



Policy Study

PRIVATE TOLLWAYS: Resolving Gridlock in Southern California

by
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EXECUTIVE SUMMARY

Traffic congestion--especially freeway congestion--threatens to destroy Southern California's economic vitality, strangling growth and curtailing economic opportunities for lower and middle-income people.

Freeway congestion occurs because the effective price to use the freeways, especially at peak hours, is zero. Direct pricing, with higher prices during rush hours, would bring demand into balance with supply. It would shift non-work trips away from rush hours, and would also generate revenues to increase roadway capacity.

In Europe and the Pacific Rim, tollways are often built and operated by private enterprise, under government franchise. Some major new projects, like the Channel Tunnel, are entirely private ventures, with stockholders as well as bondholders. At least three new private tollway projects have been proposed in this country--in Virginia, Colorado, and Illinois.

Tollways need not rely on old-fashioned toll booths. Electronic number plates on vehicles can be read by roadside equipment which identifies the vehicle, so that a computer system can send a bill for tollway use at the end of the month. A full-scale system has been tested in Hong Kong, and two such systems have been ordered by U.S. toll road operators (in Virginia and Texas).

No more freeways should be built in Southern California. All new capacity should be tollways, employing electronic toll collection. Tollways should be built for new routes (as in Orange County) and as second decks on existing freeways. Motorists would have a choice of using existing freeways or paying to use the new tollways--just as consumers can choose between the Postal Service and Federal Express.

The new tollways should be built and operated by private enterprise rather than government. Private firms can raise both debt and equity capital, without burdening the taxpayers. Private provision of infrastructure leads to lower construction and operating costs, and may well lead to innovations such as cars-only tollways and tunnels between the L.A. Basin and the San Fernando Valley. Moreover, electronic toll-collection and billing will be more acceptable if done by private firms rather than by government.

A pro-tollways coalition will involve a political compromise between traditional highway interests (the "Auto Club" side) and anti-auto/pro-transit interests (the "Sierra Club" side). The former will get their new roads only by agreeing to the latter's demand for user-pays pricing of road use.

1. TRAFFIC CONGESTION AND SOUTHERN CALIFORNIA

Traffic congestion is one of the most serious problems facing Southern California. In 1986 then-Caltrans director Leo J. Trombatore pointed out that 40 percent of California's urban roads already operated at a stop-and-go pace--especially in Orange and Los Angeles Counties. The Santa Monica, San Diego, and Ventura Freeways are among the world's most heavily traveled--and congested--roadways.

And projections by competent authorities indicate that the problem will soon get much worse. The Little Hoover Commission in 1988 projected that the number of licensed drivers in California will increase by 27 percent by the year 2000--and the number of cars by 30.5 percent. The Southern California Association of Governments projects that the Southland's population will grow to 18.3 million people by 2010 (from 12.4 million today). That would cause average speeds to plummet from 35 mph today to 11 mph by 2010, as a result of 3 million new trips to work each day. Delays would grow from 10 percent of trip time to over 50 percent.

Even today, the costs of congestion are substantial. In Los Angeles County alone, drivers waste 485,000 hours each day stuck in traffic. That equates to 72 million gallons of gasoline burned unnecessarily each year. If people's time is valued at only the minimum wage level, and gasoline is valued at about 90 cents a gallon, the dollar value of this waste of time and fuel is half a billion dollars per year. And with a more realistic value on people's time, the cost easily exceeds \$1 billion annually. By 2010, such costs would escalate dramatically.

Besides the huge waste of people's time, such massive congestion would also seriously reduce Southern California's already poor air quality. Mobile sources account for about two-thirds of all airborne pollutants, according to the South Coast Air Quality Management District. And vehicles in stop-and-go conditions produce several times more pollutants per mile than when they are traveling smoothly at ordinary speeds.

