STRATEGIES TO MAXIMIZE ASSET UTILIZATION IN THE CALIFORNIA FREIGHT SYSTEM: PART II – STRATEGIES

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A White Paper from the Freight Efficiency Strategies Development Group

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About the Freight Efficiency Strategies Development Group

In July 2015, Governor Jerry Brown issued Executive Order B-32-15, directing several state agencies to work together in developing an integrated action plan that will “establish clear targets to improve freight efficiency, transition to zero-emission technologies, and increase competitiveness of California’s freight system” and that the plan should “identify state policies, programs, and investments to achieve these targets”. In response, an interagency group was formed to oversee the development of the California Sustainable Freight Action Plan (CSFAP). Members of the interagency group include the California Air Resources Board, the California Department of Transportation (Caltrans), the California Energy Commission (CEC), and the Governor's Office of Business and Economic Development (GO-Biz). As part of developing the plan, the interagency group has solicited feedback from a broad range of stakeholders through a variety of engagement activities and outreach efforts. A component of this engagement was the development of the Freight Efficiency Strategies Development Group (FESDG) made up of freight experts from academia, industry, and government. The purpose and main task of this group was to produce a series of white papers that identify promising strategies for increasing the efficiency of the freight system. A series of six papers were developed over the course of six months. Each paper focuses on a specific theme for increasing freight efficiency within the larger freight system.

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The National Center for Sustainable Transportation is a consortium of leading universities committed to advancing an environmentally sustainable transportation system through cutting-edge research, direct policy engagement, and education of our future leaders. Consortium members include: University of California, Davis; University of California, Riverside; University of Southern California; California State University, Long Beach; Georgia Institute of Technology; and University of Vermont. More information can be found at: ncst.ucdavis.edu.

Disclaimer

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EXECUTIVE SUMMARY

This paper (the second of a two-part series) builds upon the discussion of the freight system and key inefficiencies in California (discussed in Part I) and puts forward a set of strategies targeted at improving some of those inefficiencies. The paper focuses on those that could help improve or maximize asset utilization by fostering collaborative logistics (CL) practices and/or freight demand management (FDM). CL practices are defined as those activities initiated, maintained, and/or conducted by different supply chain or freight system stakeholders in which they collaborate, coordinate, or cooperate in terms of resources, knowledge, assets or information to achieve operational or economic efficiency improvements of a larger system. And, FDM strategies are defined as transportation policies that seek to induce changes in demand patterns and freight behaviors to increase economic productivity and/or efficiency, sustainability and environmental justice. Because of the very nature of the system itself, strategies do not work in isolation, and each strategy may require complementary strategies to be feasible and implementable (e.g., sponsored programs to acquire technology, incentives to foster behavioral changes, funding for capital investments).

The paper provides insight into expected impacts, planning, technical and operational requirements, and evaluation metrics for each strategy by analyzing a number of factors such as:

- **Nature of the Strategy:** *Collaborative logistics practices (collaboration/cooperation) or freight demand management.*
- **Geographic scope of the inefficiency/improvement strategy:** *Area(s) where the inefficiency is acute, including at international gateways, on-road sections of the distribution network, and urban areas.*
- **Expected benefits:** *Anticipated benefits of the strategies* (i.e., reduce congestion, increase environmental sustainability, enhance safety and security, enhance economic competitiveness, increase revenue generation and enhance livability)
- **Level of implementation effort/time/cost:** *Estimated inputs required*.
- **Primary stakeholders targeted by the strategy:** *Stakeholders directly affected by the strategy.*
- **Stakeholders' role in the implementation/planning effort:** *Stakeholder type(s) and anticipated role(s)*.
- **Potential for unintended consequences:** *Any undesirable impacts that could be linked with a strategy.*

The research process included a critical review of the available information (e.g., research reports, operational reports, implementation programs, pilot tests) of current freight operations, discussions and stakeholder engagement (academia, public and private stakeholders, and government) to identify strategies that could help improve the efficiency of the California's freight system. The authors selected geographic scope (e.g., layer of the economy) as a categorical factor and discussed those strategies that would mainly affect the distribution economy and the international gateways. Results from the process allow identifying the following potential strategies:

- **Voluntary Off-Hour Delivery Programs**. *This strategy is based on a voluntary program of pick-up and delivery operations in the off-hours.*
- **Receiver-led Consolidation**. *This type of strategies seeks to foster behavioral changes within supply chains by taking advantage of the power of receivers to push for cargo consolidation*.
- **Development of a Chassis Pool of Pools Fully Integrated System**. *The Development of a Chassis-PoP fully integrated system that seeks to transition the current PoP to an information and management system that provides the adequate type, quantity and quality of chassis available, and offers simplified administrative and billing services*.
- **Improvement of Traffic Mitigation Fee Programs**.
- **Implement Advanced Appointment/ Reservation Systems**. *Seeks to develop and implement and advanced appointment and reservation flexible system that integrates with other information systems to maximize asset utilizations*.
- **Developing an Integrated System for Dray Operations and Services**. *This strategy seeks to foster the development of cooperation and collaborative agreements between drayage operators, beneficial cargo owners, and in some cases, shipping lines and port terminals, to offer a shared service*.
- **Load Matching and Maximizing Capacity**. *There are many variations of load matching; examples include matching empty containers with loads; first come, first take pickups; and platforms to match small loads with available space in containers which are not already full*.
- **Relaxing Vehicle Size and Weight Restrictions**. *Allowing increases in truck length and size would provide the opportunity for significant gains in efficiency for certain portions of the freight industry*.

Each strategy showed that there is variability in the potential for their impacts, the levels of effort needed for their implementation, and the type of stakeholders involved in the planning, research, and implementation phases. Some of the strategies are likely to be widely understood by the practitioner community, while others require careful analysis and implementation to avoid unintended consequences. A qualitative assessment of the strategies showed that these strategies have the potential to generate positive effects in terms of increased operational efficiency, reduced congestion, and improved environmental sustainability; while not generating major impacts on safety, security and enhancing livability. However, the magnitude of those benefits could not be estimated, as additional research, simulation, modeling and analyses are required to identify the corridors, and/or specific locations (or stakeholders) where those benefits would be realized. The analyses also indicate that the development and implementation of some of these strategies, although mainly to be initiated by the private sector, would require critical external planning, financial and policy support from local/regional/State/Federal government, planning agencies, and other public authorities. And, as also discussed in Part I of this two-part series, the analyses showed that there is no single strategy that could address the range of inefficiencies currently affecting the California Freight System. While some of the strategies are intended to mitigate pressing issues, others could help to adapt and be able to mitigate the impacts of future trends, and operational patterns. Designing a plan to improve the freight efficiency should consider a set or packages of complementary strategies.

Abstract

This paper (Part II of a two-part series) discusses the key findings from a collaborative effort between academia, public and private stakeholders, and government to identify strategies to improve the efficiency of the California's freight system.

The freight system is multi-faceted and there could be a myriad of potential strategies; however, the paper focuses on those that could improve or help maximize asset utilization by fostering collaborative logistics (CL) practices and/or freight demand management (FDM). The strategies analyzed include: receiver-led consolidation; voluntary off-hour delivery programs; development of an integrated Chassis Pool of Pools; integrated system for dray services; load matching and maximizing capacity; improving Traffic Mitigation Fee programs; implementing advanced appointment and reservation systems; and relaxing vehicle size and weight restrictions. The paper discusses each strategy terms of its nature (CL or FDM); the geographic scope of the inefficiency or implementation; the expected benefits; level of implementation effort/time/cost; the primary stakeholders targeted; the stakeholders' role in the implementation/planning effort; the potential for unintended consequences; and barriers for implementation.

The research showed that there is great variability in the level of data available (e.g., research reports, operational reports, implementation programs, pilot tests) to conduct detailed assessments, highlighting the need for additional efforts to be able to estimate the magnitude of the potential effects of each strategy to reduce inefficiencies (e.g., congestion/delays, environmental emissions, safety, and economic impacts, and costs, among others). However, stakeholder engagement during the research process allowed for a qualitative assessment based on empirical evidence from on-going efforts.

Introduction and Background

In Part I, we discussed some of the characteristics of the California Freight System, some key inefficiencies, and important aspects to consider when addressing such issues. Part II delves into strategies to address some of those inefficiencies. The freight system is multi-faceted and there could be a myriad of potential strategies. This paper focuses on those that could improve or maximize asset utilization by fostering collaborative logistics (CL) practices and/or freight demand management (FDM) strategies. For the purpose of this paper, CL practices are defined as those activities initiated, maintained, and/or conducted by different supply chain or freight system stakeholders in which they collaborate, coordinate, or cooperate in terms of resources, knowledge, assets or information to achieve operational or economic efficiency improvements of a larger system. And, FDM strategies are defined as transportation policies that seek to induce changes in demand patterns and freight behaviors to increase economic productivity and/or efficiency, sustainability and environmental justice. It is important to make the distinction between FDM and freight traffic control. Freight traffic control strategies try to modify the freight traffic in the network, without consideration of freight demand, i.e., higher tolls in a highway. Instead, FDM strategies try to modify freight demand that could translate into a reduced number of freight trips.

Because of the very nature of the system itself, strategies do not work in isolation, and each strategy may require complementary strategies to be feasible and implementable (e.g., sponsored programs to acquire technology, incentives to foster behavioral changes, funding for capital investments). This is especially the case for collaborative and cooperative based strategies. It has been a long standing practice in the freight system to engage in collaborative or cooperation agreements, whether by sharing information and knowledge or physical assets. This has been the case when facilitated by a third party which can demonstrate ultimate benefits to cargo interests and carriers. Regardless of collaborative and cooperative behaviors, the supply chain also remains an exceptionally competitive place, and consumers around the globe and in your neighborhood alike benefit from the continual downward pressure on the rates paid to transport goods.

The paper discusses some specific strategies and provides insight into expected impacts, planning, technical and operational requirements, and evaluation metrics. **Error! Reference source not found.** shows a summary of the types of suggested improvement strategies.

The key factors identified and analyzed for these strategies include:

- **Nature of the Strategy:** *Collaborative logistics practices (collaboration/cooperation) or freight demand management.* Strategies may fall into either category, or may be a combination of both.
- **Geographic scope of the inefficiency/improvement strategy:** *Area(s) where the inefficiency is acute, including at international gateways, on-road sections of the distribution network, and urban areas.* More detailed geographic scopes can be: statewide, or specific to a layer of the economy, freight corridors, a certain metropolitan area, or particular locations within the State. Considerations of scope acknowledge the fact that the freight system, and the supply chains within it, span across various geographic areas, some of which extend beyond California.
- **Expected benefits:** *Anticipated benefits of the strategies.* Strategies will be able to address specific issues and inefficiencies based on the benefits they are expected to bring about. Benefits may include:
    - Reduced Congestion
    - Increased Environmental Sustainability
    - Enhanced Safety
    - Enhanced Security
    - Enhanced Economic Competitiveness
    - Increased Revenue Generation
    - Enhanced Livability
- **Level of implementation effort/time/cost:** *Estimated inputs required*. While some strategies may require lower levels of implementation and design effort, smaller costs, and shorter implementation scales, others may require large commitments of resources,

coordination, planning and policies. It is important to consider these factors when examining the feasibility and viability of strategic options.

