Coast of the US, three ports in Asia and a refueling stop. The frequency of service is the minimum required for competitive service in the transpacific trade, particularly in the higher-value segments where the HSS/AP system would focus its marketing efforts. The port rotation, illustrated in the map below, is Los Angeles – Dutch Harbor, Alaska (refueling stop) – Yokohama – Hong Kong – Shanghai – Yokohama – Dutch Harbor – Los Angeles. There are seven HSS vessels in the rotation, with an average service speed of 50 knots and vessel capacity of 1700 TEUs. Average utilization in the Eastbound head haul direction averages about 90 percent.

LA – DH – YK – HK – SHG – YK – DH - LA



Other Pacific Rim ports are covered via daily feedership service to/from the linehaul ports. All US inland points are covered via rail or truck service to/from Los Angeles. The HSS vessels also carry Intra-Asia cargo moving between the Asia linehaul ports.

The concentration of the deployment on China reflects the growing concentration of manufacturing and transpacific supply chains through Chinese port gateways, particularly the Pearl River Delta in South China and the Yangtze River through Shanghai. China accounted for approximately 67 percent of Eastbound transpacific containerized cargo in 2002 and this share is projected to increase to 75 percent by 2006. Japan, despite a much smaller and declining share, is the source of a relatively high percentage of products that would benefit from HSS/AP service. In addition, Japan is the main destination for Westbound transpacific cargo that would be HSS/AP-eligible.

On the North America side, the Pacific Southwest (PSW) gateway is by far the largest, accounting for about 65 percent of Eastbound transpacific cargo and a relatively high share of the HSS/AP-eligible cargo. In addition, the PSW handles most of cargo that is move to inland points via rail intermodal thru-service or transloaded from containers to higher-cube highway trailers for inland distribution. The impact of transloading on the potential use of HSS/AP service is discussed in a later section of this report.

It should also be noted that the capacity and scope of the HSS/AP deployment is limited by such factors as the requirement of three-times weekly frequency; the tradeoffs of range, capacity and fuel consumption for potential HSS vessels; refueling requirements; and the geographic distribution of cargo that might be diverted to HSS/AP service. The proposed deployment, frequency, vessel speed and capacity, and price of service were driven by the objective of maximizing expected profit. Tests of significant changes in any of these variables in either direction (e.g., additional ports of call, slower vessel speed, higher prices, etc.) led to reductions in estimated profit.

Speed Advantages of the HSS/AP Deployment

The deployment offers several dramatic speed advantages over conventional transpacific service. Transpacific transit times for the HSS/AP service are typically less than half that of even the best time for conventional containership service, as shown in Table 1, below.

Table 1
Comparison of Transpacific Transit Times for Selected Port Pairs: High-Speed Ship Vessels versus Theoretical Best* Time for Conventional Containership Vessels

Origin Port	Destination Port	HSS Transit Time	Conventional Service Transit Time	Days Saved with HSS Service
Los Angeles	Yokohama	4.8 days	10.3 days	5.5 days
Los Angeles	Hong Kong	6.5 days	13.3 days	6.8 days
Los Angeles	Shanghai	7.9 days	12.8 days	4.9 days
Yokohama	Hong Kong	1.2 days	2.8 days	1.6 days
Hong Kong	Yokohama	2.3 days	2.8 days	0.5 days
Shanghai	Yokohama	1.0 days	2.3 days	1.3 days
Hong Kong	Los Angeles	7.9 days	13.3 days	5.4 days
Shanghai	Los Angeles	6.5 days	12.8 days	6.3 days
Yokohama	Los Angeles	5.4 days	10.3 days	4.9 days

**Derived by dividing the distance between ports, in nautical miles by average service speed of 22 knots and converting to days.*
Source: Transpacific carrier schedules, Manalytics analysis

The HSS/AP service also results in dramatically reduced time in port versus conventional containership service. The capacity of the HSS vessel, at 1,700 TEUs is only a fraction of the capacity of conventional transpacific linehaul containerships, which average 4,000-6,000 TEUs. For example, in Los Angeles, with both types of ship using gantry crane lift-on/lift-off operations, it may require about 18-20 hours to fully discharge a HSS vessel, versus 40-60 hours for a conventional containership. As a result, the “median” container on the HSS vessel waits 9-10 hours to be discharged while for the conventional containership the average wait is 20-30 hours. Note that for shipments of multiple containers for a single consignee (a frequent occurrence in the transpacific trade), the relevant container is typically the last of that consignee’s containers discharged from the ship. In these cases, unless the consignee has been given preferential stowage on-board the ship, the time saving from the smaller HSS vessel is even greater than in the case of single-container shipments.

