EXECUTIVE SUMMARY

SCAG has undertaken to conduct a preliminary feasibility study of an automated transport system and other landside container collection/distribution systems in conjunction with the potential establishment of fast container ship service to regional ports. This study, the Agile Port/Fast Ship project, was funded by a Caltrans State Planning and Research Partnership Grant. It closely parallels and complements a much more extensive program conducted by the Center for the Commercial Deployment of Transportation Technologies (CCDoTT).*

Fast ships, which would operate at a speed of 40 to 70 knots with higher reliability than conventional ships, represent a functional cluster of emergent nautical technologies which, taken together, could fill a "middle market" inter-continental transport niche intermediate between those filled by air freight and by conventional container liners. The cargo carried would comprise the more time-sensitive freight and higher valued goods that presently move on the cellular container ships, as well as somewhat less time-sensitive shipments and lower valued commodities than those that typify today's air freight.

SCAG's interest, in support of the Regional Transportation Plan (RTP) and the enhancement of goods movement in southern California, is to determine whether the same kind of system that could rapidly load and unload a fast ship, could also be used to facilitate automated freight transport on a grade separated guideway within the region, in expediting the landside movement of marine containers.

The intent is to determine if this would provide a feasible way to transport import and export traffic, while avoiding highway traffic congestion that slows truck movements--while minimizing air pollution. SCAG, with consultant assistance provided by ICF-Kaiser and Nieman & Associates, has investigated the potential of such a system to convey marine containers to an inland port transfer facility, as well as to serve intermediate freight stations where containers would be loaded and off-loaded.

From a number of candidate landside transport technology alternatives, it was decided that the following would be compared: an automated conveyance system on its own guideway--very much like rapid transit but with a marine container taking the place of the passenger cabin; a ChassisRailer system which allows truck chassis carrying containers to be linked together in short trains and conveyed by railroad; and the present system of truck drayage over the freeways for local hauls, combined with conventional rail intermodal service for long-distance bridge traffic.

The automated system investigated in this study would use a conventional steel rail (duo-rail) technology. All stations would be off the line, and a maximum speed in regular service of 55 MPH is assumed. Vehicles would be electric powered, with excellent acceleration and braking performance. The standard vehicle would be designed to carry a single marine container (one FEU or 40' equivalent—although longer containers could also be carried).

The rail technology was chosen in part because it would be compatible with the type of shipside-to-dockside transfer system under development by FastShip Atlantic. The latter is anticipated to be the first commercially operational fast ship service primarily for ocean freight. However, the intent of this study is not to recommend a particular automated guideway technology, but to feature the rail technology as a convenient example of an automated cargo transport system for purposes of determining operational characteristics, economic viability, and overall system attractiveness to the customers.

Functionally, the automated guideway technology would permit large pallets carrying containers to be brought on board ship using a rail-based transfer system. It will be noted that for several of our alternatives, a steel wheel-on-steel rail transfer system, similar to that under development by FastShip Atlantic, is assumed for ship-to-shore transport only. The same technology used as an Automated Container Guideway (ACG) conveyance system would extend this rail operation far beyond the port area to furnish inland transport of the marine containers to various points within the region.

The assumption is that the internal cargo decks of the fast ships would be paved to facilitate military roll on/roll off (Ro-Ro) use of the vessels, hence the track used by the transfer system would be flush with the ship's internal decks. This arrangement would allow highway and off-road vehicles to use the same deck space when in use by TRANSCOM for specialized military cargo transport (including the wheeled or treaded vehicles themselves). In the case of our alternatives, the truck and ChassisRailer systems would employ an identical rail transfer system for very rapid unloading of long strings of import containers from the fast ship, and subsequent reloading with export containers.

The automated system (ACG) alternative would eliminate a separate ship-to-shore transfer system, by allowing the railcars used in inland transport to run on board the ship to drop off and pick up the containers without a lift at dockside—the ultimate transfer to a local drayage truck would be shifted to an inland port or local freight station at some distance from the seaport. (An additional service using higher-capacity automated well cars might also be provided to allow regular container ship traffic to use the same guideway.)

The ChassisRailer system would transport marine containers on specialized flatbed truck chassis. Local freight stations, in this case, would be points for assembly of the chassis with their loads, where rail bogies are installed between each pair of trailers; the ChassisRailers then to be coupled up into train-loads to allow a locomotive to haul them to the port. At the port, the containers would be lifted onto the rail transfer system pallets, and carried onto the ship thusly. Operation in the reverse direction, for import traffic, would entail breaking up the cuts of rail-mounted trailers at the outlying freight stations by removing the bogies and allowing the trailers to be driven off over local roads to ultimate destination.

The truck alternative would function similar to existing truck drayage, except for the method of loading and unloading the ship. Export fast ship containers would be lifted from their chassis onto the rail transfer system at the quay, to be replaced by import containers coming off the ship on the same transfer vehicles. In this study, Year 2020 traffic conditions were assumed--based on highway model output developed for the Draft 1997 RTP and assuming the facilities included in the Draft Plan.

Routes considered for the automated system include: a primary trunk line from the Ports of LA and Long Beach to the City of Commerce near downtown LA, the City of Industry (with a spur to Irwindale), Pomona/Chino, Ontario, and San Bernardino/Norton AFB (with a spur to March AFB as an option). All of the inland locations would have freight stations which would collect containers for transfer to the guideway system. A second route could go to Orange County, with stations in La Mirada, Fullerton, Tustin, and Irvine Spectrum/El Toro.

The ChassisRailer system compared with the automated system would follow roughly the same route or routes, but adhering strictly to main line railroads, e.g. from the San Pedro Bay ports to Commerce and thence east to San Bernardino, with generally the same stations. Truck drayage was compared with the automated system and with ChassisRailer, using parallel freeway routes.

Another series of ChassisRailer routes was established for study purposes, including a trunk line from Port Hueneme to the San Fernando Valley and downtown LA; and with an extension to serve the San Gabriel Valley/San Bernardino, for comparison with truck drayage. The freight stations in this case would include Chatsworth and Van Nuys. A branch of this hypothetical intermodal rail service was also be extended down the Alameda Corridor to Carson where there are a number of freight forwarders and consolidators.

The study developed a year 2020 forecast for fast ship cargo in terms of container-loads, based on data bases available to ICF-Kaiser for both marine and air cargo. These forecasts were made for local import and export containers and for long distance movements (which become "bridge" traffic on the railroads). Data from the Ports of LA and Long Beach were used to develop local/long distance cargo splits; while SCAG employment data, especially Analysis Zone (AZ) figures for retail and "other" (non-service)employment were used to help predict where in this region future container traffic, warehousing, and related activity is likely to occur. Based on this information, containers were allocated to freight station collection/distribution areas including a possible inland port site.

The 2020 fast ship container forecasts for the US South Pacific Coast--which includes our regional ports--range from a low of 462,584 to a high of 1,039,799 TEU (20'-equivalent container units) per year. Assuming that the high market penetration scenario can be attained, this translates to 519,900 FEU (40'-equivalent container units) per year, of which 192,448 would be import, and 327,452 would be import FEUs. This means that of the fast ship container cargo, 37% would be export movements and 63%, import movements. (Note that in comparison, current 2020 forecasts for regular container liner or cellular ship traffic, amount to 12,570,000 TEU per year or 6,285,000 FEU/year, imports and exports together. This is about 12 times the estimated fast ship cargo potential.)

However, in terms of sizing fast ship fleets, it can be assumed that fast ships will not likely be carrying empty containers, so any deficiency in higher-valued exports will be made up in some way by carrying lower-valued cargo—and the number of import containers would be matched by export containers of various value and time sensitivity. Factoring this into the equation, it is estimated there would potentially be nine fast ship calls at southern California ports per week, or an average of 1.5 per day assuming 6-day weeks (carrying 1050 import and 1050 export containers per day).

The split of local versus long-distance container traffic would be: 577 import containers per day (55%) for local traffic, versus 473 import containers per day (45%) for bridge traffic. However, of the 577 local containers noted, only about 185 import containers (32%) would be within the effective range of freight stations along a corridor extending from the San Pedro Bay ports to San Bernardino via Commerce, Industry, Pomona, and Ontario. This restriction in the number of containers originating from/destined for shippers along a spinal fixed guideway or rail corridor is a factor that potentially constrains the economic viability of either an automated system or a ChassisRailer system in the transport of fast ship containers.

Note that an inland port facility developed for fast ship cargo alone would be restricted to only 473 FEU per day each way. This is significantly higher than the number of containers for local freight stations only, and hence a scenario was developed in which an inland transfer facility was considered for the automated system, supplementing local freight station cargo. (An additional speculative scenario was also run assuming 50% higher container traffic through the ports and use of the automated system by some cellular ship traffic as well.)

Data were developed on transit time, capital and O&M costs, and reliability for the automated guideway technology, using transit system standards. Information from the manufacturer of ChassisRailer equipment was used to establish costs and other pertinent parameters including reliability for this lightweight rail intermodal system, using also a combination of railroad sources and the SCAG railroad consolidation study simulation work, to provide a conservative estimate for train speeds using the railroad main lines. As it would be unimpeded by traffic congestion, the automated guideway system would operate at the highest average speed, close to 50 MPH.

The ChassisRailer system would operate considerably slower at an average speed of 24 MPH on the railroad main lines in most places owing to railway system conditions in an urbanized area, i.e. due to interference from other train movements and yard activity. This speed would be reduced to an overall average of 12 MPH for trains that make intermediate stops to drop off cuts of vans and pick up others. The trucking speeds, averaged between peak and off-peak conditions, are forecast to be faster than for ChassisRailer but always inferior to those of the automated technology.

Economic viability of the alternative delivery systems, was developed including fixed capital costs (e.g. guideway), variable capital costs (rolling stock), operations and maintenance (O&M) costs, costs for station activity such as additional lifts from railcars to chassis, and charges for short inland dray movements by truck. The fixed capital costs alone for an automated system, without including the inland freight stations, amount to $ 3.26 billion for a system from the San Pedro bay ports to a San Bernardino inland port (Norton AFB). For the ChassisRailer system on the other hand, using the existing railroad lines, most of the capital costs are for rolling stock and O&M, with fixed plant costs being virtually nil.

Overall economic comparisons are as follows. Overall commercial costs* per fast ship container for trips to/from the San Pedro Bay ports and three inland origins/destinations for truck drayage and for the two alternative systems are given below:

	East LA	Industry	San Bernardino
Drayage entirely by truck	$ 80	$ 159	$ 255
ChassisRailer	$ 237	$ 237	$ 237
Automated Guideway**, local only	$ 957	$ 965	$ 1011
" " local + bridge***	$ 437	$ 445	$ 491

* Commercial costs include a short local movement by truck between inland freight stations and the ultimate shipper/receiver of the container, for fixed guideway alternatives.

** This assumes public sector financing, with a 40 year project life. This is compared with the private sector financing and 20 year project life assumed for ChassisRailer. Private sector financing for the automated system, and assumption of a 20 year life would result in a cost increase of 50 to 80%.

*** Note that this does not address the fact that the haul for long-distance containers via automated system would be in addition to the rate charged for long-distance transport across the country by railroad.

Overall, it is apparent that the automated system costs per container, even under the most favorable funding scenario (public sector) are vastly more expensive than truck drayage. The costs are less when the additional bridge traffic is included; however, it is not known what reduction in railroad rates (if any) might pertain to putting a box on an intermodal train in San Bernardino or a similar inland point, instead of at the seaports. The lowest cost per container figure developed for an automated system is for a "build-out" scenario assuming 50% higher container traffic at the ports in 2020, and with cellular ship as well as fast ship traffic using the automated system. However, in this case, the average rate is still high at $ 287 per box.

ChassisRailer is considerably cheaper, but still, except for the greatest distance considered from the San Pedro Bay ports to an inland point, the per container cost is higher than for drayage. This sheds doubt on commercial viability for a ChassisRailer system from the Ports of Los Angeles and Long Beach to inland points.

The situation for alternative transport to/from a hypothetical fast ship terminal at the Port of Hueneme is better. Assuming an extensive ChassisRailer system serving points in Los Angeles and western Orange and San Bernardino Counties, it is estimated that the ChassisRailer cost per container would be $ 216 for the run from Port Hueneme to Carson or East LA (versus $ 249 for drayage to East LA and $ 255 for drayage to Carson). This is because of the additional overall distance from Port of Hueneme to major regional commercial and industrial activity zones. While these comparative figures are not as “hard” as the figures for the haul from the San Pedro Bay ports to inland points--because there are few comparable drayage rates known for Port Hueneme to the east--it is suggested that a ChassisRailer inland transport system in conjunction with a fast ship terminal at this port could be commercially viable.

Other evaluations of commercial viability conducted in the course of the study considered the relative value of time for the inland transport movement as compared to the ocean haul. The overall savings in time resulting from implementation of the fastest inland transport alternative (the automated system) would amount to only a 1.2% reduction in total transport time (ocean haul plus inland) for the longest LA Basin inland movement considered (to San Bernardino). Compared with the savings of many days for the fast ship voyage as compared to conventional container liners, this appears to be relatively insignificant.

Conversely, the increase in transport time for ChassisRailer (the slowest inland alternative) only amounts to 0.3% of the total trip time (ocean haul plus inland), also to San Bernardino. Apparently, the marginal benefit from an inland transport time savings of an hour or two, is only likely to be of significance to a relatively few shippers—by far the vast majority of fast ship users can be expected to consider the saving of many days on the ocean voyage, of much greater importance.

An assessment of military aspects of the agile port and its inland transport systems in relation to commercial operations is also included in the report, comprising a description of typical classes of military cargo/cargo geometrics, comment on present modes of shipment, a description of the roll on-roll off capabilities of fast ship, discussion of military operations phasing from the perspective of the impact on fast ship cargo and the way that military cargo might be integrated with commercial cargo, and design features of an overseas port facility that would use the fast ship transfer system—including the system used by our automated container transport technology. Unfortunately, no data were available on likely military flow volumes in time for completion of this study.

A discussion follows of reasons for possible military interest in a specialized agile port delivery system--both the automated guideway and ChassisRailer alternatives. The conclusion from this section is that the military would likely have much more interest in the rail transfer system for rapid ship unloading, common to all modes considered here, than in an expensive automated guideway system for military cargo (though they would probably use such an automated system were it convenient to local military bases/supply depots, and if it someone else built it).

Several marine container transport scenarios using fast ships suggest that an “agile” port operation with smooth integration of military and commercial cargo may be feasible after an initial “surge” period in the flow of cargo is over. The extent of military investment in an automated system (should one be already available) would probably be limited to purchasing additional fast ship container pallets, and perhaps a small number of automated cars to supplement an extant commercial fleet.

A ChassisRailer system on the other hand would permit greater flexibility in the use of rolling stock, should the military wish to purchase their own chassis, than would an automated system. This is because the chassis would be able to be used for other road transport or for operation over railroads anywhere in the country.

Implementation issues follow, including the propensity of shippers to use the "middle market" fast ships themselves, and the factors involved in implementation of either of the guideway system alternatives for inland transport. With respect to the vessels, technology developments at the larger container ports (LA and Long Beach) are driven by demands of the shippers, and the primary interest is currently focused on expanding facilities for conventional container ships. It has been suggested that fast ships might be introduced as coastwise traffic/Latin American feeders, which would probably allow the same facilities to be used for trans-Pacific runs assuming there is dock time available.

The situation is otherwise at the Port of Hueneme, which is a smaller, niche port, with more freedom to innovate, and located adjacent to a military base with ample backland and rail access. In the shorter term, Port Hueneme shows the most promise for developing an agile port for fast ship operation and for combining of commercial and potential military cargo. The ChassisRailer system, or a similar road/rail technology operating over the general system of railroads, would probably be the only practical form of specialized guideway transport to serve this port, considering the relatively small volume of cargo.

A major implementation issue for the automated guideway system would be the ability to raise sufficient capital, probably by bonding, to finance a project of the magnitude involved—$ 3.26 billion plus rolling stock. A longer term investment on this scale could more easily be justified in the public sector, considering the guideway life span of 40 years or more (and up to 30 years for rolling stock). For a privately-funded project, the investment would be likely have to be paid off over 20 years or less. (Providing electric power for a system like this would probably not be a serious obstacle.)

A ChassisRailer system would be much cheaper and easier to implement. However there remains a question of the private railroads' accepting this kind of operation on their tracks: no special priority would be accorded chassis-railers for a local operation, so speeds would be no better than for the railroads' own intermodal trains in the urbanized area, making the service less attractive. The possibility, and cost of, providing dedicated track (perhaps jointly with Metrolink) on the railroad main lines or branch lines, to afford priority equal to that of passenger trains, should be considered.

Some of the other, more important implementation issues include the question of providing all-day service as compared to an 8 AM to 5 PM schedule which is imposed on truckers providing drayage to most port terminals today; port interest in developing inland transfer facilities as opposed to conducting all of their operations on or near the docks; and whether the distribution system chosen would utilize, compete with, or complement the Alameda Corridor.

A decision to develop an inland port facility fed by some kind of automated guideway system would hinge largely on economic decisions related to the use of existing port backlands for activity other than container sorting and storage, and on whether the railroad system would have sufficient capacity to handle the forecast container volumes (for all container ships, not limited to fast ships which may or may not become established at the Alameda Bay ports). Thus far it has not been established that such capacity would not be available, although some additional tracks may be required on existing railroad rights-of-way to handle future freight needs.

With respect to the Alameda Corridor, an automated system would compete with the consolidated rail corridor for long-haul (non-local) movements at currently forecast volumes. It would probably require a very substantial increase in container traffic to justify a specialized guideway system being developed in parallel to the Corridor. On the other hand, certain ChassisRailer alternatives would utilize Alameda Corridor trackage and help to justify the rail corridor project.

A basic conclusion with regard to the automated container transport system is that it would be difficult to justify this on the basis of marine cargo alone, even under the most optimistic scenario. In all probability, such a system would have to be developed jointly with other users, such as commuters (operating passenger rapid transit vehicles on the same automated system), airport users, or shippers of local urban goods (package express, municipal wastes, etc.), and probably a combination of these, in order to be economically feasible.

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* CCDoTT, located at Cal State Long Beach, received a grant from the U.S. Department of Defense, Transportation Command (TRANSCOM) to study joint use potential of fast ship technology for commercial operations and for military supply purposes.

Section 1: Introduction and Background

Study Background and Purpose

Fast ships, with a commercial speed of 40-70 knots, have the potential to fill a niche in inter-continental cargo transport that would be attractive to some of the more time-sensitive cargoes that presently move on conventional container ships, to the less time-sensitive cargoes that currently move by air freight, and, probably, to new movements attracted by the service and by the performance characteristics of an integrated transport system based on fast ship. Additionally, once fast ship service is established, new intermediate markets may develop for goods not now trading in significant quantities across the oceans.

There are several fast ship projects currently under development, including the FastShip Atlantic project envisioned to carry Volvo products between Zeebrugge and the Port of Philadelphia, the Australian Incat Cargo Express project, and the Japanese TSL project. Numerous other fast ship designs are on the drawing board or at a conceptual stage of development.

Locally, in 1996, the Center for the Commercial Deployment of Transportation Technologies (CCDoTT), located at Cal State Long Beach, received a major grant from the U.S. Department of Defense, Transportation Command (USTRANSCOM) to study joint use potential of fast ship technology for commercial operations and for military supply purposes. SCAG's Agile Port / Fast Ship Study has been conducted in parallel with the CCDoTT work effort. The intent of the SCAG Agile Port project is to investigate the commercial applications of fast ship cargo inland delivery systems, including an electrified, automated guideway technology, in the Southern California region.

The focus is on landside transport of containerized cargo moving between the San Pedro Bay ports and representative local, inland origin/destination points, including a possible inland port facility for container transfer in the Inland Empire. However, the Port of Hueneme has also been suggested for some very valid reasons as a niche port that might accommodate fast ship operations, necessitating similar evaluation of landside access. Throughout the study, it is recognized that fast ship technology is but a single element in the long series of activities involved in development of a new freight transportation logistics chain..

Major elements of this SCAG study include:

- development of commodity types and flows for likely fast ship cargo;
- definition of a representative automated container transport technology, henceforth to be termed the automated container guideway (ACG) system to provide shuttle service from the San Pedro Bay Ports to points inland within the region;
- selection of a representative “carless” rail-based technology--ChassisRailer--to provide a comparable rail shuttle service (for both San Pedro Bay Ports and Port Hueneme);
- comparison of the ChassisRailer system and the automated system with existing truck drayage operations;

- establishment of the most likely route structures and probable operating parameters;
- establishment of cost, transport time, and reliability data for each mode;
- evaluation of the parameters for commercial viability of each alternative;
- assessment of the physical requirements of military cargo;
- assessment of military operational needs in relation to commercial utilization; and
- articulation of major implementation issues, including terminal requirements and environmental aspects.

The results of this study are intended to assist SCAG as it considers the merits of developing specialized inland delivery systems that would complement fast ship service, should the latter become established in Southern California ports. The study is also intended to provide practical suggestions and evaluations in a form that designers and operators can use, recognizing the difficulties of creating a market for a new technology/technologies and associated operational practices.

The study was conducted by senior SCAG staff with substantial assistance from the ICF Kaiser consulting group and their subcontractor, Mr. Steve Nieman. The study was funded by a Caltrans Partnership Grant.

Project Meetings and Contributors

In addition to internal project meetings between the SCAG project manager and the consultant team, several critical meetings were held at various times during the project to brief representatives of stakeholders and interested parties, and to ask for input into the study. In addition to those we met with, there were other contributors of ideas and information.

A meeting was held on March 24, 1997 with representatives from the Ports of Long Beach and Los Angeles, Caltrans, the LACMTA, and CCDoTT. During this meeting, valuable input was provided by Dean Richard Williams, of Cal State Long Beach, on the scope and progress of the USTRANSCOM-funded CCDoTT study, and by the representatives from the San Pedro Bay ports.

On April 2, 1997 SCAG staff met with representatives of Southern California Edison, to discuss possible utility involvement in providing electric power for an automated transport system (one of the alternatives considered for landside collection/distribution of containers).

On April 8, staff had a phone interview with Mr. David Giles, Director of FastShip Atlantic, Inc., which is expected to be the first commercial fast ship project to go on line. This interview provided much valuable information concerning the progress of that project, and helped in the development of our alternatives.

On April 10 and 11, 1997 there were meetings between SCAG staff, a member of the consultant team, representatives of regional port facilities, and other interested parties. The April 10 meeting was held at the Port of Long Beach, with Mr. Gordon Palmer of that port, Mr. Matt Goldman of the Port of Los

Angeles, Mr. Gill Hicks of the Alameda Corridor Transportation Authority, and Dr. Isaac Maya of CCDoTT/Cal State Long Beach.

The April 11, 1997 meeting was held at the Port of Hueneme, with Mr. Bill Buenger, the port Executive Director, and Mr. Kam Quarles, Director of Marketing. This meeting was followed by a tour of the port's facilities and the SEABEE base.

On May 20, 1997 we received information on the standard transportability characteristics of military equipment from Mr. Kelly Musick of the Transportation Engineering Agency of the Military Traffic Management Command (MTMC) in Newport News.

On May 21-22, 1997 a member of the consultant team visited the two western freight railroads to discuss the potential for operation of a ChassisRailer or other dedicated rail intermodal system within the region to serve a fast ship operation. On May 21, 1997 the meeting was with Mr. Mike Kelly, Mr. Nobu Torasaki, Ms. Liz Heim, and Ms. Lorrie Young of the Union Pacific Railroad in Omaha. On May 22, 1997 the meeting was with Mr. Jack Fields and Jim Kelly, of the Burlington Northern-Santa Fe in Fort Worth, Texas. The SCAG project manager participated in these meetings via a conference call.

Mr. Glen Lester of British Columbia Transit and Mr. Ian Graham of Skytrain Corporation provided a wealth of information on the automated transit system in Vancouver. Mr. Ron White provided additional information on the Airtrans operation at Dallas-Ft. Worth Airport, which was originally designed to handle cargo as well as passengers.

Project Overview and Major Alternatives Developed

This report presents the analysis by SCAG and its consultants of the commercial application of an agile port delivery system. The detailed results of the study, including a description of the analytical methodology and the information available for the analysis are documented here. In overview, the report includes: (A) an analysis of a proposed commercial automated container delivery system and other possible delivery systems serving the ports of Southern California; (B) an assessment of the proposed route structure and operational parameters of the alternative systems; (C) an assessment of the interaction between the military aspects of the system and the commercial operations; and, (D) presentation of implementation issues that need to be addressed in order to further develop the delivery system concept.

To move containers to and from fast ships calling at the ports requires a reliable, efficient inland transportation system. Therefore, an expanded definition of an agile port encompasses not only the transfer operation at the piers themselves, but also the inland container transport operations. To be able to assess the economic viability of any alternate systems, some understanding of costs specific to each alternative must be established. Estimates of activity levels are essential components required to establish parameters of economic viability. Hence, there are several critical dimensions to carriers' and shippers' decision-making:

- The geographical distribution of available routes
- The costs of shipping to/delivering from inland areas, which for fixed guideway systems will be centered on properly-located freight stations, in comparison with comparable areas served by truck dray
- The time it takes to ship to/deliver from the same areas, in relation to the distribution of the shippers' locations

Three basic delivery systems are considered: drayage by truck, a ChassisRailer system using main line railroads, and an automated container guideway (ACG) transport system. Operational requirements and design features of these systems are indicated below.

Traditionally, the inland options have been two-fold: a) motor truck (drayage) for containers on chassis provided by the steamship lines, to and from the metropolitan area surrounding the port, local inland production and consumption areas, and regional hinterlands*; and b) rail intermodal trains to and from points beyond the hinterlands, i.e. railroad "bridge" traffic including service from the West Coast ports to/from the East and Gulf Coasts, and the Middle West. This latter component, and its connectivity with other vital transportation corridors, will be vastly improved when the Alameda Corridor opens (see Figure 1.1 at end of Section for overview chart of port/inland transport activities).

A third, less visible option, transload, also exists. This is local drayage to/from local consolidation/distribution facilities at which point the cargo changes character, packaging, or configuration for subsequent transport--which transport may be local, beyond, or international. It is commonly believed that there is a great deal of such cargo, but there is little data from which to quantify specific amounts.

For an agile port, the rail intermodal option for service to local/hinterland market areas, is not likely to take the form of the traditional long-haul double stack and piggyback operations so prevalent in the SCAG region. Only a portion of the freight to and from a fast ship may have a prior or subsequent move via such an operation as either a full or partial intermodal load, and even a lesser fraction is expected to move intact, in through containers. Over half the freight to and from fast ships may very well originate or terminate in the SCAG region and the Ports' hinterlands.

Hence, the preferred rail-based delivery option becomes a different concept known as car-less technology in short haul service, possibly with a rail organization more like that of a shortline railroad than of today's Class I railroad. Basically, it would use a type of combination road/rail (e.g. RoadRailer) equipment for train service between the ports and various inland stations on the selected rail route.

The likely route used would follow existing rail mainlines between the Ports and points as far east as San Bernardino, and either Norton or March Air Force base, including a number of intermediate stations for local containers to and from the logical service or production/consumption area surrounding each station. The specific road/rail equipment utilized would be ChassisRailers which accommodate a single container on a specialized chassis and are coupled to other such ChassisRailers to combine the units into a train (see Figure 1.2, end of Section).