- **Primary stakeholders targeted by the strategy:** *Stakeholders directly affected by the strategy.* Stakeholder types can include: shippers, receivers, or carriers. Defining primary stakeholders helps to identify the types of modes, industries or freight facilities that would be directly impacted by the strategy. This is significant, for instance, because it is important to be able to anticipate details in regards to traffic generation (including heavy-duty traffic, light duty traffic, through-traffic, large traffic generators (e.g., ports, airports, and warehouses), rail, maritime, and inland waterways, among others).
- **Stakeholders' role in the implementation/planning effort:** *Stakeholder type(s) and anticipated role(s).* Strategies analyzed in this paper will require the participation of various stakeholders. Nearly all efficiency strategies will require private sector stakeholders to take the lead for the successful implementation of such strategies within their supply chains. Additionally, public entities will need to provide critical external planning, financial, or policy support.
- **Potential for unintended consequences:** *Any undesirable impacts that could be linked with a strategy.* It is imperative to analyze, anticipate, and avoid unidentified and unintended consequences. While real world results cannot truly be known until after the implementation of an improvement strategy, steps can be taken to anticipate and avoid any negative consequences. Past experiences can be analyzed to shed light onto potential issues and methods to circumvent such issues.

Table 1: Summary of Strategies

Layer of the Economy	**Nature of the Strategy**	**Strategy**
Distribution Economy	Collaboration/ Cooperation	Receiver-Led Consolidation
	Freight Demand Management	Voluntary Off-Hour Deliveries
Trade and Manufacturing Economies	Collaboration/ Cooperation	[Chassis] Pool of Pools (C-PoP)
		Integrated Dray Services
		Load Matching/ Maximizing Capacity
	Freight Demand Management	Improving Traffic Mitigation Fee Programs
		Implement Advanced Appointment/Reservation Systems
All	Traffic Management	Relaxing Vehicle Size and Weight Restrictions

The remainder of this paper will discuss in Section II, those strategies related to the distribution economy; Section III focuses on the international gateways; and Section IV provides a summary overview of the various strategies with respect to their impacts and other planning factors.

Improving Performance of the Distribution Economy

The distribution (urban) freight system is usually overlooked, despite the fact that it can represent the vast majority of the freight traffic in a region. This traffic includes freight and services trips to commercial establishments as well as residential locations. As discussed in Part I of this paper series, in some cases, internal distribution can represent up to 80% of the freight traffic[1] and a reduced number of locations (large building, conglomerate of establishments) within an urban core may could generate more freight traffic than a seaport or airport[2].

Transportation policy should ensure that freight is moved as efficiently as possible, as hampering the flow of cargo is bound to have a negative effect on the economy. Improving the efficiency of the system guarantees that freight shipments are reliable and arrive on time so that there are no economic losses due to lost sales. In addition, reliable operations would increase business throughput by an efficient supply of raw materials. A recent project funded by the (Transportation Research Board) National Cooperative Freight Research Program (Project Report 33) conducted an in-depth analysis of the various public and private sector strategies that could be implemented to improve freight systems performance in metropolitan areas[3]. The report produced a comprehensive classification and critical examination of the national and international evidence concerning their overall performance. More than 40 main strategies are discussed and grouped into seven major categories. Advantages, limitations, planning needs and efforts are discussed for each of the strategies. These range from those addressing supply at one end and demand at the other end. Operational and financial strategies are in the middle of the continuum. The categories include: Infrastructure Management; Parking/Loading Areas Management; Vehicle-Related Strategies; Traffic Management; Pricing, Incentives and Taxation; Logistical Management; and Freight Demand/Land Use Management (see Figure *1*).

[1] http://scagrtpscs.net/Documents/2016/draft/d2016RTPSCS_GoodsMovement.pdf

[2] Jaller, M., X. Wang, and J. Holguín-Veras (2015). Large Urban Freight Traffic Generators: Opportunities for City Logistics Initiatives. Journal of Transport and Land Use (JTLU), 8.1, 1–17

[3] http://onlinepubs.trb.org/onlinepubs/ncfrp/ncfrp_rpt_033.pdf

Infrastructure Management	•Ring Roads, Upgraded Infrastructure, Intermodal Terminals •Removal of geometric constraints, ramps for forklifts
Parking/Loading Areas Management	•On-street parking, loading zones, reservation systems •Off-street parking, enhance building codes, upgraded infrastructure
Vehicle-related Strategies	•Emission standards •Low noise delivery programs
Traffic Management	•Access and vehicle restrictions, truck routes, low emission zones •Traffic control and land management
Pricing, Incentives and Taxation	•Road pricing, parking pricing •Recognition programs, certification, incentives
Logistical Management	•Cargo consolidation •ITS, last mile delivery practices
Freight/Land Use Management	•Off-hour delivery programs, consolidation •Land use policy, large traffic generators

Figure 1: Urban freight strategies[4]

The report, discusses the potential of some of these strategies to help alleviate major issues such as congestion, environmental and health impacts, and improve quality of life and the competitiveness of the economy. However, the potential results from the implementation of each strategy are dependent on sound planning and implementation efforts. Planning agencies and private sector businesses should carefully analyze the feasibility and applicability of these strategies to their context and specific issues.

One key aspect, related to freight efficiency in urban areas is the adequate allocation and management of parking, loading and unloading areas[5]. In many locations, curb space is required to conduct freight operations (freight pick-ups and deliveries); but at the same time, other users are constantly competing for the scarce resource. In other cases, assigning the highest priority to freight may still require additional operational changes to avoid the issues associated with urban freight parking. Freight parking is a key issue for the industry that extends beyond the urban environments. This issue should be in the agenda of any planning and transportation organization. Similar difficulties are experienced when analyzing network capacity. Examples of FDM include off-hour delivery programs which incentivize receivers of the cargo to accept deliveries in the off-hours; and staggered freight programs in which businesses coordinate their deliveries or pick-ups throughout the day, rather than concentrating them in specific time periods (usually during traffic peak periods). Considering the experiences from national and international pilot tests and implementations programs, Voluntary Off-Hour Delivery Programs have the potential to play a key role in the State's effort to improve freight efficiency, as they seek to modify freight behaviors. In terms of CL practices, among the various alternatives, Receiver-led consolidation programs show great potential as they offer similar

[4] http://onlinepubs.trb.org/onlinepubs/ncfrp/ncfrp_rpt_033.pdf

[5] Jaller, M., J. Holguín-Veras and S. D. Hodge (2013). "Parking in The City: Challenges For Freight Traffic." Transportation Research Record 2379: 46-56.

benefits to traditional cargo consolidation schemes while overcoming some of the limitations and implementation challenges. The following sections will discuss these two strategies.

Voluntary Off-Hour Delivery (OHD) Programs (Demand Management)

Off-hours is usually associated with late evenings and early mornings, though it varies from industry to industry, geographic location and land use. ***This strategy is based on a voluntary program of pick-up and delivery operations in the off-hours***. Usually, participation is fostered by offering incentives to receiver establishments so that they change behaviors and allow their suppliers or carriers to make OHD. Although participation is voluntary, a successful implementation of the program requires public sector support. At the State or Federal level, public agencies should incorporate the type of funding and resource support needed for the design and implementation of the program into the legislation. The program will then be designed and implemented by local jurisdictions. Funding and support will be needed for the development of the specific types of programs, the design of the incentive scheme, stakeholder engagement and outreach activities, and more importantly for the staff to implement the various activities associated with the program. Although, there are a number of successful experiences, careful design and planning will require additional research to fully understand the freight behaviors in the areas under analysis. The research will help identify the potential target markets for implementation, the types and levels of incentives, the barriers for implementation, and to identify the appropriate performance measures to be used.

The resources required for the incentive program, will directly depend on the type of OHD program. For instance, the type of incentives analyzed in the literature include those that are continuously offered throughout the duration of the program, and those that are given as an initial one-time incentive. Incentives could be monetary or otherwise. The program implementation process in New York City evaluated various types of incentives[6]. The monetary incentives ranged from a one-time incentive of $500 to a $50,000 incentive with shift potentials ranging from 10% to 30%. The industry sector of the targeted stakeholders is a key factor determining the reach of an incentive package. Table *2* summarizes some of the studies that have investigated the receiver behavior in relation to the likelihood to participate in the program. In general, research results show that food and retail related industries are more likely to participate. Similarly,

Table 3 shows the results for two different (but contiguous) locations in New York City.

The various experiences and international studies about the potential implementation of OHD programs indicate that carriers can have direct benefits seen in the form of reductions in travel times during the off-hours (given that lower traffic volumes allow for higher speeds)[7]. In New York City, modest shift percentages can produce benefits of 5% to all network users. Moreover,

[6] Jaller, M., and J. Holguín-Veras (2013). “Comparative Analyses of the Stated Behavioral Responses to Off-Hour Delivery Policies”. Transportation Research Record (TRR), Journal of the Transportation Research Board. (2379): 18-28.

[7] Holguín-Veras, J., K. Ozbay, A. L. Kornhauser, M. Brom, S. Iyer, W. Yushimito, S. Ukkusuri, B. Allen and M. Silas (2011). "Overall Impacts of Off-Hour Delivery Programs in the New York City Metropolitan Area." Transportation Research Record 2238: 68-76.

during a pilot test conducted in the City, the travel mean speeds from the warehouses to the first stop in the delivery route improved by 70%. Other benefits include:

- Reductions in service/delivery times due to not having to wait for their delivery/parking spot;
- Reduction in idle times since there was no wait for the receiver to accept the cargo;
- Easy access to parking, loading and unloading zones closer to the establishment. This allowed the carrier to unload and transport larger shipments, thus reducing service times, and in some cases, trips to the establishment[8];
- Reductions in traffic infractions (with pre-implementation infractions in the order of $500 to $1,000+ per truck per month); and
- In some cases, travel time reductions allowed carriers to include additional stops per tour, thus minimizing the routes sent to the city. This translates in higher load factors, and asset utilization.

The program, could generate additional costs for carriers including wage differential to drivers in the off-hours; capital investments in information technology systems to improve operations, e.g., routing, dispatching, monitoring; and increased security costs. However, according to interviews and the experiences of the participants, their benefits were higher than the incurred costs. It is important to recognize that some carriers are not able to participate in this type of programs. Parcel and courier services, may not have the ability to participate due to their customers unwillingness to participate, regulatory constraints, access constraints, and hours of operations and service rules, among others.