Additional saving of time in port is possible if the HSS vessel utilizes high-speed load/discharge technology, such as the stern ramp cassette-based loading and discharge system proposed for FastShip Atlantic. In this case, total time for a full discharge of the HSS vessel could be further reduced to approximately 10-12 hours.

Finally, for that portion of the inbound US cargo that is moving on to interior points via the rail intermodal system, there is an additional potential time saving. Under either a conventional lift on/lift off terminal operating scenario or the cassette-based load/discharge technology, terminal processes would be modified to facilitate expedited movement of the HSS cargo through the terminal and exchange with inland transport modes. This includes on-dock transfer to rail for inland thru-service.

Time saving due to HSS/AP service is significantly diminished for origin or destination ports that are not on the port rotation for the HSS deployment. These outlying ports must be served via slower conventional feedership service and there will tend to be further delays involved in the transfer of cargo to/from conventional to HSS service.

First-Order Impacts of the Base Case HSS/AP Deployment on the Transpacific Supply Chain

With the deployment and infrastructure outlined above, along with assumptions about vessel operating characteristics (e.g., fuel consumption) and costs, it is estimated that the HSS/AP system could operate profitably at an average service speed of 50 knots and a price premium of 50 percent over conventional ocean container freight. The estimates of the volume/revenue side of the profit equation are based on:

- Containerized commodity flows in the transpacific trade by country of origin and destination
- An in-depth survey of buying behavior by transpacific shippers and consignees
- An econometric model, which indicates how shippers and consignees trade off key logistics variables in making modal decisions
- This leads to the development of initial, or first-order impacts of the introduction of the HSS/AP system into the transpacific trade. These impacts consider only the ocean transportation portion of the transpacific supply chain.

Econometric Model of Cargo Diversion to HSS/AP

Manalytics developed a cross-sectional econometric model to estimate diversion from ocean and air to HSS/AP service for varying HSS/AP service speeds and price premiums. The model was estimated based on survey data from over 200 transpacific shippers and consignees, identified by commodities shipped, volumes, and origins and destinations. Each of the survey respondents was asked how much cargo they would divert from conventional to HSS/AP service under a number of scenarios (between three and ten per respondent) with respect to the speed and reliability of the HSS vessel and the ocean freight rate relative to conventional service. The responses to these scenarios, combined with the characteristics of the shipper/consignee, form the cross-sectional database for the econometric model.

These survey results, both in their discrete form and summarized in the econometric model, provide an important indicator of how transpacific shippers and consignees trade off service and price in making transportation modal decisions, and how this differs by other logistics characteristics such as the value of the merchandise.

The estimated equation for the econometric model is:

$$\ln(\text{Proportion Diverted} + 1) = -0.22163 + 0.176 * \ln(\text{Days Saved}) - 0.395 * \ln(1 + \text{Price Increase}) + 0.06446 * \ln(\text{Value per Ton})$$

where:

ln – represents the natural logarithm of the quantity in parentheses

Proportion Diverted – represents the proportion of a company's transpacific cargo that would be diverted from conventional ocean service to HSS/AP service.

Days Saved – represents the average number of days of ocean sailing time in conventional service minus days of sailing time in HSS/AP service. This was derived using the nautical mile distances between major transpacific origin and destination points, and assuming an average service speed of 20 knots for conventional service and speeds of 40, 50 and 60 knots for HSS/AP service.

Price Increase – represents the price premium charged by the HSS/AP service over the conventional service, expressed as a proportion of the conventional service price. Price premiums examined were 0.25, 0.50 and 1.00.

Value per Ton – represents the average value (in thousands of dollars per metric ton) of the commodity shipped. This value is an FOB – origin figure and is not representative of the retail price of the commodity.

The equation is expressed in logarithms and the coefficients represent elasticities – the percentage change in Y, the dependent variable, with respect to the percentage change in any independent variable, X. As shown by the coefficients in the equation presented above, the likelihood of diversion to HSS/AP service is most sensitive to the relative price of the HSS/AP service followed by days saved, a proxy for the speed of the HSS vessel, and differences in commodity value. Reliability of the HSS/AP service relative to conventional service was also tested as a variable in the analysis, but the estimated effect was not statistically significant.

