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Commercial Vehicle Parking in California: Exploratory Evaluation of the Problem and Solutions

**Caroline J. Rodier, Susan A. Shaheen,
Denise M. Allen, Brenda Dix**

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**Commercial Vehicle Parking in California: Exploratory Evaluation of
the Problem and Solutions**

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Caroline J. Rodier, Ph.D.

Senior Development Engineer, Transportation Sustainability Research Center (TSRC)
University of California, Berkeley
1301 S. 46th Street. Bldg 190; Richmond, CA 94804-4648
(510) 665-3524 (O); 510-665-2183 (F); caroline@tsrc.Berkeley.edu

Susan A. Shaheen, Ph.D.

Co-Director, Transportation Sustainability Research Center (TSRC)
University of California, Berkeley
1301 S. 46th Street. Bldg 190; Richmond, CA 94804-4648
510-665-3483 (O); 510-665-2183 (F); sashaheen@tsrc.berkeley.edu;
sashaheen@ucdavis.edu

Denise M. Allen

Public Policy Analyst, Transportation Sustainability Research Center (TSRC)
University of California, Berkeley
1301 S. 46th Street, Bldg 190, Richmond, CA 94804-4603
(510) 665-3467 (O); 510-665-2183 (F); E-mail: dallen@tsrc.berkeley.edu

Brenda Dix

Graduate Student Researcher, Transportation Sustainability Research Center (TSRC)
University of California, Berkeley
1301 S. 46th Street. Bldg 190; Richmond, CA 94804-4648
510-665-3646 (O); 510-665-2183 (F); brendadix@gmail.com

ABSTRACT

California is home to major international ports in Long Beach, Los Angeles, and Oakland, as well as the second largest border crossing between Mexico and the U.S. California's highways are critical commercial links from these ports of entry to the nation and carry more commercial vehicle truck traffic than any other state in the U.S. Given the high volume of truck travel in California, it is not surprising that there is a serious shortage of truck parking in the state. This shortage negatively impacts economic productivity, roadway safety, air quality, and public health. This report begins with a summary of the relevant legislation history on truck parking in the U.S. Next, the shortage of truck parking in California and its impact on congestion, safety, air quality, public health, and the trucking industry's productivity is presented. A summary of lessons learned, from stakeholder interviews, recent surveys of truck drivers, and parking guidance information for autos, are presented next. This is followed by an evaluation of alternatives to address the truck parking problem in California, including expanded capacity, improved information, and installation of anti-idling technology. Finally, the federally funded Truck Parking Initiative in California is described. The study concludes with a summary of key findings.

KEY WORDS: commercial vehicle travel, truck parking, ITS

EXECUTIVE SUMMARY

California is home to major international ports in Long Beach, Los Angeles, and Oakland as well as the second largest border crossing between Mexico and the U.S. California's highways are critical commercial links from these ports of entry to the world and carry more commercial vehicle truck traffic than any other state in the U.S. Given the high volume of truck travel in California, it is not surprising that there is a serious shortage of truck parking in the state. This shortage negatively impacts economic productivity, roadway safety, air quality, and public health.

Legislation History

A study by the National Transportation Safety Board (NTSB) in 1990 indicated that a significant number of fatal truck collisions and crashes were fatigue-related and that a major contributor to fatigue was the lack of rest areas along the Interstate Highway System. Drivers are now limited to driving 11 hours during a 14 hour shift after ten consecutive hours off-duty. Prior to 2003, truckers could drive a maximum of 10 hours during a 15 hour shift after eight hours off-duty and could extend the 15 hour shift with off-duty time such as meal and fuel stops (U.S. DOT, 2003). The federal transportation bills passed during the first decade of the 21st Century set aside funding to investigate the adequacy of truck parking and rest areas and for programs to address parking shortages and reduce diesel exhaust emissions from idling at rest areas (FHWA, 2005)

Recent environmental and health legislation in California has placed emphasis on the need to reduce diesel exhaust emissions from idling. The Scoping Plan for the 2006 Global Warming Solutions Act (Assembly Bill [AB] 32) identifies electrification of accessories to reduce diesel exhaust from truck idling as one of the measures necessary to reduce two million metric tons of CO₂ annually by the year 2020 (26). California, as well as a growing number of other states and localities, now limit truck idling. California's Assembly Bill 233 (The Healthy Heart and Lung Act) improves the enforcement of diesel emission regulations, raises the penalty for idling longer than five minutes at any location, and requires operators to clear citations before having their registrations renewed.

Truck Parking Shortage and Consequences

California ranks first in the nation in overall (private and public) commercial vehicle parking shortage (Fleger et al., 2006). It is estimated that demand exceeds capacity at all public rest areas and at 88 percent of private truck stops on the 34 corridors in California with the highest volumes of truck travel (Caltrans, 2001). Moreover, it is estimated that by the year 2020 the demand for public rest area parking will increase by 53 percent, and for private parking will increase by 100 percent (Caltrans, 2001).

California is home to some of the most congested regions in the nation. The estimated cost of delay to California drivers and passengers in 2007 was almost \$23 million per day in lost time and excess fuel consumption (Caltrans, 2008). Trucks compose approximately 10 percent on average of all highway traffic (Caltrans, 2007). Navigational waste due to truck drivers searching for truck parking can contribute unnecessarily to congestion; studies of parking guidance information suggest that parking search traffic can be reduced by as much as 25 percent by giving drivers information on the location of

an available parking space (Rodier et al., 2005). Accidents are also a significant factor contributing to congestion. In 2007, truck drivers were found to be at fault in 72 fatal accidents and 3,095 injury accidents in California (CHP, 2007). Lack of parking and information about the location and availability of parking means that many truck drivers face the difficult and dangerous choice between illegal parking or noncompliance with HOS laws.

California's air quality is also among the worst in the nation. Diesel exhaust contributes significantly to air pollution and has serious effects on human health. The California Air Resources Board estimates that current statewide levels of diesel exhaust contribute to \$19.5 billion in annual health care related costs. Many trucks idle their engines while stopped in order to generate electricity needed to run in-cab appliances. A heavy duty diesel engine burns about one gallon of fuel every hour while idling and nonessential idling accounts for about nine percent of on-road diesel exhaust emissions (The Union of Concerned Scientists, 2005). Truck parking shortages can result in drivers seeking out alternative spaces near their routes, which are often located on residential streets and next to parks near ports (The Modesta Avila Coalition, 2005; West Oakland Environmental Indicators Project, 2003) directly exposing residents to high levels of diesel exhaust.

Lessons Learned

As part of this study stakeholder interviews were conducted with members of the California Truck Parking Sub-Committee and Goods Movements Task Force as well as the California Trucking Association's Policy Unit from June 2007 through July 2008. In addition, the literature was reviewed to identify relevant findings from recent surveys of truck drivers (Chen et al., 2002; Lutsey et al., 2000; Rodier and Shaheen, 2007) and parking guidance systems for autos. The following is a synthesis of the key lessons learned:

- Parking at public rest areas is most difficult for truck drivers in California. Public and private parking is also difficult to find in areas near ports and between key origin and destination locations. Bigger pull-through spaces are also needed.
- Private truck stops are preferred for long-term rests, and more parking is needed during overnight hours, near metropolitan areas.
- Many drivers regularly park in unauthorized areas because of lack of legal spaces and knowledge of locations of available parking where it is needed.
- Drivers may idle more frequently to cool and heat cabs in California. Few have experienced any enforcement of anti-idling laws. Most had not purchased any technology that would reduce idling emissions from their truck.
- Truckers may be a promising market for pre-trip and en-route parking information. Truck drivers (and not their carrier) most frequently decide where they will park and some do so prior to starting their trip but most do so en-route. Many drivers use online mapping programs to plan their route that currently do not include truck specific information.