[8] Jaller, M., J. Holguín-Veras, and S. Hodge (2013). Parking in the City: Challenges for Freight Traffic. Transportation Research Record (TRR), Journal of the Transportation Research Board. (2379): 46-56.

Table 2: Summary of behavioral research[9]

Variables	HV 2007	HV 2013	DOM-S 2013	DOM-B 2013
Industry Sector				
Food and beverage stores	*	+++	+	+++
Press and book	*	*	+++	++
Clothing stores	*	+	++	*
Apparel manufacturing	*	++	*	*
Accommodation	*	*	*	++
Non-durable wholesalers	*	+	*	*
Miscellaneous stores	*	+	*	*
Performing arts	*	+	*	*
Furniture stores	*	*	*	+
Personal laundry services	*	-	*	*
Commodity Received				
Commodity: Alcohol	+++	*	*	*
Commodity: Wood Lumber	++	*	*	*
Commodity: Food	+	*	*	*
Commodity: Textiles/clothing	+	*	*	*
Commodity: Medical supplies	+	*	*	*
Commodity: Office supplies	+	*	*	*
Commodity: Paper	+	*	*	*
Incentive				
Tax deduction	++	*	+++	+++
One-time monetary incentive	*	+++	*	*
Trusted vendor	*	+++	*	*
Shipping discounts	++	++	*	*
Public recognition	*	+	*	*
Business support	*	+	*	*
Other receiver attributes				
Type of facility is single	+++	*	*	*
External warehouse	*	*	++	*
Employment	+	*	*	*
Number of vendors	+	*	*	*
Number of deliveries	*	-	*	*

Notation: (*) denotes not considered or not found statistically significant. (-) denotes a low negative effect. (+) denotes a low positive effect. (++) denotes a moderate positive effect. (+++) denotes a high positive effect. Notes: New York City HV 2007[10]; HV 2013[11]; DOM-S 2013[12] the case of Santander; and DOM-B 2013 the case of Barcelona.

[9] Holguín-Veras, J., I. Sánchez-Díaz, M. Jaller, F. Aros-Vera, S. Campbell, C. Wang, and S. Hodge (2014). Off-Hour Delivery Programs. City Logistics: Mapping The Future. E. Taniguchi and R. Thomson (eds). CRC Press, Taylor & Francis Group, Boca Raton, Fl.

[10] Holguín-Veras, J., M. A. Silas, J. Polimeni and B. Cruz (2007). "An Investigation on the Effectiveness of Joint Receiver-Carrier Policies to Increase Truck Traffic in the Off-Peak Hours: Part I: The Behaviors of Receivers." Networks and Spatial Economics 7(3): 277-295. 10.1007/s11067-006-9002-7

[11] Holguín Veras, J., C. Wang, S. D. Hodge, I. Sánchez-Díaz, S. Campbell, S. Rothbard, M. Jaller, J. Wojtowicz and R. Marquis (2013). "Unassisted Off-Hour Deliveries and Their Role in Urban Freight Demand Management." (in review).

Table 3: Comparative analyses of the behavioral responses to OHD in different geographic areas[13]

		R1: Tax deduction for accepting OHD			R2: Shipping discounts for OHD			C1: Requests from customers and toll savings		C2: Requests from customers and financial rewards	
		Man.	Bro.		Man.	Bro.		Man.	Bro.	Man.	Bro.
		Rec.	Rec.	Int.	Rec.	Rec.	Int.	Car.	Car. / Int.	Car.	Car. / Int.
Policy		+++	++	--	+++		+ (i)	+++ (ii) ++ (iii)	++ (ii) +++ (iv)	++ (ii) + (v)	++ (ii) + (vi)
Industry Segment	Wood/lumber	+	+			++				+	
	Medical supplies	+	+		+					-	
	Paper	+	-		+				++	+	++
	Alcohol	+			++	--		-		-	
	Food	+			+			-	-	-	
	Metal	+		++		+				+	
	Furniture		+			+	--	-		-	-
	Electronics		+								
	Stone and concrete					+++	---			-	
	Textiles/clothing				+				+++		
	Construction and hardware		--	++		--					
	Office supplies				+						
	Petroleum/coal								++		
	Plastic/rubber		-					++	--		
	Machinery							-	+++	-	
	Household goods							-	--	-	--
Factors impacting the behavioral response to the policies	Number of employees	++			+			+	++	+	+
	Increased operational costs	--	--		--			--	--	--	
	Hours of operation	-	-						+		+
	Shipments from NJ		++								
	Number of deliveries					+					
	Accesibility to building	----			--			---		-	
	No control of delivery times					--					
	Number suppliers				+						
	Truck drivers							++		+	
	Containers from Baltimore					++					
	Containers from Connecticut					--					
	Trips to Manhattan							+++		+	
	Located in Brooklyn								---		
	Time/distance to first stop								-		-
	Trips to the Bronx and NJ								--		
	Type of facility				++ (vii)					-- (viii)	
	Line of business		---					+++ (ix)	+++ (x)	-- (xi)	
	Delivering to the Bronx										-
	Union regulations							--			-
	Parking related issues							--	-	---	-

Most likely to accept OHD (+++) to Least likely to accept OHD (---)

Notes:
(i) Only companies that receive and ship
(ii) Request from customers
(iii) Toll savings only for petroleum/coal, wood/lumber, food, and textiles/clothing industries
(iv) Toll savings
(v) Financial reward for food, computer/electronics, and textile/clothing industries
(vi) Financial reward for machinery/automotive and paper industries
(vii) Single
(viii) Headquarters
(ix) For shipper, 3PL, trucking, warehouse and mover carriers
(x) For shipper, manufacture, trucking and warehoue carriers
(xi) For Warehouse carriers

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[12] Domínguez, A., J. Holguín-Veras and Á. Ibeas (2012). "Receivers' response to new urban freight policies." Procedia-Social and Behavioral Sciences 54: 886-896.

[13] Jaller, M., and J. Holguín-Veras (2013). "Comparative Analyses of the Stated Behavioral Responses to Off-Hour Delivery Policies". Transportation Research Record (TRR), Journal of the Transportation Research Board. (2379): 18-28.

In the case of receivers, benefits include reliability improvements in the service times, staff optimization, and environmental emissions reductions, among others. For the cases when the establishments are closed during the off-hours, costs may be incurred to hire personnel. Alternatively, unassisted off-hour delivery programs can be developed (use of double door systems, closed circuit TV, remote access control)[14,15].

An additional benefit from the strategy is the impact in the traffic flow and parking conditions in the implementation area. A parking analysis in New York City revealed that about 25% of the ZIP codes in Manhattan have a demand for freight parking that exceed capacity. Moreover, the study analyzed the benefits of OHD to mitigate the parking issues. In addition to alleviating congestion and parking issues, estimates for New York City show that the program could lead to yearly reductions of 202.7 metric tons of carbon monoxide; 40 tonnes of hydrocarbons; 11.8 tonnes of nitrogen oxide; and 69.9 kg of particulate matter[16]; similar analyses for the Mexico Federal District area indicate that the program could help overall emission between .8% and 4% (see Figure *2*)[17].

One of the key aspects of the program is its voluntary nature. Only those businesses that are able to participate (with or without the incentive package) will do it. However, there are several barriers that could hamper participation: traffic constraints during the off-hours (regulation banning freight vehicles during those periods of time); limited access to the building or businesses; staffing or scheduling; union regulations; overtime costs; driver issues; hours of service rules; safety and security reasons. As mentioned before, the research have shown that receiver participation is vital to the success of the programs, as carriers do not have the ability to impose off-hour delivery times to their customers. It is not recommended that off-hour deliveries be mandated as it could introduce inefficiencies, increase costs and externalities, and reduce economic competitiveness to those freight operations that could not implement them.

Given the body of knowledge about the program, it could be expected that with additional research to explicitly consider specific freight behaviors in California, the Program could be designed and implemented in a relatively short-term. Though, the program would require the involvement of a large number of stakeholders to identify participants, conduct planning and research, pilot test the incentive program, implement and monitor. The design must also pay special attention to mitigating potential noise disturbances and community perceptions. This type of FDM must also be associated with passenger demand management strategies to mitigate the potential issues of induced demand.

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[14] Holguín-Veras, J., R. Marquis, S. Campbell, J. Wojtowicz, X. Wang, M. Jaller, S. Hodge, S. Rothbard, and R. Goevaers (2013). Fostering the Use of Unassisted Off-Hour Deliveries: Operational and Low Noise Truck Technologies. Transportation Research Record (TRR), Journal of the Transportation Research Board. (2379): 56-63.

[15] Jaller, M., X. Wang, and J. Holguín-Veras (2015). Large Urban Freight Traffic Generators: Opportunities for City Logistics Initiatives. Journal of Transport and Land Use (JTLU), 8.1, 1–17.

[16] Holguín-Veras, J., J.M. Wojtowicz, C. Wang, M. Jaller, X.J. Ban, F. Aros-Vera, S. Campbell, X. Yang, I. Sanchez-Diaz, J. Amaya, C. González-Calderón, R. Marquis, S.D. Hodge, T. Maguire, M. Marsico, S. Zhang, S. Rothbard, K. Ozbay, E.F. Morgul, S. Iyer, K. Xie, and E.E. Ozguven. Integrative Freight Demand Management in the New York City Metropolitan Area: Implementation Phase. United States Department of Transportation, 2013.