Implications of the Model for Logistics Tradeoffs

As noted earlier, the estimated coefficients quantify the tradeoffs made between service and price when making transportation modal choice decisions. For example, according to the parameters of the model, if average commodity value is $10,000 per metric ton, time saved in ocean transit using HSS/AP instead of conventional service is 6 days, and the price premium for HSS ocean freight is 50 percent, then the estimated percentage diverted to HSS/AP is about 8.6%. Table 2 presents combinations of days saved (vessel speed) and price premium that would yield the same estimated diversion of 8.6%.

Table 2
Combinations of Days Saved and HSS Price Premium That Would Yield the Same Estimated Diversion

Days Saved	HSS Price Premium
8	70
7	61
6	50
5	38
4	25
3	10

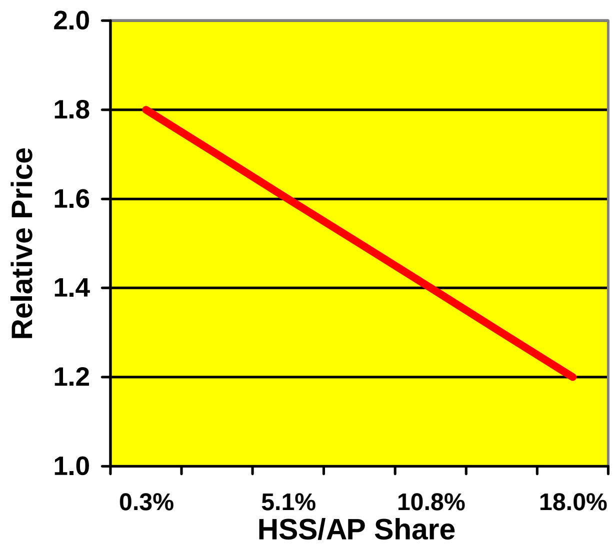
As shown, if the days saved are increased from 6 to 7, the price premium for HSS/AP service can be increased from 50% to 61%

while maintaining the same percentage diversion. Similarly, if days saved were reduced from 6 to 5, the price premium would have to be lowered to 38% to maintain the same percentage diversion. As noted earlier, the combinations presented in Table 2 represent tradeoffs between service and price made by shippers and consignees.

The econometric model also indicates the effect of commodity value on the percentage diverted. For example, using the same assumptions as above on days saved and price premium, if the average commodity value increases from $10,000/MT to $20,000/MT, the estimated diversion percentage increases from 8.6% to 13.5%. This reflects the higher in-transit inventory costs per day borne by the shipper of the higher-value merchandise and the higher value placed on (or greater willingness to pay for) a given amount of days saved.

Finally, the econometric model is also a "demand curve." Based on assumptions about the average commodity value and the number of days saved, the econometric model depicts a relationship between the relative price of HSS/AP service and its share of transpacific trade. This demand curve is illustrated in Figure 1, below.

Figure 1
Demand Curve for HSS/AP Service



First-Order Estimates of Deployment-Constrained Diversion to HSS/AP Using the Econometric Model and Projected Transpacific Trade Flows for 2006

The econometric model, or demand curve, was applied to each of the approximately 300 commodity and geographic (origin-destination) segments of the transpacific market to develop segment-specific and market-wide estimates of diversion to HSS/AP. Transpacific freight flows for the year 2000 were used as a base and commodity- and geographic-specific projections were made to 2006, the assumed first year of operation of the HSS/AP system.

In addition, it should be emphasized that the diversion estimates are deployment-constrained; i.e., for any geographic segment, the estimate of Days Saved, a critical variable in the analysis, depends on the proximity of the origin port and destination port of the cargo to the port rotation of the HSS/AP deployment. Thus, for example, cargo moving from South China to Los Angeles would receive full credit for Days Saved. By contrast, cargo moving from, say, Singapore to Seattle (both more than 1000 miles from the HSS/AP port rotation) would be heavily penalized in terms of Days Saved.

Note that the diversion estimates derived from this model apply only to the ocean speed advantage of the HSS/AP system. Improvements in speed and diversion potential due to faster load/discharge are only reflected in the estimates of overall ocean round-trip speed of the HSS vessels. The speed advantages to consignees due to faster discharge from the vessel and faster transfer from vessel to inland transport mode are not included. The diversion estimates are therefore “first-order” in two respects:

- The speed advantage to the shipper or consignee is limited to the faster speed of the vessel and does not include the advantages of faster load or discharge speed at port or faster transfer from ocean to overland transport modes.