ChassisRailer equipment is offered herein as the most logical example of carless technology for short-/intermediate range container hauls, because the Roadrailer van on which it is based is the most prevalent such technology in current operation and estimates of capital and operating costs are available. This does not constitute an endorsement or recommendation to use a specific brand of equipment.

The other fixed-guideway option for an agile port alternative delivery system entails a fixed position, dedicated, permanent structure constructed along a railroad, highway, or utility rights-of-way. This is called an Automated Container Guideway (ACG) system (see Figure 1.3, end of Section). Containers would sit on steel wheeled vehicles powered by electricity and traveling over steel rails, mechanically similar to the operation of a light rail/rapid transit passenger system. Unlike the ChassisRailer alternative but similar to truck drayage, each "train" would normally move only one container (on its own flatcar) at a time.

The route for an ACG system would be similar to, but need not be identical with, that of a local railroad/ChassisRailer option. But, like ChassisRailer, it would likely be constructed as far east as the San Bernardino area, with intermediate stations for local containers to and from commercial areas logically served by each of the stations.

Research Approach/Project Organization

The remainder of the report is organized as follows: Section 2 provides a brief overview of the agile port concept, and also discusses inland port requirements.

Section 3 develops some basic information about the type of vessels that would be used, and their capacity, likely schedules, operations, and logistics. It elaborates on the pier interface required to achieve a rapid (1000 container per hour) off-loading of the ships per USTRANSCOM's original specifications. The type of transfer system needed to achieve this is included as a given in developing the operational scenarios for the inland delivery systems considered here, and, in the case of the automated system, in defining the basic technology requirements for the system.

The next step (Section 4) is to evaluate future year (2020) forecast cargo volumes for fast ships, primarily based on diversion from container liners and from air freight, for appropriate classes of higher-valued and time-sensitive cargo. This will make it possible to establish capacity requirements for the inland transport alternatives, and the number of vehicles required per ship and/or per day, to carry the required number of containers.

This is followed (Section 5) by the establishment of the most likely routes, by highway, rail, and ACG system, for the respective inland transport alternatives--from the San Pedro Bay ports and the Port of Hueneme to local areas within the SCAG region and to a possible inland container transfer facility or "inland port." After this is provided a detailing of transit distances from the ports to various inland freight stations designated for study purposes for the fixed guideway modes and to the same equivalent areas that would be served by truck drayage; and development of the transit times for movement to and from these representative points.

The next logical step (Section 6) is to describe in detail the technology and operating assumptions for the modes considered, including the way each would interface with the seaport transfer system and with inland areas serviced. This includes the relation to the number of containers transported, details of the collection and distribution of containers, the nature of operations at inland freight stations, and the cost of providing service. Cost parameters were analyzed by reviewing those of various existing cargo distribution networks, or, where they do not exist, for comparable transport technologies.

This being done, Section 7 will develop the economic viability of each system, including a comparison of value of transport or drayage time for the alternative, with costs for that alternative. An assessment of likely commercial feasibility for the three alternatives compared follows this.

Although little information was available on military cargo volumes or specific military logistic requirements at the time of writing, consideration is given in Section 8 to the probable utility to USTRANSCOM of the inland transport systems considered. And, having considered commercial viability and possible military interest in these conveyance systems, there will follow a detailing of implementation issues from a variety of viewpoints in Section 9.

Finally, study observations, conclusions, and recommendations are given in Section 10 at the end of the of the report.

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* In this case the hinterlands referred to would include points beyond the SCAG region's urbanized area, including San Diego, Imperial County, high desert areas, the San Joaquin Valley, and adjacent states (Arizona and Nevada).

Section 2: Agile Port Concept

Dr. Isaac Maya at CCDoTT has provided the following definition of an Agile Port: "An Agile Port is a port facility which can accommodate US DOD cargo without disrupting commercial cargo. It will provide a smooth flow in military surge cargo as well as commercial cargo, and allow an interface with various types of ships."

For the purposes of this study the above definition can be expanded by building on the concept of the interface, with a focus on commercial use. It might be termed a Flexible Interface Port or Multiple Interface Port. ("Multiport" is not an appropriate term for a single port area; it implies multiple ports or a complex of Seaports and Inland Ports.)

Agile Port Functions

Expansion on the interface concept means that an Agile Port, flexible interface port, (or other concept name) would provide:

- Flexible interface between various kinds of marine vessels, cargo sorting/storage areas, and landside access/distribution systems
- Provision for fast ships, container ships, bulk cargo carriers, and others
- Truck access as well as on-dock/near-dock conventional container-on-flatcar or COFC rail intermodal terminals, and preferably convenient access to trailer-on-flatcar or TOFC facilities as well
- Provision for alternative fixed guideway modes including ChassisRailer, Iron Highway, and automated guideway systems (shuttle or line haul) as may be required
- Faster or expedited vessel loading/unloading including entirely new fast ship transfer systems, increased numbers of cranes for conventional container ships, and other means to reduce transfer time and/or reduce the need for storage on dock
- Streamlined and/or more automated transfer of containers from temporary container storage areas to landside access modes
- Adequate space for container sorting and storage including backland, and if needed, multiple deck chassis parking areas and/or vertical or other automated container storage facilities
- Access to such inland port transfer/storage areas as might be required
- Good access to freight forwarders, consolidators, warehousing, light manufacturing, and truckload (TL) and less-than-truckload (LTL) trucking associated with the same
- Improved electronic data management and container tracking
- Streamlined customs procedures

Inland Port Facility

The Inland Port facility referred to could be part of an Agile Port, Flexible Interface Port, or Multiport complex and would include:

- Access provided by conventional rail intermodal and trucking, with conventional intermodal transfer facilities associated with the same
- Ample room for surface storage of containers on chassis and stacked storage of containers as required
- Provision for new forms of rail intermodal such as ChassisRailer or Iron Highway, and for new guideway modes as appropriate
- Interface between port shuttle trains and transcontinental trains (bridge traffic)
- Provision for COFC facilities for marine as well as domestic containers and probable inclusion of TOFC
- Provision of small classification yards if required for efficient intermodal operation
- Convenient access to air freight facilities, parcel carriers, and Amtrak's cargo facilities; possibly as part of the same facility
- Proximity to forwarders, consolidators, light manufacturing, warehousing, and TL and LTL trucking associated with the same
- Possible designation as, or proximity to, foreign trade zones and enterprise zones
- Improved electronic data management and container tracking
- Inclusion of customs facilities

Section 3: Vessel Capacity and Schedule, Pier Interface, and Preliminary Cargo Flow Logistics

Vessel Design

Vessel design is not a primary task of this project. However, it is necessary to know how a fast ship could be configured with respect to cargo holds or cargo bays, in order to understand how it would interface with landside feeder/distributor systems. According to CCDoTT, at least four basic designs are being advanced at present:

- The FastShip Atlantic design, which is a semi-planing monohull type. This vessel features an upward curve towards the stern of the vessel (concave hull), developing lift as additional thrust is applied. This allows the vessel to operate with greater stability in rough seas and dock in shallow waters.
- Catamaran or quadramaran multi-hull vessels. It is understood that the Australian Incat Cargo Express system will be of this type, being an evolutionary development of the fast catamaran ferries in operation in various parts of the world today.
- Long, narrow vessel designs (slender monohull type), of which the Kvaener Masa Bathmax 4000 and Fast Container Liner would be examples.
- Surface effects vessels, such as the Ingalls Surface Effect Vehicle. This is a sidewall craft design, which has a trapped sheet of air beneath the vessel (not to be confused with a hovercraft).

An excellent discussion of the fast ship designs most advanced in their development to date, and of their potential military suitability, is provided in Advanced Technologies for Transportation Applications Technical Report, prepared by the University of Southern California Center for Advanced Transportation Technologies (1997) for CCDoTT and USTRANSCOM.

Details for a method of cargo transfer that would allow very rapidly loading/unloading cargo using horizontal cargo bays, and hence could satisfy the requirement to off-load cargo at a rate of 1000 containers per hour--per specifications adopted for this study--are at present known only for the FastShip Atlantic vessel. FastShip Atlantic may or may not be the only design which can transfer cargo at this rate.

Critical to the concept of FastShip Atlantic is turning the vessel after only eight hours at port by rapid unloading of inbound containers and reloading with outbound containers. FastShip Atlantic will be a 1448 TEU vessel (724 FEU or 40'-equivalent units) with cargo stowed on two broad internal decks that will run the length of the vessel from behind the bow, to the stern of the ship, with stern loading/unloading. Double-stacked containers are to be arrayed in longitudinal rows on each deck, corresponding to the tracks built into the deck, used in normal loading and unloading of the vessel (Figure

3.1). The method of loading/unloading the vessel is most similar to that of an ocean- going ferry, or more specifically a railroad car ferry, with strings of 40’ containers, over 700’ long being rapidly rolled on and off the vessel.

While details are not available as to possible advanced methods of unloading other fast ship designs currently under development, theoretically any of the vessel designs such as the catamaran and quadramaran vessels, or the surface effect type which provide Ro-Ro capability might be adaptable to this or a similar rapid loading technology. The same would be true of a ship design similar to that of the Bathmax 4000, a long, narrow vessel which would provide a hybrid of Ro-Ro and cellular container transport. (These rapid loading methods would not apply to the other long, narrow ship design, the Fast Container liner, which is strictly a cellular ship.)

Staff and consultants on the current project recognize that there are a number of alternative schemes for stowing containers on board a fast ship, and rapidly loading and unloading the same. For instance, for a wider-hulled vessel it could be feasible to use a compact, transverse arrangement of containers, rather than longitudinal--placed in several parallel bays that would probably be over 45’ across to accommodate 45’ long containers. In this case the containers might be somehow mounted on large pallets or parallel tracks. Once rolled off the ship and moved to a suitable unloading area, it would be possible for truck tractors to access these containers individually and from both sides--as opposed to serially--rolling them off the pallets or framework holding them and onto truck chassis.
Other pallets, preloaded with outbound containers would be replaced on the ship in reverse order.

The above certainly by no means exhausts the list of possible methods for dense stowage of containers on fast ships. However, for purposes of this study, a method of loading/ unloading the vessel similar to that used by FastShip Atlantic has been taken as the standard, and other vessel and transfer system design specifications will be based on FastShip Atlantic. The longitudinal, train-like stowage arrangement is adopted here because of its apparent ease of loading of FastShip, and because of its potential for rapid container transfer to and from rail/fixed guideway or highway intermodal equipment.

Vessel Capacity

Based on FastShip Atlantic, whose dimensions are 863’ long by 131’ wide, the following is a very rough calculation of the deployment of 1440 TEU=720 FEU on board a vessel of this kind (from this point on, our calculations depart from the FastShip Atlantic standards, and relate to a generalized fast ship):

Assuming 750’ long cargo bays, and allocating 50’ per double-stacked container space (largely 40’ containers, with some 45’ containers on the top tier), and 12 containers across, with two cargo decks it would be possible to accommodate 720 FEUs. (750’ long/50’ per double stack space x 12 spaces across per deck x 2 levels of containers/space x 2 decks = 720.) Another way of looking at it is: for each string of double stacked containers, 15 longitudinal spaces are provided, accommodating 30 containers.

FastShip Atlantic Transfer System and Pier Interface

The original FastShip Atlantic plan called for the strings of containers to be aligned and transported on and off the ship on Alicon air bearings. Each double stack 40' container would rest on a platform supported at each end by an air cushion "trolley". The trolleys would support a platform at each end, so that for 15 platforms to carry 30 containers, 16 trolleys would be needed. Each trolley would have four air cushion donuts (plenum chambers), at the four corners, and there would be a monorail guide slot with guide wheels down the center line of each trolley, to provide alignment. A reversible cab tractor tug, on large tires, and with a built-in air compressor, would be used to provide motive power to push the strings of Alicon platforms on board the vessel upon loading, and to draw them off in the unloading operation.

This system was abandoned in part because of the considerable weight of the trolleys which would be left on board the vessel on its marine voyage--which would cost additional fuel to move their dead weight. Another reason is that it is uncertain that a flat surface could be maintained at all times on the dock, and either a crack in the surface or failure of a plenum chamber could cause one of the trolleys to deflate on one corner, grounding the entire string of pallets (personal communication, David Giles).

For this reason, FastShip Atlantic decided early in 1997 to abandon the Alicon system in favor of a simpler rail transfer system. The basic idea is that conventional duo-rail track (like an ordinary railroad) would be built into the deck of the vessel, into the loading ramps, and on the dock. Under the new concept, the Alicon platforms would be replaced with container pallets, each to carry two 40' containers in double-stacked configuration. The cargo bays containing these pallets would be about 26' wide, would have three tracks across, and would be 24' high to allow the pallet and a double stacked container to be accommodated.

To unload the ship, a series of diesel-powered rail bogies (4-wheel trucks) would be rolled under the string of pallets along each track. The pallets would first be jacked up automatically to allow the bogies to roll underneath; then they would be jacked down onto the bogies and locked on. In this way, an entire string of pallets, with their double stacked containers, could be rolled off the ship at once. In the reverse movement, the pallets with their double stack containers would be rolled onto the ship, jacked up, the bogies rolled back onto the dock, and the pallets jacked down and locked onto the deck.

On dock, the rather high double stack container loads would be lined up on a transfer track parallel to a railroad system (standard gauge) yard track in a paved area. The containers would be transloaded to conventional double stack railroad well cars, or if desired single stack flatcars; or onto highway chassis for the landside movement.

The dock area would be paved around the tracks, and the ship decks would also be paved or provided with a flat surface, allowing roll on-roll off traffic also to use the vessels. (Railroad tracks are embedded in dockside pavement in many ports today, allowing trucks, chassis on rubber tires, rubber-tired cranes, port-packers and the like to easily cross the rails.) This feature is intended to render FastShip Atlantic of potential use to the military, should the vessels be needed to transport wheeled vehicles in an overseas operation. It would also provide the option of carrying some civilian roll on-roll off traffic in commercial service.

Fast Ship Transfer System as Modified for Study Purposes

The FastShip Atlantic system was modified somewhat for purposes of this study.

Our interpretation is that the container pallets used (see above) would be configured with a flattened inverted “U” section, having the lower container locked onto the flat upper surface of the pallet; and that there would be two downward extensions to bridge the gap from the platform area to the deck, with several inches of clearance. The jacking devices would be operated by hydraulics that would travel only a few inches—a greater distance up off the deck to clear the bogies, and a shorter distance back down to rest the pallets on the rail transfer system vehicles.

It is also assumed that the transfer system will be, for the purposes of this study, a series of electric-powered bogies linked together by a skeletal rail intermodal car framework, so that the entire track would be occupied by a single long articulated car. Horizontal flange-like extensions from the framework would provide positions onto which the container pallets could be locked down for the transfer movement. (This system is roughly based on a concept developed by the Norwegian sister company to FastShip Atlantic.)

Considering air quality problems in the LA basin, it is assumed that the transfer system would be electrified. A control/power car would be coupled to the landside end of each long articulated car, providing train-lined AC or DC power and commands for acceleration and braking control, hydraulic and pallet locking operations, etc. A centrally-positioned, conduit-type third rail could be used on the dock or both on the dock and extending onto the vessel--that is, an insulated “hot” rail, if used, would be sunk in a slot, and third rail shoes would be extended downward to pick up positive DC power (only DC power would be used for the track-based power supply system). The fast ships themselves would have to be set up for both diesel and electrified operation, because a similar, rail-based transfer system employed at a foreign port might be developed with diesel propulsion.

A conduit third rail is suggested instead of fixed overhead catenary or a lateral third rail, both as a safety measure and as a means of clearing the space above the containers to allow overhead cranes to work on the dock. Gaps in the running rails would allow the third rail shoes to pass at turnouts and crossovers. (Note however that other systems for providing electric power, including overhead catenary--using movable catenary on dock--might be possible.)

It should be noted that instead of electrification, another alternative to diesel for propulsion of the transfer cars could be CNG or LNG power. In this case, a small locomotive unit would be coupled to the landside end of each string of transfer vehicles, and the electric power train-lined through the cars to the motors, providing positive and negative DC power to each motor (parallel arrangement). This would simplify ship design by avoiding having to electrify track and third rails in the decking.

Yet another possibility would be to employ a dockside electric locomotive, which similarly would train-line power (third rail or catenary on dock but not on board ship) to the transfer vehicles. In other words, it would both propel itself and function as the power link to electrify the articulated transfer vehicles.

As with FastShip Atlantic, there would be tracks embedded in the ship decks very much like trolley track in a street. In fact, girder rail such as is used in light rail operations might be an option, if such is available (e.g. from European suppliers). Otherwise, conventional T-rail would be used, leaving a slot next to the head of the running rail and using a narrow guard rail to delineate the slot. The conduit third rail would be midway between the running rails, well-insulated, and embedded in the dock or in both the ship decks and dock, i.e. the space between running rail and the slot would be paved, as was done in streetcar operations many years ago, with conduit power supply.

The essential elements of this system are important to understand not only for a transfer operation from dockside to fast ship, but also for the automated inland transfer system, which for purposes of this initial study would be compatible with, and partially based upon, the fast ship transfer system. In particular, this compatibility would remove (or make unnecessary) any extra lifts; preferably not requiring a container lift to the fixed guideway conveyance system.

The exact design of the ramps leading from the fast ship to the dock, the specifics of the shoreside facility, and the movement of transfer vehicles connecting ship and shore will not be considered in great detail here. However, the fast ship would have two or more deck levels occupied by containers, requiring ramps up and down from the fixed level of the dock, as well as the capability of adjusting these ramps because of tides or weather-induced changes in sea level. These ramps would accommodate a maximum 6% grade (a lesser grade would be desirable). They would also provide beveled rail ends or such, to accommodate to a changing ramp elevation, and ability to lock into the stern of the fast ship to precisely align the track on board the vessel, with the track built into the ramps.

Since our transfer system is presumed to be electrified, a key element of docking the vessel and locking the loading ramp to the ship, would be the electric power connection. The provision of a moving ramp could complicate this, as the third rail and running rails (ground) would have to be connected to the shoreside power system. Rather than worrying about connecting with the rails of each track on board the vessel, it would probably be easier to have a separate power cable and ground plugged into the vessel, that would be connected through insulated lines to each running and power rail (for an assured connection, this arrangement might be doubled). Coupling up to the dockside power supply would be one of the first things done as soon as the vessel is tied up at the dock.

It would also be possible to have shoreside rail automation controls built into this coupling, providing a means of signaling/automatic train control for the transfer vehicles while on board ship. This coupling might resemble somewhat the kind of plug-in arrangement incorporated into the couplers of multiple unit transit equipment, except that in this case traction power would also be included. It should also be possible to operate the transfer vehicles from a control on board the vessel; perhaps a radio-control option would be provided. Finally, it is noted that the same kind of power/control connection from shore to ship would be provided to all tracks of the loading ramps.

The fast ship itself would have a series of parallel tracks on board for each deck, and for a broad-beamed vessel these tracks would run in parallel right up to the stern of the ship. The ramps might be designed with multiple tracks leading from the vessel (requiring a more massive structure) or with a narrower ramp that would swing horizontally to sequentially access different tracks. (A third possibility might be to employ ladder tracks, with switches, on board the stern of the vessel.)

Regardless of the method used, there would be a narrow throat of one, two, or more tracks leading between the ramp(s) and the yard on shore. On dock, there would be several ladder tracks allowing loaded transfer vehicles to run onto the ship to drop off their cuts of export containers, and permitting empty transfer vehicles to run on board and pick up the import containers.

Operationally, assuming that each deck is loaded from one set of ladder tracks, the first transfer vehicle to enter the ship would be an empty (articulated) car, which would enter the ship once and withdraw with a cut of import containers. The second vehicle would be loaded with export cargo, and would pull up on the track just vacated, to drop off its string of export containers. It would then withdraw back into the yard, and move forward again onto the second track on the ship, to pick up loaded import containers.

The third vehicle would unload and load in the same way (entering the ship two times), and so forth for all of the remaining transfer vehicles as they work their way from port side to starboard side (or vice versa) across the ship's deck. At the end of the cycle, the last transfer vehicle with export containers on the dock, would run in and drop off its containers on the last track, and pull back having been on the ship only once.

For multiple deck levels, this operation would take place in parallel, using another set of ladder tracks on shore. If it were desired to load/unload faster on each deck, more than one ladder track and loading ramp arrangement would be needed.

Fast Ship Loading/Unloading Rate

The intent of the Agile Port system is to have a transfer system capable of unloading a container ship at a rate of up to 1000 containers per hour. A quick examination of the container transfer system considered here is in order, i.e. can the system as described unload a fast ship at this rate?

The individual tracks on the vessel are assumed to be 750' long. Assuming that the transfer system conveys the container pallets off the ship at an average rate of 5 MPH (about walking speed; but this would include acceleration from a standstill, so the maximum speed on the boat would be a little faster), this would mean 1.7 minutes to roll each cut of cars off one of the fast ship decks (750'/5 MPH x 1 mile/5280' x 60 minutes/hour = 1.7 minutes to unload each).

Assuming that both decks are unloaded simultaneously, 1.7 minutes times 12 tracks would mean 20.4 minutes for the 360 containers on each deck. Of course, there would be additional time involved, to jack up and lock the container pallets, switching movements on dock, etc., so this time can be assumed to be increased to a more liberal 40 minutes per 360 containers per deck. However, since there are two decks being unloaded simul- taneously, the actual unloading rate would be 40 minutes per 720 containers. Using a ratio of 1000 containers/x 720 containers/40 minutes, the unloading time would be 55.6 minutes for 1000 containers.

The actual unloading rate could be doubled if it were decided to unload half of each deck (port and starbord side) independently, and for both decks as before. This would bring the unloading time down to 1000 containers in 27.8 minutes—considerably shorter than one hour! Hence, it appears to be highly feasible to unload at the rate specified, which is extremely important in terms of increasing ship productivity: reducing unproductive down time at the dock, turning the ship around faster and permitting more runs per year.

The above, considering that there will be a corresponding (and partially simultaneous) loading operation in normal commercial operations, suggests that loading plus unloading might be accomplished in as short a time as 56-111 minutes. This makes it highly credible that the time in port for a fast ship could be as short as 4 ½ to 5 ½ hours, as has been suggested.

Note that the unloading rate for the ship is not the same as the rate of transport inland. The containers would have to be transferred to highway chassis, ChassisRailers, or automated vehicles somewhere, either on dock or inland. This additional transfer time required to handle the containers could easily slow the inland transport rate to far less than 1000 per hour. It is this time differential that an agile port should seek to minimize.

Vessel Schedules and Possible Routes

Vessel schedules will have to offer calls at least several times per week and preferably at least once per day for the speed of the ship to significantly affect the shipping decisions of potential customers. If fast ships operate on less frequent schedules than other container ships, the transit time advantage of fast ships in the ocean movement would be partially undercut, and the frequent calls of the existing liner services might effectively allow them to offer the same delivery times at a lower cost. (It is, after all, ship frequency, turn-around time, and the ability to simplify the string of activities entailed in providing service from ultimate shipper to ultimate receiver, and not the cost of the vessels per se, that determines the attractiveness of a shipping service.)

The most likely routes are those where the vessels can offer their customers the greatest time savings, meaning routes that traverse the greatest distances. For southern California's regional ports, this means that the most likely routes are trans-Pacific to North Asia (Japan/Korea/China) or Southeast Asia (Taiwan, Hong Kong, Singapore). We assume hub port to hub port operations with surface transportation and/or feeder vessels linking fast ships to ultimate cargo origins and destinations.

Cargo Flow Logistics

The emergence of/worsening of world-wide congestion points in the future will affect routing and service offerings, i.e. the stopping points for containers and lines of least resistance must contribute to shortening the ultimate origin-destination time of shipments. As an example, if container traffic is congested and thus suffers delays in San Pedro Bay, then an alternative routing for Midwest-to-Far East traffic via Suez Express service calling on the US East Coast, may affect cargo potential for the SCAG region. Similarly, inland congestion could cause unwanted and undesirable deviations of traffic. Hence, the concept is to provide a door-to-door flow and furnish a service system with very reliable service performance.

Section 4: Fast Ship Cargo Forecasts

Potential Fast Ship Cargo

For this study, total demand was estimated for local transportation of potential fast ship cargoes flowing through the region's ports on a directional and commodity basis. We have also estimated the current and future share of the potential fast ship cargo that would move to and from specific alternative delivery system station areas. The methodology for local zonal forecasts used weighted employment classifications aggregated by ACG or ChassisRailer station catchment or service area to distribute the local fast ship traffic. A more comprehensive study would require shipper preference data matched against specific design and operational choices for comparison and estimation of the elasticity of demand for local transportation alternatives at the zonal level.

For purposes of this analysis, there were several variables used to model the likely share of future freight that the fast ships and local transportation alternatives could potentially capture. Separately by direction, there are implicit four key variables in this model:

- Fast Ship potential cargoes traveling by sea in the baseline forecast
- Fast Ship potential cargoes traveling by air in our baseline forecast
- The local, regional share as opposed to the inland share (long haul or bridge traffic) of cargo flowing through the region
- Growth in trade by commodity by route

Without measurements of actual shipper or carrier preferences, scenario analysis was used to bound the likely diversion to fast ships, of what would otherwise be air and conventional liner cargo. There is one 'high' and one 'low' diversion scenario, each representing different levels of fast ship penetration into air and conventional container ship freight volumes. Estimates included the value and weight share of trade by mode. Assumptions about relative service sensitivity on a commodity-by-commodity basis were prepared separately for sea and air cargoes, converting forecast weights to container volumes for the potential cargo carried by fast ships.

These factors are intended to reflect the value of the commodities, their weight, and the time sensitivity (such as for refrigerated cargo) of the freight. For air we used all air cargo as our starting universe of trade; for sea we considered only containerizable commodities.

The baseline traffic growth forecast to 2020 is from the ICF Kaiser Global Trade model. This model forecasts global trade on a commodity-by-commodity and trade partner-by-trade partner basis. For the US, the historical data is provided by the detailed merchandise trade statistics published by the US Department of Commerce, classified by Harmonized System commodity group and trade partner. The baseline US trade forecast is disaggregated geographically by groups of US customs districts. Individual industry production and consumption forecasts, matched against commodity categories, drive the demand for trade between countries.

The underlying US and international macroeconomic projections derive from the long term forecasting models of the WEFA Group. The standard ICF Kaiser Global Trade model does not forecast trade at the port level, and so no attempt was made in this study to newly forecast overall trade for specific southern California regional ports.

For the potential fast ship share of trade through the SCAG region, we considered all trade through the US South Pacific coast, to allow for the potential of the fast ships to attract cargoes from beyond the immediate SCAG area. As in earlier studies, traffic volumes were judged by volume of commodities moving in the trade, though the economic demand variables for commodities are represented in value terms. Products that could be carried by fast ships, airplanes, and conventional container vessels are already included in the ICF Kaiser Global Trade Model. Though it is difficult to characterize each of these products in terms of their potential for fast ship carriage, we based the forecast, in part, on the relationship between value and weight of the commodity groups.

We used as our baseline, historical and forecast shipment data for those products carried by air or on traditional ocean borne container vessels. For ocean cargo, all traded products were first classified into a type of carriage based on the type that predominates, i.e. has the highest share of total traffic for the individual product category. Using this approach we identified potential airborne and ocean borne shipments for diversion to carriage via a combination of fast ships and the alternative ground conveyance systems (ACG or ChassisRailer).