[17] Jaller, M., S. Sanchez, J. Green, and M. Fandiño (2016). Quantifying the impacts of sustainable city logistics measures in the Mexico City Metropolitan Area. Transportation Research Procedia. (12):613-626

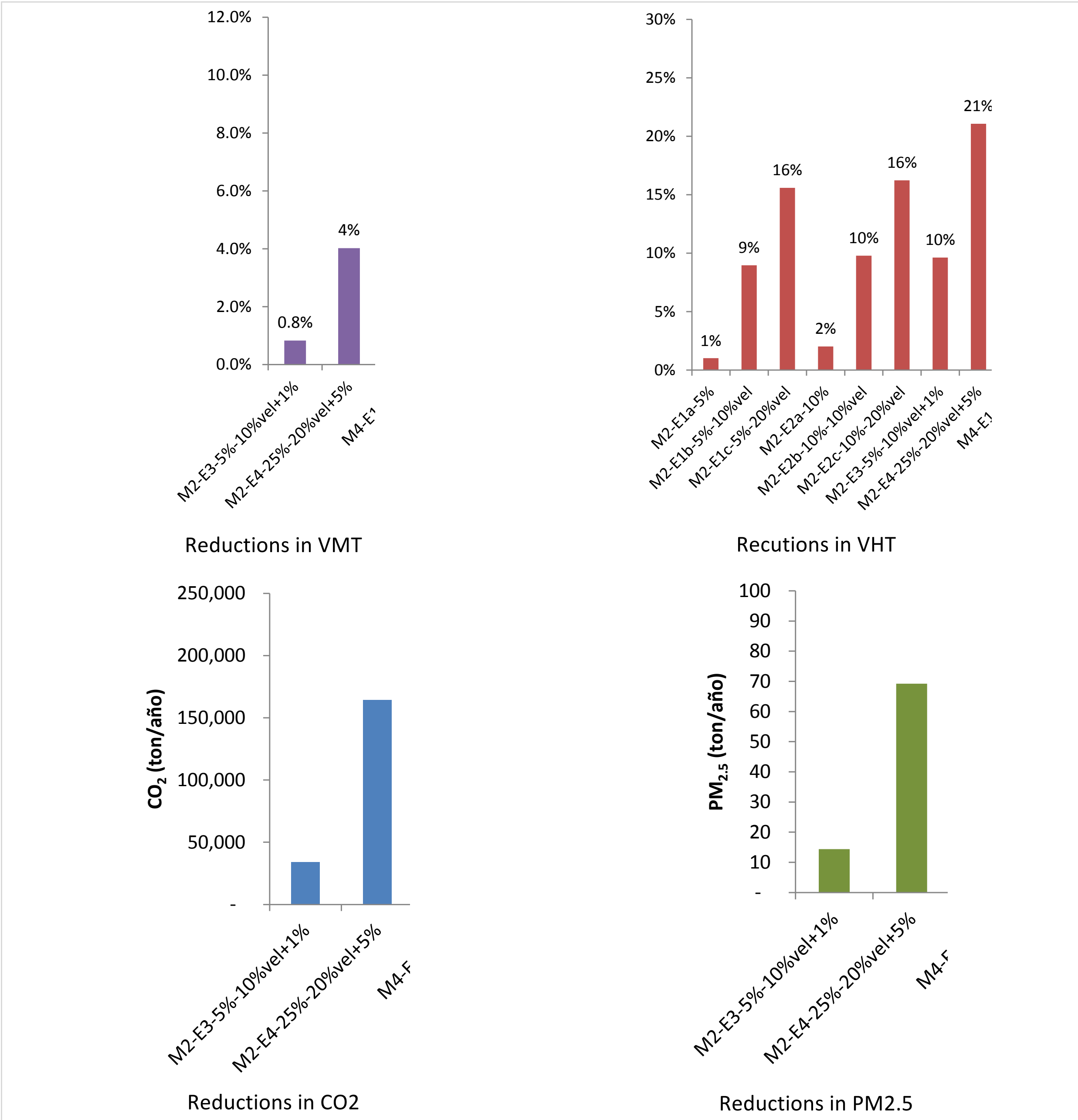

Figure 2: Example potential benefits from the implementation of OHD

Receiver-led Consolidation (Collaborative Logistics)

This type of strategies seeks to foster behavioral changes within supply chains by taking advantage of the power of receivers to push for cargo consolidation.[18] The objective of the strategy is to achieve a reduction in the number of deliveries. This could be achieved by

[18] Holguín-Veras, J., Sánchez-Díaz, I. Freight Demand Management and the Potential of Receiver-Led Consolidation programs. Transport. Res. Part A (2015), http://dx.doi.org/10.1016/j.tra.2015.06.013

reducing the number of suppliers or vendors, or by fostering the use of urban consolidation centers from the existing suppliers. The general benefits associated with this type of strategies include those to the receivers, suppliers, and the system. Receivers benefiting from having consolidated shipments, avoiding the need to deal with multiple vendors. In some cases, the can achieve economic benefits by being able to negotiate preferential or volume rates. Suppliers and carriers can increase productivity, with the negative consequence that some suppliers will be replaced. The overall reduction in deliveries, will translate in reduced freight traffic and the associated consequences.

The first case have been successfully implemented through the implementation of Delivery Servicing Plans (DSP). [19] The idea behind DSP, developed by Transport for London, is that commercial establishments in large buildings or large traffic generators, or large corporations with decentralized procurement practices conduct trip generation assessments and identify potentials for consolidation. In London, regulation requires that new developments propose construction logistics plans and DSPs. However, these plans are not subsequently enforced, and landlords or managers may not have incentives to invest the resources required for their implementation. For an implementation in California, the public agencies could develop incentives schemes to foster the implementation of these types of plans. Successful implementations in large buildings have shown their potential to reduce the number of truck trips generated from 20% to 60%.[20] Considering that in large dense urban areas, there may exist large traffic generators which could represent a significant proportion of the total freight traffic and associated externalities, these plans could help improve the freight efficiency and performance[21]. Analyses of the potential for implementation of this type of strategies in New York City, showed that they could reduce truck traffic between 6.5% and 21%.

Public agencies should identify the types of regulations that could facilitate the development of these types of strategies, considering that the focus would be on the receiver of the cargo. Moreover, research is still needed to design programs that consider the characteristics and behaviors of the California freight system.

International Gateways

The international trade economy is of high importance in California, especially due to the sheer volume of cargo handled in Southern California by the San Pedro Bay Ports. Approximately 60% of total west coast intermodal containers pass through the Port of Los Angeles and Long Beach, and the exceptionally busy international border crossings between California and Mexico.

With respect to the seaports, along with the benefits of handling more containers than any other port complex in North America come the logistical inefficiencies of waits in and around terminals, congestion at corridors feeding these gateways, and other issues introduced by

[19] Transport for London. (2013a). "Delivery Servicing Plans." Retrieved July 04, 2013, 2013, from http://www.tfl.gov.uk/microsites/freight/delivery_servicing_plans.aspx.

[20] Transport for London. (2013c). "A Pilot Delivery Servicing Plan for TfL's Palestra Offices in Southwark: A Case Study." Retrieved July 12, 2013, 2013, from http://www.tfl.gov.uk/microsites/freight/documents/20090921-DSP-Palestra-Case-Study.pdf.

[21] Jaller, M., X. Wang, and J. Holguín-Veras (2015). Large Urban Freight Traffic Generators: Opportunities for City Logistics Initiatives. Journal of Transport and Land Use (JTLU), 8.1, 1–17

labor-related factors. Myriad different types of inefficiencies within marine terminals can affect both the truck traffic and vessel operations at international gateways. For example, although non-recurrent, port downtimes can negatively affect the shipping companies that own delayed vessels. However, vessels are typically handled efficiently, and most of the inefficiencies exist in the transfer of containers from the terminal to drayman.

Port terminal inefficiencies can be exacerbated by the arrival of larger ships, coupled with the rapid increase in popularity of Vessel Sharing Alliances (VSAs). VSAs are a great example of collaborative logistics strategies, where a number of independent shipping lines consolidate to share assets and maximize the use of their resources. While larger ships and alliances are tremendously important improvements in efficiency for ocean carriers, they can pose additional logistical challenges for marine terminals. A large vessel discharging cargo from multiple ocean carriers can complicate terminal management, as each shipping line in an alliance may have its own terminal agreements, trucking contracts, dispatching agreements, railroad agreement and operations management. In some cases, once the containers are unloaded, all synergies disappear. These large vessels can also create cargo surges of more than 10,000 container moves per call. This is also coupled with VSAs having as many as six carriers in one vessel (with some other effects such as the scattering of containers across multiple terminals). The call surges can result in an increased number of container repositioning moves within the terminals before the boxes are delivered to a trucker, further increasing terminal congestion. When this process is repeated week after week, it can make the delivery of containers more complex, costly, and inefficient.

However, as VSAs are becoming the norm, and the great efficiencies and advantages of larger vessels are internalized into the supply chain, marine terminals and public port authorities are working effectively and efficiently in order to handle the increases in demand. Positive examples resulting from preparedness, planning and collaboration include the recent experiences from port calls of 15,000 and 18,000 TEU vessels. Within 10 days in December 2015, the Port of Los Angeles (POLA) AMPT terminal handled 2 of the largest vessels ever to call a port in the America's (15,000 + 18,000 TEU vessels); in February 2016, the Port of Long Beach (POLB) PCT terminal PCT terminal handled the Benjamin Franklin, a 18,000 TEU vessel as well. According to Port Authority officials, all 3 vessel calls were extremely well coordinated with all supply chain partners, including labor, and no congestion was experienced.

Given these challenges, it is important to develop strategies to foster collaboration between beneficial cargo owners, port terminals, the trucking and rail industry, equipment providers, and ancillary facilities such as warehouses and distribution centers. Although these would be private driven initiatives, public funding or incentives could be used to help support the development of collaborative relationships in strategic portions of the supply chain that could help maximize asset utilization. In addition, funds could be allocated to investigate and identify the success factors of the recent mega-ship handling experiences mega-ships. The following sections discuss some strategies that could be used to help mitigate some of the issues previously discussed and those in Part I.

Development of a Chassis Pool of Pools Fully Integrated System (Collaborative Logistics)

Chassis management has become a major issue for the intermodal supply chain, both in terms of chassis availability and also levels of utilization across the supply chains. These issues primarily emerged after many ocean carriers´ decided to no longer own and manage their own proprietary chassis fleets. Ironically, many of these new inefficiencies are the result of ocean carriers' move towards greater system efficiencies whereby they removed equipment ownership barriers and terminal specificity issues. These issues persisted in the intermodal system as a result of the lines' traditional chassis ownership and provision model. For purposes of this strategy, it is important to note that no matter who owns the equipment, chassis are critical to intermodalism, and it is impossible to move containers by truck on-road without them. As a result, being able to reduce the time and costs of chassis management by eliminating shortages or maintenance problems could improve system efficiency and become a commercial advantage in the services provided[22].

To cope with shortages of chassis', and also general availability problems, the Pool of Pools (PoP) initiative was created. This private initiative is comprised by the Direct Chassis Link Pool (DCLP), Trac Pacific Southwest Pool (TPSP) and Flexi-Van Los Angeles Basin Pool (FLBP)[23]. The PoP have alleviated the problem by providing more than 81,500 chassis to be used interchangeably and a new configuration of suppliers. The ports of Los Angeles and Long Beach utilize 31,866 chassis daily representing 40% of the total fleet. The PoP have helped reduce costs in operating private fleets and has an interchangeable pool to be utilized among all stakeholders reducing flips[24], decreasing times and fuel consumption, as well as generating a collaborative environment with stakeholders to share assets and information about their operations. However, the PoP experiences a number of issues including[25]:

- *"The number of chassis dwelling on terminal for greater than 60 days is almost 7,000 units. We need help in getting these units back into circulation."*
- *"The number of Out of Service chassis is still over 5,000. We need help in getting these units repaired and back into service."*
- *"Repositioning of chassis could be limited during this period, Pool of Pools will need each MTO to release surplus on-terminal chassis."*

These, among other issues, provide improvement opportunities for the PoP. Therefore, this strategy suggests:

The Development of a Chassis-PoP fully integrated system that seeks to transition the current PoP to an information and management system that provides the adequate type, quantity and quality of chassis available, and offers simplified administrative and billing services.