- The diversion estimates assume that shippers and consignees make no change to their networks of cargo flows (shipment size, origin-destination flows) as a result of the presence of the HSS/AP system in the transpacific.

These assumptions are relaxed in subsequent sections of this report.

Using projected containerized transpacific cargo volumes for 2006, the estimated start year for HSS/AP service, at the 50 percent price premium, it is estimated that first-order diversion from conventional ocean service to HSS/AP service would be approximately 300,000 TEUs per year of Eastbound transpacific cargo. An additional 20,000 TEUs would divert from Eastbound Transpacific air service. The Eastbound market is the "head haul" lane for the HSS/AP service, accounting for about 82 percent of all first-order diverted cargo. For the Westbound transpacific backhaul lane, an additional 40,000 TEUs per year would divert along with 15,000 TEUs per year from the Intra-Asia market. It should be noted that estimated diversions for Intra-Asia cargo are limited to cargo moving between international port pairs on the vessel rotation of the deployment (i.e., Yokohama – Hong Kong; Hong Kong – Yokohama; and Shanghai – Yokohama).

A summary of estimated first-order cargo diversion by trade lane and by mode is presented in Table 3.

Table 3
Estimated First-Order Diversions* in 2006 from Ocean and Air to HSS/AP Service for Eastbound, Westbound Transpacific and Intra-Asia Markets in the Base Case Deployment

Market	Diversion from Ocean	Diversion from Air	Total Diversion
Eastbound Transpacific	232,500 TEU	23,500 TEU	256,000 TEU
Westbound Transpacific	25,700 TEU	21,400 TEU	47,100 TEU
Intra-Asia	110,100 TEU	8,900 TEU	119,000 TEU
Total	368,300 TEU	53,800 TEU	422,100 TEU

**Diversion estimates based on cargo flows for the year 2000, projected to 2006*
Source: US Census; Journal of Commerce PIERS data; DRI/WEFA; Manalytics econometric diversion model

Within the transpacific market, the origin/destination countries in Asia closest to the port rotation of the HSS/AP deployment account for most of the diverted cargo. Indeed, the port rotation was designed to maximize the amount of diverted cargo that would have direct service. Table 4 presents the percentage distribution of estimated diversions by Asia country/region of origin or destination.

Table 4
Percentage Distribution of Estimated First-Order Diversions from Ocean and Air to HSS/AP Service in 2006 for Transpacific Markets by Asian Country in the Base Case Deployment

Market/Country	Percentage Diversion
Eastbound Transpacific	
China/Hong Kong	51%
Japan	20
Taiwan	11
Korea	6
Philippines	2
Malaysia	2
Thailand	2
Other	6
	100%
Westbound Transpacific	
Japan	35%
China/Hong Kong	24
Taiwan	17
Philippines	6
Singapore	6
Korea	6
Other	6
	100%

Source: US Census; Journal of Commerce PIERS data; DRI/WEFA; Manalytics econometric diversion model.

The main commodity groups that would be diverted are concentrated in the relatively high-value, perishable segments, where “perishable” refers to certain food and related products, fashion goods, and commodities subject to a high rate of technological obsolescence. The percentage distribution of estimated diversion by commodity is summarized in Table 5.

Table 5
Percentage Distribution of Estimated First-Order Diversions from Ocean and Air to HSS/AP Service in 2006 for Transpacific Markets by Commodity in the Base Case Deployment

Market/Commodity	Percentage Diversion
Eastbound Transpacific	
Non-Electrical Machinery & Parts	24%
Electrical Machinery, Equipment & Parts	21
Apparel, Accessories, Textiles	13
Toys & Sporting Equipment	9
Footwear & Related Products	7
Vehicle Parts	6
Optic/Photo/ Med. Instruments	3
Furniture & Parts	3
Other	14
	100%
Westbound Transpacific	
Non-Electrical Machinery & Parts	29%
Electrical Machinery, Equipment & Parts	17
Tobacco and Tobacco Substitutes	12
Vehicle Parts	8
Optical, Photo, Medical, etc. Instruments	4
Toys & Sporting Equipment	3
Chemicals & Related Products	3
Other	24
	100%

Source: US Census; Journal of Commerce PIERS data; DRI/WEFA; Manalytics econometric diversion model.