Our potential fast ship cargo forecast is presented for the high and low market penetration scenarios in Figures 4.1 and 4.2 for import and export cargoes respectively, measured in Twenty foot Equivalent Units (TEUs). A detailed TEU table with this forecast can be found in Appendix A.

Figure 4.1

Total Potential SCAG Region Fast Ship Import Cargo
1997-2020 in TEUs

Figure 4.2

Total Potential SCAG Region Fast Ship Export Cargo
1997-2020 in TEUs

The aggregate potential fast ship cargo forecast ranges from a total of approximately 100,000 TEU to about 230,000 annual TEUs today, under the low and high penetration scenarios respectively. As this volume is spread across all trade lanes using the ports in the SCAG region, the required fast ship frequency of service today for any one specific trade lane is unlikely to be more than once per week, which would limit the amount of cargo for which fast ships could effectively compete.

However, looking out towards 2020--the end of the forecast period--the forecast potential fast ship cargo is much larger. The 2020 level of fast ship cargo ranges from 462,000 TEU to about a million TEUs annually, under the low and high market penetration scenarios respectively. This means that by 2020, there are ocean trade lanes where the potential volumes are large enough to fill fast ships offering frequent enough service for this mode to be theoretically viable.

These total potential fast ship cargo forecasts demonstrate however not the viability of the fast ship operation itself, but rather, that the classes of cargo which are the target for fast ship service will grow to volumes that could utilize or fill the capacity offered by fast ships offering a frequent schedule. There are service-related factors associated with the fast ship mode, such as the potential for these high-speed vessels to carry traffic that "missed" a regular liner shipment, which can pertain to cargo of any value if the shipment is required to satisfy a particular shipper commitment or link in a logistic chain. However, this kind of factor is difficult to document in terms of forecasts, especially when there are not, as yet, any fast ships in commercial service.

For purposes of analysis of the alternative delivery systems to serve the ports, those cargoes originating in or destined for the local SCAG region are those that are primarily applicable to our analysis. For both efficient service and cost minimization reasons, the inland bridge cargoes will likely be carried on double stack container trains offering direct service to the ports using the Alameda corridor. The use of container well cars for regional container traffic to and from the ports, on the other hand, is not likely under nearly all scenarios due to reasons of cost and because of the railroads' desire to use their capacity for the more profitable long haul traffic. Calculation of the portion of the total potential fast ship cargo applicable to the region is then needed for further analysis of delivery systems for the SCAG region, and for analysis purposes this will be assumed to be comprised only of local traffic.

Previous studies for the Port of Los Angeles and the Port of Long Beach have estimated various shares of the Ports' container traffic that are 'local'. In general, these shares fall within a range of about 50% to 60% of the containers handled by the ports; i.e. about half or a little more than half of the marine containers through these ports, originate in or are destined for the SCAG region. For purposes of our analysis, we have assumed a constant share of 55% of total potential cargoes to be SCAG regional traffic.

Geographical Dispersion of Forecast Cargo

For analysis of the alternative delivery systems, the distribution of the potential fast ship cargo is required for each of the areas surrounding proposed or likely freight station sites. Several data bases were available to assist in this effort--including a file on cargo presently transported to/from congressional districts within the region; also SCAG employment forecasts with considerable detail on employment categories but aggregated by county, and other SCAG employment forecasts with only a few categories, distributed by Transportation Analysis Zone (TAZ).

Using primarily the SCAG regional employment projections, estimates were prepared for the share of potential cargo under both high and low market penetration scenarios for the employment base year of 1994 and the year 2020, by automated container guideway system station zone—the same zones being generally assumed also for ChassisRailer. The methodology uses a weighted average of employment by category, aggregating up from the individual SCAG regional TAZ figures, to apportion the SCAG region's potential cargo for each freight station catchment area.

In the allocation process, we used "retail employment" (reflecting in part consumption of import retail goods) and "other employment" which includes manufacturing. We did not use "service employment", as this is farther removed from freight imports and exports. The total potential fast ship cargo levels originating or destined for each ACG or ChassisRailer freight station area by the year 2020 are presented in Table 4.1 below.

Note that the largest concentration of forecast fast ship cargo is destined for or originating in the Carson zone surrounding the Ports of Los Angeles and Long Beach; Zone 16 per Table 4.1 accounts for about 11% of the SCAG region's potential fast ship cargo. This traffic would not originate in, nor would it be destined for, any of the zones served by any automated container guideway system or ChassisRailer station providing inland delivery service for the San Pedro Bay Ports. The next largest concentration of potential fast ship cargo is destined for, or originating in, the Commerce zone that includes the Los Angeles city center.

Table 4.1

Potential SCAG Region Fast Ship Cargo
by Delivery System Station Zone
in TEUs for 2020

Station Zone	Total TEUs (High)	Total TEUs (Low)
1 - Chatsworth	33883	15074
2 - Van Nuys	19764	8793
3 - Commerce	67320	29949
4 - Irwindale	14845	6604
5 - Industry	22586	10048
6 - Pomona	31924	14202
7 - Ontario	23070	10263
8 - Norton AFB	23041	10250
9 - March AFB	10321	4591
10 - La Mirada	14766	6569
11 - Fullerton	28219	12554
12 -Tustin/Santa Ana	43016	19137
13 - Irvine Spectrum	20282	9023
14 - Corona	5269	2344
15 - Hemet	5613	2497
16 - Carson	147875	65786

Though the total cargo volumes are important for revenue estimation and system activity planning, it is important to understand the directional movement of cargo using the transport system. In Table 4.2, below, the potential fast ship cargo is separated by direction of trade for both the high and low market penetration scenarios.

Table 4.2

Comparison of Import and Export
Potential SCAG Region Fast Ship Cargo
by Delivery System Station Zone
in TEUs for 2020

	Exports TEUs		Imports TEUs	
Station Zone	(High)	(Low)	(High)	(Low)
1 - Chatsworth	12542	6443	21341	8630
2 - Van Nuys	7316	3759	12448	5034
3 - Commerce	24920	12802	42401	17147
4 - Irwindale	5495	2823	9350	3781
5 - Industry	8361	4295	14226	5753
6 - Pomona	11817	6071	20107	8131
7 - Ontario	8540	4387	14530	5876
8 - Norton AFB	8529	4382	14512	5869
9 - March AFB	3820	1963	6500	2629
10 - La Mirada	5466	2808	9300	3761
11 - Fullerton	10446	5366	17773	7188
12 -Tustin/Santa Ana	15923	8180	27093	10957
13 - Irvine Spectrum	7508	3857	12774	5166
14 - Corona	1950	1002	3319	1342
15 - Hemet	2078	1067	3535	1430
16 - Carson	54738	28121	93137	37665

The imbalance in volumes between import and export cargo is marked. This is relevant to the Agile Port concept as the continued capacity demands for handling import cargo will mean that at least some of the potential military demands for outbound deployment of equipment, supplies, and other materiel might be accommodated without disrupting commercial users of the alternative delivery systems. This subject will be examined further in Section 8, below.

A factor which has reinforced the project team's decision to relate the allocation of potential container cargo on employment, has been the projected growth of air freight to/from the SCAG region as this pertains to the probable future development of air cargo capacity at existing airports and potential new facilities using converted or jointly-used military bases, at locations including those in the Inland Empire. Air cargo requires consolidation and deconsolidation activities (e.g. container stuffing and stripping), functions which are tending to move away from, or to locate peripheral to, the airports due to land values/space availability. This creates a need to dray air cargo containers to/from said consolidation/deconsolidation sites. Such sites are likely to be in close proximity to light manufacturing, warehousing, truck terminals/truck stops, intermodal railyards, etc.

As more and more firms are specializing in these value-added services, it may become attractive to have common facilities to do this for air cargo, domestic LTL freight, and import/export LCL shipments. This could be rendered more attractive if the sites used for such activities could be serviced by reliable inland truck drayage or fixed guideway transport systems as envisioned in this report.

The aforementioned would aid the potential for fast ship-air intermodal cargo transfer (generically, sea-air/air-sea shipments) and probably more importantly, in light of the current focus on just-in-time delivery (JIT), it would facilitate diversion of cargo depending upon shipment priority between alternative long-distance modes for international shipments such as air cargo, fast ship, and regular container liners; and between air, truck, and rail intermodal for long-haul domestic shipments.

Total San Pedro Bay Ports Maritime Container Cargo Forecasts

Though the alternative conveyance systems discussed in this report would primarily designed for fast ship cargo, other freight could also use these transport facilities. The most likely additional cargo customers for these conveyance systems, in a common user operation, would be regular container ship liner traffic, traveling on conventional cellular container ships. The universe of this traffic would encompass potentially all maritime container traffic moving to and from the ports, that originates or terminates in the SCAG region. Except for the Port of Hueneme, the current volume of this container traffic dwarfs the level of traffic that could competitively use fast ship service. Assuming the same 55% local share used above for the Ports of Los Angeles and Long Beach, the 1996 container volume for which the alternative conveyance systems might compete, is over 3.1 million TEUs.

In this study, no independent forecasts of overall San Pedro Bay port container traffic volumes were produced. Instead, we used existing Los Angeles and Long Beach port forecasts to 2020, from the WEFA Group. With the 55% local share assumption, the total local container traffic moving to and from the ports by 2020 will be over 6.9 million TEUs. The portion of this traffic that is likely to be attracted to the alternative conveyance systems under current assumptions of port area land use, etc., is probably low. However, from such a large base, the total volumes could be significant.

Section 5: Inland Conveyance System Route Network and Transit Time

Route Structure for Conveyance System Alternatives

Local inland freight origin/destination zones were developed with reference to existing and future manufacturing and warehousing areas using SCAG's Geographical Information System (GIS) maps (Figure 5.1), supported by a general knowledge of the pattern of freeways and railroad main lines; the locations of major rail yards, trucking terminals, and airports (including former military air bases with air freight potential); and the localities where freight consolidation/forwarding activity presently occurs. The expectation of employment growth and future major freight activity in certain areas (e.g. in the Inland Empire and southern Orange County) was also factored into the development of these zones (Figures 5.2, 5.3).

The freight origin/destination zones themselves were developed so as to be about 10 miles in diameter or larger (with larger zones especially farther east in the Inland Empire), each with a candidate freight station located in a "seaward" direction from the geographical center of the zone, and placed along a major transportation facility (railroad or freeway alignment). The off-center position of the freight station in these zones reflects the expectation that local trucks headed towards the stations would more economically move towards the ports en route to the transfer facility.

The freight zones with relevance to the development of inland conveyance systems are as follows (see also Figure 5.4):

- Western San Fernando Valley/Santa Clarita Valley
- Eastern San Fernando Valley/Burbank
- Central Los Angeles area with Glendale and western San Gabriel Valley
- Northern San Gabriel Valley, including Irwindale
- Southern San Gabriel Valley, including El Monte and Industry
- Pomona area, with Chino and Corona
- Ontario-Fontana-Rialto, with Riverside. This would include Ontario Airport, a major air freight activity area.
- San Bernardino and Colton. This would include a potential inland port site at Norton AFB, major UPRR yards in West Colton and BNSF yards in San Bernardino
- Moreno Valley-Perris-Hemet. This would include a potential inland port site at March AFB
- Santa Fe Springs-Norwalk-Buena Park
- Northern Orange County - Fullerton, Anaheim, and Placentia

- South-Central Orange County - Santa Ana, Tustin, and Costa Mesa
- South-Eastern Orange County, including Irvine Spectrum
- Southern LA County, downtown LA to the San Pedro Bay ports, including Carson and Long Beach

Considering that there are two port areas in the study—San Pedro Bay Port area which comprises the Ports of Los Angeles and Long Beach, and the Port of Hueneme in Ventura County--and that there are several likely geographical corridors, with major transportation facilities at present, it was decided to establish three major potential inland routes: each served by at least one fixed-guideway conveyance system and linking a number of the freight catchment zones listed above, with a freight station in each zone. In addition to the basic routes, several variations and branches were also developed.

For each major corridor served by a fixed guideway mode, a truck drayage alternative was developed from each major port area to the same freight zones. Unlike the fixed guideway alternatives, trucks have considerable flexibility of operations and would be free to follow any of a number of parallel freeways. Hence, the specific route from either port area, to any specific inland freight zone may not be along the same freeway or combination of freeways, as that used to reach another freight zone along the same broad corridor.

The following major routes were established to connect the ports with these potential service areas, via fixed guideway systems following railroad lines, freeways, and/or utility rights-of-way:

1. San Pedro Bay Ports to San Bernardino. Alternatives considered for this route complex are truck drayage, ChassisRailer, and ACG
2. San Pedro Bay Ports to Irvine Spectrum. Primary alternatives considered for comparison are truck and ACG. However information has also been compiled for a possible ChassisRailer alternative.
3. Port of Hueneme to San Bernardino. Alternatives considered for this route are truck drayage and ChassisRailer.

These system routes are mapped in Figures 5.5-5.7.

Several extensions from/variations of these basic routes have also been considered. For route 1, an ACG branch line might extend to Irwindale. There is also a branch line alternative from Colton south to March AFB, and there are several railroad routes possible for service between downtown LA and the Riverside area.

For route 3, a branch line has been considered from downtown LA to Carson. This would allow major existing freight consolidation and freight forwarder facilities in Carson, South Gate, Long Beach, and other cities in this area just north of the San Pedro Bay ports, to be accessed by ChassisRailer from the Port of Hueneme.

Detailed descriptions of these transportation routes are given below:

Routes Between San Pedro Bay Ports and The Inland Empire

For route 1, the following is assumed for the three modes, in comparisons of travel time and costs done in this study.

The ChassisRailer technology option would utilize this basic route: Alameda Corridor north to Vernon, east on UPRR to East LA Yard, old UP main line east to Pomona, old SP main line (now UPRR) east to Ontario and Colton, extension along the Yuma Line to the vicinity of Loma Linda, and new right-of-way north to Norton AFB. Approximate locations of stations would be in the Commerce area, at the west end of Industry (truck drayage used from there to Irwindale up the 60 and 605 Freeways), at the west end of Pomona, in Ontario east of Ontario Airport, and at Norton AFB on the east side of San Bernardino.

A major alternative route between Vernon and the San Bernardino area would be to follow the BNSF main line (with stations in western/northern Orange County), through Fullerton and east to Riverside and Colton, and thence to the San Bernardino yards of the BNSF or Norton AFB via the UP line.

There are also several possible railroad routes that could access March AFB as an alternative inland port site. One would follow the UPRR route as above except following the old UP main line from Pomona to Riverside, the former SP Riverside Branch from downtown Riverside to the former ATSF San Jacinto Subdivision (now county owned), and San Jacinto Subdivision South to March AFB near Moreno Valley. The other way to access March would be to follow the BNSF main line to Riverside, and the Riverside Branch and San Jacinto Subdivision thence to March.

For the ACG option, the following basic route would be used: Alameda Corridor north to the 91 Freeway, SR-91 east to 710 Freeway, the 710 Freeway and/or river channel/utility right-of-way north to Commerce, and the old UP main line east to Industry. At the west end of Industry there would be a branch line north along the 605 Freeway to Irwindale; the main trunk line would continue east along the old UP main line to Pomona, thence along the former SP main line east to Ontario and continuing along the same railroad line and the 10 Freeway to Colton. At Colton it would follow the 10 Freeway east to Loma Linda, and a new alignment north to Norton AFB.

Freight stations would be located in the Commerce area east of the 710 Freeway, in Irwindale off the 605 Freeway (branch line), at the west end of Industry, at the west end of Pomona, in Ontario east of the Airport, and at Norton AFB. The stations in Industry, Pomona, and Ontario, and at Norton, are assumed to be in the same locations as those assumed under the ChassisRailer option, and the Commerce station would be in approximately the same place.

Note that all of the ACG segments following railroad lines or freeways are assumed to be on aerial structure. No sharing of railroad track between the specialized ACG system and the general system of railroads, or taking of freeway lanes is considered.

The ACG option would access March AFB by diverting from the above route at Old Colton Yard, running down along the Santa Ana River to the old SP Riverside Branch, thence crossing over to the BNSF main line at Grand Terrace (215 Freeway), and going south to the old SP Riverside Line in northeastern Riverside. It would use the 215 Freeway alignment past the University of California at Riverside and then the San Jacinto Subdivision and/or the 215 Freeway south to March. This branch to March AFB would have the latter as its only additional station stop.

The truck drayage option would begin at the south end of the 710 Freeway, and route trucks to the Commerce area entirely along 710. Other truck traffic serving the same freight catchment areas as the fixed guideway options would be routed east along the 91 Freeway, and north along the 605 Freeway. At the junction of the 605 and 60 Freeways, trucks to the Irwindale area would continue north along the 605, while other trucks would be routed east along the 60 Freeway. Trucks would continue east on the 60 to Ontario, where they are assumed to go north along the 15 Freeway and then east along the 10 Freeway to Colton/San Bernardino, and the vicinity of Norton AFB.

For trucks that might serve an inland port at March AFB, the route taken would follow the 60 Freeway from Ontario to Riverside, and then the 215 Freeway south to March AFB. Other than assumptions about possible inland ports at Norton AFB and March AFB, there are no special truck freight stations assumed. Trucks would follow local arterials to various origin and destination points, in the same areas served by short truck drays under fixed guideway options.

A variation used for transit time in truck drayage, per the following section of the report, is operation over an assumed truck lane system using truck lane projects as proposed in the Draft 1997 Regional Transportation Plan (RTP). This does not, however, result in a change in truck route for purposes of this study. The basic route from the ports to Industry, the Pomona Valley, Ontario, and San Bernardino is assumed to be the same, following a route that utilizes truck lanes along the 710, 91, 605, and 60 Freeways, with the truck lane system ending at I-15 east of Ontario.

[Subsequent to this analysis being conducted, note the truck lane system was reconfigured in the Final Plan to run north from the Ports and east towards the Inland Empire, entirely along the 710 and 60

Freeways. However, it is believed that this will not result in any significant changes in the results of the inland conveyance system vs. truck drayage comparisons made in the Agile Port Project.]

Routes Between The San Pedro Bay Ports and Orange County

For route 2, the following is assumed for the ACG and truck drayage modes.

For the ACG alternative, this route is assumed to run north along the Alameda Corridor to the 91 Freeway, thence east along this freeway to Cerritos/La Palma, where it would turn northeast roughly following Coyote Creek, to the BNSF main line in Buena Park. It would continue east along this railroad line to Fullerton, south and east along the Orange Subdivision rail line owned by Orange County (formerly ATSF) to the 57 Freeway in Anaheim (at Anaheim Stadium), again south along the freeway to the Orange Subdivision line again in Santa Ana, and thence run along the railroad line down to Irvine Spectrum, ending in the vicinity of El Toro MC Air Station.

Freight stations would be located in La Mirada near I-5, in Fullerton on the Orange Subdivision, in Tustin near the 55 Freeway, and at Irvine Spectrum near Alton Parkway, perhaps at El Toro, particularly if it is to become an air cargo facility. As with the longer, northerly route to San Bernardino, all of the segments following railroad lines or freeways are assumed to be on aerial structure. No sharing of railroad track, or taking of freeway lanes is considered.

The truck drayage option, which is the major comparison with ACG for this route, would really comprise two routes depending upon whether cargo is bound for northern Orange County or central/southern Orange County. For the comparison with ACG La Mirada and Fullerton freight station access, the assumption is that trucks would be routed north along the 710 Freeway, and east along the 91 Freeway to Fullerton.

For the comparison with the Tustin and Irvine Spectrum freight stations, it is assumed that trucks would be routed north on the 710 Freeway to the 405 Freeway, thence east to Costa Mesa/Irvine (access to Tustin via the 55 Freeway or arterials) and to the Irvine Spectrum via the 405 Freeway as far east as Irvine Center Drive (access to shippers in this part of Irvine via arterial highway).

While a ChassisRailer option has not been studied in detail for this corridor, there would be two possible ways to route the rail intermodal equipment into Orange County. One is to run north along the Alameda Corridor to Redondo Junction in Vernon, and follow the BNSF main line past Hobart yard and down into Santa Fe Springs/La Mirada and Fullerton. The continuation down to Tustin and Irvine Spectrum would follow the Orange Subdivision. Stations accessed might include Commerce, either Santa Fe Springs or La Mirada, Fullerton, Tustin, and Irvine Spectrum.

The other possible way to route ChassisRailers from the San Pedro Bay ports to Orange County would be to run north on the Alameda Corridor main line to Compton, follow the slower, surface drill track along Alameda St. north to Firestone Blvd., use the Y track to turn east onto the UP Santa Ana Branch (formerly SP), and continue on the Santa Ana Branch to La Mirada. At La Mirada a short strip of new

R/W would be required, approximately following Coyote Creek over to the BNSF main line. The route would continue on the BNSF to Fullerton, and follow the Orange Subdivision down to Tustin and Irvine Spectrum as in the above. Stations would be located in La Mirada, Fullerton, Tustin, and Irvine.

It should be noted that a ChassisRailer service following the BNSF main line east to Fullerton and the Orange Subdivision to Irvine Spectrum could be continued south to access the Camp Pendleton area and San Diego. (It follows that service by ChassisRailer from San Diego towards Orange County and Los Angeles County by following this route in the reverse direction, would also be possible if fast ship were established at the Port of San Diego. Such a service could also access the Inland Empire via the Olive Subdivision and the BNSF main line to the east. This alternative, however, is beyond the scope of the current study to evaluate.)

Routes Between the Port of Hueneme and LA, San Bernardino, Riverside, and Orange Counties

For route 3, the following is assumed for the ChassisRailer and truck drayage modes in comparisons of travel time and costs done in this study.

For the ChassisRailer option, the route followed onward from Port Hueneme would use the north branch of the Ventura County Railway to access the former SP Coast Line (now UPRR) in downtown Oxnard. It would proceed east along the Coast Line through Camarillo and Simi Valley to the San Fernando Valley. It would continue over the Coast Line which runs diagonally across the Valley to Burbank Junction where the Saugus Line comes in, and thence south on the Coast Line past LA Union Station, staying on the east bank of the LA River on the River Line (former UP, now Metrolink-owned) to Bridge Junction, where the Alameda Corridor will cross the river.

The route to San Bernardino could follow the old UP main line through East LA Yard in Commerce, go east to Industry and Pomona, and transition east of this point to the old SP main line to access Ontario. It could then continue on to an inland port facility at Norton AFB. ChassisRailer freight stations unique to this scenario are assumed to be located at Chatsworth in the western end of the San Fernando Valley, and in Van Nuys/North Hollywood west of the Burbank Airport in the eastern end of The Valley. Other freight stations could be in Commerce, Industry, Pomona, Ontario, and San Bernardino as described above for Route 1 above.

A branch of this basic trunk line could be extended south from the LA Central Business District to Carson using the Alameda Corridor. This would probably diverge from the other service near Union Station, running down the east or west bank of the LA River, and accessing the Alameda Corridor near the Amtrak roundhouse and J-Yard, above Vernon. This branch would then continue down the Alameda Corridor and end somewhere near Dominguez Junction below Compton, just south of the point where the depressed trainway comes to surface. The object of this route would be to access freight forwarders and consolidators/deconsolidators already established near the big San Pedro Bay ports. (Automobiles that arrive by ship at Pt. Hueneme are already trucked to Carson, so it is not unreasonable to expect this kind of movement could be made by ChassisRailer.)

To return to the route from Port Hueneme to the eastern LA County and the Inland Empire, of course most of the route variations described above for the ChassisRailer under Routes 1 and 2 could also be developed for this service. That is, it would be possible to reach March AFB via the old UP main line from Ontario to Riverside, or via the BNSF main line via Fullerton and Riverside. It would also be possible to access the BNSF yard facilities at the west end of San Bernardino from the BNSF main line (or the UP for that matter). And, to serve Orange County, the BNSF main line and Orange Subdivision would be followed south and east from Commerce to Irvine Spectrum as discussed under the route 2 railroad option.

An alternative route to the east of the Los Angeles city center that became apparent at the very end of the study, would depend on a cooperative venture with Metrolink to avoid possible congestion and slow running through the big downtown rail yards of the UPRR and BNSF, and perhaps elsewhere. Under this scheme, ChassisRailer trains could operate at a high rate of speed (70 MPH or faster) similar to Metrolink trains; as light weight freights running in short, fast consists, this kind of container transport service might very well be compatible with the passenger operations.

The Metrolink joint use concept would have ChassisRailer intermodal trains run from Port of Hueneme to downtown LA as above, and employ a combination of the former SP Alhambra line and possibly also the Metrolink State Street Line (which could be operated as paired track with the Alhambra Line) east to El Monte, thence continuing along the Alhambra Line to Bassett at the west end of Industry (Metrolink owns one of the tracks on this segment of R/W). The route would extend north and east on the former SP Baldwin Park Branch through Covina to Pomona where the commuter trains transition to the former ATSF Pasadena Subdivision (the State Street Line, Baldwin Park Branch, and Pasadena Subdivision are now county-owned railroad lines used by Metrolink).

The route would continue farther east through Claremont and presumably follow the Pasadena Subdivision through Rancho Cucamonga (the industrial section contiguous with the big industrial park area of Ontario) and thence to Fontana and Rialto. The ChassisRailers would then join the BNSF main line, passing their yards in San Bernardino, and get onto the UP line in Colton, with the possibility of accessing Norton or March AFB as described elsewhere. (The segments of the Baldwin Park Branch right-of-way easterly from Claremont as an alternative to the current Metrolink line, have recently been converted to trails.)

Stations, other than in the San Fernando Valley, might include the old SP LATC facility, currently slated for closure; an industrial location in El Monte; Irwindale on the Baldwin Park Branch; somewhere in the San Dimas/La Verne area; Rancho Cucamonga north of the Ontario Airport; and San Bernardino.

This kind of operation would hinge on the availability of track space from Metrolink, in turn related to their future year headways on the San Bernardino Line; the ability of the ChassisRailers to completely clear the line for passing passenger trains; and possibly on participation on the part of the ChassisRailer operator in some Metrolink track expansion projects (double tracking, etc.). It would on the other hand provide an opportunity for Metrolink to earn some additional income, from track fees.

The truck drayage option for fast ship service to Port Hueneme would entail a number of routes, depending upon the ultimate inland destination. For truck access to the San Fernando Valley, it has been assumed that the 101, 23, and 118 Freeways would be used (although there are other arterial routes that might substitute for this, including the Route 118). The industrial area in the northwestern end of The Valley is close to the 118 Freeway, and that in the eastern end of The Valley could be accessed via the 118 and 5 Freeways.

Access by truck to the freight catchment areas near downtown LA/Vernon/Commerce however is assumed to be via the 101 and 134 Freeways to Glendale, and the 5 Freeway below this. Service to Industry would probably be via the 60 Freeway east of the Commerce/East LA area. Access to Irwindale on the other hand is assumed to be via Route 118 across the north end of the San Fernando Valley, thence via the 210 Freeway to Pasadena and east to the 605 Freeway.

Similarly, it is assumed that access to Pomona would be via a continuation along the 210 Freeway, and down SR-71. To reach Ontario, the 10 and 60 Freeways would be used (the latter especially if truck lanes are constructed). Access to San Bernardino might be via the 10 Freeway along; a combination of the 60, 15, and 10 Freeways; or the new 30 Freeway.

Access to Orange County would probably be via the 101 Freeway and then the 5 Freeway southeast of downtown Los Angeles. Finally, a route to Carson would be via the 101 to North Hollywood, and then via the 405 Freeway all the way to the Carson area (which would apparently be faster than via the 5 and 710 Freeways).