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[22] http://www.fmc.gov/assets/1/Page/PortForumReport_FINALwebAll.pdf
[23] http://www.morethanshipping.com/the-gray-chassis-pool-and-what-it-means-to-you/
[24] "Need to transfer a container from the chassis it is resting upon to another chassis", NCFRP Report 20
[25] http://www.pop-lalb.com, accessed November 30th, 2015

An effective provision of chassis requires the optimal and reliable provision of “certified” equipment to truckers. To be successful in the long run, the strategy requires that the private and public sector work together to create a reliable information and management system that provides an adequate quantity of chassis in optimal conditions. The scheme of a “gray pool” requires fully interchangeable equipment, simplification of management and billing, good and regular maintenance and repair of assets, and the development of robust information systems which provide to participants in the supply chain data regarding equipment availability timely and accurately. Having this information about the incoming equipment could help determine the reconfiguration of chassis at terminals and at virtual and off-site yards, and improve level of service. In addition, the average street dwell time for chassis is 4.5 days, thus reducing dwell time will improve the availability of chassis[26].

A report released by the Federal Maritime Commission (FMC) in July 2015[27], contains an overview of discussions from different stakeholders about port congestion and supply chain issues. Participants agreed on the need of more “gray pools” to provide chassis interoperability. Gray pools are most effective when there aren’t rules or provisions limiting motor carriers from utilizing any particular chassis, or chassis provider, and motor carriers are able to pick the provider from the pool that best suits their requirements. This type of equipment intermodalism is possible only when facilitated by legal interchange agreements. In this regard, there is a Uniform Intermodal Interchange and Facilities Access Agreement (UIIA)[28] which is an industry contract between truckers and drayage companies and water and rail carriers and leasing companies that serves as a standard interchange agreement for equipment but is not applied for chassis. The PoP has instituted its own interchange standards to facilitate its pool.

The improved Chassis-PoP should combine both the collaboration of different leasing companies that share a common interchangeable agreement of equipment but competing in service and price, and the ability to improve the land operations at the port facilities within a separate off-terminal yard or yards. In general, it would help reduce the number of flips between trucks and chassis and reduce the times of repair and inspection. Flips and trips to deliver chassis that belong to one terminal or operator is an inefficiency of the current system. Moreover, it would help reduce truck turn times at marine terminals, increasing the number of turns per vehicle, reduce the number of movements per chassis, and the number of out of service chassis.

The new Chassis-PoP integrated system will also help to improve roadability in addition to relieving congestion and inefficiency. The Federal Motor Carrier Safety Administration (FMCSA)[29] requires chassis to be in optimal conditions before interchange, but truckers at marine terminals are inconvenienced if they are only told of the need to make repairs at the roadability gate after they have already received the chassis. The problem here occurs when

[26] Journal of Commerce (JOC) (2015), “Extended free time contributes to chassis shortages in LA- Long Beach”, October 1, http://www.joc.com/port-news/us-ports/extended-free-time-contributes-chassis-shortages-la-long-beach_20151001.html, accessed October 2015

[27] U.S. Container Port Congestion and Related International Supply Chain Issues: Causes, Consequences and Challenges, 2015

[28] http://www.uiia.org/about/index.php

[29] https://www.fmcsa.dot.gov

roadability inspections are performed after the chassis is provided to the trucker. There's no inbound chassis interchange inspection, because truckers must report chassis conditions or problems when they drop the equipment as required by the FMCSA, but most do not. Without these required reports being filed, no quality assurance system exists to ensure that chassis provided are in good conditions until it is provided to the next trucker. Most chassis are repaired only if a trucker decides to take it to the roadability gate which impacts their hours of service, because they have to wait for them to be ready. Under this strategy, because roadability will be improved, it will stop the inefficiencies that result from a chassis in bad condition just going back into the pool and being directed to another trucker which will have to face the same problems and delay.

The POLA/POLB C-PoP is currently developing and implementing management systems to improve operations. Also, the FMC sanctioned POLA/POLB "Supply Chain Optimization" effort is working with the C-PoP to explore system improvements, including possible integration with other intermodal logistics management systems such as: eModal and the USDOT's FRATIS project, currently in the demonstration phase. The POLA/POLB are also working with LA METRO and CARB for incorporation of the aforementioned systems and "connected vehicle systems" into the proposed State's CARB Sustainable Freight Action Plan (SFAC) Pilot Project, being considered for funding.

As demonstrated by the current efforts, the successful implementation of this strategy and expansion to other ports would require collaboration between various stakeholders. Moreover, the effectiveness of the system to maximize asset utilization requires integration with other management and information systems, within the marine terminals, and participating stakeholders. Public agencies support for pilot testing will be crucial in the development and evaluation of such integrated systems.

Improvement of Traffic Mitigation Fee Programs (Demand Management)

The Traffic Mitigation Fee (TMF) Program, *PierPass,* has been a success in the San Pedro Bay ports. This program fosters freight operations in the off-hours. Since 2005, as a result of severe congestion, the Off Peak program has been in place and a TMF has been charged to container movements during the day shifts to pay for the nighttime shifts. The program handles 17,000 truck trips on average per night during the 6 pm to 3 am shift; this represents around 55% of the daily truck trips[30,31]. In 2015, the Port of Oakland announced that its marine terminals are considering the implementation of a similar Off peak program called OakPass.

According to a public report, while many carriers express willingness to move their operations to nighttime deliveries, there doesn't appear to be a corresponding response on the side of the businesses to operate during off-peak nighttime hours[32]. During the interviews conducted as part of this paper, it was identified that about one third of the warehouses in the SCAG region operate in the off-hours mainly because they are part of the PierPass program. By performing

[30] PierPASS (2015), "OffPeak Information", http://www.pierpass.org/offpeak-information/, accessed October 2015
[31] http://www.pierpass.org/wp-content/uploads/2015/07/2014-Operational-Costs-and-Financial-Report_Final.pdf
[32] The Tioga Group, Inc. – Dowling Associates, Inc. (2008). Truck parking facility feasibility and location study. Available from: http://www.alamedactc.org/files/managed/Document/10635/Truck_Parking_Facility_Feasibility_and_Location_Study.pdf.

operations during these times, the program is able to improve operations related to: time spent waiting between dispatches, time spent waiting to enter the terminal, and time spent inside the terminal either picking up or dropping off a load. Moreover, reduced truck traffic during the peak hours improves operations to all users in the network. Considering that about 95% of all the truck trips to/from the POLA/POLB are to/from container terminals, any reduction in the number of trips during the daytime would have a significant environmental and traffic impact.

Despite the initial success of PierPass, there are current issues affecting its performance which could be optimized. The first issue has to deal with the perception of truck drivers about the direct benefits of operating at the night times. Due to claims of insufficient demand to meet the increased costs of operating in the off-hours, a number of port terminals have reduced the number of night (and weekend) shifts provided (only 4-5 terminals). In some cases, this reduction of shifts have resulted in perceived diminishing benefits from customers during these time periods. The reduction in direct benefits coupled with an increase in the TMF of $69.15 per TEU, have prompted criticism to the program. Efforts have been invested by the terminal operators to explain and support the fee increases[33,34].

In addition, due to the fixed and static format of the program, queues form outside terminals before the night shifts (by the number of drivers that want to take advantage of the differential pricing). Therefore, with the improvement of PierPass it is also important to improve the efficiency of truck dwell times and validations processes. According to PierPASS, usual truck turn times are at about 60-70 minutes average, 40 minutes for a pick-up transaction and 20-30 for a drop-off. But if some information about the truck is not fully supported by documentation, online appointment validation or any other issue that could raise, truckers are required to go to the trouble ticket windows which can take on average 1 hour (but could be much longer). As part of the Supply Chain Optimization (SCO) effort, the POLA/POLB are working with the Metropolitan Transportation Organization and other supply partners to explore modifications/ improvements to the PierPass system, including better measuring of turn times and appointment systems. Regarding turn times, the POLA/POLB are considering partnering with a new system soon to be launched by the Harbor Trucking Association, which utilizes a smart phone/tablet application to constantly track trucks, and produce turn times. Additionally the POLA/POLB is considering incorporating this system, into the aforementioned CARB SFAC Pilot Project.

In general, the program has provided benefits to the system, and has shown the success of implementing a Traffic Mitigation Fee that is charged to cargo owners instead to the truckers (as it is typical in other pricing or charging schemes). Therefore, the strategy put forward here***, seeks to improve the TMF Program***. This could be accomplished by:

- Addressing inefficiencies within the marine terminal to increase the benefits experienced by the Program users. Inefficiencies in marine terminals exist regardless of the time period, therefore, to increase the benefits from the Program, the root cause of these inefficiencies must be addressed.

[33] Rule 7 of the WCMTOA Schedule reads: "…the Fee shall be adjusted annually to reflect increases in labor costs based on Pacific Maritime Association maritime labor cost figures." The approximate 3.5% increase in the TMF reflects this fee. It is part of ongoing rate increases applied per this Rule.

[34] http://www.pierpass.org/wp-content/uploads/2015/11/PierPass-Financial-Overview_10-21-2015.pdf

When looking at system level improvements, terminal operators are best positioned to engineer solutions. Ports can help to foster terminal optimization and best practices, but non-operating ports cannot develop and implement a program. As part of the SCO effort, the POLA/POLB is exploring "push (as opposed to pull) terminal logistics IT systems to convey containers to/from drayman.

- Revising the current pricing scheme. A more dynamic congestion management pricing scheme may prove more optimal at reducing congestion and improving efficiencies during both the day and off-peak hours. These charges could be lower during periods of lower utilization during the day and some minimal charges could be instituted for periods of high demand and utilization during off-peak. Although a fully dynamic pricing scheme would optimize the port (terminal) utilization, it could create confusion among the various stakeholders. An alternative would be to identify block/segments of time, and charge them differently. The development of an appropriate pricing scheme requires additional research.
- Normalize the multiple existing industry performance and efficiency indicators in order to measure improvements or degradations of off-peak programs.
- Implementing appointment/reservation systems. The TMF Program could also be combined with the implementation of appointment and reservation systems.

Implementation of these strategic changes would reduce turn times of trucks and improve terminal efficiency. This in turn, would help reduce congestion, truck waiting times at the queues, and increase throughput. Some of the changes described below could be addressed in the short-term, though careful planning and research about optimal program design could require additional time and funding support. Public agencies could provide the funding and planning support for the development of the improved program, and at the same time, work with Port Authorities, terminals and other stakeholders to identify additional opportunities for perceived benefits. If a dynamic system is found to be the optimal pricing scheme, a data collection and information dissemination framework and system must be developed. This could require investment and planning beyond the marine terminals, thus requiring a higher level of coordination, planning and funding.