As shown, for the Eastbound head haul market, the top divertible commodities are concentrated in the fashion and technology area. These products tend to be relatively high-value and either time-critical producer goods or fashion-sensitive retail consumer goods.

As noted earlier, these diversion estimates represent first-order effects; i.e., the estimates assume that the structure of all of the underlying supply chains -- the production and distribution locations and commodity flows for all shippers and consignees – remain constant. These projected diversions to HSS/AP are simply the result of shippers and consignees with particular logistics characteristics (e.g., relatively high-value or perishable commodities) determining that HSS/AP service offers a combination of price, speed and reliability that is superior to what they are getting with existing ocean or air service. "Superior" in this case means the lowest total logistics cost, the sum of transportation and other logistics costs.

A more comprehensive supply chain analysis has to look beyond first-order effects, however. The next step is to ask: suppose the supply chain structure was not held constant -- what if shippers and consignees were operating on a longer-term time horizon, where production and distribution locations were allowed to vary? This would have the effect of shifting the demand curve (Figure 1, above) outward, so that:

- A higher price can be charged for a given volume of cargo moving in HSS/AP service,
- At the same price, more cargo would divert to HSS/AP service
- Some combination of the two

Factors that could lead to a shift in the demand curve are explored in the following section of this report.

Extended Impacts of HSS/AP Service on the Structure of the Transpacific Supply Chain

As shippers and consignees and intermediaries are given more time to take into account and adjust to the speed/price advantages of the HSS/AP service, there will likely be changes in the structure of the supply chain, with greater potential cargo available for the service. This would allow the HSS/AP service to improve its profitability through an increase in its capacity and/or increase in price. This section examines various types of extended supply chain impacts, including relocation of production and distribution, increased cargo segmentation, response to improved terminal throughput speed of HSS/AP, integration of HSS/AP service into the modal mix of logistics intermediaries, introduction of new products into the trade, and further use of HSS/AP to enhance overall supply chain performance, particularly at the level of retail sales.

It should be noted that these extensions beyond first-order impacts are by no means mutually exclusive. Order-of-magnitude estimates are presented of the separate and cumulative effects of these extensions on annual HSS/AP volume potential for the year 2006.

Impact of Shifts in Production and Distribution Locations

Although the deployment for the HSS/AP service was designed to maximize the first-order diversions, there remains a large potential cargo volume with origin and/or destination that are not situated close to the port rotation of the HSS vessels. As noted earlier, the deployment of the HSS vessels is limited to three ports in Asia and one port on the U.S. West Coast, and it is not likely that the geographic scope of this deployment will be extended. Therefore, conventional service would have to be used to feed "off-line" cargo to or from ports on the regular rotation of the HSS/AP deployment.

The use of the slower conventional feeder service plus the time taken to coordinate with the HSS vessel schedule and transship to or from the HSS vessels significantly reduces the potential for off-line cargo to benefit from HSS/AP service. Therefore, there is a potential gain for shippers and consignees to relocate production or distribution to be in line with the port rotation of the HSS/AP deployment.

Relocation or Reallocation of Production within Asia
Changes in the location of production, in response to opportunities to gain an advantage in cost, product quality or service, occur continuously in the global marketplace, particularly for industries and commodities that have relatively low setup costs for production and where there are low barriers to market entry or exit. The transpacific market has several high-volume commodity segments, where exporting or importing firms frequently change location in response to cost or other advantages. The most prominent of these commodity segments include:

- Textiles and Apparel
- Footwear and Related Products
- Toys and Sporting Equipment
- Furniture and Related Products

These are all high-potential HSS commodity segments and are all moving in the Eastbound or head haul direction of the transpacific trade. As shown in Table 4, above, within the constraints of the baseline HSS/AP deployment, these segments together account for about 32 percent of the first-order estimate of Eastbound transpacific cargo that would be diverted to HSS/AP.   Other smaller segments where production could be relatively easily relocated amount to an additional 5 percent of Eastbound divertible cargo.

It should be noted that in a growing market such as the transpacific, it is not necessary for all production to physically relocate to take advantage of the HSS/AP service. Many growing companies are manufacturing the same or similar products in several countries. If these companies already have a significant portion of their production in close proximity to the HSS/AP port rotation, they may allocate all of the growth in their production to these areas. Other considerations such as economies of scale may also induce companies to concentrate more of their production near the HSS/AP port rotation.