Truck Times and Distances

Based on data from the Draft 1997 Regional Transportation Plan (RTP), running time for trucks was computed for all freeway segments presumed to be used in port service.

The way that truck times were developed is as follows. The RTP maps indicate four ranges for freeway peak period delay and speed, “green” for 30-65 MPH, “blue” for 23-30 MPH, “red” for 16-23 MPH, and “broad-banded red” for the worst case at 10-16 MPH. SCAG’s RTP Section recommended using peak period speeds for trucks that are 9.1 MPH slower than the average speed for traffic overall, because of congestion, difficulty of accelerating trucks through a range of gears in start-and-stop traffic, etc.. In developing the freeway truck speeds for this study, this absolute speed reduction was interpreted as being applied to the “green” range only to be conservative; and other truck speed reductions in lower speed ranges were kept in the same proportion.

Hence, for the “green” range (forecast to occur only in a few places on the freeway network in 2020, the truck average speed was assumed to be 38 MPH. Truck speeds for other speed ranges were: for the “blue” range, 21 MPH; for the “red” range, 16 MPH; and for the “broad-banded red” range, 10 MPH. Hence, there is relatively little absolute reduction in truck speed for the slower freeway segments, i.e. severe recurrent congestion is assumed to have an equalizing effect on different classes of highway traffic.

For off-peak periods, the RTP Section recommended using a default value for truck speed reductions such that for mid-day truck speeds should be reduced by only 6.5 MPH as compared to other traffic. This has meant that mid-day truck speeds in the "green" range would be 38 MPH, and in the "blue" range, 35 MPH on the average. For the night period, a different default value was used, assuming that truck speeds would be 50 MPH on the average, throughout the system.

For simplicity, an average of freeway conditions was developed over a 14-hour truck day. For 2020, it was assumed that truckers would operate over 6 peak hours, 6 mid-day hours, and 2 night hours (early morning). In fact the Draft RTP assumes that the AM peak period will be 3 hours long and the PM peak, 4 hours long; however, for this study, we have assumed a conservative 3 hours per peak period.

Cumulative times given below represent direct time on all freeway segments to bring the trucks out near the mid-point of the freight station zone, plus additional access time on local streets for that zone only. The assumption is that in future years (2020) peak spreading will result in a shorter off-peak period, which experiences less delay due to recurrent congestion, applicable to mid-day.

The truck data given below are "complete" for weighted average transit time and distance. However, they do not include time spent at the port (containers transferred onto chassis, yard hostler to waiting draymen, pick-up by the latter, etc.) which will be discussed in a later section of the report. The data presented here do not include the effects of incidents and accidents (freeway SIG Alerts, etc.) on trucking operations, as data on the impacts of this non-recurrent congestion specifically on trucking have been difficult to obtain.

Tables 5.1-5.3 indicate the cumulative truck drayage times and distances for the San Pedro Bay Ports to the Inland Empire and San Pedro Bay to Orange County corridors, and for the Port of Hueneme to the Inland Empire corridor. Each Figure provides a comparison between the 1994 base year, the 2020 RTP Baseline, and 2020 assuming a truck lane system is included. The distance traveled over the freeways and the radius on local streets for each assumed freight zone are included on these tables.

Table 5.1
Cumulative Average Truck Times and Distances
Ports of LA/LB to Inland Empire

Station	Cum. time (hrs), fwy & loc. sts.: weighted av. peak/mid-day/night*		
	1994 Base Year	2020 Baseline	2020 with Truck Lanes
3 - Commerce	0.79	0.86	0.82
4 - Irwindale	1.11	1.29	1.22
5 - Industry	1.16	1.31	1.23
6 - Pomona	1.70	2.03	1.80

7 - Ontario	2.21	2.78	2.36
8 - Colton/SB (near Norton AFB)	2.74	3.35	2.92
9 - March AFB	3.22	4.02	3.61

* 1994: 5 peak: 7 mid-day: 2 night
  2010: 6 peak: 6 mid-day: 2 night

Station	Cum. Distance**	Radius on local streets***
3- Commerce	17.3	4.1
4 - Irwindale	30.7	1.45
5 - Industry	31.05	1.2
6 - Pomona	42.35	3.5
7 - Ontario	56.2	3
8 - Colton near Norton AFB	68.95	4.7
9 - March AFB	74.2	12.5

** Distance in miles by freeway from ports to "typical" ramp near the freight station in each zone

***Distance in miles on local streets from point near freight station, to "centroid"

Table 5.2
Cumulative Average Truck Times and Distances
Ports of LA/LB to Orange County

Station	Cum. time (hrs), fwy & loc. sts.: weighted av. peak/mid-day/night*		
	1994 Base Year	2020 Baseline	2020 with Truck Lanes
10 - La Mirada	0.68	0.76	0.72
11 - Fullerton	1.04	1.16	1.08
12 - Tustin/Santa Ana	0.94	1.20	1.20
13 - Irvine	1.39	1.50	1.50

* 1994: 5 peak: 7 mid-day: 2 night
  2010: 6 peak: 6 mid-day: 2 night

This applies to all freeway and local street traffic, all modes.

Station	Cum. Distance**	Radius on local streets***
10 - La Mirada	16.95	2.35
11 - Fullerton	24.35	3.9

12 - Santa Ana/Tustin	27.55	1.85
13 - Irvine Spectrum	34.35	2.6

** Distance in miles by freeway from ports to "typical" ramp near the freight station in each zone
***Distance in miles on local streets from point near freight station, to "centroid"

Table 5.3
Cumulative Average Truck Times and Distances
Port of Hueneme to Inland Empire

Station	Cum. time (hrs), fwy & loc. sts.: weighted av. peak/mid-day/night*		
	1994 Base Year	2020 Baseline	2020 with Truck Lanes
1 - Chatsworth	1.88	2.04	2.04
2 - Van Nuys	2.28	2.46	2.45
3 - Commerce	2.89	3.14	3.10
4 - Irwindale	2.99	3.28	3.22
5 - Industry	3.3	3.54	3.43
6 - Pomona	3.64	4.06	3.91
7 - Ontario	4.15	4.81	4.42
8 - Colton/SB (near Norton AFB)	4.67	5.37	4.98
Port of Hueneme to Carson			
16 - Carson	3.03	3.22	N.A. (slower)

* 1994: 5 peak: 7 mid-day: 2 night
2010: 6 peak: 6 mid-day: 2 night

Station	Cum. Distance**	Radius on local streets***
1 - Chatsworth	54.7	3.2
2 - Van Nuys	67.75	1.8
3 - Commerce	76.8	4.1
4 - Irwindale	89.3	1.45
5 - Industry	90.9	1.2
6 - Pomona	104.05	3.5
7 - Ontario	117.9	3
8 - Colton near Norton AFB	130.65	4.7
16 - Carson	81.25	2.1

** Distance in miles by freeway from ports to "typical" ramp near the freight station in each zone

***Distance in miles on local streets from point near freight station, to "centroid"

ChassisRailer (rail intermodal) Distances and Speeds

The following distances are from a common point on Terminal Island south of the Henry Ford Avenue Bridge and north of Ocean Boulevard, to assumed inland freight stations. Additional distances from this point near the San Pedro Bay ports to individual docks will probably add one to three miles to this, traversed at a speed of about 10-12 MPH.

It was assumed that the average speed for intermodal freight trains between downtown and the Inland Empire is 24 MPH, upon advisement from the Union Pacific Railroad. This is also precisely the speed used in railroad simulations for intermodal trains in SCAG's Regional Railroad Consolidation Study, applicable to the slowest day of the 5-day week simulated. For the Alameda Corridor, an average speed of 23 MPH was applied, as recommended by ACTA.

(Note that the slower main line average speeds do not correspond to the maximum that trains will operate, which may be 60-70 MPH or so on main lines, and 40 MPH on the Alameda Corridor. The average speed includes all speed reductions at the beginning and end of corridors, through major railroad yards, at railroad-railroad crossings, etc. No speed reductions, incidentally, are attributable to railroad-highway grade crossings, where freight trains have the right-of-way at all times.)

For operation on the Coast Line from Ventura to the San Fernando Valley, where there is considerably less freight activity than on other main lines, the assumption was that an average of 40 MPH would be possible east to Chatsworth, and 45 MPH through the San Fernando Valley; however, speeds from Burbank south are figured to be 20 MPH for our purposes.

The average speeds just cited will not apply where trains have to stop and work: adjustments are made in the Section 6 discussion of ChasisRailer, to take into account stopping to drop off and pick up cuts of this lightweight intermodal equipment.

Tables 5.4 and 5.5 indicate the cumulative distances for ChassisRailer service from the San Pedro Bay ports to the Inland Empire, via the UPRR and the BNSF main lines respectively, including various alternative termini in the Riverside-San Bernardino area. Table 5.6 indicates the cumulative distances for the San Pedro Bay ports to southern Orange County route, via the BNSF and a Santa Ana Branch/BNSF combination. Table 5.7 indicates the cumulative distance from the Port of Hueneme to Carson, Orange County points, and stations en route to the Inland Empire for ChassisRailer service.

Appendix B provides applicable distances required for computing intermodal rail running times, from station to station as may be required depending upon the ChassisRailer operating plan chosen.

Table 5.4
Cumulative Average ChassisRailer Distances
Ports of LA/LB to Inland Empire via UP Lines

Station	Norton	March AFB*	March AFB**
	Cumulative Distances by Rail for line haul (in miles)		
3 - Commerce	22.1	same	same
4 - Irwindale	(use Industry)	"	"
5 - Industry	33.8	"	"
6 - Pomona	46.8	"	"
7 - Ontario	59.25	"	57.55
8 - Norton AFB	80.2	n.a.	n.a.
9 - March AFB	n.a.	86.65	85.7

* Via UP main line and south from Colton on BNSF
** Via old UP Main Line via Riverside, with Alternate Station in Ontario

Table 5.5
Cumulative Average ChassisRailer Distances in miles
Ports of LA/LB to Inland Empire, via BNSF Main Line

Station	to Norton	to San Bernardino	to March AFB
3 alt.- Commerce	22.1	(same as left, unless otherwise indic.)	
10 alt. Santa Fe Springs *	31.15		
10 alt. Buena Park**	36.45		
11 - Fullerton	42		
Corona	61.7		
Riverside (3rd)	78		
Norton AFB***	91.7	n.a.	n.a.
San Bernardino Yd./Rialto Ave.	n.a.	86.75	n.a.
March AFB	n.a.	n.a.	89.2

* Alternative to Buena Park
** Alternative to Santa Fe Springs
*** On UP east of Colton

Table 5.6
Cumulative Average ChassisRailer Distances in miles
Ports of LA/LB to Orange County

Station	using BNSF/ Commerce	via Santa Ana Br./ACTA drill track
Commerce	22.1	n.a.
Santa Fe Springs*	31.15	n.a.
Buena Park**	36.45	n.a.
La Mirada***	n.a.	28.55
Fullerton	42.05	35.25
Tustin	53.35	46.55
Irvine Spectrum	61.7	54.9

* Alternative to Buena Park

** Alternative to Santa Fe Springs

Table 5.7
Cumulative Average ChassisRailer Distances in miles
Port of Hueneme to Points East

Station	Carson	Orange County	Inland Empire
1 - Chatsworth	41.65	(same)	(same)
2 - Van Nuys	52.95	"	"
16 - Carson	83.9	n.a.	n.a.
3 - Commerce	*.	74.75	74.75
10 - Buena Park		89.7	
11 - Fullerton		95.3	
12 - Tustin		106.6	
13 - Irvine Spectrum		114.95	
4 - Irwindale			[use industry]
5 - Industry			86.45
6 - Pomona			99.45
7 - Ontario			111.9
8 - Norton AFB			132.85

* Could locate a stop somewhere in Vernon area or in old Taylor Yard

Truck Dray Length for Rail Alternatives

Table 5.8 below provides dray length over local streets/arterials (radius around freight station) for rail lines likely to be used by ChassisRailer.

Table 5.8
Truck Dray Length Distances
For Rail Alternatives

Station	Dray length in Miles
1 - Chatsworth	3.8
2 - Van Nuys	3.5
3 - Commerce	4.1
4 - Irwindale	11.15 (2.65 miles local street, 8.5 mi. freeway)
5 - Industry	5.6
6 - Pomona	7 (3.5 local sts., 3.5 freeway)
7 - Ontario	6.2
8 - Norton	8.5

16 - Carson	4.6

For possible Orange County ChassisRailer stations, note that this radius would be the same as that assumed for the ACG alternative discussed at the end of this section.

Cumulative ChassisRailer Plus Truck Dray Times

Cumulative transit times combining the rail haul and the local truck dray to/from inland freight stations are indicated on Tables 5.9 and 5.10, respectively for container shipments between the San Pedro Ports and the Inland Empire, and for movements between the Port of Hueneme and Carson, as well as the Inland Empire. The totals in each case include the rail haul from the port to each station, plus the local dray.

Table 5.9
Cumulative Average ChassisRailer + Local Truck Dray Times (hours)
Ports of LA/LB to The Inland Empire

Station	Rail Haul	Local Truck (2020)	Cum. Total
3 - Commerce	.96	.20	1.16
4 - Irwindale	[use Industry]	.48	1.93
5 - Industry	1.45	.27	1.72
6 - Pomona	1.99	.31	2.30
7 - Ontario	2.51	.30	2.81
8 - Norton AFB	3.38	.40	3.78
9 - March AFB*	3.65	.89	4.54

Speeds assumed are 23 MPH for the Alameda Corridor and 24 MPH for the main lines to the east.

Table 5.10
Cumulative Average ChassisRailer + Local Truck Dray Times (hours)
Port of Hueneme to Downtown LA and The Inland Empire*

1 - Chatsworth	1.34	.18	1.52
2 - Van Nuys	1.59	.17	1.76
16 - Carson**	3.07	.22	3.29
3 - Commerce	2.68	.20	2.88
4 - Irwindale	[use Industry]	.48	3.65
5 - Industry	3.17	.27	3.44
6 - Pomona	3.71	.31	4.02
7 - Ontario	4.23	.30	4.53
8 - Norton AFB	5.10	.40	5.50

* Average train speeds assumed:
for Ventura County Railway: 12 mph
for the Coast Line, Oxnard to Chatsworth, 40 mph
for the Coast Line, Chatsworth to Van Nuys, 45 mph
for the Coast Line and River Line, Van Nuys east and south, 20 mph
** Speed for Van Nuys to Alameda Corridor via Coast Line/west bank of LA River, assumed to be 20 mph.

Automated Cargo Guideway System (ACG) Times and Distances

ACG system equipment would operate up to 55 MPH in normal operations. However, taking into consideration frequent gradient changes where the line would go over/under other transportation structures (railroads, freeways, etc.), this has been reduced for analysis purposes to an "average" maximum assigned speed of 50 MPH. In addition, the speeds developed in this section are also adjusted slightly downward because of the initial acceleration and final deceleration of the ACG vehicles at terminals, following transit modeling practice.

A conservative average acceleration rate of 1 mph/s (including all ranges of speed) and an average braking rate of 2 mph/s were used to develop the critical time (acceleration and braking, to and from maximum speed) for the corresponding start-up and slow-down distance. (Note that acceleration rate will initially be higher than this figure, and above a "straight-line" range over which the rate is governed, the rate will decline. Braking rate can be controlled at a more constant rate, blending several kinds of brakes as required.)

This means that in practice, the average speed as computed is slightly less than 50 MPH, especially for shorter runs (e.g. seaport to Commerce). Note however that all ACG trains would run non-stop from origin to destination, with no intermediate stations in normal operation. Therefore this adjustment is considerably less than it would be for an automated transit system, with frequent station stops.

Cumulative distance to freight stations including all stations en route on each line is given in Table 5.11, with the starting point assumed to be 3 miles "seaward" from the intersection of Henry Ford Avenue and Ocean Boulevard (no specific fast ship terminal location is assumed). Drayage distance on local streets is unique to each station.

Table 5.11
Cumulative Distances (in Miles) to Freight Stations
for Automated Cargo Guideway System Alternative
From San Pedro Bay Ports to Inland Stations

Station	ACG	Local Truck Radius
3 - Commerce	23	4.1
4 - Irwindale (own branch)	34.45	2.65 (differs from RR alternative)
5 - Industry	30.8	5.6
6 - Pomona	43.8	7 (3.5 local and 3.5 freeway)
7 - Ontario	56.25	6.2
8 - Norton	76.1	8.5
9 - March	84.7	12.5
10 - La Mirada	23.25	3.8
11 - Fullerton	29.85	3.9
12 - Tustin/Sta Ana	40.7	2.4
13 - Irvine Spectrum	49.05	2.6

Note that the drayage distance for Irwindale is shorter than for the rail alternative because a spur of the ACG line runs up the 605 Freeway to provide an additional freight station, more or less central to the Irwindale freight zone.

Time from The San Pedro Bay Ports to Inland Stations for The ACG Alternative

Table 5.12 indicates direct running time from the POLA/POLB to all freight stations, and drayage time on local streets. Local truck radius is unique to each station area; and the totals include line-haul transport time over the guideway, plus time for local haul by truck for specific station zones.

Table 5.12
Time (in Hours) to Freight Stations
for Automated Cargo Guideway System Alternative
From San Pedro Bay Ports to Inland Stations

Station	ACG (hrs.)	Local Truck Radius (hrs.)	Total
3 - Commerce	.51	.20	.71
4 - Irwindale	.74	.12	.86
5 - Industry	.67	.27	.94
6 - Pomona	.93	.31	1.24
7 - Ontario	1.17	.30	1.47
8 - Norton	1.57	.40	1.97
9 - March	1.74	.89	2.63
10 - La Mirada	.51	.18	.69
11 - Fullerton	.65	.19	.84
12 - Tustin	.86	.11	.97
13 - Irvine Spectrum	1.03	.12	1.15

Section 7: Economic Viability of Alternative Inland Systems

In order to evaluate the effectiveness of the proposed alternative inland distribution system, the value of carriers' costs and shippers' time--with respect to overall transportation costs by mode and by route--were examined on a scenario basis. Costs of various local inland transport alternatives were estimated for commodity shipments and were measured in volume terms (in FEUs) which best approximate the units of activity measurement for the alternate delivery systems considered. There are several dimensions to carrier and shipper decision making:

- The geographic distribution of available routes and services,
- The time it takes to ship to or deliver from the inland station(s) in comparison with shipper locations,
- The costs of shipping to or delivering from the inland station(s) in comparison with the direct shipment to or from the port via truck dray,
- The time it takes to ship to or deliver from the inland station(s) in comparison with the total shipment time; and,
- The costs of shipping to or delivering from the inland station(s) in comparison with the total cost of the entire shipment.

Our research shows that cargo that is of high value and/or time sensitive (usually both) is most likely to be attracted to the new system, as this cargo demands reliability and speed. Hence, estimates of the variance of truck dray delivery times were considered as well. The movement of specialized commodities such as refrigerated, perishable cargo is obviously very sensitive to unexpected delays, thus the value of time for the shippers of these commodities will tend to be higher due to spoilage factors and inventory carrying costs. We also considered the potential for air freight diversion to a combined agile port / fast ship system—applicable to relatively lower value or less time sensitive portions of existing air freight.

After the potential cargo for the fast ships was estimated, relative cost differentials were examined for the delivery alternatives based on distances between the ports and the assumed set of agile port delivery system inland freight stations. Calculated differentials in cost for trip segments provided indicators of the potential viability of the alternative systems. (This methodology also provides a framework for future analyses relative to possible TRANSCOM-preferred designs for transfer technologies and inland transport systems.)

To be able to assess the economic viability of any alternate delivery system, some estimate of costs specific to each alternative must be established. Estimates of activity levels provide the other critical component in establishing parameters for measuring economic viability. For this analysis, cost parameters were first analyzed by reviewing various existing and potential distribution networks and likely transport modes.

Currently, the distribution of cargo containers to and from the ports of Southern California requires movement by truck to and from either a specific shipper or forwarder, a local distribution / consolidation point, or an intermodal rail connection site. Additionally, the proposed Alameda corridor will vastly improve rail connectivity and highway access to the Ports of Los Angeles and Long Beach for container traffic transiting the SCAG region.

Cargo containers moving locally are carried by truck with steamship lines providing the chassis. The management of chassis fleets and the use of local (within-region) trucking for container drayage is a minor expense as compared to the total freight rate ultimately paid by shippers. For this study, we have assumed that a lightweight rail intermodal operation or an automated delivery system would offer alternatives to container handling to and from the ports, all by highway, primarily for local cargoes (not for bridge intermodal unless other special conditions related to inland port development would favor this).

Although each port's throughput capacity is critical to the rapid loading and discharge of ocean carriers, the fast and efficient delivery into, or departure of containers out of, the port region is also essential to the overall transportation chain: container congestion can intensify space limitations reducing the efficiency of the ports. The viability of each delivery system alternative was evaluated given the potential cargo and proposed costs for each service option, including ChassisRailer and an automated container guideway system. The factors considered in this evaluation included:

- route distance for representative origin-destination pairs,
- trip speed along each route (including local dray to/from stations),
- mode type and characteristics, and
- system operating and capital costs.

The ChassisRailer and ACG delivery system analysis included an assessment of localized truck drays allowing shippers access to each freight station. Other factors considered included the costs of energy (electricity or fuel) and fixed costs for the system. Due to a paucity of resources and readily available information, it was not possible to do a comprehensive evaluation of relative environmental impacts of the transport alternatives included in the model. A more comprehensive study of actual proposed systems would include emissions and air quality impacts of the rail intermodal and ACG delivery system options linked in the same model to costs, service, and forecast cargo volumes.

Though the cost for a movement within the region is critical to shippers, the value of (transit) time for each movement is another important factor to shippers and carriers. Additionally, the variance(reliability) in transportation time can also be very significant for shippers and carriers in the short run, if such variance becomes a large enough part of the total move or if connections (such as ship sailings) are missed. For some of the potential fast ship cargoes, the time value of other resources, indirectly dependent on a particular shipment may easily exceed the value of the time of the shipment itself (e.g. the cost of a plant shut down due to delayed inputs or replacement parts).

Time-definite service is increasingly important to many shippers, who value the average transportation time less importantly than the variance around this average transport time. This variance in turn depends on several factors for any particular trip--including the specific inland distribution route followed, the time of day, day of week, shipment size, and types of cargo moving to and from the port.

Two considerations are unique to the kind of analysis conducted here, in which a landside transport system is linked to an ocean haul. An assessment that looks at only some of the intermediate steps in the activity chain--in isolation from the total, door-to-door service-- could result in sub-optimization. It is difficult to prevent this from occurring, particularly as the door-to-door activity chain gets longer (e.g. any intermodal movement). Hence, here, where primarily local shipments and trips are under consideration, analysis of two similar kinds of activity chains, door to water for export trips and water to door for import trips, is required.

These are not mutually exclusive, but closely intertied--for example, the sequence of loading the vessel at origin may affect the activities as, and after, the same ship is unloaded. A more serious problem occurs when portions of the activity chain are poorly known or difficult to control (e.g. activities at foreign port and its inland distribution system). For these reasons, an evaluation of primarily the inland movement to/from a domestic port, as in the current study, definitely risks sub-optimization. Basically, the point is that an evaluation of microscopic changes in demand related to alternatives to drayage, may not be particularly useful when dealing with major cargo ocean movements.

The second consideration is the applicability of existing economic and behavioral models to the present circumstance. What is noticeably different in this case is that the shipper (or its forwarder) using a fast ship service has an opportunity to remove many days from a transoceanic movement, rather than just one or two days at the port or several hours on an inland move. Presumably, such an opportunity will change the values, or utility curves, of trade-off, conjoint or multi-logit decisions relative to those existing today.

This is a major change not unlike what occurred when FedEx created an overnight parcel service. It was hard for potential users to envision the concept, much less put a value on it. Today, better research techniques exist with which to do this. Hence, applying extant models or conventional industry wisdom in this unique circumstance is likely to be misleading, and may even be entirely wrong.

While the problem of assessing traffic growth in the face of new local transportation alternative is complex, it is not impossible. As any forecast represents a particular view of reality that may change during the forecast period, our approach to the analysis of potential future flows is to compromise between complexity and simplicity of form, given available information and the assumptions about the design and operation of our alternative systems.

Commercial Viability Scenarios

For this project, we had originally planned to develop a local area traffic model using specifications originating from a USTRANSCOM-sponsored design, tailored to military deployment from points inland. Unfortunately, this information was not available during the study, so our own estimates for the parameters of hypothetical alternative inland transport systems have been used. Using the assumptions for the system route network and operating characteristics described in Sections 5 and 6, projections were prepared for potential cargo applicable to each system under different scenarios were prepared.

The baseline scenario assumes that shippers' price elasticity with regard to local delivery service to and from the ports is such that they will use the mode with the lowest total delivered cost, to or from the port under all circumstances. This scenario is very close to today's practice in which truck drayage rates are low and few customers are willing to pay premiums for high quality, higher priced drayage service. As presented in Section 5, the direct drayage trip times to and from the ports in 2020 are expected to increase, at most, by about 45 minutes over 1994 levels.

For purposes of this scenario, this local trip time increase is assumed, conservatively, to not matter very much to the customers using the ports for overseas shipments. This scenario also assumes that the draymen could adapt to any changes in the frequency of accidents or incidents so as to maintain their current average incidence-related trip delay time.

Comparisons of the ACG and ChassisRailer delivery systems with direct truck drayage times are presented in Table 7.1 (next page). The variance in elapsed time for local moves to/from these potential ACG station areas in 2020 is significant as a share of local delivery trip times. Compared with conventional local truck drayage time, the time savings resulting from use of the ACG system in 2020 ranges from 15 minutes to one and a half hours. The ACG local time savings represents from 29 % to 51% of the comparable direct truck drayage time in 2020. (Note that for ChassisRailer, on the other hand, the trip times projected could be longer, especially for relatively close-in destinations such as Commerce or Irwindale.)

For shippers, local inland delivery time to and from the port is not an end unto itself, however. Total shipment door-to-door delivery time including the ocean voyage is what matters in the business decision-making of shippers, so inland delivery system time savings must ultimately be considered from this perspective. Given the days of total elapsed time for any seaborne shipment, using either a fast ship or conventional container vessels, the widest variance in local delivery time becomes a very small percentage of the total shipment time.

Table 7.1

Comparison of ACG System and ChassisRailer
One Way 2020 Trip Times With Direct Truck Drayage
Ports of Los Angeles / Long Beach to
Representative Inland Stations (in hours)

	ACG System		Chassis Railer	
Station Area	Hours	Percent	Hours	Percent
3 - Commerce	-0.25	-29%	0.86	100%
4 - Irwindale	-0.53	-41%	1.01	78%
5 - Industry	-0.47	-36%	0.41	31%

6 - Pomona	-0.89	-44%	0.27	13%
7 - Ontario	-1.41	-51%	0.03	1%
8 - Norton AFB	-1.48	-44%	0.43	13%
9 - March AFB	-1.49	-37%	0.52	13%

Two transpacific route voyage time scenarios were developed for fast ships, to allow quantification of the significance of local delivery time as a percent of total shipment time. A South Pacific route scenario assumes direct service between Southern California ports and Singapore, while a North Pacific route scenario assumes direct service between Southern California and Yokohama, Japan. Scenario shipment time estimates were calculated, based on the sum of sailing time in hours plus local southern California inland delivery system transit time to/from the ports. Under these two fast ship route scenarios, it is assumed that the fast ships will be sailing at 46 knots (FastShip Atlantic would sail at 37.5 knots) versus the 19 to 23 knots achieved by conventional vessels on these routes.