Alternatives

A range of alternatives to address the truck parking problem in California, including expanding capacity, improving information, and anti-idling technology, were evaluated and the following are key findings:

- Developing new parking facilities is challenging because of (1) community opposition due to health, safety, and quality of life concerns, (2) high land values and construction costs in metropolitan areas where the parking is most needed, and (3) overlapping jurisdictional authority in areas adjacent to Interstate Highways.
- Converting park-and-ride lots, weigh stations, and large store parking lots for truck parking does not appear to be feasible because (1) trucks are too large to enter park-and-ride lots and (2) entities responsible for weigh stations and retail parking lots are unable to assume increased liability and maintenance costs associated truck parking use. More research needs to be conducted to evaluate the feasibility of converting closed army bases in California for truck parking use.
- The physical space of existing parking could be bettered used to accommodate more parking through improved enforcement, adjusting time limits, and restriping parking spaces at public rest areas.
- Public private partnerships should be explored to develop comprehensive, free paper and electronic truck parking guides as well as real-time, en-route parking and route guidance information with reservation capabilities. Barriers to implementing these services include demand, willingness-to-pay, and the development of a self-sustaining business model.
- Idling at truck stops may be addressed in the short term by implementing Advanced Truck Stop Electrification units (TSEs) to reduce idling by truckers unable to equip vehicles with Auxiliary Power Units (APUs) or onboard TSEs because of added weight and/or high installation and maintenance cost.

Truck Parking Initiative in California

The California Department of Transportation funded exploratory research programs to better understand the parking problems and possible solutions in California. The result of these efforts was a successful application to the Federal Highway Administration to fund a Truck Parking Initiative in California along Interstate 5 to provide pre-trip and en-route (real-time) truck parking availability, route-guidance information, and parking reservation capabilities. Caltrans has partnered with NAVTEQ, ParkingCarma™, and the TSRC at the University of California, Berkeley to implement and evaluate the pilot. The project will update NAVTEQ's map systems to include a database of public and private truck parking with features of importance to truckers (e.g., restrooms, hot food, showers, fuel, etc.). Truck drivers will be able to access this information as well as directions to parking facilities by phone (511 or 800 number), websites (both Internet and WiFi), and possibly satellite radio. Real-time truck parking availability and reservation capabilities will be integrated into the truck parking mapping and routing services by ParkingCarma™. Linking this project to the provision of TSEs may be a promising opportunity to reduce idling and meet California's air quality and public health goals. Researchers will conduct an analysis of alternative business cases, including advertising,

transaction, and subscriptions models, to determine how a public-private partnership could continue to operate in a steady state, self-financing mode after the prototype project is completed.

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INTRODUCTION

The over 700,000 heavy-duty trucks in California are a vital part of our nation's economy and freight system. California is home to major international ports in Long Beach, Los Angeles, and Oakland as well as the second largest border crossing between Mexico and the U.S. California's highways are critical commercial links between these ports of entry and the rest of the nation and the world and they carry more commercial vehicle truck traffic than any other state in the U.S. (Office of Freight Management and Operations, 2002). The major California ports contribute almost 40 percent of all U.S. containerized cargo trade—triple California's share of the U.S. population— and container traffic is expected to grow by at least 2.5 times its current volume by 2024 (WCC, 2004). Eighty percent of freight shipments in California are made on state highways (Office of Freight Management and Operations, 2002).

Given the high volume of truck travel in California, it is not surprising that there is a serious shortage of truck parking. The state ranks first in the nation in overall (private and public) commercial vehicle parking shortage (Fleger et al., 2006). Recent estimates indicate that demand for truck parking exceeds capacity at all public rest areas; this is also the case at 88 percent of private truck stops on the 34 corridors in California with the highest truck travel volumes (Caltrans, 2001). The truck parking shortage in California and the U.S. has a number of serious consequences that threaten our roadway safety, public health, and economic productivity.

This report begins with a summary of the relevant legislative history on truck parking in the U.S. Next, the shortage of truck parking in California as well as its consequences for congestion, safety, air quality, public health, and the trucking industry's productivity is presented. A summary of lessons learned, from stakeholder interviews, recent surveys of truck drivers, and parking guidance information for autos, are presented. This is followed by an evaluation of a range of alternatives to address the truck parking problem in California, including expanded capacity, improved information, and provision of anti-idling technology. Finally, the federally funded Truck Parking Initiative in California is described. The study concludes with a summary of key findings.

BACKGROUND

Public rest areas were built along the Interstate Highways System as part of the federal-aid highway program and are maintained by state departments of transportation (DOTs). These spaces were built to accommodate the physically smaller trucks on the highways in the mid-20th century. As the trucking industry has evolved and truck sizes have dramatically increased, space availability has decreased because trucks require multiple spaces to park. In addition, most rest areas do not provide pull-through parking, which modern trucks prefer because of difficulties backing-up larger trucks.

Private truck stops gained momentum during the building of the Interstate Highway System and the National Association of Truck Stop Operators (NATSO) was formed in 1960 (NATSO, 2005). Private truck stops offer more parking spaces and amenities than public rest areas. Public rest areas are generally located along major highways, and private truck stops are typically located nearby, but not adjacent, to highway facilities.

The Federal Hours-of-Service (HOS) regulations, originally instituted in 1939, have contributed to the demand for both private and public truck parking. These regulations mandate the number of hours a truck driver can operate a commercial vehicle before taking a rest. Drivers are now limited to driving 11 hours during a 14 hour shift after ten consecutive hours off-duty. Prior to 2003, truckers could drive a maximum of 10 hours during a 15 hour shift after eight hours off-duty and could extend the 15 hour shift with off-duty time such as meal and fuel stops (U.S. DOT, 2003).

Congressional mandates related to truck parking studies began with the National Transportation Safety Board (NTSB) (1990) estimate that 31 percent of fatal truck collisions and crashes were fatigue-related and that a major contributor to fatigue was the lack of rest areas along Interstate Highways. In 2000, with help from the NTSB, Congress recommended that the Federal Motor Carrier Safety Administration (FMCSA) create a guide to inform truck drivers of the locations of parking and parking availability in advance and during trips.

Congress continued to place importance on truck parking through the Transportation Equity Act for the 21st Century (TEA-21), setting aside funding to investigate the adequacy of truck parking and rest areas. Section 4027 of TEA-21 mandated a study to determine the location and quantity of parking facilities at both commercial truck stops and public rest areas. This study inventoried the current facilities and examined shortages.

The subsequent Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) further emphasized the importance of investigating truck parking availability. SAFETEA-LU authorized \$6.25 million for four years starting in 2006 to establish the Truck Parking Facilities Pilot Program. This program provided funding to address the shortage of long-term parking for commercial vehicles on the National Highway System.

SAFETEA-LU also addressed the problem of idling emissions and the truck parking shortage. The Interstate Oasis Program and Idling Reduction Facilities on Interstate Rights-of-Way Program were designed to establish standards for rest facilities along the Interstate that included the provision of products and services to the public, provide 24-hour access to restrooms, clean appearance, supply parking for heavy trucks, and alternative power to support truck driver comfort and reduce idling while parked in a public rest area.

Recent environmental and health legislation in California has placed emphasis on the need to reduce diesel exhaust emissions from idling. The 2006 Global Warming Solutions Act (Assembly Bill [AB] 32) mandates reduction of green house gasses in California to 1990 levels by 2020 which is approximately a 25 percent reduction from current levels. The 2008 Climate Change Scoping Plan to implement AB 32, outlined electrification of accessories to reduce diesel exhaust from truck idling as one of the measures necessary to reduce two million metric tons of CO₂ annually by the year 2020 from the good movement sector (CARB, 2008).

California, as well as a growing number of other states and localities, now limit truck idling. In California, strict restrictions have been placed on the idling of all diesel-fueled commercial motor vehicles greater than 10,000 pounds traveling in the state including (1) a five minute operating limit at any location, (2) certification of diesel fueled auxiliary power systems; and (3) automatic shutdown systems on all 2008 and subsequent heavy-duty diesel engines (U.S. DOT, 2005; California Code of Regulations, Section 2485).

In September of 2007, California also passed Assembly Bill 233 – The Healthy Heart and Lung Act— to improve the enforcement of diesel emission regulations. It specifically raised the penalty for heavy duty truck idling (longer than five minutes) from \$100 to \$300 and requires operators to clear all citations before renewing their registrations.

TRUCK PARKING SHORTAGES

Throughout the U.S., shortages of public truck spaces are considered to be more severe than shortages of private spaces. In 2002, 71 percent of states reported public shortages, but only 16 percent reported private shortages (Chen et al., 2002). This trend is expected to continue: the annual demand for public rest area spaces is projected to be 1.7 percent greater than the growth in supply, while the annual increase in private spaces is expected to exceed demand (Fleger et al., 2002).