To be successful, there is a need for some specific common metrics to measure the turn time. As with the current system, queues outside the terminal constitute a potential unintended consequence. The ability of the system, the incentives/penalties, and the implementation of the reservations system could alleviate those issues. One important aspect to be considered when designing the pricing scheme is how this FDM strategy will affect the corridors and locations surrounding the marine terminals. Research to investigate such potential outcomes is recommended.

Implement Advanced Appointment/ Reservation Systems (Demand Management)

It is clear that trucking is often characterized as the most irregular and unpredictable mode of transport in port-related operations. In a study on truck announcement times, van Asperen et al. notes that "…if we consider the different transport modes a container terminal has to deal with, then road transport by truck is the least coordinated"[35]. Despite a lack of coordination between trucking companies and other parts in the intermodal machine, general research results have shown that total number of truck arrivals tend to follow certain patterns. While a

[35] van Asperen, Eelco, Bram Borgman, and Rommert Dekker. "Evaluating Impact of Truck Announcements on Container Stacking Efficiency." Springer. 19 Oct 2015. Web. 23 July 2011.

specific truck may not be predictable, truck arrival numbers have been shown to peak during certain hour windows within a day. This inefficient characteristic lends itself well to being addressed by truck scheduling strategies.

Consequently, the strategy put forward here ***seeks to develop and implement and advanced appointment and reservation flexible system that integrates with other information systems to maximize asset utilizations***. However, developing such a system requires the analyses of various operational aspects and potential consequences resulting from the system's implementation and the research about the effectiveness of appointment systems is not conclusive.

Many studies have chosen to use truck line (or queue) lengths and/or truck turn-around (or waiting) times as measurements of efficiency. Reducing line lengths and overall wait time lessens or erases the physical representation of truck traffic outside of ports, hence addressing the most visible problem with container-movement inefficiency. Appointment windows have been a popular solution, underlining the ultimate goal of evening out truck appointments over the day in order to take advantage of less busy time periods and avoid peak demand. Current trends indicate that trucks will be required to schedule appointments in 10 out the 13 container terminals in the San Pedro Bay by the end of next year[36].

In a Marseilles study[37], authors attribute the success of their truck appointment system (TAS) to the fact that the system was well thought-out and thorough, rather than myopic. The authors of the study note that previous studies have failed to include all of the pieces of a system that need to be considered in order to effectively implement a scheduling strategy. In their study, they focused on the supply-demand relationship between truck or vessel arrivals and cargo-handling equipment availability at time of arrival. This could be evaluated for application in California ports.

According to a report that analyzed initial appointment systems implemented in some terminals in California indicated that "…the estimates of potential turn time savings from appointments suggests that a large proportion of trips would have to use appointments, and appointment trips would have to be given some priority to realize significant time savings. It is only under these conditions that an appointment system would reduce truck queuing enough to result in lower truck emissions..."[38]

Other studies have shown no impact or have even shown a negative result. In contrast with the success seen at Marseilles, Le-Griffin et al.[39] concluded that addressing truck congestion by

[36] http://www.polb.com/news/displaynews.asp?NewsID=1491, accessed October 2015

[37] Zehendner, Elisabeth and Dominique Feillet. "Benefits of a truck appointment system on the service quality of inland transport modes at a multimodal container terminal". European Journal of Operational Research. 19 Oct 2015. Web. 15 July 2013.

[38] Giuliano, G., & O'Brien, T. (2007). Reducing port-related truck emissions: The terminal gate appointment system at the Ports of Los Angeles and Long Beach. *Transportation Research Part D: Transport and Environment*, *12*(7), 460-473.

[39] Le-Griffin, Hahn D., Lam Mai, and Mark Griffin. "Impact of container chassis management practices in the United States on terminal operational efficiency: An operations and mitigation policy analysis." Research in Transportation Economics. 19 Oct 2015. Web. 20 July 2011.

making appointments to let trucks through terminal entrance gates more quickly simply shifted the inefficiency of the system from outside of the gate to inside of the gate. Unintended consequences must be considered. This demonstrates that taking away the most visible representation of a problem, such as trucks, does not necessarily mean that that problem has been fixed, or that another problem has not been created.

Historically, truck appointment systems have not been as appealing to terminals because truck queues were more of a burden to trucking companies waiting in line than they were for terminal operators serving those lines. In addition, it is claimed that by setting appointments inefficiencies are introduced as they are associated with a fixed number of transactions in a day. However, as demonstrated by the Marseilles study, some research in recent years has begun to highlight the importance of considering the interconnection of all modes operating both in and out of a terminal. The value in coordination is starting to be more strongly recognized

As trucking appointment systems have been evaluated in many studies around the globe, investigating their feasibility in reducing congestion and improving efficiency in California ports would be wise. Developing such system requires an integrated effort between the public and private sector. It is important to identify the root causes for the irregular and unpredictable operations both in and out of the marine terminals. This would allow defining the rules and logics of the flexible system, and defining the appropriate time windows considering the uncertainties about the exact transaction times. Due to the mixed results reported in the literature, appointment systems should not be implemented lightly, rather they should be the result of significant research and planning efforts. The public authorities should provide the support (funding, access to information, stakeholder engagement) needed for those activities. One important aspect that would require careful attention is how to deal with the penalties and enforcement of appointments and reservations. Similarly as with the other strategies, the appointment system should be integrated with the other management systems put in place by some of the system stakeholders.

Nevertheless, it is expected that an appointment system (granted that terminal operations are optimized) would help mitigate some of the inefficiencies currently observed. The appointment system needs to be flexible enough to handle the operational needs when implementing strategies ranging from push systems, to peel-off and free-flow.

As mentioned before, as part of the SCO effort, the POLA/POLB is working with the MTO and other supply partners to explore modifications/improvements to the PierPass system, including appointment systems. An existing intermodal logistics system, eModal, which has been in existence and used by trucking companies, terminal operators, customs brokers, 3PL, etc., since 2002, provides appointment systems for several of the POLA/POLB terminals already. Emodal will be expanding their appointment systems to more terminals in 2016. The POLA/POLB is working with eModal and the terminal operators to have a universal and uniform system in place in the near future. Additionally, the POLA/POLB is considering incorporating this system into the aforementioned CARB SFAC Pilot Project.

Developing an Integrated System for Dray Operations and Services (Collaborative Logistics)

This strategy seeks to foster the development of cooperation and collaborative agreements between drayage operators, beneficial cargo owners, and in some cases, shipping lines and port terminals, to offer a shared service that can facilitate practices such as "free flow" or "peel off." The main objective would be to optimize container flow in Port Terminals. A dray agreement does not necessarily involve the provision of a pool of vehicles, but it would require the implementation of information systems that allow, among other things, container visibility to entire supply chains, real time traffic data, roads and terminal turn time and queues.

In addition, a strategy like this could help with new port paradigms such as push systems. As the name indicates, in push systems, containers are "pushed" out of the terminal instead of being pulled by beneficial cargo owners at their discretion. This in essence would help reduce cost, increase container velocity and truck turns, improve reliability and predictability, and improve labor and equipment deployment.

These new practices, push systems, peel-off, dray-off, and free flow are similar in the sense that they try to move boxes out of the terminal more efficiently. However they may impose additional challenges to individual operators, especially drayage companies that have contracts with specific clients. Push systems and peel-off type of systems could be implemented together, as push could be implemented for all sized shippers, and peel-off for large beneficial cargo owners. The success of these strategies heavily depends on the fluidity of the system which is affected upon inland facility operations and capacity[40].

The creation of the Dray system, would work similarly as the peel-off/dray-off cost model, but extended to the integrated operations with other stakeholders in the supply chain. Peel-off/dray-off models generally assume that the control and ownership of each box from ship to door is all managed by a single agency that minimizes overall costs. In general, the model estimates total terminal and drayage costs based on unit capital and operating costs and typical productivity factors

The public sector, as in the case of the Chassis-PoP, should foster a competitive and collaborative environment. Moreover, investments would be needed to develop the integrated information system that should be compatible with solutions such as the California Freight Advance Traffic Information System (FRATIS), and other commercial systems. A pilot test at the Port of Los Angeles showed that using a commercial (online and app-based brokerage) system and a free flow strategy could increase productivity by 500% (250 container deliveries per shift vs. 50) and reduce the average driver turn times in half (42 mins vs. 85 mins). [41]

An important aspect of a strategy like this would be the need for the implementation of incentives or the creation of an appointment system that is capable of handling the different

[40] Davies, P. and M. Kieran (2015). Port Congestion and Drayage Efficiency. Presentation at the 2015 INUF Metrans Conference. Long Beach, CA.

[41] Harman, D. (2016) On-demand Load Matching for Trucks. Presentation at the 2016 TRB Annual Conference Urban Freight Workshop on On-Demand Technology and Sharing Economy for Freight. Washington, D.C. January 10th.

requirements of port related activities, depending on the type of operational strategy in place. Moreover, this types of systems that rely on information sharing and technologies need to be developed considering data access and custodial, as well as the framework for their management. While the public sector could not mandate the collaboration between dray operators and services, it could provide the support for the analysis and research of effective incentive programs that foster participation and a behavioral change.

As part of the SCO effort, the POLA/POLB is exploring "push" (as opposed to pull) terminal logistics IT systems to convey containers to/from drayman.

Load Matching and Maximizing Capacity (Collaborative Logistics)

As cargo rates are increasing, ports are facing challenges to meet demand. Scheduling arrival of ships and aligning other elements in the supply chain to achieve a good level of service requires information systems and collaboration among stakeholders. One of the by-products of an effective and globalized containerized cargo is the ability of the system to keep a healthy number of "empties" in the system and available for shippers. The number of empties also reflects the relative balance of trade between nations, which is a function of the international economy and factors out of the control of any one seaport. As a result of the United States' current imbalance of trade, for instance, in 2015 at the Ports of Los Angeles, while empties accounted for only 2.8% of imported containers they accounted for 57.3% of all exported containers (2.2 million TEUs).[42] The transportation of these empty containers, primarily back to the terminal for export, require transportation services to and from facilities after use, but these are repositioning moves which are not revenue-generating, and although needed, the transport of empty containers can add to total system inefficiency. Some of the causes of empty container inefficiencies arise from size and type of equipment, lack of visibility and collaboration within stakeholders as well as information systems to track containers[43].

To remediate this issue, ***Load Matching Strategies*** could provide key benefits. The objective of load matching strategies is to reduce VMT associated with empty trips. There are many variations of load matching; examples include matching empty containers with loads; first come, first take pickups; and platforms to match small loads with available space in containers which are not already full.