Further, it is assumed that the local inland delivery system transport times are those given in Section 5 for the year 2020 and that reserved truck lanes will not be operational or available for use, for purposes of the comparison. The estimates are conservative ones because no overseas local delivery time, feeder vessel voyage time, or port handling time was included in the total voyage times. With these assumptions, difference between local alternative inland delivery system time and direct truck dray, as a percent of total trip time, is shown in Table 7.2 (next page).

The local delivery time savings resulting from use of the ACG system, using the conservative assumptions above, range from 0.1% to 1.2 % of total shipment time. Conversely, the time penalty associated with using ChassisRailer service ranges from almost no difference, to 0.8% of total shipment time. (As these estimates ignore port handling time, vessel loading/unloading time, and delivery time to or from the overseas fast ship port, the percentages would be even lower for total shipment time.) Though the ACG system would produce a lower total trip time (including required local drayage) than either the ChassisRailer or conventional truck drayage to any of the comparable ACG station zone areas, the significance of the time savings is very small.

Table 7.2

Local Delivery System Plus Fast Ship Voyage Time
On South and North Pacific Routes
Comparison with Direct Truck Drayage in 2020
for ACG System and ChassisRailer System
to the Ports of Los Angeles / Long Beach from
ACG Inland Station Zones
(Percent of Trip Time in Hours)

ACG System		Chassis Railer	
Percent of	Percent of	Percent of	Percent of

Station Area	Total S Pacific Shipment Time	Total N Pacific Shipment Time	Total S Pacific Shipment Time	Total N Pacific Shipment Time
3 - Commerce	-0.1%	-0.2%	0.5%	0.7%
4 - Irwindale	-0.3%	-0.4%	0.6%	0.8%
5 - Industry	-0.3%	-0.4%	0.2%	0.3%
6 - Pomona	-0.5%	-0.7%	0.2%	0.2%
7 - Ontario	-0.8%	-1.1%	0.0%	0.0%
8 - Norton AFB	-0.8%	-1.2%	0.2%	0.3%
9 - March AFB	-0.8%	-1.2%	0.3%	0.4%

Even with the greatest differences, for service to and from the Norton and Air Force Base zones (the farthest inland points considered), the ACG system's time advantage of one and a half hours of over direct truck drayage, amounts to at most only 1.2% of the total shipment time for fast ship service. If similar estimates were made for shipments using conventional container ships, the local trip times as a percentage of total shipment time would be even lower, as the total time at sea is much greater with slower vessels.

Comparisons of alternative delivery system unit trip cost differences with total shipment cost are similar to the results of the time comparisons. For conventional container ship service, current local drayage rates, as a share of total ocean shipment costs, range from approximately two to seven percent of the total. With the higher expected unit operating costs for fast ships, the local drayage cost share of total ocean shipment rates would be smaller than for conventional container ships, perhaps from less than one percent to as much as three percent. As with time savings, the absolute cost difference between direct truck drayage and the ChassisRailer and ACG alternatives is greatest at stations furthest from the ports.

For illustrative purposes, a cost comparison was made for the direct truck drayage, ChassisRailer, and ACG alternatives for the movement between the San Pedro Bay Ports and San Bernardino. As with the time comparisons, the north and south Pacific fast ship routes scenarios were used as representative voyages. Comparisons made for the inland movement between the ports and San Bernardino provide the most favorable conditions for alternative systems to be competitive, due to the increased length of haul over which to spread the ACG or ChassisRailer system fixed costs. In these scenarios we have assumed the same 2020 high market penetration fast ship cargo volumes that was used in earlier examples. For the ACG system, the scenarios also assume that public financing is available and that bridge traffic as well as fast ship cargoes are carried by the ACG system.

With these assumptions, the comparison, as shown in Table 7.3 below, is favorable for the ChassisRailer system, but not for the ACG system. Even under these most favorable conditions, ACG system costs are so much higher than direct truck drayage that they would impose an additional 4.5 percent to 7.3 percent on the total ocean transport costs. The ChassisRailer costs are close to that of direct truck drayage and therefore save only 0.4 to 0.6 percent of total voyage costs, i.e. a very modest amount.

Table 7.3

Local Delivery System Plus Fast Ship Voyage Cost
On South and North Pacific Routes
Comparison with Direct Truck Drayage in 2020
for ACG System and ChassisRailer System
to the San Pedro Bay Ports from San Bernardino

	Dollar Difference Versus Direct Truck Drayage	Percent of Total S Pacific Voyage Cost	Percent of Total N Pacific Voyage Cost
ACG System	$ 236	7.3%	4.5%
ChassisRailer	$ - 18	-0.6%	-0.4%

Under the baseline cost scenario, the local commercial shipment cost comparisons in Section 6, Figures 6.3 and 6.4 show that the ChassisRailer alternative to direct truck drayage could likely capture only traffic moving over the longer distances such as from the San Pedro Bay Ports to San Bernardino and from Port Hueneme to Carson. Under the baseline scenario there are no local movements under which the ACG system, even with public financing, could realistically capture a share of the traffic.

To approximate the affect of a distribution of possible shipper preferences regarding time and cost, alternative scenarios were also developed based on the idea that there is some proportion of local shippers for whom time of delivery to and from the ports is very important, whether using truck drayage, ChassisRailer, or an automated system. In these scenarios, a hypothetical two percent share of potential cargo is considered to be inelastic: demanding minimum transit time at any cost up to the upper bound of the air cargo cost. It is further assumed that no shipper would send via fast ship at a total cost exceeding shipment by air.

Under these scenarios, the small volumes of cargo attracted to the alternative systems despite the higher costs, have to bear the high fixed costs of these systems. For the ACG system, these scenarios still collapsed such that there would be no cargo moving, because there is not enough time-inelastic demand cargo to carry the fixed ACG costs without the cargo being diverted more cheaply to air.

A benefit of the ACG system, potentially, is the reduction in the distance that the local movement must move on the highway, and therefore a reduction in the variance in trip time, allowing later cut-off times before shipments must be tendered for carriage to the ports. The value of this service improvement is extremely difficult to quantify without having in hand specific operating choices to present to shippers, from whom to measure the value of cargo shipment time.

However, the inventory carrying cost savings for cargoes saving up to one and a half hours of total trip time is only in the range of $2-$15, depending on the value of the cargo. With such a relatively low value placed on the marginal time savings from the ACG delivery system, the high fixed costs of the systems appear to prevent it from being commercially viable.

Conversely, returning again to the fact that fast ships could save many days on an ocean haul as compared to conventional container ships, an increased transit time of only a few hours by ChassisRailer may be perceived by many shippers to be only of marginal importance if the overall shipment is very fast and highly reliable. In this case, for longer inland movements (where the ChassisRailer rate is lower than for drayage), a fast ship + ChassisRailer combination may still be seen as a tremendous improvement in total time over regular container liner + direct trucking--even though the drayage component of the latter might be faster. In other words, the speed advantage of the fast ship might overwhelm the small time penalty involved in using ChassisRailer.

And, in this case, the fact that the haul by ChassisRailer would provide a small discount against the hefty ocean rate for the fast ship (as compared to a fast ship + drayage combination for the longer inland movement), might be seen as a small bonus by some shippers.

Viability of Other Alternative Delivery System Implementation Options

There are a number of other implementation options that could be used to provide different service offerings affecting the viability of an automated container guideway system versus competing direct truck drayage, or that of a new rail intermodal system (not limited to ChassisRailer). Changing any of the many assumptions required for the analysis that was conducted in this study could affect the cost and market share numbers, and the resulting variations in service offerings would alter the commercial viability of the competing alternatives. However, this change would most likely turn out to be an incremental one, at the margins, rather than producing a fundamental difference in the results.

Further research of alternate fast ship delivery systems for the SCAG region (or for that matter, for other port areas) should carefully consider the dimensions of service variables that will affect the commercial viability of any proposed system. The variables that should be considered include:

- Frequency of service through the system
- Scheduled versus irregular (on demand) service
  - By commodity
  - By route
  - By cargo type and size
- Use of intermediate loading/off loading points
  - Links to other existing terminals
  - Assumptions regarding additional routes
- Maintenance and development requirements
- Service pricing alternatives
- Accompanying information requirements

Alternative delivery system options will involve time and expense to implement (as compared to pre-existing truck drayage) and therefore the market viability of each option would require considerable planning in order to optimize the system so as to be attractive to users. For potential commercial customers, inception of an alternate delivery system would affect import/export business planning. Further, carriers that know they will be given new shipping modal alternatives to work with, or compete against, may be better able to deploy their equipment to maximize the benefits or minimize the losses resulting from the introduction and availability of such systems.

However, carriers' planning horizons are sufficiently long that some may have already committed to particular technologies--making it difficult to rapidly benefit from the introduction of an alternative conveyance system. Without knowing specific shipper preferences, it is assumed that (with acceptable price and service) the expected market response to the system would improve over time provided the system proved reliable and convenient. However, there is not enough information available to allow us to gauge the specific timing of the acceptance of either of the alternative systems investigated here, or of other possible new systems. Future research should include measurements of shipper preferences for use in estimating the acceptance of these new systems.

Relation To / Impacts On the Alameda Corridor

One additional complexity in performing this assessment relates to estimating the impact on the local transportation system that will result from Alameda corridor implementation. Completion of the Alameda Corridor will cause changes to the local truck drayage industry. This major rail freight corridor project which will speed up and improve reliability of the rail haul from downtown yards to the ports (with improvements to parallel Alameda Street beneficial to some truckers), complicates analysis of impacts of new alternatives such as an ACG or ChassisRailer system. However, previous, extensive studies of the Alameda corridor emphasize the importance corridor development much more as a link to long haul inland rail traffic, than for use as part of the local freight transportation/distribution system.

For the purposes of this study, the most important impact of the Alameda corridor would be on the demand for local drayage. The potential relationship between the Alameda corridor and alternative container transport systems relates not so much to competition for the same cargo, as to changes in transportation system capacity, including that offered by present drayage trucks. Improvement in rail movements between the San Pedro Bay Ports and downtown LA will have a small but uncertain impact on the drayage industry, with respect to the availability of draymen and equipment. The displacement of drayage services would have a certain impact on potential to introduce alternative systems, especially with regard to local shipments to and from near-dock facilities.

Where a ChassisRailer local delivery system alternative would use the Alameda Corridor, in the event it would reduce available capacity, the revenue to repay Alameda Corridor bonds could also be affected, provided the revenues from this use of track capacity were less than for use by double stack trains. On the other hand, if the capacity problems can be overcome, a new rail service such as ChassisRailer using the corridor would contribute revenues, resulting in a favorable economic impact.

Section 8: Military Use of Agile Port Delivery Systems and Relation to Commercial Operations

During the short duration of this study, it was not possible for the study team to obtain USTRANSCOM estimates of military force strength and deployment time in relation to fast ship, conventional vessel, or air freight utilization. Hence, it has not been possible to complete a quantification of the interaction or synergy between military and commercial operations to any TRANSCOM system parameters. Similarly, it has not been possible to recommend specific modifications of vessel, port facility, or inland conveyance system designs currently under development for the military, although a technology study has been conducted for TRANSCOM by CCDoTT (Cal State Long Beach) in parallel with the current effort. Time did not permit contacting local military base personnel to determine their possible mobilization requirements as they might relate to the fast ship/ inland transfer system combinations investigated in this report. While the Port of Hueneme and March Air Force Base may appear to be natural staging areas, it is suggested that this investigation be deferred to a future study, probably by CCDoTT.

Due to the uncertainty surrounding military requirements, as they might modify the parameters in this study, our conclusions relative to military/commercial interactions of the proposed agile port delivery system are necessarily rather general and of a theoretical nature. We have had to make our own assessments using general assumptions regarding potential military requirements for an agile port operation.

Military Cargo Types

From the limited information obtained from the Military Traffic Management Command (MTMC), we have some non-classified information on the dimensions of military equipment that would need to be moved in times of deployment. We do not have data as to quantities or shipment lot sizes, only the dimensions of individual pieces of equipment.

In Table 8.1 below, examples are given of dimensions for military equipment, taken from the over 16,000 individual items listed in the MTMC data base.

Table 8.1
Sample Military Equipment Dimensions

Equipment	Weight (tons)	Length (inches)	Width (inches)	Height (inches)
Abrams Tank	61	354	144	104
Heavy Cargo Truck	25	431	96	128
Light Howitzer	5	216	108	75
Light Cargo Truck	4	221	87	105

For non-transportation or vehicle related military cargo, we assume that the large majority of it will be able to be moved in ISO standard containers. Note here that much military cargo, as manufactured and provided civilian suppliers, probably already moves to military bases in ISO-sized containers or in truck trailers with roughly similar dimensions.

Current Method of Transportation

In terms of present day transport, some items such as trucks, command vehicles etc. would be expected to move in a roll on/roll off (Ro-Ro) ship or a vessel with Ro-Ro capability. Other cargo that will fit in ISO containers would be expected to move by larger container ships or feeder ships, presuming that docking facilities are available. Alternatively, high-priority shipments for cargo needed most immediately would be moved in large transport planes.

In terms of seaport access, wheeled weapon systems and military transport trucks would move under their own power over shorter distances (within the region) or over long distances the same way, depending upon priority. Alternatively, wheeled vehicles might move over long distances on railroad flatcars if rapidity of shipment is of somewhat lower priority. Some items such as tanks or other tracked weapon systems probably usually travel on low-bed trucks over short distances and on railroad flatcars over longer distances, to avoid highway damage (of course under absolute emergency conditions even treaded vehicles might very well move some distance on domestic highways).

Some items, including smaller weapons systems, ammunition, food, clothing, electronic equipment, etc. that are assumed to be containerizable, can move over the highway in standard ISO 20' or 40' containers (or longer containers) mounted on truck chassis, in highway vans or straight trucks (again, shorter distance, or any distance if high priority), or on railroad flatcars (COFC) over a longer distance and if somewhat lower priority. Again, in some cases containers loaded with military cargo might move on chassis or in van type trailers by railroad flatcar (TOFC) if the trucks/chassis are required overseas at the same time as the cargo they are carrying.

Interface with Emergent Fast Ship Technologies

With the introduction of fast ships as a new marine transport mode, it follows that there could be opportunities for the military to expedite cargo movements at a speed superior to that of conventional container ships, but at a cost that is presumably much lower than via military air transport. Also of potential interest to the military would be vessel designs which do not require expensive and massive, relatively immobile fixed facilities such as large container cranes and heavily-reinforced docks that can bear their weight for loading/unloading containers, especially in the event the theatre of operation is remote from existing commercial port facilities designed for cellular ships.

It has been noted above that the fast ship designs contemplated here assume a rapid loading/unloading rate. TRANSCOM has been interested in transfer technology that will load and unload cargo much more expeditiously than is possible using conventional container ships, at a rate of up to 1000 containers per hour, and presumably allowing speedy and direct transfer to truck chassis for military transport on land. This, of course, requires an alternative to today's cellular container ships. The vessel design alternative considered here assumes stern loading/unloading and horizontal decks that would allow containerized traffic to be rapidly rolled on or off the vessel in solid queues: specifically, in cuts of rail transfer vehicles.

Per the fast ship and transfer system design described previously in Section 3 of this report, once the container pallets are jacked down onto the transfer vehicles or railcars (depending upon which landside collection/distribution system is used), an entire cut of cars can be very rapidly rolled off the vessel at a rate of 5 MPH or faster. More time-consuming transfer operations such as lifting containers onto chassis could be accomplished dockside at a somewhat more leisurely pace, without taking up valuable ship time. The reverse operation, loading a cut of containers onto the vessel, would be equally fast. As each incoming cut is withdrawn from the ship, it is replaced by an outbound cut, which will reside on the same piece of track on board the vessel. This system will permit very speedy loading/unloading of either military or commercial cargo carried in containers.

The internal decks of the fast ship contemplated here, would be paved or surfaced, sufficient to carry motor vehicles in Ro-Ro mode using the same cargo bays that would otherwise be used by the fast ship rail transfer system (similar to FastShip Atlantic concepts) or by rail ACG vehicles that roll onto the ship to pick up pallets of containers. This would be a major advantage to joint use with the military, because the vessel, when not calling on ports adapted to the fast ship rail container transfer system, can be instantly converted into a Ro-Ro ship carrying military cargo on wheels or treads, including tanks, self-propelled guns, rocket launchers, artillery, straight trucks, tractor-trailers, detached trailers, containers on or off chassis, palletized loads, etc.

In the event that the fast ship is carrying both military and civilian cargo, and making stops both at commercial fast ship docks and impromptu military landing facilities, the cargo bays used for civilian cargo would have containers on pallets, as described above for the standard commercial operation; the other cargo bays in use at the same time for military cargo would simply have wheeled or treaded vehicles fastened down to the deck.

As described previously, the ship's decks, loading ramps, and dock area used by fast ship transfer vehicles would be provided with imbedded girder rail or T-rail, and the track would be flush with the deck/pavement. There should therefore be no problem with military Ro-Ro cargo occupying the same space on the ship or with the vehicles crossing over the tracks on the wharf. (It will be noted that the design of the ship with paved decks would also facilitate commercial cargo of a Ro-Ro nature, including transport of automobiles, trucks, trucks with containerized cargo, etc., should such cargo be carried on an occasional basis.)

The specific transfer system technology discussed in earlier sections of this study as applicable to a domestic port in an area such as Los Angeles, would be electrified in part because of air quality concerns, and also so as to be compatible with an electric-powered inland cargo transport guideway technology. This would require a conduit third rail system or movable overhead catenary to be used to power the transfer and (ACG) line-haul operations. Any electrified third rails used would be insulated and safely buried below pavement surfaces, allowing wheeled vehicles to safely move across the tracks dockside. On board ship, once the loading operation is complete, the third rail or overhead wires would presumably be de-energized and would pose no danger.

It has been noted that it might be necessary to strengthen the stern of the fast ship as well as the loading ramps used, to accommodate especially heavy loads, depending upon the kind of military cargo that might be required to be transported on these vessels.

Geometric Requirements of Military Cargo In Relation to Fast Ship Design

The FastShip Atlantic vessel design, which has been used as a likely model for the fast ships contemplated here, will have bays about 26' wide, sufficient to accommodate three railroad tracks across, and 24' high, sufficient for a container pallet carrying a double stacked container. Our design for the ACG system allowing the line-haul transport vehicles to come aboard ship to drop off/pick up their containerized loads, is on the other hand intended for single stacked containers, and so the headroom for this type of transport would be only about 16' (assume the width of the bays would be the same as for the double stack design).

It is anticipated that most military cargo likely to move by fast ship would be accommodated in bays 26' wide and 16' high, which would correspond to our ACG system requirement. All of the military ISO-containerizable cargo would be accommodated in these cargo bays, and the truck and container-on-chassis cargo would also use them. It is possible however that certain kinds of cargo (probably weapons systems) would require a cargo bay 24' or even higher, and ships designed for joint use might very well have to provide several cargo bays with greater headroom for this reason.

It lies beyond the scope of this study to determine the overall economies of 16' versus 24' high cargo bays (or combinations) with respect to a blend of civilian and military cargo, or alternating use of the vessel for military and civilian cargo. However, considering that the military is likely to be an occasional, or much less frequent, user of the vessels (other than regular supply of permanent overseas bases), it is probable that optimization of commercial cargo transport requirements would be the controlling factor in establishing the fast ship deck layout and landside transport system design. Transport of occasional oversize military cargo by fast ship can probably be accommodated in other ways, as indicated just below.

Oversize and Overweight Cargo

In the event the military would want fast ship capability for the transport of overly-large items, they could invest in strengthening the upper (outer) deck or roof of the vessel to carry large pallets that will accommodate oversized vehicles, weapons systems, modular command center buildings, etc., or provide deck space where such oversize items could be covered and tied down. This would probably be located amidships aft of the pilot house, and could be enclosed with telescoping, sliding covers.

Such oversize loads might be heavy enough to require a considerable increase in fuel use, which the military would pay for.

Of course, this equipage would also facilitate, on occasion, commercial transport of large items, provided the civilian shippers were willing to pay for the extra fuel. Heavy lift cranes, or possibly a ramp system with conveyers, would be required to unload oversized cargo from a fast ship top or outer deck installation.

Note: the remainder of this section on military cargo requirements will refer to the standard fast ship rail transfer system or to Ro-Ro using internal decks of the vessel, unless otherwise indicated.

Logistics Considerations for Military Cargo Transported by Fast Ship

At the home end, it is assumed that the ramps used for transfer of containerized loads using the rail transfer or ACG system would be paved or surfaced for use by wheeled and treaded military vehicles. Hence, there would be few special problems involved in loading military cargo onto fast ships at a dock facility designed specifically for these vessels.

Overseas, the situation is much more complicated with regard to transfer from ship to shore. A rail-based transfer system of the kind under development by FastShip Atlantic, or any similar rail or fixed guideway type transfer system, could be used only a distant port already equipped, or supplied with, the same (tracked) system. Note that this transfer system technology would apply to all containerized loads on fast ship pallets, regardless of the kind of domestic collection/distribution system employed at the home end: truck (chassis), ACG, ChassisRailer, or conventional intermodal railcars. In all cases the rail transfer system with bogies, skeletonized railcars and hydraulically-equipped pallets would have to be compatible with the technology installed at the US port.

However, to accommodate the lack of specialized facilities at many overseas port locations in third-world countries, including impromptu installations near a military theatre of operations, the simplest alternative to use of this specialized transfer system would be to rely on Ro-Ro, i.e. the tanks, straight trucks, tractor-trailers, and containers on chassis with their tractors, would simply be driven onto the fast ship at the home end, ready to be unloaded under their own power in short order at the distant port location. This would take advantage of the flat, ferry-like decks of the fast ship.

Hence, military cargo could be moved in two ways by fast ship—either Ro-Ro mode or in containers on pallets using the rail transfer system developed for commercial cargoes.

Military Operational Phases from a Fast Ship Perspective

With regard to phasing of military operations, the highest priority cargo at the start-up of an operation would of course go by air. Next in line would be cargo that can be moved on such fast ships as may be available. The cargo that could tolerate the slowest movement would go by Ro-Ro, conventional container ships, self-unloading ships, other kinds of freighters, etc. Of course, a parallel supply chain will also be in place with some kinds of military cargo previously stocked on pre-positioned or pre-stationed supply ships, already in place at various locations around the world and ready to be deployed.

The need to unload cellular container ships conventional container ports provided with extremely large, heavy overhead gantry cranes designed to lift the containers, and then transfer the containers onto another transport system in order to carry them to the military theatre of operations, should militate against their use and favor fast ships which would be able to move and unload Ro-Ro cargo very rapidly. Hence, the real contest would probably be between fast ships and conventional, but slower, Ro-Ro ships—although one can expect that some military cargo would almost certainly continue to go in cellular ships.

As noted above, for newly established, temporary ports near a military theatre of operations, the simplest short term alternative using fast ships would be to employ a Ro-Ro operation carrying all self-propelled vehicles on the vessels, such that containerized military cargo on chassis would move with attached highway tractors permitting the ship to be rapidly unloaded and turned around, simultaneously permitting fast delivery of the cargo.

An item the military might want to consider would be a mobile “fast dock”: a specialized vessel used as a wharf facility, which could unload fast ships at one end, and extend a modular ramp onto the beach/onto shore. Such a vessel might use technology similar that of one of the fast ships considered for commercial service, or be based on a fairly fast conventional ship design. Its availability, and ability to arrive on the scene at the start-up of operations, would be an asset to rapid deployment and would allow fast cargo ships to be used to best advantage.

After the immediate start-up of an operation, there would be an option to use fast ships in a different Ro-Ro mode of operation--moving only the trailers/chassis with containers in compact configuration and unloading them piecemeal using tractors which have already been delivered. The disadvantage of this is the longer loading/unloading time involved as compared to movement of self-propelled vehicles. (Note that commercial interests also sharing use of the fast ships would want to see the most rapid possible turn-around at the military port facility, so that the vessels could be returned to commercial operations without undue delay.)

For a longer-term operation, there would be the option of installing track on shore and using the fast ship system of unloading, rapidly, at the impromptu destination end port facility. This would probably use diesel powered bogies/skeletonized railcars (non- electrified) as there would be no point in installing an expensive electrification system at a temporary and distant location. Modular track sections might be used to facilitate use of this rail transfer system which would be most compatible with commercial operations using the same kind of container pallets on the fast ships, and would thus have a logistics advantage in joint military-commercial operations.

In designing a temporary military installation for unloading fast ships at the stated rate of up to 1000 per hour (or at least, substantially faster than any cellular container ship can be unloaded), it is not certain how many tracks would need to be installed, or how elaborate a landside installation would be desirable. It is certain that the transfer vehicles used to carry the containers + pallets off the ship would be required at the start-up of rail transfer operations, and hence would need to be moved along with the first military cargo moved on the pallets—then remaining at the military port facility for the duration of operations.

Certainly, at least a double track lead would be required, to extend from the docking facility to shore; in all probability these tracks would be paved to allow Ro-Ro traffic to use the same ramp facilities. Landside, modular track might be used with steel ties, be laid directly on a flat, graded area, and designed with segments that are easily bolted or otherwise fastened together. Instability could be a problem here for double-stacked container equipment; the single stack containers on pallets recommended for the basic ACG stateside access system would more easily be able to accommodate faults in the track or roadbed than the lofty double stacks proposed for some other kinds of commercial operations.

Control systems for operating the powered bogies in the military installation would undoubtedly be much simpler than those designed for a domestic application, probably entailing radio control or manual operation of the transfer vehicles. Switching might be in part automatic (including use of slip-switches where possible) and in part manual. The rails laid down on graded areas would be equipped with simple wedge-like ramps to permit trucks, forklifts or small mobile cranes, and other wheeled or treaded vehicles to easily cross over the tracks in at appropriate points. (Hence, roadway sections between the track would be similar to soft-ride grade crossing installations at domestic railroad grade crossings.)

In all probability, fast ships carrying military cargo on pallets for rail transfer would probably also carry some Ro-Ro traffic.

Integration of Military Cargo and Domestic Cargo

If the military invested in fast ship construction, or in elements of the ship and dock construction, such as stronger ramps, strengthened decks, etc. to carry heavy military loads, they would doubtless do so with a provision that they have priority in cargo transport, and in emergency conditions would preempt the use of the ships in entirety. This would probably entail some alternative way of ensuring that domestic cargo flows not be unduly interrupted, including provisions to send some commercial freight via some combination of air freight and direct container liner until the emergency is over, i.e. until regular commercial operation of the fast ships could resume.

(A possibility develops during the start-up of a fast ship commercial operation that in the event there has been a short-term over-investment in vessels, e.g. if ships are on hand sufficient for a twice daily service, but the demand has not built up to necessitate such a service frequency, a military operation could take up the slack in the initial schedule and make use of the ships in the interim. This could make integration of commercial and military operations easier, but of course would only represent a temporary condition.)