California ranks first in the nation in overall (private and public) commercial vehicle parking shortage (Fleger et al., 2002). Recent truck parking demand estimates in California indicate that demand exceeds capacity at all public rest areas and at 88 percent of private truck stops on the 34 corridors in California with the highest volumes of truck travel (Caltrans, 2001). Table 1 provides an overview of supply and demand for truck parking based on the results of surveys and demand estimates conducted by Caltrans and the U.S. DOT. The California Highway Patrol (CHP) has identified 198 illegal truck parking locations, most of which are around existing public rest areas and private truck stops (Caltrans, 2001). Moreover, it is estimated that by the year 2020 average daily truck travel will increase by approximately 50 percent; the demand for public rest area parking will increase by 53 percent, and demand for private parking will increase by 100 percent (Caltrans, 2001). States that are contiguous to California also have a shortage in public rest areas but a surplus of private truck stops (see Table 2).

Table 1 Overview of the Supply and Demand for Truck Parking in California.¹

Attribute	Public Rest Area	Private Truck Stop	Other Private Location	Illegal Parking Locations
Ownership	Public	Private	Private	Public
Legal parking time	Typically, a few hours	Unlimited	Unlimited	Zero (illegal to park)
Number of Facilities	88	33	Unknown	198 ²
Spaces per Location	Maximum: 205 Minimum: 0 Average: 85	Maximum: 420 Minimum: 0 Average: 53	Unknown	Undefined
Number of Spaces Overall	7,496	1,106	Unknown	Undefined
Space Shortage as of 2000	8,057	6,106	Unknown	Undefined
Location Convenience	High	Moderate	Varies	High
Parking Convenience	Varies	Varies	Varies	High
Safety from Crime	Varies	Varies	Perceived as Moderate to Low ³	Varies
Safety from Crashes	Safe	Safe	Safe	Not as safe

¹ Smith et al., 2004; California Department of Transportation, 2001.

² Based on California Highway Patrol's observations of unauthorized parking locations.

³ Smith et al., 2002.

Table 2 Demand/Supply Ratio of States Contiguous to California.¹

State	Public	Private	Overall
Nevada	2.62	0.46	0.57
Oregon	1.89	0.67	0.79
Arizona	1.88	0.43	0.53
Utah	1.64	0.54	0.62

¹ Fleger et al., 2002

THE IMPACTS OF TRUCK PARKING SHORTAGES

Congestion and Safety

Congestion is a real and growing problem on the major highways of California: California is home to some of the most congested regions in the nation and delays increased by seven percent in just one year from 2006 to 2007 (Caltrans, 2008). Forty-six percent of the urban freeway miles were congested during peak hours in 2007 (Caltrans, 2008). The estimated cost of delay to California drivers and passengers in this year is almost \$23 million per day in lost time and excess fuel consumption (Caltrans, 2008). Over the next ten years, congestion is expected to grow by 35 percent in California (Caltrans, 2007).

Navigational waste due to truck drivers searching for truck parking can contribute unnecessarily to congestion. Studies of parking guidance information suggest that parking search traffic can be reduced by as much as 25 percent by giving drivers information on the location of available parking (Rodier et al., 2005).

Accidents are also a significant factor contributing to congestion on California highways. Trucks compose approximately 10 percent on average of all highway traffic (Caltrans, 2007). In 2007, trucks drivers were found to be at fault in 72 fatal accidents and 3,095 injury accidents in California (CHP, 2007).

Fatigue is a major contributing factor to truck collisions: eight percent of all fatal collisions and 16 percent of all truck collisions (Quan, 2006). HOS regulations limit truck drivers to 11 hours of driving during a 14 hour period followed by eight hours of sleep (U.S. DOT, 2003). Lack of information about the location and availability of parking means that some drivers face the difficult and dangerous choice between parking illegally or risking noncompliance with HOS law. Illegal parking is also dangerous: “(1) it limits the ability of parked vehicles to accelerate safely into the traffic stream from their parked position; (2) the presence of parked vehicles creates a conflict between existing and parked vehicles; and (3) errant vehicles may stray into the shoulder area and strike parked vehicles” (Trombly, 2003, p. 3).

Air Quality and Public Health

California’s air quality is among the worst in the nation. Over the past decade, major metropolitan areas in California have consistently exceeded state and national air quality standards. Diesel exhaust contributes significantly to air pollution and has serious effects on human health; it is classified by California as a carcinogen and contains forty hazardous air pollutants listed by the Environmental Protection Agency. Out of the top metropolitan areas in the U.S. with the greatest health impacts due to diesel, four are in California: Los Angeles, San Francisco-Oakland-Fremont, San Diego-Carlsbad-San Marcos, and Riverside-San Bernardino-Ontario, ranking second, seventh, 21st, and 25th respectively (U.S. GAO, 2004; American Lung Association, 2000). The California Air Resources Board (ARB) estimates that current statewide levels of diesel exhaust contribute to \$19.5 billion in costs related to premature deaths (3,500 per year); lung cancer (250 per year); decreased lung function in children; chronic bronchitis; increased respiratory and cardiovascular hospitalizations; aggravated asthma; increased respiratory symptoms; and lost workdays.

Many trucks idle their engines while stopped in order to generate electricity needed to run in-cab appliances. A heavy duty diesel engine burns about one gallon of fuel every hour while idling (The Union of Concerned Scientists, 2005). Nonessential idling contributes to about nine percent

of all on-road diesel emissions (The Union of Concerned Scientists, 2005). Over half of these emissions are from diesel trucks equipped with sleeper cabs. Truck parking shortages cause truck drivers to seek out alternative spaces near their routes. Because of the concentration of truck traffic near ports and other intermodal facilities, illegal parking is a common occurrence in these areas. Often the alternative spaces drivers find are located on residential streets and next to parks (The Modesta Avila Coalition, 2005; West Oakland Environmental Indicators Project, 2003). When idling occurs in residential neighborhoods, which are often already located near huge sources of ambient air pollution like ports, people are more directly exposed to high levels of diesel exhaust both inside and outside of their homes.

Trucking Industry

The shortage of truck parking also negatively impacts the productivity of the trucking industry though (1) increased liability due to crashes resulting from illegal parking and fatigue, (2) lower driver productivity due to excessive parking search travel, and (3) driver dissatisfaction and higher turnover due to the inability to obtain a rest (Smith et al., 2004).

LESSONS LEARNED

Stakeholder Outreach

To gain understanding of stakeholder concerns and needs related to truck parking in California, researchers attended meetings of the California Truck Parking Sub Committee and the Goods Movements Task Force from June 2007 through July 2008 and conducted interviews with attendees. Researchers also attended the California Trucking Association's Policy Unit meeting in June 2008 and implemented an informal survey with 11 members to assess truck driver concerns and interests in strategies to address truck parking problems in California.

Difficulties Finding Parking

Most participants indicated that truckers find parking at public rest areas to be most difficult. Some also indicated that parking is difficult to find in areas near ports and between destinations in the San Francisco Bay Area and the Central Valley. At one meeting, a participant suggested that most of the truck accidents in Sacramento area occur when fatigued truck drivers try to make the last two hour drive to the San Francisco Bay Area (Caltrans, 2007).

Route Planning

Participants indicated that many drivers use online mapping programs to plan their route, some use routes they are familiar with, and others uses routes provided by their company. Currently, online mapping programs do not offer truck specific information, including truck routes and facilities.

Idling

Participants indicated that the most common reason for idling is to cool and heat cabs and less frequently to warm the engine and power auxiliary equipment and in-cab appliances. Participating drivers reported idling for more than five minutes most often in traffic, followed by truck stops, rest stops, loading and unloading areas, and finally on roadsides. None of those interviewed experienced any enforcement of anti-idling laws. Most had not purchased any technology that would reduce idling from their truck; those that had, purchased APU/generator sets.

Response to Alternatives

It is generally believed that better distribution of parking location directories would reduce illegal truck parking. A system for real-time dissemination of parking availability would be beneficial; however, concerns were raised about the cost, maintenance, and reliability of the technology. The use of park-and-ride lots and weigh stations for truck parking are likely not feasible options because of issues related to liability, accessibility, and the potential infrastructure damage. Some believe that expansion of public rest areas, especially near ports and distribution centers, is necessary. Others indicated that such solutions were not feasible because of the cost to the state to build or expand these facilities.

Concerns about Regulations

Participants also indicated that they had a number of concerns about California specific legislation and regulations. These concerns are summarized in Table 3 below.