The amount of additional divertible cargo due to reallocation of production can be estimated by examining unconstrained estimates – volumes that would be diverted with direct HSS/AP service available to all ports in the transpacific; i.e., without the need for transshipments to or from HSS/AP service. Unconstrained projections to 2006 indicate that the volume of cargo from commodity segments that could be easily relocated and would divert to HSS/AP amounts to approximately 117,000 TEUs per year. Of this amount, about 78,000 TEUs would already be moving from China and Japan, which have ports on the baseline HSS/AP deployment, and it is assumed that all of this cargo would divert to HSS/AP.

The remaining 39,000 TEUs are from other Asian countries, which are not located on the baseline deployment. Because of the need for conventional feeder service and transshipment to the HSS/AP ports (and the resulting reductions in days saved versus direct service), first-order, deployment-constrained estimates indicate that only about 18,000 TEUs per year would be diverted from the off-line countries, with the remaining 21,000 TEUs continuing to be shipped via conventional service for the entire transpacific voyage.

Interviews were conducted with Transpacific shippers representing segments that could be readily relocated, and these shippers indicated that they would be willing to relocate at least some of their production (or reallocate growth in production) from off-line countries in response to the potential to take time out of their order cycles. For example, an importer of apparel may have earlier relocated production from Taiwan or Korea to Bangladesh, trading off order cycle time for lower cost. For this importer, the introduction of the baseline HSS/AP deployment offers the potential to relocate to, say, China, thereby achieving significant reduction in order cycle time. Similarly, a furniture importer may accelerate the shift of production to China that was already underway and concentrate production of relatively high-value, time-sensitive items in close proximity to the HSS/AP ports.

Despite the new incentives, it is not likely that all or even most of the production of these commodities in off-line countries would shift to take advantage of the HSS/AP deployment. For some companies, the benefits of reduced order cycle time would be outweighed by increases in production cost and/or a potential reduction in product quality. For others, even if there are net benefits, considerations of business risk would prevent them from concentrating all of their production in one country, in this case, China.

The estimated impact of relocation or reallocation of production from off-line areas to locations in close proximity to the HSS/AP deployment is an additional 5,000 to 10,000 TEUs per year in Eastbound transpacific volume, or about 24 to 48 percent of the 21,000 TEUs per year that would otherwise move in conventional service.

Relocation or Reallocation of Worldwide Production

In the context of the global supply chain, there is further potential for relocation and/or reallocation of production to take advantage of HSS/AP service. However, for 3 out of the 4 commodity groups mentioned above as most likely to relocate production, Asia already has a very high share of worldwide exports to North America: Footwear – 90%, Furniture – 81% and Toys – 98%. Only Textiles and Apparel, with 58% of exports to North America originating in Asia, has significant potential for adding to HSS/AP volume. The potential for this commodity segment to relocate production or reallocate by origin is especially great with the future elimination of import quotas by origin for much of this merchandise.

By 2006, about 60,000 to 70,000 TEUs per year of HSS/AP eligible cargo will be imported into North America from non-Asia origins. Of this amount, it is estimated that production equivalent to 2,000 to 3,000 TEUs per year would migrate to the Eastbound transpacific HSS/AP deployment.

Relocation of Distribution – Transloading

An additional source of relocation benefits from the HSS/AP deployment is in the area of inland distribution, particularly in relation to the transloading of inbound cargo, at the port of destination, from international containers to higher-cube domestic containers or trailers. The higher cube results in fewer units and reduced inland transportation costs. An additional supply chain benefit of this transloading is the reduction in lead time and greater accuracy of matching inbound loads with demand for product by destination. This reduces the likelihood that the merchandise will be marked down due to a mismatch between supply and demand by area. The lead time benefits of transloading apply mainly to shippers with a high level of product diversity and relatively high variability of customer demand. These are mostly consumer goods, particularly at the retail level.

If, for example an importer of consumer electronics is shipping multiple products from Asia to multiple inland destinations in North America, the typical lead time for determining how much of each product to ship to each destination is 2-3 months. However, if the pattern of demand changes, there will be a mismatch, and the importer will incur lost sales, additional shipping expenses or markdowns or all of the above. The transloading operation intercepts the merchandise at the destination port and affords the opportunity to re-combine loads 1-2 weeks before arrival at inland destinations. This reduction in lead time minimizes the probability or expected cost of lost sales, markdowns or of transporting merchandise from surplus to deficit areas.