These types of strategies have been implemented with some success in various regions of the country. For empties, empirical evidence indicates that it is possible to match between 20-30% of the trips. However, the main limitation is most cases is the positioning cost, or the cost to transport the empty container between its location and the location of the cargo. Although, analyses are still needed, these costs could be in the order of $200-$300 per movement.[44] Therefore, the public sector could develop an incentive program to increase the likelihood of matching and thus contribute to reduce the number of empty trips in the system. Considering

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[42] https://www.portoflosangeles.org/Stats/stats_2015.html

[43] Lee, Meng, ed., Handbook of Ocean Container Transport Logistics: Making Global Supply Chains Effective, Switzerland, Springer, 2015

[44] Turman, R. (2015) Southeast Streamline. Developers of load-matching system for importers and exporters on the East Cost. Coalition of Responsible Transportation. Personal communication.

the higher numbers of empties compared to loaded outbound shipments, the potential benefits of fostering these types of strategies is high.

Other examples involve the development and use of information technologies to facilitate traditional freight services such as freight brokerage. These types of technology platforms allow participation from carriers, manufacturers and distributors, freight forwarders, 3PLs, brokers, or businesses that regularly or sporadically have freight needs. One of the key factors that benefits from these technologies is the ability to provide information about unused capacity, asset visibility and reduction of "dead head" miles or empties. These systems could help reduce some of the inefficiencies at the long haul (city to city) transport, short-haul, last mile, international, and even at the courier express services. Complementary strategies have also been developed to help mitigate some of the problems associated with "empties" at the warehousing level. Figure *3* shows examples of these systems[45].

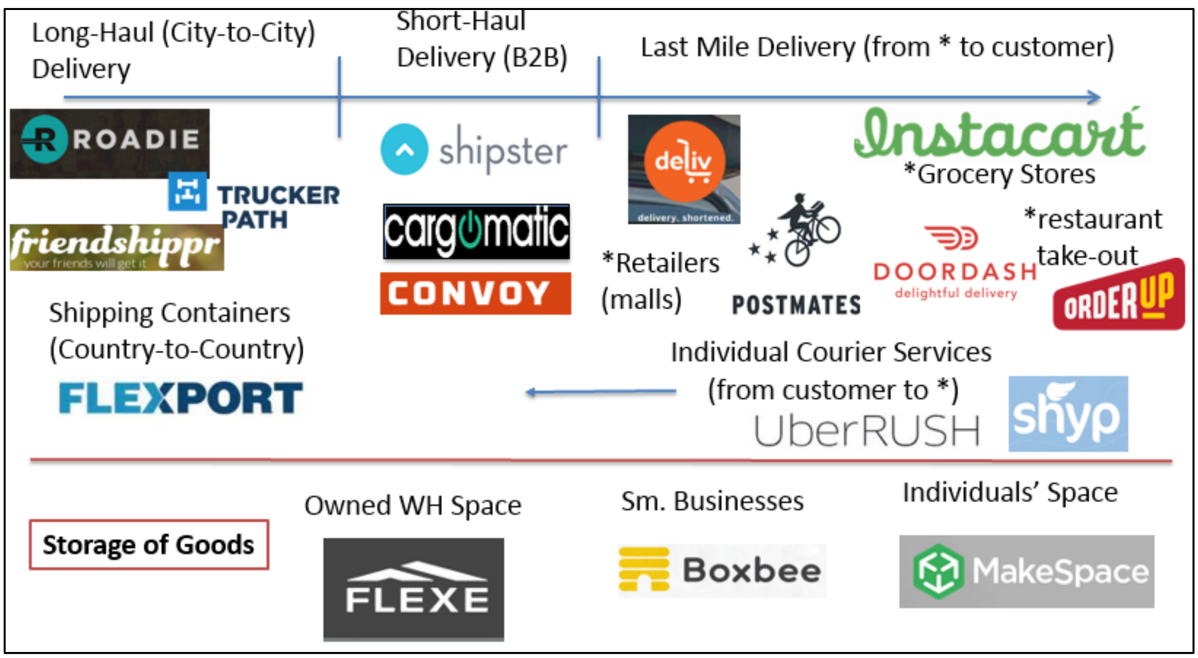

Figure 3: Examples of On-Demand Logistics Platforms

Although some of the examples in Figure 3 are new technological platforms for traditional freight services, current on-demand technologies and sharing practices have resulted in new freight operations and behaviors. Public agencies should support the planning and research for the potential applications of such services. However, it is clear that technology and information systems could play a key role in maximizing asset utilization. Public sector agencies should also identify the adequate allocation of resources such that these planning and research efforts are conducive to an efficient system and do not interfere with private business models.

[45] Pazour, J. (2016). The On-Demand Economy and Urban Freight. Presentation at the 95th Transportation Research Board Annual Meeting, Washington, D.C.

The Ports of Los Angeles and Long Beach are exploring a Virtual Container Yard (VCY) as part of their Supply Chain Optimization effort (SCO). The Ports have been in discussion with a private entity which will soon be launching a VCY service. The Ports and SCO participants will continue to promote such a service, and others that might emerge. However, the Ports will not actually deploy its own VCY to supplant or supplement other VCY services.

All Layers of the Economy

The previous strategies have concentrated in freight demand management and collaborative logistics; however, traffic management in the form of relaxing vehicle size and weight restrictions could have the potential to contribute to maximizing asset utilization. This strategy could affect the distribution economy as well as the freight corridors in the international gateways.

Relaxing Vehicle Size and Weight Restrictions (Traffic Management)

This final strategy, does not specifically relate to demand management or collaborative logistics; however, due to its importance to alleviate some pressing issues (investment in rail infrastructure, driver shortages, and freight traffic) it is discussed here.

Allowing increases in truck length and size would provide the opportunity for significant gains in efficiency for certain portions of the freight industry. Heavier GVW maximums and longer trailer configurations, e.g., 97,000 lb weight limits or use of 2-3 trailer long combination vehicles (LCVs), could provide benefits in multiple different forms. In terms of expected benefits, examples of metrics measures used in some studies looking at the US system include reduced number of trips, reduced administrative costs, less congestion, fewer hours of idling, less demand for drivers, reduced total fuel usage, and lower total emissions.

Truck weight and size limits in the US have not been changed since the 1982, when the Surface Transportation Assistance Act (STAA) mandated an 80,000 lb federal weight (GVW) limit for interstate highways. This is exacerbated by the continued existence of a previous prohibition [from 53 years before 2009] that requires that, in order to increase their size or weight limits on sections of the interstate highway within their borders, individual states must demonstrate a grandfathered right (from before 1956) to do so. Additionally, in 1991 ISTEA froze the weights, lengths, and routes of operation of long combination vehicles (LCVs). It is clear that vehicle size and weight restrictions is a complex issue.

A few different opportunities exist where truck weight and/or size increases would provide easily achievable efficiency benefits. “It is generally accepted that in the U.S. the ratio of mass-limited to volume-limited semitrailers ranges from about 50/50[46] to 40/60”[47]. According to a survey of the NPTC, 86 percent of companies experience some weight out, 76 percent experience some cube out, and 66 percent have both weigh outs and cube outs. A more in-

[46] NRC [National Research Council] (2010). Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles. Available at: http://www.nap.edu/catalog.php?record_id=12845

[47] Woodrooffe, J. (2014). Reducing truck fuel use and emissions: tires, aerodynamics, engine efficiency, and size and weight regulations. http://deepblue.lib.umich.edu/bitstream/handle/2027.42/109749/103144.pdf?sequence=1&isAllowed=y

depth survey found that fifty-six percent of companies' shipments regularly weight out, and 34 percent regularly cube out. Any situation that involves a weight out can be equated with an opportunity for heavier weight allowances to have an impact on efficiencies. Similarly, any situation involving a cube out represents an opportunity for trailer size/length increases such as the use of LCVs.

In the bright side, companies estimated that they could see a 10% reduction in truck trips if weight restrictions were increased, and a 6 percent reduction in trips if LCVs were allowed. For 5 companies that could benefit from weight restriction increases, an increase of 8,000 lbs in GVW allowance would save 7.5 million gallons of fuel, and an increase of 14,000 lbs would save 10.8 million gallons. Use of LCVs are estimated to achieve a 34.9% reduction in fuel usage, on average. "Of the three scenarios evaluated, the LCV option has the greatest projected influence on fuel consumption and emissions reduction"[48]. Looking at the scenarios, combined, can provide even more benefits. Assuming all companies in the study are representative of the general truck population in the US (an issue the authors acknowledged was an unknown), if both a 8,000 lb increase and use of twin 53-ft trailer LCVs were allowed, national annual diesel fuel usage would decrease by 2.6 billion gallons. If a 14,000 lb increase and LCVs were used, that reduction would be nearly 3 billion gallons.

Investigating the potential for longer and/or heavier trucks in California would provide a significant prospect to address goals specified by the Governor's Executive Order. Compared to other countries that already have looser restrictions on size and weight, the US has a large opportunity to increase their efficiency and have a more competitive freight system. "The potential gains in freight efficiency for freight that could make use of vehicle weight increases matching our NAFTA partners Canada and Mexico are 44 and 53 percent, respectively"[49]. Large increases in efficiency that could be achieved by adjustments to the federal weight and size limits could provide efficiency gains that could possibly meet or exceed the Governor's goal. It is important to consider, however, several factors that can have large effects on estimated results[50]:

- Each company has different areas where efficiency gains can be achieved through the expansion of size and weight limits; not all companies would benefit from each possible loosening in regulation;
- "Larger trucks, including LCVs, will not be suitable for all roads, and route selection, permitting and monitoring will be important issues";
- There could be increased wear-and-tear on the trucks, tires, and trailers, affecting the lifetimes of the equipment;

[48] Woodrooffe, J., Belzowski, B. M., Reece, J., & Sweatman, P. (2009). Analysis of the potential benefits of larger trucks for US businesses operating private fleets. http://deepblue.lib.umich.edu/bitstream/handle/2027.42/65000/102510.pdf?sequence=1&isAllowed=y

[49] Woodrooffe, J. (2014). Reducing truck fuel use and emissions: tires, aerodynamics, engine efficiency, and size and weight regulations. http://deepblue.lib.umich.edu/bitstream/handle/2027.42/109749/103144.pdf?sequence=1&isAllowed=y

[50] Woodrooffe, J., Belzowski, B. M., Reece, J., & Sweatman, P. (2009). Analysis of the potential benefits of larger trucks for US businesses operating private fleets. http://deepblue.lib.umich.edu/bitstream/handle/2027.42/65000/102510.pdf?sequence=1&isAllowed=y

- Weight increases would be compatible with most existing infrastructure, but bridge weight restrictions need to be considered in addition to interstate highway restrictions;
- Heavier trailers that only have 2 axles will need a third axle in order to handle more weight. This raises cost concerns and issues surrounding who owns the trailer/would be responsible for retrofits/turnover in the trailer fleet. Estimating retrofit costs would be very difficult, considering the large variety of equipment/uses;
- LCV use has limitations largely based on infrastructure-related geometric constraints;
    - LCVs will likely require special government permitting and additional training for drivers; they also would require significant infrastructure changes in different areas of use, including on roads and also at the point of transition from interstate to urban area (e.g. needing drop yards); operational adjustments, on the side of the companies, would be needed as well;
- The use of for-hire carriers, versus private carriers, can have an impact on the feasibility (and cost burden) of weight increases and LCV use.