Table 3 Truck Drivers Concerns about Regulations.

California Regulations	Truck Driver Concerns
Assembly Bill 32	Timeline for reductions is too strict and truckers need more time to implement strategies.
Assembly Bill 233	Anti-idling enforcement will increase and without more available truck parking, truck drivers will be forced to violate the law, receive fines, and not be able to register, renew, or transfer their vehicle registration.
California Code of Regulations 2485	Anti-idling technologies and automatic shutdown systems designed to meet NOx emission standards are too expensive and individual owner operators will not be able to afford these technologies. Truck drivers are unsure of the benefits of anti-idling technologies if these technologies are not coupled with more parking.

Recent Truck Driver Surveys

The characteristics of truckers, truck parking behavior, and parking needs are explored in three relatively recent surveys. The first is the nationwide survey of 2,000 truck drivers sponsored by the Federal Highway Administration (FHWA) (Chen et al., 2002). The second is a smaller survey of 338 truckers at six Travel Centers of America private truck stops (Lutsey et al., 2000), conducted to explore truck parking and idling-related issues. The third is a survey of truckers in California to explore responses to possible truck parking information services, which included 433 responses that were collected through in-person administration at various locations throughout California during the summer and fall of 2006 (Rodier and Shaheen, 2007).

Parking Locations

Both the FHWA and the Lutsey et al. surveys indicate that private truck stops are preferred for long-term rests and that a sizeable number of truckers regularly park in unauthorized areas. According the FHWA survey, 90 percent park in private truck stops for long-term rest (four times a week on average); 67 percent use rest areas (two times a week on average); and 67 percent park in illegal spaces for long-term parking (two times a week on average), including entrance or exit ramps (33 percent), other parking lots (21 percent), and highway shoulders (11 percent). According to the Lutsey et al. survey, 90 percent of respondents had used a truck stop for at least one overnight rest, 53 percent had used a public rest area, and 25 percent parked in an unauthorized location.

Parking Decisions

Results of both the FHWA and the Lutsey et al. surveys indicate that truck drivers (not their carrier) decide where they will park—98 percent according to the FHWA survey and 84 percent according to the Lutsey et al. survey. Truck drivers' parking decision making can be conceptualized as follows: “(1) 12 to 24 hours in advance; (2) an hour or so prior to a planned

rest, typically within a 100-mile radius; and (3) at the end of the day, a driver decides whether or not to pull off when approaching a rest area” (Smith et al., 2004, pp. 10-11).

Among those drivers who make their own parking decisions, 21 percent do so before they start driving and 83 percent decide en-route (Chen et al., 2002). Among those who park illegally and make their own parking decisions (97 percent), 89 percent decide en-route and 16 percent do so before driving (FHWA, 2002). The FHWA survey found that: (1) owners and lessees are more likely to plan their own parking than company drivers; (2) company drivers are more likely than owners and lessees to select truck stops before they start driving; and (3) owners and lessees are more likely to decide where to park en-route (Chen et al., 2002).

Approximately 300 respondents to the FHWA survey provided additional comments. These are summarized as follows, drivers: “(1) often try to plan their parking stops but circumstances arise that prevent them from parking when or where they had planned; (2) frequently become tired before they thought they would, experience delays at shippers/receiver locations, and fail to find available parking spaces at their pre-planned destinations; (3) decide where to park as their on-duty hours elapse based on how far they think they can drive in the remaining hours of service; and (4) often do not plan ahead but simply park whenever they find an available space” (Chen et al., 2002, p. 13).

Illegal Parking

The FHWA and Lutsey et al. surveys found that a sizable percent of respondents do park in unauthorized parking locations (97 and 25 percent, respectively). The FHWA survey found that the two top reasons cited by truckers for parking illegally were: (1) no empty spaces at nearby facilities (94 percent of respondents) and (2) no nearby parking facilities (83 percent of respondents). In many instances, these responses may reflect lack of knowledge about available parking rather than actual knowledge. For example, interviews conducted with truck drivers in unauthorized spaces by the Maryland State Police in 2004 indicate that many drivers park illegally because they are unsure of the nearest authorized parking area, and trucks were parked illegally very near facilities with available parking capacity (Maryland DOT, 2005). Moreover, “almost 40 percent of drivers who park in these unconventional locations indicated that alternative parking, if made available, would improve the parking situation” (Chen et al., 2002, p. 12). The FHWA study concludes that: “there may be some connection between poor planning and parking on shoulders and ramps” (Chen et al., 2002, p. 15).

Parking Needs and Preferences

According to the FHWA study, most drivers indicate that more truck parking is needed during overnight hours, near metropolitan areas, and in specific regions: the northeast, the northwest, and Southern California (Chen et al., 2002). In general, drivers indicate that important attributes of long-term rest locations are food, fuel, restrooms, phones, showers, nearby highway, well-lit parking lots, and security (Chen et al., 2002). Drivers also commented that “big parking spaces that allow trucks to maneuver in and out” were important attributes of truck parking locations (Chen et al., 2002, p.15).

Response to Improved Truck Parking Information Services

Improving truck parking information and methods of communicating this information were explored in the FHWA survey (Chen et al., 2002). Seventy-three percent of respondents indicated that they would like to receive information by the radio in their vehicle; 40 percent

preferred to use their vehicle’s electronic visual display; and 12 percent preferred the Internet (Chen et al., 2002). Respondents also indicated a desire for the following real-time information: “(1) location of truck parking facilities along the road being traveled (84 percent); (2) features (e.g., showers, hot meals) that are available at upcoming parking facilities (77 percent); (3) number of truck parking spaces available at upcoming parking facilities (6 percent); and (4) length of time limits on upcoming truck parking spaces (46 percent)” (Chen et al., 2002, p. 19). From the over 200 written comments, respondents also expressed interest in obtaining information about: “(1) the layout and size of parking spaces at upcoming facilities and (2) whether a parking facility can accommodate trucks that are oversized, hauling hazardous materials, or multiple–trailer loads” (Chen et al., 2002).

The Rodier and Shaheen study explored truck parking information services and the results are documented in Table 4. Respondents were asked: “If you had up-to-the-minute information about parking areas and spaces available when you were deciding to rest, would you use it?” These results indicated that 67.9 percent of respondents would use such a service; 19.9 percent said they would not; six percent were unsure; and the remainder declined to answer the question. Among those respondents who indicated that they would use up-to-the-minute information about parking areas and spaces, most indicated that road signs (47.2 percent), mobile phones (21.6 percent), and radio (18.8 percent) were their preferred method of accessing this information. Respondents expressed less interest in accessing this information via the Internet or GPS. Forty-six percent of these respondents indicated that they would use the service to reserve a parking spot and, among this group, individuals preferred to do so by mobile phone (56.6%), by Nextel (24.6 percent), and by the Internet (9.7 percent).

Table 4 Parking Information Service Results.¹ N=433

Use of Hypothetical Parking Information Service	
Yes	67.9%
No	19.9%
Unsure	6.0%
No Response	6.2%
Preferred Method(s) of Receiving Parking Information^a	
Road Signs	47.2%
Mobile Phone	21.6%
Radio	18.8%
Internet	9.4%
GPS	6.3%
Other	21.6%
Willingness to Use Parking Reservation Service	
Yes	45.9%
No	39.7%
Unsure	8.8%
No Response	5.6%
Preferred Method(s) of Reserving Parking^a	
Mobile Phone	56.6%
Nextel ^b	24.6%
Internet	9.7%
Other	2.3%
No Response	6.9%

¹ Lutsey and Brodrick, 2007; ^a More than one response allowed

^b walkie-talkie-type mobile phone service

In sum, the results indicated that almost 70 percent of the truckers surveyed would use up-to-the-minute information about parking areas and spaces when planning their next rest. Among these respondents, most indicated that road signs, mobile phones, and radio were their preferred methods of accessing this information, and almost half indicated that they would reserve a parking spot in advance, most preferably, by mobile phone.