After the emergency is over, or during a non-emergency military operation, there could remain a surge condition over a period of weeks or months that would favor fast ship use, blending in military cargo and commercial cargo and adding one or more extra stops to the most nearly applicable fast ship civilian route. Presumably the military would pay for additional fuel required to transport heavy loads, and for any route extensions. To the extent that there is any slack in normal fast ship operations, it is presumed that this would be taken up by the military surge. In this case, with regard to stowage on board the fast ships, some cargo bays would be occupied by military Ro-Ro cargo, and others by regular fast ship containers on their specialized pallets.

A significant aspect of the commercial cargo/military cargo relationship is that military cargo will usually be moving in an the export direction, from the viewpoint of the west coast of the United States, while the highest-valued domestic cargo will more likely be moving in the other, import direction (Pacific Rim into West Coast ports) since imports volumes are forecast to continue to exceed exports in commercial trade.

Assuming that imbalance in commercial export/import transpacific traffic means that there would normally be empty spaces on fast ships departing the west coast--and assuming that relatively few empty containers are carried on fast ships (they would probably go as deck cargo on other ships/travel via other routes)--the added, outward-bound military traffic could help to alleviate an empty back-haul situation. In the event that there is a heavy enough flow of military cargo outbound so that it would begin to displace domestic export traffic, it should be noted that what is most likely to be displaced initially would be cheaper cargo induced by low backhaul rates, etc.

A problem with the above scenario in which there is some balance between outbound military cargo and inbound commercial cargo, is that some classes of military cargo would not be able to use the specialized container pallet transfer system developed for regular commercial fast ship operations. Hence, under a short-term military operational scenario, cargo bays used by the military to transport Ro-Ro traffic outbound might remain empty for the trip into the U.S.--unless filled with some form of uni-directional cargo such as autos (however the latter can be expected to move under long term contracts and would not be susceptible to a short-term diversion). Of course, the military would compensate the commercial ship operator for any imbalance in commercial traffic in one direction.

A strategy that could alleviate this would be to triple or quadruple stack the fast ship pallets to be sent as empties in the outbound direction from the U.S. port, in parallel with a military cargo movement towards an overseas theatre of operations. At the distant commercial port, these stacked pallets would be off-loaded and broken down into single pallets, then loaded with single or double stack containers for the return trip to the US (import movement towards a domestic fast ship port). This could partially solve the problem of having to move unoccupied pallets in an unbalanced move.

(Again, empty containers involved in an unbalanced trade movement would have to be sent back overseas on a cellular ship, perhaps through another port, or taking the long way around the globe--or in some cases, perhaps at the start-up of a military operation, some old, soon-to-be-discarded containers might be acquired overseas for this kind of movement, etc.)

Longer-term operations with a minimum of surge would of course allow a more normally scheduled fast ship service, in which case military traffic would blend in with commercial operations with a minimum of disruption, as per the basic Agile Port concept.

A factor that should not be ignored is the potential to add military cargo to the fast ship at an overseas commercial port, or a combined military/commercial fast ship port facility near an overseas military base. This would allow ship capacity, vacated by commercial export cargo, to be utilized by some additional military cargo already stored overseas. Such cargo might be Ro-Ro or containerizable.

This component of the combined commercial/military operation would impose much less interference between commercial and military cargo movement, because a higher percentage of ship space would probably be available to commercial cargo for export movements. (There might even be some potential for shorter or longer term shipment of some commercial cargo from the vicinity of the military theatre to the Asian commercial port, as well, increasing efficiencies even more.)

Finally, note that some military cargo, such a classified, expensive, or non-expendable hardware, would eventually return to the U.S. or to overseas military bases at the end of an operation. This materiel might be more likely to move by fast ship if shipment via this new marine mode were demonstrated to be more secure with the equipment less subject to damage than if moved on normal container ships; or if the cargo were needed somewhere else, immediately.

Possible Military Interest in a Specialized Agile Port Delivery System

Surge control combined with the rapid yet economical deployment of military cargo, and smooth integration of military and domestic cargo are of considerable interest to TRANSCOM. It is apparent that fast ships, and their ancillary methods of rapid loading/ unloading, and improved, congestion-free access could be of some interest to the military.

However, it should be observed that the possibility of delivering locally-originated cargo at night, during the relatively congestion-free period for the freeway system in a large urbanized area like LA, could mean that the military would be unlikely to want to invest in an expensive agile port delivery system for operations of limited time scale or infrequent occurrence. Likewise, note that longer-distance transport by rail, including standard TOFC or COFC modes, conventional flatcars carrying tanks, and covered military cars, would allow delivery direct to the ports, without highway congestion, even if the rail transport through the urbanized area were to take 2 to 3 hours or so.

Conventional transport alternatives (including overseas air transport direct, without using our seaports) seem readily available, and this would militate against an extensive military investment in novel systems for only occasional use.

On the other hand, if commercial use would support development of a specialized agile port collection/delivery system, the military would no doubt consider taking advantage of it during periods when it utilized fast ship service. There might indeed be periods when it would be desirable to ship military cargo by fast ship combined with rapid access to the port during congested daytime hours--which service would be best provided by a fixed-guideway delivery system capable of accommodating surges in traffic.

Note that continual supply of relatively permanent overseas bases would constitute the longest-term overseas military operations. In this case, the military might want their own fast ship transfer facilities, of a more permanent nature similar to what would be installed at a U.S. port, especially if such facilities could be combined with commercial uses overseas.

Potential for Military Use of an ACG Agile Port Delivery System

As noted in a previous section, an automated guideway system for agile port access would appear to have very considerable excess guideway capacity in terms of track time and track space to accommodate surges. (This would probably be true whether such a system were developed in the SCAG region or to some other urbanized area with a port.) However, the problem in actually providing more service would be availability of equipment i.e. the rolling stock actually purchased for use on a line of this kind would be carefully matched to likely regular daily commercial demand—scenarios in which there is considerable excess rolling stock available which might accommodate major military surges, would probably not be feasible in terms of system finance, at least private sector finance. No one would invest in cars costing (in the case of the automated system option) between one and two million dollars each, without expecting to use them regularly and frequently.

The imbalance between commercial import and export shipments could however allow military cargo to take advantage of a back-haul situation likely to occur on the agile port collection/delivery system. That is, similar to what could happen on the fast ships, spaces on the ACG or ChassisRailer vehicles that might otherwise remain vacant or occupied by empty containers/cheap commercial backhaul traffic could be occupied by more valuable military cargo moving in the direction of the U.S. fast ship seaport. Hence, military cargo surges could be much more easily accommodated than in a balanced commercial trade environment. This might obviate the need to purchase very much additional rolling stock to move military traffic.

Several scenarios will indicate what the impact of joint commercial/military use of the fast ship system would be on an automated collection/distribution system, and what additional equipment/what kind of equipment, might be needed by TRANSCOM to participate in this kind of joint use. All of these scenarios will assume a 720 FEU (40' equivalent container) fast ship similar to the FastShip Atlantic vessel in total capacity, and that 85% of the ship capacity will be used on average in the peak direction. They will further assume that due to an imbalance between exports and imports, that export FEU traffic will be 68% as heavy as import FEUs (close to a 40:60 split between exports and imports).

Scenario 1 variants below assume that all military traffic moves on the vessel in Ro-Ro configuration, and Scenario 2 variants assume that all military traffic moves via containers on pallets using the ACG system from some inland point (assuming tanks, weapons systems, and other such Ro-Ro traffic has already arrived at the theatre of operations). For the sake of illustration, an Asian commercial port is assumed and the westbound direction corresponds to exports, eastbound to imports from an American west coast perspective.

Under Scenario 1a, the ship would be loaded at the 85% factor with commercial containers in the import direction from an Asian port, meaning 612 import containers and 416 export containers. With container pallets stacked four high for transport in the export direction, an additional 49 FEU spaces would be required. This would leave the equivalent of 255 FEU spaces that could be occupied by military Ro-Ro traffic. In this case, no additional equipment would be required by TRANSCOM, and the military operation would utilize only normally spare capacity in the export direction.

Under Scenario 1b, all of the space on the ship in the export direction would be occupied by military Ro-Ro traffic. That is, all of the space except that required to deadhead container pallets to the Asian commercial port so that a normal commercial load (612 import containers) can be carried east. This would mean 153 FEU spaces would be required to carry pallets west, and the equivalent of 567 FEU spaces would remain for Ro-Ro traffic. In this case, there would be an impact on commercial traffic, with empty ACG cars shuttling pallets from inland freight stations to the dock, resulting in a revenue loss to the automated transport system. This cost would be borne by the military users of the fast ship.

Scenario 2a assumes that ship capacity in the export direction is fully utilized. The mix of containers would be 416 commercial + 304 military containers in the export direction, while there would be 612 commercial import containers (85% factor applied) as above. The additional containers moved in the export direction would mean that an additional 108 pallets are needed per run to fill the ship with military traffic westbound. However, considering that ship cycles are lengthened by an extra stop overseas, more pallets than that would actually be required for the operation. Also, 16.7% more ACG rolling stock would need to be utilized, provided cycle times for the landside operation are the same as before. This additional rolling stock would be made available by purchase or perhaps by improved operational efficiences (see below). In this case, no commercial export traffic would be displaced, while the ACG system would have additional, military business.

Scenario 2b is a "straw man" situation in which it can be assumed that all of the export capacity would be taken up by military container traffic on fast ship pallets. As with 2a, there would be additional fast ship container pallets required, and the same additional rolling stock. The level of business for the ACG system would be the same. However, in this case commercial container export traffic that would normally go by fast ship would be displaced, probably with some cost penalty borne by the military user. It is apparent that the number of military containers carried by the fast ship and borne by the ACG system could fall somewhere between 304 and 720, with the same equipment requirements and with impacts on commercial exporters (with associated costs) being proportionate to the level of displacement or diversion.

Note that Scenarios 1a and 2a most closely fit the Agile Port definition of providing easy integration of commercial and military traffic, with smooth flows for both.

While there are innumerable other scenarios that could be looked at, one further example will suffice. Scenario 3 builds upon 1a and 2a and assumes that there would be 612 import commercial containers and 416 export commercial containers. This leaves 304 FEU spaces available on the vessel, westbound. If 196 of these were occupied by military containers on fast ship pallets and delivered to the dock on the commercial ACG system, no additional ACG vehicles would need to be purchased as the military traffic will have fully utilized the practical capacity of the guideway fleet (practical capacity being the number of containers that can be moved using the spaces available on the cars)

Under Scenario 3, the equivalent of 108 spaces would remain for military Ro-Ro traffic moving in a westbound direction, so that the split for military cargo at the overseas theatre would be about 65% palletized and using the rail transfer system, and 35% Ro-Ro. This may be very reasonable as it is expected that some roll on-roll off traffic is likely to continue to move during all phases of a military operation. There would be a requirement for additional container pallets, because the pallets moving on to the military port would have a longer haul time. They would deadhead back from the military port to the Asian commercial port, where they would rejoin the commercial import logistics chain.

A combined operation similar to Scenario 3 but with a greater percentage of military traffic moving on container pallets could mean that additional ACG rolling stock would be required, but probably substantially less than the 16-17% increase indicated in Scenario 2. Scenario 3 and possible variations of this would satisfy the definition of an agile port operation very well, allowing a smooth flow of both civilian and military cargo, with a minimum of additional, major capital acquisitions required.

In the event that military cargo surges were (even considering the ability to take advantage of commercial trade imbalance) heavy enough to challenge the practical capacity of the ACG system as sized for commercial use to provide enough rolling stock, there are several other possible ways to enhance practical system that might make it possible to avoid expensive ACG car purchases. These are as follows:

First, better utilization of ACG vehicles might be obtained by very carefully balancing train schedules between military cargo and commercial needs. Second, there would be some latitude to increase average speeds (the vehicles would be designed for 70 MPH, while normal operations would be 50-55 MPH) and hence increase the number of cycles per day accommodated by the existing fleet. Third, it might be possible to accelerate vehicle maintenance cycles to the extent possible to make somewhere between 5% and 10% more equipment available during a military surge.

Fourth, normal maintenance of way might be scheduled so as to avoid taking any track segments out of operation for routine maintenance during a military operation (the guideway is designed with numerous crossovers and pocket tracks, to maximize operational flexibility in any case). In the event of increased power demand and vehicle maintenance, these additional costs would be assumed to be paid for partially by the military clients of the system.

Hence, a combination of movement against the flow, with several strategies to marginally increase productivity, might very well allow military surge traffic to be handled with a minimum of disruption, even without expanding the fleet size. Only if military operations were fairly regular, is it likely that TRANSCOM would have an interest in participating in a rolling stock purchase (and subsequent lease to the commercial operator).

(It should be noted that as with the fast ship itself, there would be a short term opportunity to accommodate military surges prior to the ACG system coming into full commercial utilization, i.e. while it is in the process of building up business.)

Potential for Military Use of a ChassisRailer Delivery System

For ChassisRailer the imbalance between import and export commercial container flows would similarly allow military Ro-Ro cargo to travel at the same time as the export commercial movement, much as discussed just above for the ACG system. The only real differences in operations would be those inherent to the ChassisRailer system, i.e. the containers are normally lifted onto the pallets positioned on the special rail transfer system, on dock. The same lifting devices that would otherwise be used to trans-load containers, would also be used to stack pallets for a more compact trip in the export direction (towards the overseas commercial port).

The impact on equipment requirements would be very much as described under Scenarios 1 through 3 above, except that ChassisRailers would be acquired to satisfy military surge conditions instead of ACG vehicles, should extras need to be purchased,. Additional fast ship container pallets would be needed as with the ACG alternative, except that in this case they would be shuttled only between the US port, the Asian commercial port, and the military theatre (they would not be used inland of the domestic port).

There are other possibilities for operational flexibility using ChassisRailer equipment in combined commercial/military service. The road/rail chassis would be able to be used as conventional chassis and travel in Ro-Ro fashion if necessary; and could be returned in a stacked chassis configuration if desired.

However, there may remain imbalances due to military surge traffic that would require some additional ChassisRailer equipment to be obtained to guard against the eventuality of a shortage. For ChassisRailers, purchase of a dedicated fleet of equipment primarily to satisfy military surge requirements would be considerably cheaper than purchase of ACG vehicles, since the road-railer equipment--both chassis and rail bogies--is vastly simpler, both mechanically and electrically.

During non-surge periods, the chassis might be used for other, non-rail transport purposes by the military, i.e. they could switch the road-railer chassis between rail/highway and all-highway use, and divert them from one geographical area to another, as might be required. This scenario would suggest that additional chassis would be required more than would additional bogies.

Another consideration is that as the equipment would operate over the general system of railroads, ChassisRailers could be used to transport loads from a considerable distance outside of the region to the fast ship agile port, if there were a military requirement for such shipments. In this case, there would of course be a need for a proportionately greater number of bogies and chassis.

Overall, then, ChassisRailer as in inland port delivery system is likely to provide much greater utility to the military in conjunction with fast ship operations, than would an automated guideway system.

Military Stores and Inland Ports

Military cargo transported by fast ship might include cargo previously stored or stockpiled at military depots as well as cargo regularly re-supplied direct from the factory. It lies beyond the scope of this study to investigate military logistics in any detail. (It will be noted in passing, that one notable military store in this area, the US Naval Weapons Station in Seal Beach, is definitely not located close to any of the proposed inland guideway transport corridors investigated in this study.)

Nevertheless, there is the possibility of integrating fast ship operation with transport of military goods from temporary or long-term depots located at on former, converted military bases or at still active, joint use facilities, which could be on the waterfront or inland (the latter often formerly military air bases). The latter could be connected to a commercial fast ship facility via conventional rail intermodal, by ChassisRailer, or by means of an automated system of the kind investigated here.

In terms of direct supply, of course locally-manufactured or assembled items could go by truck or via an agile port delivery system (chassis railer or ACG), depending upon location.

A ChassisRailer or ACG fast ship delivery system could collect containerized loads which arrive at the inland port area by truck, train, or air. Synergy with air cargo transport could be important as the higher priority cargo could be loaded onto aircraft at an inland port facility developed from a former air base; while there would be an opportunity to divert somewhat lower priority cargo as may be appropriate, to fast ships via the inland transfer system, allowing reduced fuel and aircraft costs.

In the case of rail transfer, particularly under surge conditions, note that conventional intermodal equipment could also be used as a means of transfer from the inland port to either fast ships or conventional container ships, even if this kind of movement is not normally made in commercial service.

Transport of Military and Civilian Railroad Equipment by Fast Ship

Branches of the US military service have had considerable experience in the past in operating railroads, including the Military Railway Service and separate operations in various military depots. The fast ship transfer system contemplated here, loosely based on designs of FastShip Atlantic, would include railroad track built into the cargo decks of the vessels. This would provide an opportunity for the military, should it need to operate trains on a local railroad system in some theatre of operation, to easily transport railroad equipment in ferry mode.

For a premium cost in vessel fuel, railroad cars and locomotives (probably smaller switch engines) could be sent in support of some overseas theatre. In this regard, it should be noted that while most European railroads are operated on standard gauge (which is 4' 81/2"), many countries around the Pacific Rim do not use Standard Gauge track. The other track gauges commonly used around the Pacific Rim are 3' 6" and meter gauge, although broad gauge track (wider than Standard Gauge) is used in some other parts of the world.

Of course, transport to countries operating on Standard Gauge would be relatively easy. For transport of rolling stock intended for some other track gauge (probably equipment made available from an overseas railroad, supplier, or equipment leasing company), there would be three ways to do this using fast ship rail technology.

First, it would be possible to provide gantlet track in several of the cargo bays of the ship. The two outer rails comprising one track of this setup would be built to 4' 8 ½" gauge. One of these outer rails, say the rail on the starboard side, would be used by 3' 6" gauge equipment, with the other rail for this purpose being set 3'6" away, between the Standard Gauge rails. The outer rail on the port side of this track would then be used for meter gauge equipment, with the other rail required for this being set one meter away, again between the two outer rails of this track. Greater lateral clearance might need to be provided, however, as the track centers for the narrow-gauge equipment would be offset in different directions from the Standard Gauge track center.

A second way would to be to employ lengths of modular track sets (ties or an equivalent structure with rails affixed, designed to snap or bolt together) which could be installed on the ship, locked onto the deck in the cargo bays. A third way would be to use variable gauge railcars with an arrangement like that used to move Talgo Trains between Spain and France. However, this kind of equipment, if employed for military freight, would be somewhat heavier and more costly to transport than standard railroad cars.

With regard to extending track from a fast ship overseas dock to a civilian railroad line pressed into military service, it would be possible to use modular track of the kind mentioned previously. This could be moved by fast ship and itself rolled on and off by some kind of vehicle on tires, transported along with the track. Lengths of this track could be used to extend a temporary pier railway to shore or over to the railhead if close by. Some equipment for constructing new track sections would also have to be provide, in order to make whatever connections might be required.

There could also be occasional civilian use of the track provided on a fast ship, in the event railcars or railroad maintenance equipment were imported from overseas for urban transit system or railroad use and had to be delivered in a hurry. Either entire cars, or detached wheelsets (trucks or bogies) might be transported in this way using the tracks built into fast ship decks. Specialized maintenance vehicles that would be effectively one-of-a-kind for the transit property or railroad ordering said equipment, might be ferried by fast ship in this manner. Such rolling stock could simply be driven right onto our railroad system, connecting to major US railroads. (In this regard, note that railroad locomotives have even been transported by heavy lift cargo planes, lending credence to this scenario.)

Cargo Security

Some military cargo, such a classified or expensive weapons or information systems, might be moved preferably by fast ship if it were demonstrated that such cargo could be moved with greater security (fewer lifts, obviation of the need to store containers on the ground at a port while waiting for transfer, etc.). If required, military personnel could accompany high-security cargo on the fast ship and stay with the containers in question while the cargo is transferred from one mode to the other.

In the case of an automated guideway system, normal container movements would be unaccompanied. If it were necessary or desirable, it would be possible for military personnel to accompany such a shipment riding in a maintenance vehicle with a cabin. Such rolling stock would of necessity have to have the same performance as the container-hauling vehicles. Other security provisions, of course, could also be made.

Dangerous Cargo

Special procedures would be needed to deal with ordinary hazardous cargo (e.g. fuel, solvents), as well as hazardous weapons-related cargo (such as ammunition), dictating what can be handled by the fast ship and its inland delivery system, at what times, and in conjunction or combination with what other kinds of cargo.

Section 9: Agile Port Implementation Issues

This section of the report provides an examination of the issues that could impede or ease Agile Port delivery system implementation.

Issues for Development of the Agile Port Delivery System

Below are presented a number of issues that need to be addressed to facilitate further planning of an Agile Port delivery system. These issues are discussed in detail, but not quantified, or prioritized as to their affect on implementation. The issues are grouped into several categories:

- Fast ship issues which will also impact the feeder system
- ACG system development issues
- ChassisRailer System-related issues
- General questions regarding implementation of any fixed guideway alternative
- Inland port development issues
- Role of the Alameda Corridor
- Involvement of the electric power utilities
- Regional highway congestion, air pollution, and other environmental/local transportation system issues
- Regional land use and growth allocation issues
- Coordination with the military/military interest

Fast ship issues which will also impact the feeder system

Markets

- Buyer behavior/preferences
- Diversion from existing supply chains, that the new service might induce
- New supply and logistic chains may influence use of the new marine mode
- Identification of shipments not currently made at all
- Market research needed on customer willingness to use and pay for a "middle market" option
- Will air cargo growth forecasts for high value/fast international cargo growth be realized? If so this will favor fast ship potential as well
- Containers "rolled" to this service due to service complications on existing containership routes
- Lag time to deploy full coverage
- Lag time to gain market acceptance

General Economic Conditions

- Increased reliance on expedited services to insure on-time service/delivery

- Increased internationalization of production and demand for shipment of high-value components
- Vacillation in the US economy and demand for imports--especially high value imports
- US success in generating export traffic in high value or time sensitive market segments: fast ships will not do well with a high volume of empty or low-rated backhauls considering ship and fuel expense
- Impact of unionization of fast ship and delivery system operators
- "Cannibalization" of the existing drayage and consolidation industries
- Impact of telecommunications technology on some high-value imports/exports (sending information rather than goods, e.g. tapes, discs, etc.)
- Maintenance of "Most Favored Nation" trading status with China and the general health and viability of Asian economies

Routes & Operations

- Impact of Southwest Passage development and trade with Mexico using our seaports and rail/highway inland ports of entry
- Development of fast ships as a replacement for smaller, slower feeders in the Latin American west coast and/or Panama Canal/Caribbean/Brazilian etc. trades
- Potential joint use of fast ship docks between Latin American feeders and transpacific fast ships
- The question of how many en-route stops are desirable, and how fast ship routes will interrelate operationally (e.g. transpacific and Latin American routes—extend the same routes or transfer cargo between lines?)
- Issue of mid-ocean stops (Hawaiian monopoly held by two extant liner companies will impact this)

Route & Port Diversion issues

- The general port diversion question: provide adequate service inland or face possible diversion to other ports
- Shift in general deep-sea supply lines towards South East Asia/Suez Canal, competition with shorter northerly/westerly routes, etc.

Competing Modes

- Competition from improved air freight service (large all-cargo aircraft)
- Competition with large post-Panamax vessels (lower price per box) especially if methods of unloading cellular ships are speeded up

Investors and Shippers

- Attractiveness to major surface-air integrators
- Investor interest in fast ship and willingness to finance ships and/or terminal facilities: against heavy prior investment in existing kinds of ships and facilities, and the tendency to improve the latter instead of going into new technologies
- Sheer magnitude of the investment

- Resistance of existing container ship lines and short planning horizon in industry: commitment to extant technologies/operational methods
- Shippers and investors used to currently-used modes/operations/routes

Technology-Related Issues

- How much faster than conventional vessels will first generation fast ships actually be? Can they actually deliver on speed and provide better reliability in rough weather? What can we expect from second generation fast ships?
- Issue of mid-ocean refueling: put in to port to refuel en route, or refuel at sea?
- Alternate, after-market uses for the vessels, transfer system, and other equipment
- Fuller use of electronic pre-clearance for customs
- Fuel price uncertainties, for high cost turbine fuel
- Success of the first projects, like FastShip Atlantic, the Australian and Japanese projects, will have a major impact on future thinking on fast ships. If they work, others may be interested in emulating them.

Automated Container Guideway (ACG) System Issues

Funding and Finance

- Long lead time to full operation
- Project would be very expensive
- Issue of private versus public funding, or public/private combinations
- Private investment demands quicker return; e.g. within 5,10, or 15 years: only public investment can take the "long view" with 40-year projects
- Note that even public investment has to support costs
- Repayment of bonds, etc. from fees, and allocation of such payments between stations/inland port by distance or other methods
- Tax incentives and bond guarantees might be considered if private development is desired but risky
- Any level of public investment or public bond guarantee for ACG could compete with funding/bonding required for passenger transport

Construction/Implementation

- Need to access manufacturing and warehousing market areas/condemn property
- Additional planning (structural and operations) and engineering needed
- Length of construction time/long time to implement

- Right-of-way issue: involves ACTA, freight railroads, utilities, Army Corps (LA River), Caltrans, private landowners in SB County near Norton AFB (new R/W)—although the system is elevated or mostly elevated, it would still require R/W

Technology Development

- Technology probably not an impediment to development but breakthroughs might reduce O&M costs or improve close vehicle following capability
- The real issue is capital costs, an area where no breakthrough is likely
- Can the new technology really deliver? Some new transit systems have had major technical and operational problems on inception (e.g. BART) or very long development time (VAL)
- For alternative, non-rail technologies as may be proposed, switching response time is a problem, reducing system utility as compared to rail (cumbersome transfer table type switches required as compared to fast RR switches): impacts system capacity
- Would require construction of a test track with several cars (enough to permit coupled operation) and several sidings to test switch response, close vehicle following , etc. before construction of a large scale route is possible. An existing fast ship dockside transfer system would facilitate tests of loading and unloading the ship with ACG.

Other Uses or Guideway Sharing

- Possibility of transporting commuter or general passengers*, air passengers, air freight, express mail, or municipal wastes
- Likely necessity of carrying such additional cargo for economic viability of system
- What strings would be attached to public funding or public loan guarantees?