By the year 2006, about 600,000-700,000 TEUs per year of inbound (Eastbound) transpacific cargo would be transloaded and about 80-90 percent, or 480,000-630,000 of these TEUs, would be moving through the PSW gateway. This transload cargo is mainly retail or other high-value merchandise, and approximately 10 percent, or 60,000-70,000 TEUs per year would already be likely to divert to HSS/AP based on unconstrained first-order effects outlined in the previous section. Of this amount, 48,000-63,000 TEUs would be moving through the PSW gateway and would divert to HSS/AP under the baseline deployment.

The remaining transloaded cargo eligible for HSS/AP service (7,000-12,000 TEUs) would be moving through the Pacific Northwest, Pacific Central or Southeast gateways. For shippers moving cargo through these gateways, the prospect of the combined effect of minimizing lead time by using HSS/AP service and shifting transload operations to the PSW could be compelling. It is estimated that the shift of additional transload operations to PSW gateway would result in an additional 3,000 to 5,000 TEUs per year diverted to Eastbound transpacific HSS/AP service.

Impact of Segmentation by Value or Other Key Logistics Characteristics

The existence of a new transportation option such as HSS/AP could induce market participants to restructure their supply chains in an additional way; i.e., further segmentation of product according to value or perishability. Shippers with cargo having an average value per ton of, say, less than $5,000 would generally not have an incentive to ship via HSS/AP. However, many of these shippers have a small percentage of products that are high value and could derive a net benefit from a premium service, in terms of lower in-transit inventory cost more than offsetting a price premium. Segmentation of these shipments for premium service would add further potential volume to HSS/AP service.

Perhaps the most prominent commodity example of this is chemicals, which by 2006 will account for about 350,000 TEUs per year of Westbound transpacific cargo and 50,000 TEUs per year of Eastbound. It is estimated that approximately 1 percent, or 3,000 TEUs to 4,000 TEUs per year of this cargo would migrate to the HSS/AP deployment, with most of this volume in the Westbound or backhaul direction.

Similar benefits could be gained from segregating relatively perishable cargo for premium service. “Perishable” here refers to potential deterioration in value in the supply chain due to physical factors (e.g., in food products), technological obsolescence or fashion obsolescence. Commodities in this category include: Electrical Machinery, Refrigerated Food Products, Footwear and Apparel. Diversion to HSS/AP for 2006 related to segmentation by perishability is estimated at 3,000 TEUs to 5,000 TEUs per year for the Westbound transpacific and 8,000 TEUs to 12,000 TEUs per year for Eastbound.

Impact of Enhanced Terminal Speed and Intermodal Connections

As noted earlier in Section 2, the days saved due to the faster ocean speed of the HSS/AP vessel may be only a part of the overall saving in time. Additional time may be saved due to less time in port by the HSS vessel or through greater port efficiencies due to Agile Port cargo handling techniques. The Agile Port efficiencies include faster discharge due to cassette technology and faster exchange from ship to rail transport mode. Drawing on estimated time differences between HSS/AP and conventional container service in Section 2 of this report, it is estimated that for the median container discharged in Eastbound service, the range of hours saved using HSS/AP service is 10-25 hours, or 0.4-1.0 days.

Using the econometric model and diversion methodology discussed in Section 3, the impact of this potential additional time saving can be estimated. Note that the time saving applies across the board to all transpacific cargo, regardless of origin or destination. The results for the range of 0.4-1.0 additional days saved are as follows:

Additional Days Saved Due to HSS/AP Port Efficiencies	Incremental TEUs per Year in 2006
0.4 days	33,300
1.0 days	136,200

As shown, the results are dramatic. The impact of an additional 0.4 days saved is about an 8 percent increase in the total deployment-constrained potential HSS/AP volume, with the results concentrated in the Eastbound market. For a 1.0 day improvement, the estimated impact is a 32 percent increase with again the bulk of the increase concentrated in Eastbound. These results are due mainly to the distribution of cargo by value in the transpacific market. In the diversion model, as days saved increase, lower-value segments of the market become eligible for HSS/AP service. The results of the above simulation suggest that increases in days saved from the base case vessel deployment at some point hit a major “sweet spot” in terms of the amount of cargo divertible to the HSS/AP service. Further research is required to estimate the size of the sweet spot and how much further it can be exploited.