Parking Guidance Information for Autos

Smart parking management systems for automobiles have been implemented throughout Europe, the United Kingdom, and Japan since the early 1970s and provide information on available parking locations. Parking guidance information (PGI) systems, and more recently transit-based smart parking systems, provide real-time information to motorists regarding available parking spaces and locations. Lessons learned by evaluating and modeling these systems suggest that awareness and understanding can be relatively high, but that people who are less familiar with the area (i.e., visitors rather than commuters) tend to be the most frequent users (Thompson and Bonsall, 1997). Truckers, however, may be more like visitors and use en-route parking information more frequently because they often cannot or do not plan their parking in advance and/or lack parking information knowledge due to high driver turnover. PGI systems also tend to reduce parking facility queue lengths and provide modest system-wide reductions in travel time and vehicle travel (Thompson and Bonsall, 1997). Recommendations to improve these systems include: (1) targeting messages to the information needs, decision points, and knowledge levels of market segments early on in the system development process; (2) making messages conspicuous and providing some reinforcement; and (3) providing messages that are consistently credible (Thompson and Bonsall, 1997).

ALTERNATIVES TO ADDRESS THE TRUCK PARKING PROBLEM

The alternatives available to address the truck parking shortage problem generally include increasing the supply of spaces and better matching supply and demand. In this section, we evaluate capacity expansion, information, and anti-idling technologies.

More Truck Parking

Expanding capacity is one alternative to addressing truck parking shortages, but there are many barriers to doing so. Communities aware of the increased cancer risk and other health and quality of life problems associated with high numbers of trucks and diesel exhaust often oppose the construction of new truck parking facilities near their homes (U.S. DOT, 2005). In addition, purchasing suitable land in areas where shortages are the worst, such as Southern California, is extremely expensive due to rising land values and construction costs (U.S. DOT, 2005). There are also conflicts between local, state, and federal interests centering on ownership of land adjacent to interstate highways and the leasing of land to private businesses, which can prevent both convenient parking facilities and driver services (NTSB, 2000).

There are also significant barriers to using park-and-ride lots, weigh stations, and large store parking lots for truck parking in California. Heavy duty trucks will not fit into the entrances of park and ride lots because of their size and turning radii. Weigh stations in California are operated by the California Highway Patrol (CHP) and they are not able to assume liability associated with the use of these stations as truck parking facilities (e.g., theft, truck damage, and violence). Truck parking would also increase maintenance costs and require the construction of additional service facilities at weigh stations. Stores such as Wal-Mart and Target often have large parking lots which exceed customer demand and are virtually unused at night, when truck parking demand is highest. Unfortunately, while these stores may allow small numbers of truck drivers to use their parking facilities, like the CHP they are unable to assume increased liability and maintenance costs associated with the use of these lots for truck parking.

Old army bases are another possible alternative. Many air fields and army bases were constructed in the Central Valley in the years leading up to and during World War II. Since 1988, 29 major California bases and several smaller installations have been closed due to the Base Realignment and Closure Act. Bases are large enough to accommodate even the largest of trucks and suitable for pull-through spaces. Also, since they are government owned, it may be possible to acquire this property at prices that are generally more affordable than private land. However, there are also many challenges to using these locations for truck parking. Locations would have to be evaluated to determine: (1) proximity to a major freight transport corridor, (2) highway accessibility, and (3) available services. Many are also EPA Superfund sites where cleanup efforts are still underway but portions of the bases have been approved for redevelopment (U.S. EPA Superfund Information Systems, 2008). Community opposition may also be a barrier to using these facilities for truck parking. Table 5 lists closed military bases which could be potential sites for truck parking facilities.

Another alternative is to make some minor changes to existing capacity. Time limits could be changed at existing rest areas by either relaxing them to allow for overnight parking or more strictly enforcing them to ensure higher turnover rates. Existing spaces could also be redesigned

to meet the needs of modern trucks, i.e., larger spaces that allow for pull through rather than parallel parking (U.S. DOT, 2005).

Table 5 Closed Military Bases with Parking Lot Potential.

Base Name	City	County	Size	Use	Nearby Highways
Alameda Naval Air Station	Alameda	Alameda	1850.7 acres	Superfund cleanup underway. Portions ready for reuse.	I-880
Castle Air Force Base	Merced	Merced	6336.92 acres	Superfund cleanup underway. Portions ready for reuse.	HWY 99,
Fleet Industrial Supply Center	Oakland	Alameda	Unlisted	In contention for redevelopment.	I-880, I-580
Fort Ord Army Base	Marina	Monterrey	7584.32 acres	Redevelopment in the planning process.	HWY 1, HWY 68
George Air Force Base	Victorville	San Bernardino	6961.2 acres	Superfund cleanup underway. Portions ready for reuse.	I-15, HWY 18
Hamilton Air Force Base	Novato	Marin	Unlisted	Much land still unused, partly restoration and business park.	HWY 101
Moffett Naval Air Station	Moffett Field	Santa Clara	1000 acres	Active airfields, university uses, deserted structures.	HWY 101, I-280, I-880
Oakland Army Base	Oakland	Alameda	1800 acre	Redevelopment underway; will include truck parking.	I-880, I-580

An interesting example of using technology to use existing space more efficiently is a telematics-controlled parking (TCP) pilot at the Montabaur Service Station in Germany. This pilot launched in September 2005 through a public-private partnership. It uses magnetic field sensors to signal free spaces (Victor, 2006). Drivers arrive at a barrier to the parking area, enter their departure time and vehicle type into a terminal, and are then assigned a parking space behind a truck scheduled to leave before their own desired departure time. Depending on the size of the truck, three to five trucks can be parked behind one another, which can increase capacity by 40 to 100 percent without expanding the parking area (Centrico Award, 2006). A diagram of the spacing for this type of system can be seen in Figure 1. Truck driver's response to the pilot program was positive in respect to the additional parking and pull-through parking spots which are much easier for trucks to navigate. The cost to install a TCP system is estimated to be only about 50 percent of the cost of creating the equivalent spaces in a new parking lot (Centrico Award, 2006). The program will soon employ TCP at other rest areas in Rheinland-Phalz.

Figure 1 Telematics-Controlled Parking Space Optimization Diagram.¹



¹ Centrico Award, 2006

Information

In California, many public truck parking facilities are at capacity, but many private facilities are not. Truckers' decision to park illegally may reflect lack of knowledge about available parking rather than a lack of actual parking, as discussed above.

Paper Guides

To date there are still no free or comprehensive guides to public and private truck parking facilities in the U.S. in either paper or electronic form. NATSO has produced an online guide that contains information on the name of the stop, the address, nearby freeways, available services, phone number, and website if applicable. However, only members of NATSO are allowed to be listed in this guide and it cannot be accessed in a paper form. Currently, this guide only lists information for 34 truck stops in California, which is only a partial representation.

Another guide that is available is the Trucker's Friend, which is available online for a fee of \$10 for 100 searches. There is also a yearly updated book edition that can be purchased for \$14.95 and contains "more than 400 pages of maps and truck stop services ... maps [that] list only the towns that have diesel ... phone numbers, size of the truck over-night parking lot, whether or not the location has showers, a sit-down restaurant, scales, repairs, etc...[and] what fuel cards are accepted" (The Trucker's Friend, 2008). Their listings are provided both alphabetically by city, and by interstate in the order of the exits. However, this publication also only contains private truck stops and does not provide information on public rest areas.

ITS Guides

The NTSB published a special report on truck parking-related problems in May 2000. They concluded that in many large trucking companies, trucks are equipped with GPS that enable dispatchers to inform drivers where to pick up a load, drop off, and get fuel, based on the truck's precise location. GPS, combined with electronic guidance, could enable dispatchers to notify truck drivers of the nearest parking facility (NTSB, 2000, p. 23).

Subsequently, the National Cooperative Highway Research Program (NCHRP) surveyed highway maintenance engineers from 49 states to identify effective and feasible solutions to

truck parking problems (Trombly, 2003). Using “ITS to expand the amount of information available to truckers” ranked first (among a list of improvements including building new rest areas and truck stops) when evaluated against *effectiveness and feasibility* criteria (Trombly, 2003, p. 17). Moreover, it was reported that “...the responses reflect a belief among agencies that the most effective and feasible way to reduce shortages is to make better use of existing resources, combined with a prudent expansion of existing public spaces. Because all of the respondents work in the public sector, it can be speculated that their responses reflect recognition that a public role is appropriate—but the resources to meet all needs are not available, and that the private sector is in a better position to provide these resources” (Trombly, 2003, p. 17). Two specific recommendations made by the states include: (1) developing ITS deployments that provide drivers with real-time information on the location and availability of parking spaces. For example, investigating the use of mobile phones and radio frequencies to broadcast parking locations and availability to drivers; and (2) distributing a “truckers’ map” that pinpoints parking facilities for drivers (Trombly, 2003, p. 19).