Additionally, impacts on California's roadways and pavements need to be considered. The Transportation Institute at Texas A&M has conducted research in this general area, and their findings should be looked at and considered when looking at the potential of heavier trucks in California. Although a complex topic, the potential for improvements due to modifying size and weights restrictions warrants the need for additional research to identify those locations or corridors where they could be implemented. Federal and State Agencies should take the lead on identifying those opportunities. Concerns about infrastructure damage, safety, and other issues are valid reasons to invest resources to identify the feasibility of such strategies. However, technical feasibility may not equate with regulatory constraints.

Summary of Strategies

In general, the discussions for each strategy showed that there is variability in the potential for their impacts, the levels of effort needed for their implementation, and the type of stakeholders involved in the planning, research, and implementation phases. Some of the strategies are likely to be widely understood by the practitioner community, while others require careful analysis and implementation to avoid unintended consequences. Moreover, the amount of public information available about experiences and assessments, varies from strategy to strategy; this is especially the case for the required level of costs and implementation efforts. This section summarizes the various proposed strategies based on a qualitative assessment of some of the factors discussed in Section I: potential benefits; stakeholders' role in the implementation/planning effort; requirements; and the opportunities for the implementation of new technologies. The qualitative assessment is based on the discussion and critical analysis of each strategy. For each factor, a 3-level scale is used, indicating low, medium and high relationship (i.e., positive effect, level of involvement, and level of effort/investment). Lack of an assessment indicates that the criterion does not apply to the strategy, or that the relationship is very low. In general the assessment is made considering that the strategy is feasible for implementation, and that the unintended consequences have been addressed. This assessment should be used as a general guideline, and for comparison purposes between the strategies. The assessment does not imply the real magnitude of the effects as it will depend on the specifics of the program to be implemented.

For example,

Table *4* shows the potential benefits expected from the implementation of each of the strategies. The assessment clearly indicates that these strategies have the potential to generate positive effects in terms of increased operational efficiency, reduced congestion, and improved environmental sustainability; while not generating major impacts on safety, security and enhancing livability. However, the magnitude of those benefits could not be estimated, as additional research, simulation, modeling and analyses are required to identify the corridors, and/or specific locations (or stakeholders) where those benefits would be realized. For example, while some of the benefits could be perceived inside maritime terminals, other beneftis such as reduced congestion could impact all network users (thus quantifying them is a complex task). For the cases for which information is available, overall emission reductions could be in the order of 4% as in the case of Off-Hour Deliveries. Another important aspect that limits the ability to quantify the benefits is the fact that, in most cases, the implementation of various strategies does not have an additive effect. Though, controlling for unintended consequences such as induced demand, it is expected that the benefit would be a compounded positive effect.

Table 4: Potential Benefits

Potential Benefit / Strategy	Increase Operational Efficiency	Reduce Congestion	Environ-mental Sustain-ability	Enhance Safety	Enhance Security	Enhance Economic Competi-tiveness	Public Sector Revenue Generation	Enhance Livability
Chassis-PoP	+++	++	+			++		
Integrated Dray Services	++	+++	+++	+		++		
Advanced Appointment/ Reservation Systems	+	+	++	+	+	+	+	+
Load Matching/ Maximizing Capacity	++	++	++			+++		+
Improving Traffic Mitigation Fee Programs	++	++	++	+		+	+	+
Relaxing Vehicle Size and Weight Restrictions	+++	+	+			++	+	
Receiver-led Consolidation	+++	+++	++			++		+
Voluntary Off-Hour Delivery Programs	+++	++	++	+		++		++

(+) denotes a low positive effect. (++) denotes a moderate positive effect. (+++) denotes a high positive effect

When desiging the various strategies and conducting the planning efforts, it is important to identify the stakeholders' role in the process (see

Table *5*). For the purpose of this paper, when refering to the local/regional/State/Federal government, planning agencies, and other public authorities' involvement, the analyses refer to the level of engagement required from each of those stakeholders to provide critical external planning, financial, or policy support. A clear difference should be made between the stakeholder engagement for the design, planning and implementation process, and the specific stakeholders targeted by the strategy. For example, while receiver-led consolidation primarily targets shippers and receivers of the cargo, other stakeholders such as logistics operators and ancillary facilities would need to coordinate the changes in operational patterns; governmental involvement requirements may be limited. Voluntary off-hour delivery programs exhibit similar characteristics in terms of the targeted stakeholders; however, the implementation and planning efforts require engagement from many other stakeholders including, local, regional and national public agencies.

In other cases, the planning effort should consider issues resulting from the improvement of operations of specific modes. For examples, relaxing truck size and vehicle restrictions may induce an undesirable mode shift from rail to truck; moreover, the infrastructure investments to facilitate the traffic of heavier vehicles may create equity differences between the publicly and privately owned infrastructures (e.g., rail). In this specific example, relaxing vehicle size and weight restrictions for over the road vehicles, could generate opposition from the rail industry, and communities.

Table 5: Stakeholders' role in the implementation/planning effort

Stakeholder / Strategy	Shippers	Carriers - Road (Drayage /Distribution)	Carriers - Rail	Carriers - Maritime (Shipping Lines)	Receivers (Large and Small Establishments)	Port Terminals	Warehouses/ Distribution Centers	Logistics Operators	Local Government/ Planning / Authorities	State / Regional	Federal	Others (Trade organizations, scientists, academia, communities)
Chassis-PoP	+	+++	+	++		+++		+++	+	+++	+	+
Integrated Dray Services	++	+++	++	++	+	+++	++	+++	++	+++	+++	++
Advanced Appointment/ Reservation Systems	+	+++	++	+++	+++	+++	+++	+++	+	+		+
Load Matching/ Maximizing Capacity	+++	+++	++	++	++		+++	+++		+	+	+
Improving Traffic Mitigation Fee Programs		++		+++	+++	+++	+	+	+++	+	+	+
Relaxing Vehicle Size and Weight Restrictions	+	+++	+		+	+	++	+	+	+	+++	+++
Receiver-led Consolidation	++	+++			+++		+++	+++	+	+	+	+++
Voluntary Off-Hour Delivery Programs	++	+++			+++		+++	+++	+++	++	++	+++

(+) denotes a low involvement. (++) denotes a moderate involvement. (+++) denotes a high involvement

Each stakeholder could participate in the implementation and planning efforts in many forms. However, the type of requirements to develop a sound strategy could be categorized in: cooperation and coordination efforts; need for incentives or taxation; the need for funding or capital investment; development of information technologies; development of new technologies such as hardware, equipment; infrastructure improvements; and regulatory framework. In essence, the requirements could be in terms of technological, financial, planning, policy or operational support. Table *6* summarizes the type/level of requirements expected for each strategy. The assessment shows that cooperation and coordination, development of incentives and taxation schemes, and the development or use of information technologies are the primary requirements for these strategies. Designing each strategy should try to guarantee participation from the targeted stakeholders. Examples include the off-hour delivery program and the use of incentives to foster participation; or the recent experiences with the SCO at the POLA/LB, where a number of stakeholders are cooperating and considering optimizing strategies. The cooperation and coordination among the stakeholders have resulted in successful stories such as the handling of the 3 largest vessels ever to call a port in the US.

Table 6: Requirements

Requirements / **Strategy**	**Cooperation and Coordination**	**Incentives / Taxation**	**Capital Investments**	**Information Technologies**	**New Technologies (Hardware, Equipment, Vehicles)**	**Infrastructure Improvements**	**Regulatory Framework**
Chassis-PoP	+++		++	+++	+	++	+
Integrated Dray Services	+++	++	++	+++	+	+	++
Advanced Appointment/ Reservation Systems	++	+	+	+++	+	+	+
Load Matching/ Maximizing Capacity	+++	++		+++			+
Improving Traffic Mitigation Fee Programs		++		+		+	+
Relaxing Vehicle Size and Weight Restrictions			+			+++	+++
Receiver-led Consolidation	+++	+++		+			+
Voluntary Off-Hour Delivery Programs	+++	+++	+	+	+		+

(+) denotes a low level of effort/investment. (++) denotes a moderate level of effort/investment. (+++) denotes a high level of effort/investment.

In addition to the previous factors, the proposed strategies could also provide some opportunities (directly or indirectly) to introduce or foster the implementation of new or sustainable technologies. These include, zero or near zero emission vehicles and equipment; improvement and retrofits to existing facilities; automation; and the implementation of information technologies. The qualitative assessment (see Table *7*) is done under the following assumptions: 1) these strategies will provide system efficiencies that translate onto operational efficiencies for the individual stakeholders; 2) system efficiencies also generate economic benefits; 3) operational and economic benefits will allow for the stakeholders to invest in some of those new technologies; and 4) other operational efficiencies, and improvements in the overall system conditions could allow for the use of the new technologies within their technical limitations (e.g., range of electric vehicles; loading capacity). Moreover, considering that the development of some of the strategies could be involve incentive and funding programs, these programs could also include the adoption of these technologies.

Table 7: Additional opportunities for the adoption and implementation of new technologies

Opportunities for Strategy	Sustainable Vehicles	Sustainable Equipment	Improved Facilities	Automation	Implementation of Information Technologies
Chassis-PoP	+	+++	+	+	++
Integrated Dray Services	+++	+	+	+++	++
Advanced Appointment/ Reservation Systems		+	++	+++	+++
Load Matching/ Maximizing Capacity	+		+	+	++
Improving Traffic Mitigation Fee Programs		+		+	++
Relaxing Vehicle Size and Weight Restrictions	++	+		+	+
Receiver-led Consolidation	+		++		+
Voluntary Off-Hour Delivery Programs	+++	++	+	+	++

(+) denotes a low positive effect. (++) denotes a moderate positive effect. (+++) denotes a high positive effect

In general, and also discussed in the first paper of this two-part series, the analyses showed that there is no single strategy that could address the range of inefficiencies currently affecting the California Freight System. While some of the strategies are intended to mitigate pressing issues, others could help to adapt and be able to mitigate the impacts of future trends, and operational patterns. Designing a plan to improve the freight efficiency should consider a set or packages of complementary strategies.