ChassisRailer System Issues

Market

- Lag time to implement full system and gain acceptance
- Price may be greater than current cost, for shorter distance runs and for some routes
- Shifts of industry/consolidation activity/warehousing etc. to Inland Empire, north toward San Fernando Valley, and/or south towards San Diego

Ownership Issues

- Who would make the investment?
- Who would own the trains: main line RR's, shipping lines, shippers, or others?
- Short line railroad question, e.g. related to use of Ventura County Railway: how far could it operate into LA? (railroad labor union rules, costs, and priority issues)

- Required capacity additions to underlying railroad assets/infrastructure

Operations Issues

- Cost of service on shorter hauls
- Train priority would need to be more firmly established—expect it to be same as intermodal bridge traffic, which may not be fast enough for local cargos; existing TOFC/COFC trains operate provide expedited intercity service, but are not necessarily fast within urban areas
- Need own spur tracks, attention to interface with railroad drill tracks, signaling system improvements, scheduling to avoid passenger train interference, etc.
- Maintenance issue - where is the equipment maintained?
- Track fees or trackage rights
- Possible use of Metrolink line from LA to San Bernardino

General Questions for any Fixed Guideway Alternative Serving Inland Ports / Freight Stations

- Need sufficient containers to/from fast ship piers, to justify the service
- Assuming either alternative system is workable, which stations really merit development?
- Charge by the box, mile, or hour; level of charges when boxes are empty
- Issue of quantity discounts/rebates etc., especially to attract customers during the start-up of service
- Question of all-night operation as opposed to shifts which impact hours of truck draymen
- Development time not the same for different alternatives: ChassisRailer or other rail intermodal may be much more easily implemented in short term--ACG would be a very long-term option
- Phasing issue: ChassisRailer might be an initial phase of development on some routes to test the market, with ACG being developed later if strong demand manifests itself
- Selection of the most viable routings and targeting the most likely market niches
- Cost of financing
- Burden of start-up costs
- Improved processes and costs in backlands handling near the pier
- Viability of options to move all containers off the piers to an alternate inland gathering/ disposition facility
- Data on impact of incidents on running time is needed
- Lesser capital intensity options would be more attractive
- Overcoming of current equipment inspection routines could be important
- Pricing for shorter lengths of haul, to be competitive with drayage
- Development of a precise cost model for variations/scenarios including imbalanced cargo flows (e.g. fill-in imbalances with regular liner cargo or with very low-valued cargo)
- Evaluation of projects using alternative financing methods

Inland port issues

- Question of San Pedro Bay ports' interest in any remote inland facilities (Los Angeles perhaps is more likely to consider this than Long Beach, in part because of the city's experience with its regional airport system)
- Practicality of shuttle trains for general container ship cargoes complementing fast ship cargo use of the same facility
- Question of whether ports may eventually provide vertical container storage rather than considering new backland in distant locations
- Will the ports have room for a novel technology with its own intermodal transfer facility requirements?-- ports' land allocation priorities are a major factor
- Possibility to physically "shoehorn" a fast ship facility in or locate the same on irregular-shaped pieces of property (long, narrow parcels etc.)
- Streamlined customs procedures
- Vehicle inspection procedures

Alameda Corridor Issues

- Some options (e.g. ChassisRailer) may use the corridor directly (Pt. Hueneme to Carson; San Pedro Bay ports to Inland Empire/Orange County/San Diego)
- Other options (ACG) may compete with the corridor if implemented too early
- If the Alameda Corridor and east-west railroad main lines reach capacity within the basin (congested section at 24 mph average speed), ACG system may complement the railroad lines/provide an alternative way to transport intermodal bridge containers to the edge of the region where the main lines fan out across open country en route to the Middle West/Gulf Coast
- Use of Alameda Corridor right-of-way for ACG aerial line in less built-up sections
- Providing alternatives to again enlarging the ICTF

Electric Power Utility Issues

- An ACG system would be a new customer
- Utility might participate in finance of electrification / maintain substations, catenary or third rail, and other electrification plant per contract arrangements
- Capacity to supply power probable but needs to be demonstrated definitively

Congestion, Environmental / Local Transportation System Impacts

- Will future predicted levels of recurrent highway congestion occur, justifying fixed-guideway alternatives and especially ACG?
- Will future freeway accident/incident levels increase, similarly increasing the justification of fixed guideway alternatives?
- Cost of congestion and incidents is difficult to assess: few reliable/definitive studies

- Air quality impacts difficult to assess, would need to run regional airshed model etc.
- Any new system not running over extant operative railroad tracks, would need environmental clearance
- Risk that a severe natural disaster will shut down transportation capability without alternate capacity
- Fast ship "niche port" physically separated from main container liner ports, and/or ACG as a new mode with its own guideway could provide a cushion in event natural disasters such as earthquakes close certain port terminals/disrupt freeways or railroad lines

Regional Land Use and Growth Allocation Issue

- Inland port relationship to foreign trade zones, enterprise zone development, zoning for new industry, etc.
- Question of the location of freight forwarders/consolidators/warehousing/industrial development: will this activity really extend or relocate eastward towards the Inland Empire? Air freight potentials and current trends with trucking company locations suggest it may. This could favor alternative delivery systems such as ChassisRailer or ACG.
- Environmental and mobility impacts

Coordination with the Military / Military Interests

- Integration step needed with subsequently published CCDoTT findings
- Question of military interest in system: needs more extensive research and commitments
- Volumes, frequency/longevity, logistics of military shipments uncertain (constant supply versus specific operations), and some of the information may very well be classified
- Port of Hueneme has its own backland and looks promising for fast ship and joint-use transfer facilities; however, Port Hueneme joint use potential would need further study
- Other local military bases would need additional study as to their role in supplying overseas operations and relation to any new fast ship-related guideway system
- The propensity of military to use new air freight facilities at former, closed military bases should be researched
- Question of military and civilian labor use at a joint-use facility

Implementation - Final Remarks

Though all of the listed issues may be important, we expect that a mixture of commercial viability and financial criteria will be of paramount importance. Shippers' mode choice alternatives and the cost and service differentials involved in using the novel systems described in this report, as opposed to remaining with traditional truck drayage or direct-to-rail intermodal operations via the Alameda Corridor, will be primary factors that will affect new system implementation. As any emergent alternative system may alter the commodity origin / destination pattern for cargoes due to new service and cost options, another important issue would be the resulting pathways of goods flow on the local road network (especially to and from automated or ChassisRailer delivery system freight stations).

Ocean carriers, shippers, and forwarders that are aware of upcoming increases in costs due to either higher truck drayage rates or alternative delivery system fees, might opt to switch to using other ports. Shippers and carriers might also start experimenting with new routes or begin using other landbridge options prior to the onset of the increases. On the other hand, users of the system may expect incremental improvements in service delivered with a high technology service offering. The cost of improvements is one justification for increases in costs for local transportation; and customers will expect to see resulting increases in quality of service (higher speed, reliability, etc.), in return.

If improved service does not appear to be forthcoming, user perceptions of the system and even of the ports as a whole may suffer, potentially resulting in diversion of cargo to alternate routes and other ports. Potential customer response including resistance to change or raised expectations can be anticipated through the use of appropriate, detailed market research -- involving use of surveys of carriers, shippers, and other interested parties -- in the advance of any implementation actions being taken.

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* Light rail systems, which are by definition not fully grade separation are currently in vogue in urban passenger transport for reasons of cost reduction, ease and speed of implementation, and risk reduction, as opposed to rapid transit which is by definition fully grade separated. An automated container/other cargo delivery system would have to have a fully grade separated trunk line. This does not, however, mean that an ACG system is incompatible with light rail. There is the option of operating ACG equipment over a grade separated trunk line, in mixed operation with light rail which could have its own branch lines with grade crossings.

The Los Angeles Green Line, originally intended to be automated, uses the same light rail vehicles as the Blue Line but technically the Green Line operation, on aerial structure and in the Century Freeway median, is medium capacity rapid transit, not light rail. Common use of a trunk line between ACG and light rail vehicles is feasible, so long as horizontal clearances are maintained at passenger station platforms (suggesting gantlet rail or off-line loading). Of course, ACG vehicles could also be operated over grade crossings in freight station/yard areas if the vehicles were under human surveillance in these locations, i.e. station a main at the grade crossing, not on the vehicle.

Section 10: Final Observations, Conclusions, and Recommendations

This study establishes parameters across which the commercial viability of fast ship, agile port, and automated delivery system technologies can be evaluated for the SCAG region. Compiled in this report is a considerable amount of information that will be valuable for future analysis. This project has also established within the SCAG staff an expertise on this topic that should be maintained for future studies. A complex set of assumptions was developed in order to evaluate hypothetical agile port conveyance systems for potential commercial use.

Due to the lack of fast ships and alternative delivery systems in actual service at time of writing, the parameters of their operation had to be constructed from a variety of other sources to create plausible alternatives for comparative evaluation. Staff and the consultant team used the best estimates possible for technological parameters, likely operations, and anticipated costs for these systems. The applicability of the specific economic viability conclusions resulting from this detailed analysis, is limited by the large number of assumptions required to conduct such a study.

One of the things the study team discovered in the course of this research is that landside access to a new marine transport mode, such as fast ship, is a very complex problem. The completion of the work of this study has raised a great many new questions.

There are three levels of interest in, or applicability of, this study. The first, and most important, audience is regional and local. SCAG, and its constituent counties and cities have a strong interest in promoting efficient goods movement and international trade to assist in enhancing the southern California regional economy. Beyond this, there is a statewide interest, in boosting the California economy as a whole: other ports in this state (San Diego, or the Bay Area) might be interested in fast ship and ancillary inland transport systems. Finally, there is a nationwide interest, and in this light it is noted that the present study is complementary to efforts of CCDoTT to investigate and promote new maritime, container, transfer system, intermodal, and information technologies with military and civilian transport potential.

Though some specific commercial equipment types and technologies were evaluated as part of this study, no endorsement or policy recommendations regarding the same is intended. These particular kinds of equipment and transport modes were used only to provide a real-world basis for some of the assumptions used in planning alternative systems. Data provided from the commercial market-place adds strength to the conclusions regarding the viability of the alternatives. There are specific conclusions drawn as to the difficulty of establishing the commercial viability of the systems analyzed; it is expected that these results will help guide SCAG and other interested parties (public and private) in examining these issues relative to future proposed systems.

However, there is no intention to recommend specific policy positions for SCAG on the issues identified here regarding fast ships, agile ports, automated or non-automated delivery systems, or implementation of any particular route or technology for inland transport connected with fast ships at this time. As this is only a first study of the commercial viability of fast ship, agile port, and automated guidance system technologies in the SCAG region, some considerable effort was expended just in determining what information will be needed for future research. It is believed that a substantial framework for future analysis has been established which will benefit those conducting further study of these topics for the SCAG region, or elsewhere.

What follows are the detailed study findings and conclusions, followed by relevant observations on inland transport systems that could feed a fast ship operation. These comments will be followed by the recommendations that have emerged from this intensive initial investigation of the agile port question.

Findings and Conclusions

The analysis detailed in previous sections allows some final generalizations to be made about the factors which could facilitate or allow the success of a fixed guideway inland conveyance system such as is considered herein. Some of these conditions are given just below. For purposes of illustration, the examples given are drawn from other areas:

- a dominance of local import/export containers, as opposed to bridge traffic; e.g. the Port of New York/New Jersey
- major metropolitan centers lined up sequentially along a rail line with a preferred port; e.g. Montreal, Ottawa, Toronto, Hamilton, Windsor, Detroit
- a major inland metro and distribution area 100-400 miles inland (port hinterlands), e.g. Atlanta, Dallas-Fort Worth, or Mexico City
- more than 500 containers each way each day for a carless rail technology such as ChassisRailer
- more than 5000 containers per day total for an automated, electrified guideway system
- long, narrow corridors, e.g. Miami-Palm Beach and north, or Boston-Baltimore
- commercial density contiguous to the freight stations, e.g. the Alliance, Texas plan
- common users of the system, e.g. not exclusive to fast ship customers (especially pertinent to an automated, exclusive guideway operation)
- fully automated, rapid interchange between modes
- definition of the trip in terms of individual containers (as preferable to blocking and assembling into trains)
- significant numbers of containers too heavy for travel on public roads (or potential to aggregate what are now multi-container loads into single 40’ or so ISO containers)

This being said, the findings and conclusions of this study are as follows:

i) One important conclusion of the study is that the embedded advantage of the truck drayage industry for short hauls in an urbanized area, will be difficult for any new conveyance system to overcome. Drayage is well known, and highly resilient due to numerous communications systems in use by the draymen. Drayage is also relatively simple in terms of the activity chains involved. Other alternatives may involve extra lifts/time to make up trains, etc. and would have to be extremely efficient and well-run to compete.

ii) Despite forecasts for increasing congestion, which will certainly impact trucks, drayage when considered over a longer period of the day (14 hours was used in this study) does not, based on integration of existing forecasts, appear likely to be subject to a prohibitive increase in time per container trip between the present day and 2020. (This picture could change as better data becomes available on non-rush hour congestion and incident impacts.)

iii) Of the modes investigated, an automated fixed guideway system does indeed show the shortest local trip times, often substantially better than for truck drayage. ChassisRailer on the other hand exhibits longer trip times, partly because of the batching of containers and the way they would be handled en route, and partly because of anticipated railroad network congestion.

iv) On the other hand, considered as part of a total transportation supply chain, from overseas port to local destination within the region, transport time for the inland drayage or haul component is a very small percentage of the total trip.. Hence the added expense of a fast, automated system for cargo transport inland within the urban area does not appear to justify the cost, from the viewpoint of the overall shipment. The major time savings from fast ship operation will be on the ocean haul and result from reduced time spent by containers on the dock, not from an improved inland system.

v) Overall, an automated guideway system dedicated to fast ship inland cargo transport appears to be prohibitively expensive. ChassisRailer on the other hand may be cheaper than truck drayage for certain origin-destination pairs, largely related to distance. Further, although this should come as not great surprise, from the investigation of the Chassis-Railer alternative it is strongly suggested that a longer inland haul from port to local destination will greatly improve the economics of this or any other new rail intermodal alternatives.

vi) The success of a ChassisRailer system is highly dependent on levels of train movement, and agreements that would have to be made with host railroads. Of the fixed-guideway alternatives, the low start-up cost and ease of implementation would make this alternative much easier to implement than an automated system.

vii) There is little reason to believe that choice of a guideway technology other than the rail system used as an example here would make any difference in commercial viability of a seaport inland transportation system. The key factor is increasing the amount of cargo (number of containers) relative to the high fixed cost of the system, not the basic technology used for driverless transport. The rail system actually has advantages that certain other technologies would not have (ability to run directly on board a fast ship/across the dock at grade, fast switching), supporting this conclusion.

viii) Compared to ChassisRailer, capital and O&M costs for an automated, urban freight transport system are relatively poorly known as there is no system like this operating anywhere in the world. However, the costs adopted in this study are lower than those for comparable (elevated/automated) urban passenger transport systems and it is doubtful that a more detailed engineering analysis would make the particular modal application considered here (marine containers, at least in smaller volumes), more feasible.

ix) The nature of military surge flow requirements is unlikely to justify DOD investment in an automated system, even though the military would almost certainly be willing to use any and all appropriate civilian transport modes available. The DOD would probably have a much greater interest in fast ship use, and could find a ChassisRailer system of considerable utility, because of its longer haul potential (beyond the urbanized area) and ability to run on road or rail as needed.

x) Of the regional ports, the Port of Hueneme appears to have the greatest overall potential for joint military/commercial operation in "agile port" configuration, as well as the best possibilities for employing a fixed guideway system (ChassisRailer or some other new rail intermodal technology) for inland transport of fast ship cargo.

Further Observations

Additional observations relative to the agile port and possible specialized inland delivery systems related to fast ship development are as follows:

i) The establishment of fast ships, and any potential new fixed guideway inland transport modes or novel forms of operations, will probably be undertaken by parties not heavily attached or committed to traditional practices. As such, members of the airline industry, expanding into new cargo areas, might be willing to test unconventional vessel types and practices (note the ships will employ high-technology components, some derived from the aerospace industry, e.g. turbine engines).

ii) Another industry that might be interested in fast ships and their ancillary inland transport systems would be package express companies. In fact developments of this kind could help towards the expansion parcel-size shipments on a world-wide basis. Large volume shippers of time-sensitive, expensive, and/or perishable goods could be other parties interested in this.

iii) It is probable that the private sector would not likely be able to afford the investment level required for an ACG system, as the payback period would be too long. Even the ports would probably find it difficult to implement a system of this kind. It would probably require a major undertaking by the public to afford a longer distance shuttle network of 20-80 miles in extent, as a "payback" period as long as 40 years would likely be entailed.

iv) If extensive public finance or public loan guarantees were required to establish an automated container guideway system, it could be perceived as competitive with the resources needed for passenger transport and highway projects, particularly in this era of shrinking transit funding. It is probable that any public participation in projects of this kind would have major "strings attached" such as a requirement to also carry passengers, or cargo of other, specific kinds on the same system.

v) Adaptation of existing public-owned rail transport systems for container transport might be possible, but could be difficult because transit systems have been developed to very different specifications, and would require considerable adaptation (e.g. full grade separation & automation in the case of ACG). Joint use of ChassisRailer with commuter rail lines would appear to be more feasible (both use short, fast trains) with fewer infrastructure adjustments required but there would still remain many institutional factors to be worked out for something like this to occur.

vi) At its inception, the automated cargo guideway concept was linked to an Inland port development issue. Development of an inland container transfer area far distant from the San Pedro Bay ports would necessarily be driven by factors beyond the scope of this study, such as increased land values in the port area. However, there are several other options the ports could consider first: increasing their storage capacity by double decking the areas used for container storage on chassis; use of vertical automated container storage facilities; development of conveyer belts for containers and/or overhead shuttle systems to move containers around or between terminals, and so on.

vii) It would apparently also be possible for the ports to expand inland within 5 miles or so, with shuttles to new, near-dock terminals. The ICTF in Carson is the first step in that direction; it does not eliminate drayage but does take advantage of a nearly exclusive freeway direct from the ports--the Terminal Island Freeway. Further expansion of this facility, or creation of others, would be an alternative to full inland port development and would have potential for joint use (loading TOFC trailers originating from local consolidators, etc.).

viii) Development of an inland port would almost certainly hinge on other developments quite apart from AGT or ChassisRailer system potential, such as increased air cargo movement to the Inland Empire, probable relocation of, or establishment of new, warehousing, forwarding, consolidation, and related activities in that area--related to expansion of production facilities and growth of the consumer population in that part of the region. Other factors influencing it would be foreign trade zones and enterprise zones related to manufacturing and trade, such as exist or may emerge in the vicinity.

ix) While it is attractive to consider that there could be an expansion of these activities filling in vacant or underutilized land towards the east, taking advantage of a combination of highway, railroad, and airport infrastructure, plus the prevalence of trucking companies already established in that geographical sector, it is uncertain today just what “critical mass” would be required to cause a major inland port development to take place.

x) And, even if this does eventually occur, it would require continually worsening congestion of the highway and railroad networks to justify an expensive new guideway facility dedicated to or designed largely for freight movement, to be constructed from there to the seaports. Shuttle trains operating over the general system of railroads, using the Alameda Corridor and the railroad main lines, and/or improvements in drayage brought about by development of dedicated freeway truck lanes, might very well take place before a new ACG facility is considered.

xi) Drayage, ChassisRailer, and ACG could, however, be considered as theoretical phases in the evolution of inland local port transport systems, ranked by terms of increasing cost and ease of implementation. Drayage of containers on truck chassis is of course the phase we are in now. It is possible that as highway congestion and incident levels increase, it may be necessary to consider a rail alternative using extant tracks, such as ChassisRailer, at least on some of the potentially applicable routes.

xii) However, railroad capacity could also become reduced with increasing numbers of conventional intermodal trains. At this point, in the more distant future, it might be necessary to go to a new automated fixed guideway system such as the ACG alternative considered here. However, as noted, this would not likely happen without shared use with other kinds of traffic on the same guideway.

xiii) The Port of Hueneme appears to present some interesting potentials with respect to fast ship development together with ChassisRailer for landside access. This port has some has 1500 acres of backland and many miles of track including a rail yard currently used for loading auto-rack equipment. A specialized niche port, it is not encumbered with traditional methods of loading cargo. Automobiles (of at least a half dozen makes) are one of the primary cargoes currently moved through the port. It is worth noting that automobiles/automobile parts are the primary cargo that is expected to be moved by FastShip Atlantic.

xiv) Among the possibilities at the Port of Hueneme are easy diversion of cargo between a fast ship facility at Port Hueneme and the air base at Point Mugu--should the latter be developed as an air freight facility--facilitating diversion of cargo back and forth as needed between sea and air (thus facilitating just-in-time cargo delivery). This kind of development with road, rail, and air access to adjacent air- and seaports, would go a long way towards realization of the agile port concept, including military and commercial cargo shipment integration potential.

xv) It may actually be an advantage for the San Pedro Bay ports to have a fast ship terminal at this nearby niche port (i.e. Port of Hueneme), which would not be a regular competitor. This would allow the possibility of diverting overflow traffic or handling traffic during emergencies or in disaster situations. From the viewpoint of the big ports, novel technologies introduced at smaller niche ports can function in a sense as pilot projects that could test and presage future developments elsewhere. Major ports may wait until this new technology is proven, probably in the second or third generation of its development, before they begin to use a refined version of it themselves. (This is especially appropriate for fast ship where there are at least 4 maritime technologies, and probably at least as many alternatives for loading/unloading cargo from such ships.)

xvi) There are also interesting potentials for fast ships (and their accompanying landside access systems) under the load center concept. If fast ships were developed as feeders to the San Pedro Bay ports from Brazil/the Caribbean (via the Panama Canal) or from the west coast of Latin America, this could eventually place a fast ship terminal in the San Pedro bay. Note that fast ships are not dependent on conventional methods of loading with large dockside cranes, and would permit freedom to innovate at small, presently underdeveloped Latin American harbors. This kind of development would permit a trans-Pacific fast ship operation to the San Pedro Bay to use the same terminal on a time-sharing basis, which could be a loss leader (without the need for additional terminal development).

xvii) Another potential is suggested under the UP-SP railroad merger implementation plan, which will render the former Southern Pacific's Los Angeles Transportation Center rail intermodal facility near downtown LA, obsolete. Such a facility might be a logical site for a local freight station on a ChassisRailer route from Pt. Hueneme to the Inland Empire using the Alhambra Line. This would also serve the El Monte industrial area and could provide access to other station sites in Industry and Ontario on the UP main line, and at Irwindale and other locations on the Metrolink line. While LATC is too restricted a location for a major TOFC facility (which is why its functions will be transferred to East LA Yard on the UP), it could be useful if re-deployed/re-used for a novel, but smaller-scale rail intermodal operation like ChassisRailer.

Recommendations

Study recommendations are as follows:

i) A commercial cost competitiveness study should be conducted before a full market study is done, on the concept of a fixed guideway transport feeder to fast ship as part of an agile port operation in the SCAG region. Such a competitiveness study would further examine length-of-haul, distance to water, and hinterland access issues for the alternative conveyance system that are beyond the scope of this study.

ii) Also related to this, more needs to be known concerning DOD freight needs and the way that they can be integrated smoothly with commercial freight. Further studies should also examine the impact of various potential funding scenarios, both public and private, which could be used to build and/or operate an inland transport system of the kinds discussed in this report, including military support for inclusion of certain features or capabilities specific to their deployment needs.

iii) A recommendation is that wider commercial studies be done on the "middle market" between air freight and ocean container freight, including the extent of diverted cargo flows and of lower value freight that sometimes has to move via new, faster supply chains; and of possible new industries and induced freight that might be made possible by introduction of fast ships.

iv) More work is also desirable on how to translate air cargo volumes and dollar levels into numbers of ISO-sized containers; in fact a mode model is needed to help predict diversion of air cargo to other modes, related to speeds, routes, rates, and so forth.

v) A purely local dray model appears to be highly inadequate to determine shipper behavior for a system closely tied in with an ocean movement of much greater duration. Suitable models should be developed for this purpose.

vi) With respect to local container cargo, this study made a first attempt to devise a methodology for allocation of cargo by SCAG Subregion or local area. More work in this field, related to factors such as employment growth in different sectors, forecast land use change—especially related to areas of industrial growth, synergy with air freight, and such, is desirable. It would be extremely useful to know how the freight consolidation/ freight fowarding industries will respond to these factors in the future.

vii) Work on drayage versus other alternatives for inland transport of marine containers would profit greatly from a better model for forecasting mid-day congestion impacts on trucks; and much better data is needed on how freeway incidents and accidents will impact truck and drayage costs.

viii) With regard to bridge traffic presently traveling by rail intermodal, research is needed on the way cuts of container cars are handled or disbursed when they reach far inland destinations, to help predict the feasibility of batching containers for a local rail haul component of such trips. Additionally, more information is required on potential rail intermodal shipments of intermediate range to the "hinterlands" beyond the immediate urbanized area of the SCAG region (e.g. Nevada, Arizona, San Diego etc.). While rail freight operations serving such areas might be combined with a local operation of the kind investigated in this study, much more information is needed on costs, logistics, operations, etc.

ix) The method of rapidly unloading containers from fast ships used as a model in this study is very strongly influenced by FastShip Atlantic developments. No doubt other methods of cargo stowage will be tested out in future fast ship design work and eventually, some of these concepts will be tested out on real vessels. Such work would not only focus on reducing the time spent at the dock but should also pay close attention to improving landside access, whether based on drayage or fixed-guideway transport modes.

x) An extensive automated fixed guideway system solely for container transport as noted does not appear to be cost-effective. Future work therefore should probably be directed towards looking at additional cargo and passenger markets that could share the use of a system like this, e.g. commuters, airport traffic, urban package express, municipal wastes, etc.

xi) Finally, more information is needed on air quality and other environmental impacts of, or benefits from, development of alternative goods movement systems such as those intended to serve agile port and fast ship facilities, as described in this report.

Appendix A - SCAG Region Potential Fast Ship Cargo

The forecasts of potential fast ship cargo for the SCAG region, for the high and low market penetration scenarios are presented below from 1997 to 2020. As the date of the beginning of fast ship service is unknown, it is assumed for the purposes of this estimate that full transpacific fast ship service is available immediately and throughout the period.

SCAG Region Potential Fast Ship Cargo
in TEUs 1997-2020
For High and Low Market Penetration Scenarios

	Import TEUs		Export TEUs		Total TEUs	
	High	Low	High	Low	High	Low
1997	141,049	56,872	88,142	43,828	229,191	100,700
1998	151,845	61,288	94,243	46,898	246,088	108,186
1999	163,592	66,067	101,166	50,336	264,758	116,403
2000	176,058	71,025	108,597	54,110	284,655	125,135
2001	189,280	76,321	116,350	57,947	305,630	134,268
2002	203,610	82,114	124,934	62,300	328,544	144,414
2003	218,703	88,206	133,975	66,913	352,678	155,119
2004	234,854	94,741	143,587	71,761	378,441	166,502
2005	250,761	101,146	153,004	76,553	403,765	177,699
2006	267,050	107,754	163,012	81,656	430,062	189,410
2007	284,234	114,712	173,639	87,087	457,873	201,799
2008	302,618	122,187	184,718	92,810	487,336	214,997
2009	317,611	128,383	196,609	98,964	514,220	227,347
2010	333,505	135,002	209,469	105,558	542,974	240,560
2011	356,225	144,248	223,033	112,528	579,258	256,776
2012	381,010	154,382	237,475	119,971	618,485	274,353
2013	407,479	165,154	251,841	127,485	659,320	292,639
2014	435,500	176,453	266,961	135,422	702,461	311,875
2015	465,321	188,459	283,211	143,984	748,532	332,443
2016	497,551	201,450	300,647	153,166	798,198	354,616
2017	532,415	215,484	319,396	163,090	851,811	378,574
2018	570,086	230,672	339,612	173,782	909,698	404,454
2019	610,846	247,085	361,438	185,292	972,284	432,377
2020	654,904	264,849	384,895	197,735	1,039,799	462,584

Source: Analysis of ICF Kaiser Global Trade Forecast for US South Pacific Coast

Appendix B - Station to Station Rail Distances

Railroad Intermodal Train Distances

Applicable distances for computing railroad intermodal train running times are:

Port Hueneme to UP Coast Line at Oxnard	5.15 miles
Coast Line from Oxnard to Chatsworth	36.5 miles
Coast Line from Chatsworth to Van Nuys	11.3 miles
Van Nuys to N. end of Alameda Corridor	19.95 miles
Alameda Corridor from N. end to Carson	11 miles
Van Nuys to East LA Yard	21.8 miles
Alameda Corridor from Ports of LA/LB to East LA Yard or Hobart	22.1 miles
East LA Yard to Industry	11.7 miles
Industry to Pomona	13 miles
Pomona to Ontario	12.45 miles
Ontario to Norton AFB	20.95 miles
Ontario to March AFB via UP	27.4 miles
Pomona to alternative location Ontario yard, via old UP main Line	10.75 miles
Ontario to March AFB via BNSF etc.	28.15 miles
Alameda Corridor from POLA/LB to Hobart	22.1 miles
Commerce on BNSF to Santa Fe Springs	9.05 miles
Santa Fe Springs to Buena Park	5.3 miles
(Santa Fe Springs and Buena Park are alternative station locations; presumably only one of these sites would be used)	
Buena Park to Fullerton (Raymond; on San Bernardino Subdivision)	5.55 miles
Fullerton to Corona (Railroad St.)	19.7 miles
Corona to Riverside (3rd St.)	16.3 miles
Riverside to March AFB	11.2 miles
Riverside 3rd St. to Rialto Ave./San Bernardino	8.75 miles
Riverside 3rd St. to Norton AFB	13.7 miles
Alameda Corridor from POLA/LB to Hobart Yard	22.1 miles
Commerce to Santa Fe Springs	9.05 miles
Santa Fe Springs to Buena Park	5.3 miles
Buena Park to Fullerton (San Diego Subdivision)	5.6 miles
Fullerton to Tustin	11.3 miles
Tustin to Irvine	8.35 miles

Alameda Corridor from POLA/LB to La Mirada	28.55 miles
(uses ACTA drill track north of 91 freeway and Santa Ana Branch -- 20 mph maximum speed)	
New right-of-way along flood channel, former SP Santa Ana Branch (now UP) to BNSF main line	1.1 miles
(alternative location for station is Buena Park instead of La Mirada)	
other times from Buena Park on, as just above	

Note that additional time to stop and drop off cars, or stop and pick up cuts of cars, could be added to the above through running times, to better estimate total time for actual operations.