There are several different technologies available to detect the number of currently available spaces in parking lots. Real time tools help drivers determine whether they should pull into a lot when they are approaching the lot, but do not provide forecasted data about whether spots will be available when they reach the next lot. Current capacity information may still be useful to drivers if there are a large number of spaces available at a lot that is only a moderate distance away; then, odds are that they will be able to park there. This will be most useful to drivers who are driving a familiar route and generally know how fast available spots will fill.

One approach to counting the number of available spaces is by detecting vehicles at each spot (U.S. DOT, 2005). This can be achieved through sensors underneath each space or a video pattern recognition system. The sensors are inductive loops which operate after installing a wire coil under the pavement of each spot. When a car is parked over the sensor, the magnetic field of the sensor is interrupted and the inductance of the wire coil change. The installation of this system requires cutting the asphalt or concrete to place the sensors beneath and then refilling the holes. Video pattern recognition requires poles or overhead structures to be installed at each parking space. Both of these installations are expensive, but they do provide more accurate counts than other measurement options (U.S. DOT, 2005).

A pilot program for inductive loop sensors in Illinois at two rest stops along I-80 tested such a system. Inductive loops counted vehicles in the parking lots and communicated to a sign on the highway, which displayed when the parking lot was full. The observed error in the first part of the study was approximately one vehicle per hour which quickly added up to a high level of inaccuracy. Loops were repositioned part way through the pilot in an attempt to improve accuracy. The pilot is no longer in place due to the inaccuracy of vehicle counts (U.S. DOT, 2005).

Another approach is to count the number of vehicles that enter and exit the lot. This can be achieved through a number of different sensor systems such as break-beam inductive loops, magnetometer, infrared, or ultrasonic sensors (U.S. DOT, 2005). This system is not as accurate as space specific sensors since it cannot detect whether a vehicle takes up more than one space, or the difference between a truck and a car in mixed use lots. Detection of cars versus trucks can be achieved by installing additional technologies such as weigh-in-motion technologies or pole-mounted break beams (U.S. DOT, 2005). However, the costs of these systems will significantly add to the cost of the infrastructure upgrade. Counting vehicles also requires an established

entrance and exit flow for the lot (U.S. DOT, 2005), that is, vehicles cannot be entering and exiting through the same driveways. Over time, counts often lead to an accumulation of errors. Thus, an operator may be needed to manually reset the count every few days. This could even be done remotely if a video system was installed (U.S. DOT, 2005).

Once information on space availability is collected it still needs to be distributed to the drivers. This can be achieved through a diversity of ways but a combination of different distribution methods is best. Table 6 lists space availability communication methods.

Table 6 Space Availability Communication Methods.¹

Technology Description	
Variable Message Signs	Several minutes driving time before a truck stop, a sign will display the number of spots available. At this distance, signs can be communicated with via a radio-frequency or cell phone interface. At a closer distance the signs can be hard wired.
Traveler Information Radio	The extreme ends of the AM radio frequency are reserved by the Federal Communications Commission for local information for motorists. One of these stations could be used to easily reach truck drivers with a synthesized recording of the number of spaces.
Citizen's Band Radio (CB)	This is a short distance radio that allows communication between truck drivers in the same area. There are no regulations against using one of these channels to broadcast availability to near by truck drivers.
Phone-in	Almost everyone has a cell phone now so it would be appropriate to set up a phone in service and/or a text message service with availability.
Online Services	Setting up an online system with a phone service would allow drivers to check historical data online before their trip and call in via cell phone or land line to check on real time availability.
On-board Computers	Carriers occasionally install on-board computers so drivers can communicate with them and record their driving logs, etc. Due to safety issues, this system may have to be converted to a voice-to-text system if it is to be used on-route.

¹ U.S. DOT, 2005

Anti-Idling Technologies

One class of idle reduction technology is truck stop electrification (TSE). Off-board truck stop electrification can significantly vary in price from IdleAire (which is now owned by CRG Partners) which costs \$29,000 capital installation costs and requires a staff of six to operate the system to AireDock which costs \$11,500 to install and requires no staff. Truckers can access

these units without purchasing any equipment. The spaces in which the units are installed can be selected to avoid or minimize loss of parking spaces.

Off-board TSE units serve a significant trucker market unable to equip vehicles with Auxiliary Power Units (APUs) or onboard TSEs because of added weight and/or high installation and maintenance cost. Many truckers will not purchase APUs because of upfront and installation costs, their weight (200 to 300 lbs), and ongoing maintenance issues. Onboard TSE systems are costly relative to advanced shared use TSE systems. Lower priced systems (\$2,300 plus installation costs) only allow truckers to use small appliances. Higher priced systems provide heating and air conditioning at a higher cost (\$3,500 plus installation costs). These high upfront costs limit truckers' adoption of these systems.

One solution to reducing diesel emissions from heavy-duty trucks may be to provide anti-idling equipment at truck stops. Advanced TSE units serve a significant trucker market unable to equip vehicles with APUs or onboard TSEs because of added weight and/or high installation and maintenance cost. Information about the availability and location of the anti-idling units could be widely disseminated via phone, Internet, and radio to ensure high use (for example, by linking this project to the truck parking pilot project described below). Digital and thermal imaging devices could be installed to count the occupancy of the truck parking spaces and monitor use and availability.

CALIFORNIA'S TRUCK PARKING INITIATIVE

To address the shortage of truck parking in California, the Federal Highway Administration, as part of its Truck Parking Initiative, has provided \$5.5 million in funding to Caltrans over six years for a pilot that provides real-time truck parking availability and guidance information and reservation capabilities on the federally recognized Corridor of the Future, the I-5. The 800 mile I-5 corridor carries between 15,000 and 40,000 trucks a day, which is five to 30 percent of its total average daily traffic. It is a critical commercial link between California's ports of entry and the rest of the nation. Like the major transportation corridors in the rest of the nation, truck traffic has grown dramatically (by 17 percent) on I-5 over the last ten years, and this growth is expected to continue for the foreseeable future (about four percent per year in the Central Valley). Available data indicates that public truck parking is at capacity along the I-5 corridor, but private truck parking does have excess capacity. See Figure 2 for a map of the I-5 corridor including the location of public and private rest stops.

Figure 2 Map of the I-5 Corridor in California.



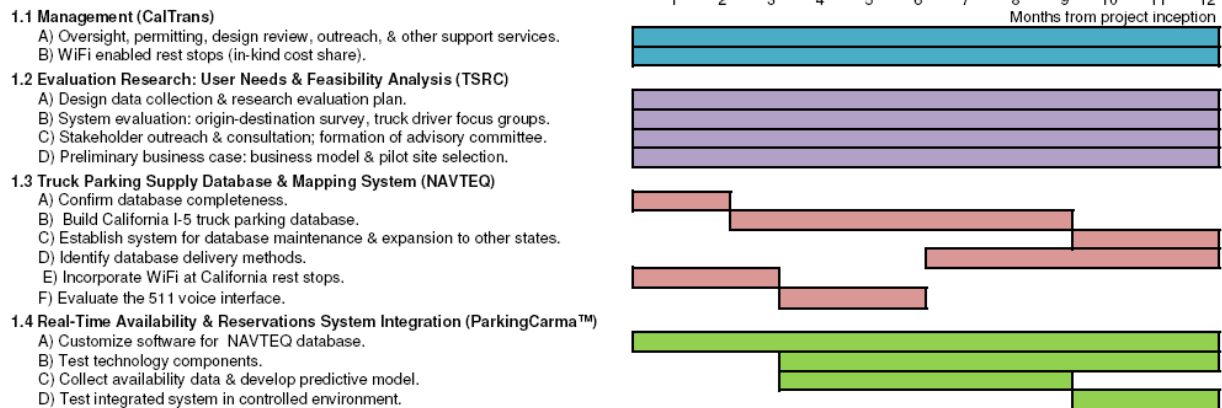
Caltrans has partnered with NAVTEQ, ParkingCarma™, and the Transportation Sustainability Research Center (TSRC) at the University of California, Berkeley to implement and evaluate the pilot. See Figure 3 for a description of the project timeline, tasks, and milestones. Building on NAVTEQ's map customization systems, a database of public and private truck parking with features of importance to truckers (e.g., restrooms, hot food, showers, fuel, etc.), will be updated and incorporated into the digital maps. These maps will be developed first along the I-5 in California, but based on the business case assessment and demonstrated business model analyses, the project may be scaled along the I-5, into states contiguous to California, and finally nationwide. Truck drivers will be able to access this truck parking information as well as directions to parking facilities by phone (511 or 800 number), websites (both Internet and WiFi), and possibly satellite radio.