Impact of the Introduction of New Products into the Transpacific Trade

The opening of HSS/AP service could lead to new commodities entering the trade. The prime example here is fresh, "sensitive chill" agricultural commodities that are highly susceptible to perishability but are not competitive in long-distance markets if the only option is high-cost air service. Sensitive chill commodities include fruits like strawberries and vegetables like asparagus, both produced in North America.

With conventional containership service transit times of 10 to 17 days from the US West Coast to key Asia locations, these commodities have a high risk of poor product out-turn at destination, even with up-to-date refrigerated container equipment. Air is not an option, due to the 5x to 10x premium over ocean service, which would render the commodities uncompetitive in the Asian markets. HSS/AP service could cut these transit times by 30%-60%, particularly since key destinations, such as Japan and Hong Kong, are on the port rotations of the deployment. These reductions in transit time bring the overall speed closer to air service, without the uneconomical price premium. Therefore, it is reasonable to expect new commodities to appear in the transpacific trade, particularly in the Westbound direction, with the advent of HSS/AP service. Estimated annual volumes for 2006, all Westbound, would be 2,000-3,000 TEUs.

Impact of Intermediaries

Using surface transportation as substitute service for air is common among air express carriers and intermediaries in North America, where truck service is widely available. Express carriers and intermediaries can elect to ship by truck for certain shipments, save significantly versus air costs and still meet the service time and reliability requirements of their customers. This is particularly the case when customers are buying deferred air service.

This ability to substitute surface transportation for standard air or even deferred air service generally does not exist in the transpacific market, due to the vast gap in transit time performance between air and conventional ocean transport. HSS/AP would offer something analogous to truck service in North America: an acceptable option for international intermediaries, such as freight forwarders and 3PLs, to substitute surface for air while meeting speed and reliability requirements at far lower cost.

Most likely, a high percentage of the potential volume for HSS/AP due to substitution of surface for air is already reflected in the first-order estimates of diversion from air. As shown in Table 3, air diversion estimates for 2006 are 53,800 TEUs. Nevertheless, it is reasonable to expect that intermediaries, looking to save on transportation cost, could be an additional driver of diversion. It is estimated that intermediaries could shift an additional 5,000-10,000 TEUs per year to the potential demand for HSS/AP.

Summary and Implications of Extended Supply Chain Impacts

The cumulative effect of these extended supply chain impacts is not additive and is difficult to estimate. Some of the impacts may be overlapping, as in the case of relocation of production to Asian countries in close proximity to the HSS/AP deployment. By contrast, other impacts may be complementary; for example, an increase in days saved due to terminal efficiencies may lead to further relocation or reallocation of production and distribution activity in close proximity to the port rotation of the HSS/AP deployment.

Table 8, below, summarizes the estimated impacts of extended supply chain effects.

Table 8
Summary of Impact of Extended Supply Chain Effects on 2006 Annual Volume Eligible for the HSS/AP Service

Extended Supply Chain Impact	Incremental Annual HSS/AP Volume
Reallocation or Relocation of Production and Distribution	10,000 – 18,000 TEUs
Segmentation by Value and Perishability	14,000 – 21,000 TEUs
Increases in Days Saved Due to Terminal Efficiencies	48,000 – 105,000 TEUs
New Commodities Entering the Trade	2,000 – 3,000 TEUs
Intermediaries Substituting Surface for Air Transport	5,000 – 10,000 TEUs

With no overlaps or complementary effects the range of cumulative impacts is 79,000 – 157,000 TEUs per year, which represents a percentage increase of 19-37 percent.

Referring back to the demand curve in Section 3, Figure 1, these extended supply chain impacts represent an outward shift in demand. At the currently assumed price premium for HSS/AP service of 50%, this would allow a significant expansion in volume, with potential implications for the HSS/AP deployment. By contrast, if HSS/AP volume were held constant, the outward shift in demand means that the price premium could be increased significantly. Either of these responses to the shift in demand increases the profit potential of the HSS/AP system.

Another important consideration is that many of these extended supply chain impacts, particularly those associated with relocation or reallocation of production or distribution, will not happen immediately and may take up to 5-10 years after the initiation of the HSS/AP deployment to fully play out.

List of Abbreviations and Acronyms

3PL	Third Party Logistics Company
AP	Agile Port
FOB	Free on Board
HSS	High-Speed Ship
PSW	Pacific Southwest
TEU	Twenty-foot Equivalent Unit