Appendix C - ACG System Cost Sensitivity Scenario

Combined Fast Ship and Cellular Ship Service with 50% Higher 2020 Container Traffic

In this appendix, the Automated Container Guideway System (ACG) costs are analyzed for their sensitivity to possible higher cargo volumes which would allow lower fixed costs per unit. For purposes of the analysis, the route from San Pedro Bay Ports to Norton Air Force Base was used as a representative example. It is assumed that currently planned capacity, such as to be provided by the Alameda Corridor and along the railroad main lines, will be sufficient to 2020 for bridge traffic container movements. This scenario quantifies the effect that a large increase in container volumes could have on the unit costs.

Number of containers and their allocation:

Fast ship 2020 forecast:

1,039,799 TEU/year = 519,899 FEU/year.

Assume 50% higher fast ship cargo so fast ship cargo = 1.5x 519,799 = 779,849 containers/year

Assume 55% local and 45% bridge traffic, thus:	local containers =	428,917 /year
	bridge containers=	350,932 /year

Cellular ship forecast, for all container ships per current 2020 forecasts:

12,570,000 TEU/year = 6,285,000 FEU/year

Assume all port cargo is 50% higher (include fast ship cargo with cellular ship totals) so
total = 6,285,000 x 1.5 = 9,427,500 FEU/year.

Subtract fast ship cargo (ignoring for the moment that there is some air cargo in the fast ship forecast):
9,427,500 - 779,849 = 8,647,651 FEU/year

Now adjust to assume that the current forecast of 6,285,000 /year will all go via conventional drayage (local) or rail intermodal (on-dock or ICTF) via the Alameda Corridor, so only the excess would have to be handled by the ACG system:

8,647,651 - 6,285,000 = 2,362,651 FEU/year. This is the excess volume that would be assigned, for this exercise, to the automated conveyance system.

Split between local and bridge traffic for this excess is: 1,299,458 FEU local

1,063,193 FEU bridge

Returning to fast ship cargo,

local containers = 428,917 /year and
bridge containers = 350,932 /year

Local traffic for ACG freight station areas now has to be calculated:
428,917 x .32 = 137,253 containers/year

Now, using a 365 day year, for this overall high volume of cargo in 2020 (all port operations combined):

137,253 FEU/year / 365 days = 376 FEU/day for local freight stations

Divide by six freight stations, so 376 FEU / 6 stations = 63 containers per station per day

Five of the freight stations will handle 63 fast ship containers/day only
These containers are assumed to move on 1-platform cars.

One freight station (Norton) will handle 63 fast ship containers/day plus fast ship bridge traffic (see just below).

Fast ship bridge traffic amounts to 350,932 FEU/year.

350,932 FEU / 365 days = 961 bridge FEU/day. This traffic goes to Norton only.

Total fast ship FEU/day to Norton = 63 (local) + 961 (bridge) = 1024 FEU/day
These containers are assumed to move on 1-platform cars.

Turning again to cellular ship cargo,

Totals amount to 1,299,458 local FEU and 1,063,193 bridge FEU /year

For local cargo multiply by .32 to determine ACG corridor share of local FEU:

1,299,458 FEU x .32 = 415,827 FEU /year

Using a 365 day year for this high volume of port traffic,

415,827 FEU / 365 days = 1139 FEU/day

Divide this by the six local freight stations:

1,139 / 6 stations = 190 FEU /station per day

Note that five of these stations will carry only 190 cellular ship FEU/day
These containers are assumed to move on 1-platform cars.

The sixth station (Norton) will also carry 190 local cellular ship FEU/day plus cellular ship bridge traffic (see below).

Cellular ship bridge traffic = 1,063,193 /day

Dividing by a 365 day year, the result is

1,063,193 FEU / 365 days = 2913 FEU /day at the inland port (Norton)

So the total cellular ship containers moving to/from Norton AFB is:
190 per day + 2913 per day = 3,103 per day

These containers are all assumed to move on 5-platform cars (10 box capacity).

For local freight stations container activity per day would be as follows.

At each of five stations:

63 /day fast ship local containers + 190 cellular ship local containers = 253 local containers /day.
These are all assumed to move on 1-platform cars

For the inland port (Norton AFB) container activity per day would be as follows.

1,024 local + bridge fast ship containers assumed to move on 1-platform cars
3,103 local + bridge cellular ship containers assumed to move on 5-platform cars

(total for inland port facility is 4,127 fast ship and cellular ship containers)

Controlling volumes on the guideway are based on import containers.

This will amount to, at each of 5 local stations:

253 containers/day x .63 = 140 containers/day, import direction
(1-platform cars - fast ship and cellular ship local containers combined)

And, for the inland port (Norton AFB assumed):

1,024 containers/day x .63 = 645 containers/day, import direction

(1-platform cars - fast ship local and bridge containers combined)

plus

3,103 containers/day x .63 = 1,955 containers/day, import direction
(5-platform cars - cellular ship local and bridge containers combined)

Rolling Stock Required

Calculations of rolling stock requirements assume that with a volume this high, fast ship and cellular ship single platform cars will be pooled, and the 5-platform cars will be in common use for local and bridge traffic from cellular ships to the inland port.

The calculation of cycle time is:

2 x (running time + time in terminals).

Time in terminals for 1-platform cars will be taken to be the same for cellular ship cars as for fast ship cars, and is set at 25 minutes (.42 hours) for a one-way trip. This is based on twice the time required for a 2.5 minute lift inland, or 5 minutes, plus 20 minutes average time spent in the inbound or outbound move at the agile port—or, for cellular ship movements, an equivalent amount of time is assumed spent waiting for a box to appear for a particular destination plus the additional 2.5 minute lift.

Time in terminals for 5-platform cars will be taken to be 50 minutes spent at terminals (10 containers x 2.5 minutes/box times two lifts per trip), times 1.5, to provide additional time for terminal operations. Hence it is assumed 75 minutes (1.25 hours) will be added to the 5-platform car one-way trip.

This means that the cycle times are as follows for the inland movements, for the two types of equipment:

For 1-platform cars:

Run Time(hrs.):	transit	terminal	1-way total
Seaport to Commerce	.51	.42	.93
Seaport to Irwindale	.74	.42	1.16
Seaport to Industry	.67	.42	1.09
Seaport to Pomona	.93	.42	1.35
Seaport to Ontario	1.17	.42	1.59
Seaport to Norton AFB	1.57	.42	1.99

For 5-platform cars:

Run Time(hrs.):	transit	terminal	1-way total
Seaport to Norton AFB	1.57	1.25	2.82

Round trip cycle times are given below, along with cycles/day/car. In this case, cycles per car per day are computed by dividing 24 hours by round trip cycle time, and then rounding down to be conservative:

For 1-platform cars:

Run Time(hrs.):	1-way total	round trip total	cycles/car/day
Seaport to Commerce	.93	1.86	12.9
Seaport to Irwindale	1.16	2.32	10.3
Seaport to Industry	1.09	2.18	11
Seaport to Pomona	1.35	2.70	8.8
Seaport to Ontario	1.59	3.18	7.5
Seaport to Norton AFB	1.99	3.98	6

For 5-platform cars:

Run Time(hrs.):	1-way total	round trip total	cycles/car/day
Seaport to Norton AFB	2.82	5.64	4.2

1-platform rolling stock needed will be based on the following:

	2 x import containers/day	cycles/car/day	cars needed	rounded up
Commerce	280	12.9	21.7	22
Irwindale	280	10.3	27.18	28
Industry	280	11	25.45	26
Pomona	280	8.8	31.8	32
Ontario	280	7.5	37.33	38
Norton AFB	1290	6	215	215

Total cars, unadjusted: 361. 361 /0.9 to account for down time due to car maintenance = 401 cars actually needed.

5-platform rolling stock needed will be based on the following:

	2 x import carloads/day	cycles/car/day	cars needed	rounded up
Norton AFB	392	4.2	93.3	94

(1,955 import containers divided by 10 containers/car = 196 cars one direction)

Total cars, unadjusted: 94. 94 /0.9 to account for down time due to car maintenance = 105 cars actually needed.

Total fleet size required is 401 single platform cars, and 105 five-platform (10 container) cars.

Mileage calculations for computing power and other O & M costs

The sum of one-way distances is as follows:

Seaport to Commerce	23 miles
Seaport to Irwindale	34.45 miles
Seaport to Industry	30.8 miles
Seaport to Pomona	43.8 miles
Seaport to Ontario	56.25 miles
Seaport to Norton AFB, local only	76.1 miles

Sum of individual station route miles = 264.4 miles, one-way. This can be applied to local stations with assumed equal volumes per station.

In addition to this, for additional volumes to/from the inland port, the one-way distance will of course be from the seaport to Norton, or 76.1 miles.

Fixed facility costs

Guideway costs POLA/LB to Norton AFB	$ 3,261.7 million
Six inland freight stations (ICTF, Commerce, Irwindale, Industry, Pomona, Ontario, $ 20 million each	$ 120 million
Inland port facility (Norton AFB)	$ 140 million
Inland Port Railroad connection	$ 28.9 million
plus	$ 75 million
ACG facility at 10 new/existing port liner terminals, on-dock $ 18 million each	$ 180 million
Additional guideway, track, electrification, and controls to serve port liner terminals	$ 400.38 million
ACG facility improvement at ICTF	$ 20 million
Additional costs at fast ship seaport	$ 9 million

State-of-the-art information system $ 25 million

Total for fixed facilities: $ 4,259.98 million

Variable Capital Costs

Rolling stock requirements, from above, are:

401 single platform cars x $ 2.34 million each = $ 938.34 million

105 five-platform cars x $ 4.17 million each = $ 437.85 million

Rolling stock total: $ 1376.19 million

Electric Power Costs

Power costs can be computed for four classes of traffic, then summed: fast ship local station traffic, fast ship bridge traffic, cellular ship local traffic, and cellular ship bridge traffic. Each calculation is based on the cumulative one-way route miles for all station pairs (seaport to inland point) included in the set, times two directions, times total of one-way containers, times power cost. These figures produce:

Fast ship, local 264.4 miles x 2 x 40 containers x $ .0726/ box = $ 1,536/day
Cellular ship, local, 264.4 miles x 2 x 120 containers x $ .0822/ box = $ 5,216/day
Fast ship, bridge, 76.1 miles x 2 x 606 containers x $ .0726/ box = $ 6,696 /day
Cellular ship, bridge, 76.1 miles x 2 x 1,836 containers x $ .0497/ box = $13,888/day

Total power cost per day = $ 27,336 for system

Other O & M Costs

Operations and maintenance costs can be similarly be computed for four classes of traffic, then summed: fast ship local station traffic, fast ship bridge traffic, cellular ship local traffic, and cellular ship bridge traffic. Each calculation is based on the cumulative one-way route miles for all station pairs (seaport to inland point) included in the set, times two directions, times total of one-way containers, times O & M cost. The figures used for O & M costs will be $ 0.951 /container mile for 1-platform cars and $ .16 /container-mile for 5-platform cars ($ 1.599/ car-mile / 10 containers/car). These figures produce:

Fast ship, local 264.4 miles x 2 x 40 containers x $ 0.951 /container = $ 20,116 /day
Cellular ship, local, 264.4 miles x 2 x 120 containers x $0 .951 /container = $ 60,347 /day
Fast ship, bridge, 76.1 miles x 2 x 606 containers x $ 0.951 /container = $ 87,714 /day
Cellular ship, bridge, 76.1 miles x 2 x 1836 containers x $ 0.16 /container = $ 44,710 /day

Total O & M cost per day = $ 212,887 for system

O&M Costs for Freight Stations

The cost for operating the inland freight stations is priced at $ 25 per lift. The cost of an additional lift, where needed, at the cellular ship dock will also be $ 25.

Cost for station and pier operations will be:

Fast ship, local, 6 stations 2 x 40 containers/station x $ 50/container =	$24,000 /day
Cellular ship, local, 6 stations x 2 x 2 x 120 containers/station x $ 50/container =	$144,000 /day
Fast ship, bridge, 1 station x 2 x 606 containers x $ 50/container =	$60,600 /day
Cellular ship, bridge, 1 station x 2 x 2 x 1,836 containers x $ 50/container =	$367,200 /day

Total cost for station operations becomes $ 595,800 per day.

Similarly, as the cost for draying containers to/from local inland freight stations is $ 80 per container, the cost of this per day is 6 x 2 x 160 x $ 80 or $ 172,800 /day. This only applied, in our region, to the fast ship and cellular ship local containers, and not to the bridge traffic.

Cost Per Container

Cost per container based on 5,392 loaded containers (no empties) per day, for all services under this scenario would be computed as follows:

<u>ACG scenario 3</u>

(public finance considered only)

Fixed facilities: $ 4,259.98 million /40 years /365 days/year =	$ 291,779.40/day
Rolling stock: $ 1,376.19 million/30 years/365 days/year =	$ 125,679.40/day
Total capital	$ 417,458.8 /day
Power	$ 27,336 /day
Other O & M	$ 212,887 /day
Station operations	$ 595,800 /day
Total operating/maintenance	$ 836,023 /day

Total of all costs $ 1,253,481.80 /day

Total divided by 5,392 loaded containers $ 232.47 /box

Total with added $ 80 local inland dray, local containers only $ 312.47 /box

A sensitivity test assumes that guideway costs might be able to be lowered by incorporating more surface right-of-way such that fixed facilities could be lowered by 25%; and that O & M costs, other than electric power, could be lowered by 30% of what has been developed in detail elsewhere in this study. This is speculative, as overall costs could turn out to be higher, and not lower, than those developed. Nevertheless, it is worth examining further an additional scenario.

<u>ACG scenario 4</u>

(public financing considered only)

(Fixed facilities: assume 0.75 x $ 4,259.98 million = $ 3194.99 million)

Fixed facilities: $ 3,194.99 million /40 years /365 days/year = $ 218,834.90 /day
Rolling stock: $ 1,376.19 million/30 years/365 days/year = $ 125,679.40 /day

Total capital $ 344,514.30 /day

Power $ 27,336 /day
(Other O&M assume .7 x $ 212,887/day = $ 149,020.90 /day)
Other O & M $ 149,020.90 /day
Station operations $ 595,800 /day

Total operating/maintenance $ 772,156.90 /day

Total of all costs $ 1,116,671.20 /day

Total divided by 5,392 loaded containers $ 207.10 /box

Total with added $ 80 local inland dray, local containers $ 287.10 /box

Conclusions

Overall, for the scenarios using expanded 2020 container forecasts, assumed to represent a post-2020 time period (if these levels are in fact ever reached), with ACG serving both fast ship and cellular ship port facilities, cost per box is calculated under Scenario 3 to be

$ 312.47 /box . Scenario 4, which takes as its assumption that some capital and O & M costs can be reduced below the levels developed during this study, indicates that a local container shipment on the ACG system with inland dray would cost $ 287.10 /box.

These figures, for the average of the entire system, remain somewhat higher than the $ 80-255 /box figures developed for truck drayage ($ 255 representing port to San Bernardino haul). Thus, even with this expanded traffic scenario, the cost of shipment inland via the ACG system appears to be higher than for trucking to the farthest point, and the average for all stations remains substantially higher than for truck drayage..

Appendix D - Potential Emissions Reductions

Using available data from prior studies and assumptions regarding alternative delivery systems, we have performed a preliminary investigation of potential emissions impacts from the proposed systems. The emissions reduction for the electrified, automated system will be assumed to represent nearly 100% of the emissions that would otherwise be produced by the trucks used for drayage. The emissions reduction for a ChassisRailer system as compared to drayage is more problematic, as data for this particular class of service--local trains running between 20 and 150 miles with fast, lightweight intermodal equipment--are not available. Comparisons therefore have to be made using average figures for rail freight.

The primary pollutant from diesel engines used in goods movement (other than PM10 and smaller sizes of particulates that have received considerable recent attention), is oxides of nitrogen (NOx), which with reactive organic gases (ROG) is an ozone precursor. For diesel trucks weighing over 33,000 lb., of total ozone precursors NOx amounts to 85% and ROG, 15%. For freight trains, the ratios are even higher, NOx being 96% and ROG, 4% of the ozone precursors produced (1). The discussion that follows will relate primarily to potentials to reduce NOx emissions from truck drayage, using either an ACG or a ChassisRailer technology.

In 1987, truck NOx emissions for truck freight were .009 lb./ton-mile (heavy duty diesel truck fleet average), and railroad NOx emissions, .006 lb./ton-mile. Emissions for 2010, the most distant future year for which we have figures, are forecast to be .005 lb./ton-mile for trucks, and .003 lb./ton-mile for freight trains (2). Hence, for trucking the 2010 figure for emissions per ton-mile is 66.7% of the 1987 average, and for trains the 2010 figure is 60% of the 1987 figure. (Of course, the present Agile Port study uses a forecast year of 2020, which is one decade later than 2010.)

Emissions figures and future estimates have also been provided for diesel engines used in goods movement; the 1987 heavy duty truck fleet average being 7.83 g/Bhp-hr (per EMFAC7 model), with a 2010 EMFAC estimated fleet average being 4.6 g/Bhp-hr and the 2010 standard, 4 g/Bhp-hr. For trains, the current standard for 2010 is 5 g/Bhp-hr, although various alternatives could reduce these emissions to 2 g/Bhp-hr (3). Obviously, emissions for both trucks and trains will be dropping over the next several decades.

As compared to air quality strategies with no further control for trucks and trains beyond those that will produce the reduction levels cited above, it is possible that further reductions might be possible using strategies such as dual-fuel (diesel/LNG) locomotives and CNG/lean fuel spark-ignition (SI) for trucks. It is estimated that this could reduce truck emissions to about 40% of the 2010 “no further control” baseline level for trucks, and reduce train emissions to about 26% of the baseline for trains (4).

Hence, as compared to the 2010 baseline figures, truck emissions using the CNG strategy would be only .002 lb./ton-mile and train emissions using the dual-fuel strategy would be only .00078 lb./ton-mile. (Again, note that the baseline figures used in the comparisons would be .005 lb./ton-mile for trucks and

.003 lb./ton-mile for trains.) Employment of these further emission reductions strategies would carry a cost penalty, estimated to amount to (in 1997 dollars) .285 cents per ton-mile for trucks and .109 cents/ton-mile for trains (5).

Any comparison of an electrified ACG system against truck drayage should consider the 2010 baseline (no further control) emissions levels for trucks, as well as a strategy for further reduction (such as CNG/Lean-Burn SI). Similarly, a comparison of ChassisRailer with truck drayage should consider rail baseline versus truck baseline, as well as a railroad emissions reduction strategy against the aforementioned truck emissions reduction strategy used for ACG (so the comparison would be dual fuel locomotive versus CNG/lean-burn SI for trucks). Any cost benefit study should include the estimated costs to implement the low-emissions strategies for truck and freight train as well.

Assigning dollar values to benefits from reducing freight-related emissions, such as ozone precursors (NOx and ROG) from diesel exhaust, is speculative. Based on SCAQMP research, it is suggested that the range of benefits from reducing NOx and ROG would be on the order of $ 11,253 - 11,655 /ton of ozone precursors reduced (6). The benefits computed by AQMD include increases in crop yields, visibility improvement, reduction in deaths and higher survival rates, reduced damage to materials, and some congestion reduction.

Figures related to benefit per ton of pollutants removed should be used with extreme caution. Since ozone production is a chemical reaction involving both ROG and NOx, it is uncertain what the impact would be of reducing primarily one of these precursors (NOx) but not the other. Also, the reduction in ozone, if proven, would have to be related to population distribution etc. in affected areas, to relate this to benefits.

Hence, AQMD staff recommend that for a detailed benefit evaluation to be done for a goods movement project of this kind, the Regional Airshed Model should be re-run with the desired assumptions on modal replacement of container trucks with the other mode; including a look at the dose response relationships for impacted geographical areas (7). Time and budget for the current study, however, did not permit this kind of detailed air quality model evaluation.

A sample calculation is provided for a trip along the San Pedro Bay ports to San Bernardino freight corridor, using as an example a trip of average length from the ports to Pomona. In this case, trip length is:

Truck dray, total trip	45.85 miles
ACG	40.8 miles line haul + 7 mile truck dray
ChassisRailer	46.8 miles line haul + 7 mile truck dray

Average benefit per ton of pollutant reduced assumed to be $ 11,454

Tonnage per container: assume fast ship numbers except that empty backhaul for export traffic will be replaced by general container traffic

Tonnage per FEU container, loaded:

Fast Ship export	11.97 short tons
Fast Ship import	13.76 short tons
Cellular Ship export	32.48 short tons
Cellular Ship import	25.86 short tons

Assume a 1:1 ratio of import/export for air quality purposes

Fast ship imports:	50%
Fast ship exports	29.4%
Other export*	20.6%

*Assumed to divert other cargo to fast ship, thus avoiding an empty backhaul

Average tonnage for load per container (both ways)	17.09 tons
Weight of container empty	2.21 tons
Average weight of loaded container	19.3 tons

Comparison 1. ACG versus truck dray with no additional 2010 truck controls

Mileage difference is 45.85 mile truck dray minus 7 mile local dray to ACG

38.85 truck miles x 19.3 tons/container x .005 lb/ton-mile =
3.75 lb. emissions reduction /container

3.75 lb./container x $ 11,454 savings/ton x 1 ton/2000 lb. = $ 21.48 external benefit of ACG haul/container ($ 1997)

Net savings in this comparison = $ 21.48 per ACG-diverted container

Comparison 2. ACG versus truck dray but with CNG/SI truck

Mileage difference is 45.85 mile truck dray minus 7 mile local dray to ACG

38.85 miles exclusive truck miles x 19.3 tons/container x .002 lb/ton-mile =
1.5 lb. emissions reduction /container

1.5 lb./container x $ 11454 savings/ton x 1 ton/2000 lb. = $ 8.01 external benefit of ACG haul/container ($ 1997)

But add the following penalty that corresponds to conversion of truck to CNG/SI

.285 cents/ton-mile x $ 1 / 100 cents x 38.85 miles x 19.3 tons/container =
$ 2.13 /container penalty ($ 1997)

Net savings in this comparison = $ 8.61 + $ 2.13 = $ 10.14 per ACG diverted container

Comparison 3. ChassisRailer versus truck dray with no additional 2010 train or truck controls

Mileage difference is 45.85 mile truck dray - 7 mile local dray to ChassisRailer

38.85 truck miles x 19.3 tons/cont x .005 lb/ton-mile =
3.75 lb. emissions reduction /container

46.8 miles rail haul x 19.3 tons/cont x .003 lb/ton-mile =
2.71 lb./emissions per container

Net emissions reduction = 3.75 lb. - 2.71 lb. = 1.04 lb. emissions/container

1.04 lb./container x $ 11454 savings/ton x 1 ton/2000 lb. = $ 5.96 external benefit
of ChassisRail haul/container ($ 1997)

Net savings in this comparison = $ 5.96 per ChassisRailer diverted container

Comparison 4. ChassisRailer with dual-fuel locomotives versus truck dray with CNG/SI

Mileage difference is 45.85 mile truck dray minus 7 mile local dray to ChassisRailer

38.85 truck miles x 19.3 tons/container x .002 lb/ton-mile =
1.5 lb. emissions reduction /container

46.8 miles rail haul x 19.3 tons/container x .00078 lb/ton-mile =
0.7 lb./emissions per container

Net emissions reduction = 1.5 lb. - 0.7 lb. = 0.8 lb. emissions/container

0.8 lb./container x $ 11454 savings/ton x 1 ton/2000 lb. = $ 4.58 external benefit
of ChassisRailer haul/container ($ 1997)

But add the following penalty that corresponds to conversion of truck to CNG/SI

.285 cents/ton-mile x $ 1 / 100 cents x 38.85 miles x 19.3 tons/container =
$ 2.13 /container penalty ($ 1997)

And subtract the cost of converting to dual-fuel locomotives

.109 cents/ton-mile x $ 1 / 100 cents x 46.8 miles x 19.3 tons/container =
$ 0.98/container cost ($ 1997)

Sum $ 2.13 - $ .98, which = $ 1.15 /container penalty ($ 1997)

Net savings in this comparison = $ 4.58 + $ 1.15 =
$ 5.73 per ChassisRailer diverted container

Again it should be remembered that the above calculated levels of emissions-related dollar savings are extremely speculative, and depend upon the assumptions made as to input. They provide only a very rough idea of what the external emissions benefits related to diversion of container traffic might be. A definitive answer would require a much more detailed study, and as noted, running the regional air quality and other models.

(1). Jack Faucett Associates, Assessment of the Effects of Proposed Locomotive Regulations on Goods Transport Modes and Locomotive Emissions, Final Report, Feb. 1996. Study for California Air Resources Board. Figures based on Table E-1.
(2). Ibid, Exhibit E-2. Truck figure for 1987 based on EMFAC7 output.
(3). Ibid, p. ES-4.
(4). Ibid, based on Exhibit E-5.
(5). Ibid, see Exhibit 5-8 for trucks and 5-7 for locomotives.
(6). 1997 Air Quality Management Plan, Appendix V Modeling and Attainment Demonstrations (SCAQMD Nov. 1996), Tables 4-9 through 4-11 were used for VOC and NOx emissions budgets for 1999-2010. The 1997 AQMP Socioeconomic Report (Nov. 1996), Table 3-10 was used for external benefits. The dollar benefits in the latter AQMD document are based on an average annual benefit for 1997 through 2010. Note that some PM10 benefits were also included in the AQMD analysis.
(7). Ms. Sue Lieu, personal communication to SCAG staff.

Appendix E. Letter from Wabash National