Real-time truck parking availability and reservation capabilities will be integrated into the truck parking mapping and routing services provided by ParkingCarma™. The total number of spaces available in each truck parking facility will be keyed into the reservation and check availability engines. Truck parking facilities will be equipped with vehicle detection technology that automatically relays, via a local Internet connection, parking inventory by sending an increment/decrement message when a vehicle enters or leaves the lot. The availability and usage data will allow for the dissemination and reservation of available parking spaces. Ultimately, a "next stop" reservation algorithm will be available to advise truckers of the availability of parking spots at: (1) the next rest stop, (2) some distance ahead, and (3) a specific location. Each facility will be equipped with a suitable number of pan-tilt-zoom video cameras to provide a means of manual error correction, remote monitoring, and augmentation of data reported by vehicle detectors. See Figure 4 for an illustration of the Smart Truck Parking architecture.

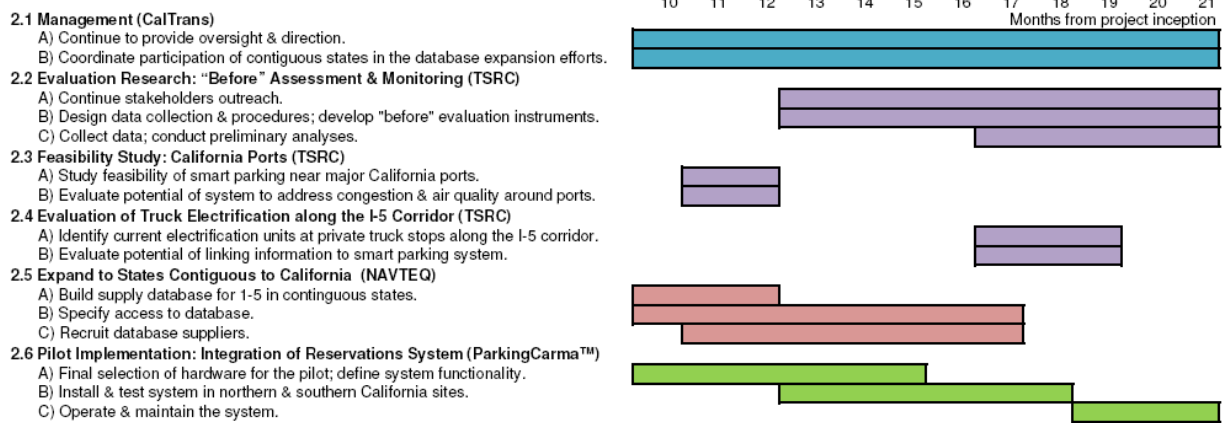
The implementation and operation of the proposed project will be evaluated by researchers at TSRC at the University of California, Berkeley. Researchers will collect data before, during, and after the implementation of the project to evaluate the technology, functionality, and user performance of the system. The proposed evaluation includes an origin and destination survey of truckers traveling along the I-5 corridor to better understand travel patterns, parking needs, and to assist in the evaluation of project effectiveness. Extensive stakeholder outreach efforts will be conducted to assess institutional barriers to implementation and operation as well as to educate truckers about the program. Researchers will also conduct an analysis of alternative business cases, including advertising, transaction, and subscriptions models to determine how a public-private partnership could continue to operate in a steady state, self-financing mode (after the prototype project is completed).

Figure 3 Pilot Timelines, Tasks, and Milestones.

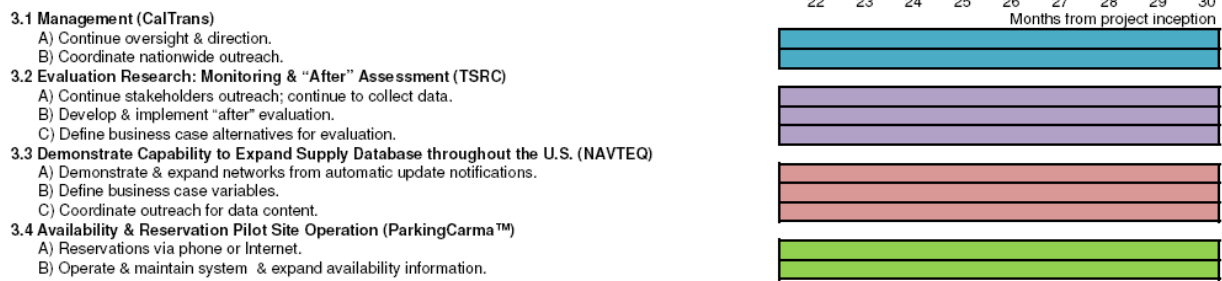
Phase 1: Project Initiation, Feasibility Analysis, and Pilot Site Selection



Phase 2: Before Assessment and Pilot Implementation



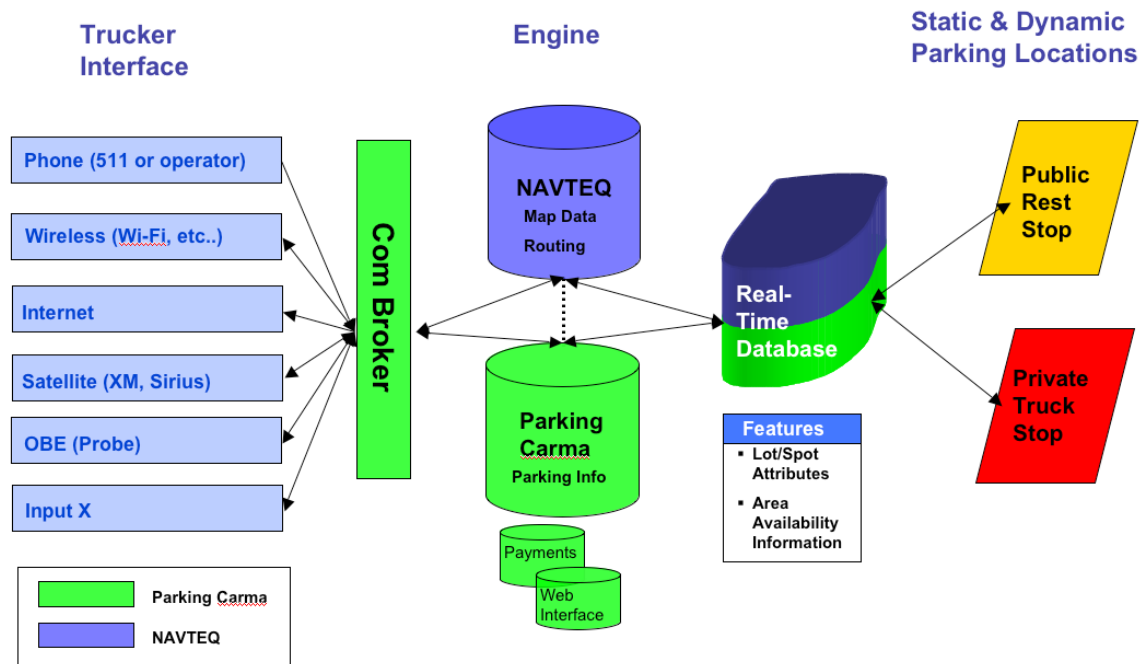
Phase 3: Pilot Operation and After Assessment



Phase 4: Continued 3 Years Monitoring



Figure 4 Smart Truck Parking Architecture.



The smart parking pilot could add as much as three to four percent more effective peak period truck parking spaces per day along this corridor; however, these figures exclude the more effective use of non-peak truck parking that route scheduling and guidance capabilities could enable. Each additional parking space added to the system, assuming an 80 percent utilization rate¹, could reduce parking search travel by as much as 96 truck miles traveled per day and 34,650 truck miles traveled per year, which is estimated to be valued at \$210 per day and \$75,600 a year in cost savings to the trucking industry. Moreover, over the last three years, on average there have been approximately 1,700 truck crashes a year on I-5 in California; two percent included fatalities, 57 percent included injuries, and one percent included parked trucks; even a marginal improvement in truck driver fatigue resulting from greater effective truck parking supply could help reduce truck crashes, injuries, and fatalities. Linking the Truck Parking Initiative in California to the provision of TSEs is may be a promising opportunity to reduce idling and meet California’s air quality and public health goals.

¹ Assumes 21 stops turned per day per spot; time saved per stop is five minutes; the cost to operate a truck is two dollars per minute; truck travel speed is 55 miles per hour; 360 truck travel days per year.

SUMMARY AND CONCLUSIONS

California is home to major international ports in Long Beach, Los Angeles, and Oakland as well as the second largest border crossing between Mexico and the U.S. California's highways are critical commercial links from these ports of entry to the world and carry more commercial vehicle truck traffic than any other state in the U.S. Given the high volume of truck travel in California, it is not surprising that there is a serious shortage of truck parking in the state. This shortage negatively impacts economic productivity, roadway safety, air quality, and public health.

Legislation History

A study by the National Transportation Safety Board (NTSB) in 1990 indicated that a significant number of fatal truck collisions and crashes were fatigue-related and that a major contributor to fatigue was the lack of rest areas along the Interstate Highway System. Drivers are now limited to driving 11 hours during a 14 hour shift after ten consecutive hours off-duty. Prior to 2003, truckers could drive a maximum of 10 hours during a 15 hour shift after eight hours off-duty and could extend the 15 hour shift with off-duty time such as meal and fuel stops (U.S. DOT, 2003). The federal transportation bills passed during the first decade of the 21st Century set aside funding to investigate the adequacy of truck parking and rest areas and for programs to address parking shortages and reduce diesel exhaust emissions from idling at rest areas (FHWA, 2005)

Recent environmental and health legislation in California has placed emphasis on the need to reduce diesel exhaust emissions from idling. The Scoping Plan for the 2006 Global Warming Solutions Act (Assembly Bill [AB] 32) identifies electrification of accessories to reduce diesel exhaust from truck idling as one of the measures necessary to reduce two million metric tons of CO₂ annually by the year 2020 (26). California, as well as a growing number of other states and localities, now limit truck idling. California's Assembly Bill 233 (The Healthy Heart and Lung Act) improves the enforcement of diesel emission regulations, raises the penalty for idling longer than five minutes at any location, and requires operators to clear citations before having their registrations renewed.

Truck Parking Shortage and Consequences

California ranks first in the nation in overall (private and public) commercial vehicle parking shortage (Fleger et al., 2006). It is estimated that demand exceeds capacity at all public rest areas and at 88 percent of private truck stops on the 34 corridors in California with the highest volumes of truck travel (Caltrans, 2001). Moreover, it is estimated that by the year 2020 the demand for public rest area parking will increase by 53 percent, and for private parking will increase by 100 percent (Caltrans, 2001).

California is home to some of the most congested regions in the nation. The estimated cost of delay to California drivers and passengers in 2007 was almost \$23 million per day in lost time and excess fuel consumption (Caltrans, 2008). Trucks compose approximately 10 percent on average of all highway traffic (Caltrans, 2007). Navigational waste due to truck drivers searching for truck parking can contribute unnecessarily to congestion; studies of parking guidance information suggest that parking search traffic can be reduced by as much as 25 percent by giving drivers information on the location of an available parking space (Rodier et al., 2005). Accidents are also a significant factor contributing to congestion. In 2007, truck drivers were found to be at fault in 72 fatal accidents and 3,095 injury accidents in California (CHP, 2007). Lack of parking and information about the location and availability of parking means that many

truck drivers face the difficult and dangerous choice between illegal parking or noncompliance with HOS laws.

California's air quality is also among the worst in the nation. Diesel exhaust contributes significantly to air pollution and has serious effects on human health. The California Air Resources Board estimates that current statewide levels of diesel exhaust contribute to \$19.5 billion in annual health care related costs. Many trucks idle their engines while stopped in order to generate electricity needed to run in-cab appliances. A heavy duty diesel engine burns about one gallon of fuel every hour while idling and nonessential idling accounts for about nine percent of on-road diesel exhaust emissions (The Union of Concerned Scientists, 2005). Truck parking shortages can result in drivers seeking out alternative spaces near their routes, which are often located on residential streets and next to parks near ports (The Modesta Avila Coalition, 2005; West Oakland Environmental Indicators Project, 2003) directly exposing residents to high levels of diesel exhaust.

Lessons Learned

As part of this study stakeholder interviews were conducted with members of the California Truck Parking Sub-Committee and Goods Movements Task Force as well as the California Trucking Association's Policy Unit from June 2007 through July 2008. In addition, the literature was reviewed to identify relevant findings from recent surveys of truck drivers (Chen et al., 2002; Lutsey et al., 2000; Rodier and Shaheen, 2007) and parking guidance systems for autos. The following is a synthesis of the key lessons learned:

- Parking at public rest areas is most difficult for truck drivers in California. Public and private parking is also difficult to find in areas near ports and between key origin and destination locations. Bigger pull-through spaces are also needed.
- Private truck stops are preferred for long-term rests, and more parking is needed during overnight hours, near metropolitan areas.
- Many drivers regularly park in unauthorized areas because of lack of legal spaces and knowledge of locations of available parking where it is needed.
- Drivers may idle more frequently to cool and heat cabs in California. Few have experienced any enforcement of anti-idling laws. Most had not purchased any technology that would reduce idling emissions from their truck.
- Truckers may be a promising market for pre-trip and en-route parking information. Truck drivers (and not their carrier) most frequently decide where they will park and some do so prior to starting their trip but most do so en-route. Many drivers use online mapping programs to plan their route that currently do not include truck specific information.

Alternatives

A range of alternatives to address the truck parking problem in California, including expanding capacity, improving information, and anti-idling technology, were evaluated and the following are key findings:

- Developing new parking facilities is challenging because of (1) community opposition due to health, safety, and quality of life concerns, (2) high land values and construction costs in

metropolitan areas where the parking is most needed, and (3) overlapping jurisdictional authority in areas adjacent to Interstate Highways.

- Converting park-and-ride lots, weigh stations, and large store parking lots for truck parking does not appear to be feasible because (1) trucks are too large to enter park-and-ride lots and (2) entities responsible for weigh stations and retail parking lots are unable to assume increased liability and maintenance costs associated truck parking use. More research needs to be conducted to evaluate the feasibility of converting closed army bases in California for truck parking use.
- The physical space of existing parking could be better used to accommodate more parking through improved enforcement, adjusting time limits, and restriping parking spaces at public rest areas.
- Public private partnerships should be explored to develop comprehensive, free paper and electronic truck parking guides as well as real-time, en-route parking and route guidance information with reservation capabilities. Barriers to implementing these services include demand, willingness-to-pay, and the development of a self-sustaining business model.
- Idling at truck stops may be addressed in the short term by implementing Advanced Truck Stop Electrification units (TSEs) to reduce idling by truckers unable to equip vehicles with Auxiliary Power Units (APUs) or onboard TSEs because of added weight and/or high installation and maintenance cost.

Truck Parking Initiative in California

The California Department of Transportation funded exploratory research programs to better understand the parking problems and possible solutions in California. The result of these efforts was a successful application to the Federal Highway Administration to fund a Truck Parking Initiative in California along Interstate 5 to provide pre-trip and en-route (real-time) truck parking availability, route-guidance information, and parking reservation capabilities. Caltrans has partnered with NAVTEQ, ParkingCarma™, and the TSRC at the University of California, Berkeley to implement and evaluate the pilot. The project will update NAVTEQ's map systems to include a database of public and private truck parking with features of importance to truckers (e.g., restrooms, hot food, showers, fuel, etc.). Truck drivers will be able to access this information as well as directions to parking facilities by phone (511 or 800 number), websites (both Internet and WiFi), and possibly satellite radio. Real-time truck parking availability and reservation capabilities will be integrated into the truck parking mapping and routing services by ParkingCarma™. Linking this project to the provision of TSEs may be a promising opportunity to reduce idling and meet California's air quality and public health goals. Researchers will conduct an analysis of alternative business cases, including advertising, transaction, and subscriptions models, to determine how a public-private partnership could continue to operate in a steady state, self-financing mode after the prototype project is completed.

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