Traffic congestion is already having significant political effects. It is the principal reason for the popularity of growth-control measures in Los Angeles and Orange Counties. Since 1971 there have been 198 growth-control measures on California ballots, one-third of them in 1986 alone. And about two-thirds of these measures have passed. Growth control, originally associated mostly with Northern California, is increasingly becoming a Southern California phenomenon.

Traffic congestion, especially on the Los Angeles's Westside, was a significant factor in building support for Proposition U, sponsored by Council members Braude and Yaroslavsky, enacted by Los Angeles voters in 1986. In Orange County, the reported three-to-one support for the controversial slow-growth initiative on the June ballot correlates strongly with voter identification of traffic and growth as the county's two most critical problems. Survey researcher Mark Baldassare told a Town Hall meeting in

February 1988 that "people are very upset about growth issues, especially traffic issues."

While such frustration is understandable, stringent growth controls could have serious impacts on Southern California's future. The region's ability to absorb immigrants and provide jobs for the children of current residents depends on a healthy, growing economy. Limiting the supply of housing will, by the operation of supply and demand, drive up its average price, putting housing beyond the reach of lower and middle-income families.

Both traffic gridlock and growth controls threaten to undercut Southern California's climate of economic opportunity, especially for those of limited means. It is essential that solutions to current and projected traffic congestion be found and implemented.

2. WHY ROAD USE SHOULD BE PRICED DIRECTLY

A. Rationale

Reduced to its essentials, freeway congestion occurs when demand for the scarce resource of freeway space exceeds its supply. Congestion does not occur continually, but only at the busier times of day (though these are growing longer year by year). At other times, the supply is adequate to handle the demand.

Economists who have studied road use conclude that the demand/supply imbalance occurs because the effective price to use the freeway at busy times is zero. Hence, people have no economic incentive to economize on the use of this scarce resource. Some drivers who could feasibly car-pool or reschedule trips decline to do so, because there is no economic incentive to do so. Were there a direct charge (i.e., a toll), people would pay more attention to the costs of driving--both to themselves and to others.

Many people at first reject the idea of having to pay directly for freeway use. They point out, correctly, that they are already paying for roads through gasoline taxes. But a user tax is quite different from a direct price. The user tax does generate revenues which can cover the costs of building and maintaining roads. But it does nothing to bring supply and demand into balance at the point of use--which is what prices do.

Consider the following analogy. Demand for household electricity is also variable, like demand for freeway use. It is conceivable that we could pay for electricity indirectly, the way we pay for freeways--i.e., by means of an electricity user tax. We might pay a special use-tax whenever we purchase light bulbs and electrical appliances, for example. The tax rate could be set high enough to cover the full costs of producing and distributing household electricity. What would happen to the demand for electricity under such a system? It would be significantly greater than it is today. People would have virtually no incentive to turn off lights or to purchase energy-efficient appliances if they did not pay directly for each kilowatt-hour they use. The result would be a "need" for a much larger number of power plants, simply due to the wasteful, inefficient use of this scarce resource.

The demand for many other services varies by time of day and day of week. In most cases, the system operators respond by charging lower prices at off-peak times and higher prices at peak periods. Examples include the telephone system (with day, evening, and night rates), movie theaters (with matinees and Monday or Tuesday-night specials), restaurants (with happy hours and before-six prices) and airlines (with lower fares for certain days of the week and at night). Ignoring the pricing mechanism leads inevitably to congestion, as demand exceeds supply.

Direct pricing on freeways would have three important advantages:

1. Reduced demand for freeway access. Pricing would motivate people to conserve on their use of the scarce resource of freeway space. Confronting a direct charge for each use of the freeway would motivate people to consider the cost of alternatives to driving alone--such as car-pooling (spreading the charge over several people) or using some form of mass transit (which also carries a direct charge). Today the average car on Los Angeles freeways carries only 1.2 occupants. If that average occupancy could be increased to just 1.7 people, the number of cars would be cut by 30 percent (see Table 1). The impact on congestion would be quite dramatic.

Table 1

How Increasing Occupancy Reduces Congestion

People	Number of 2-Pass. Cars	Number of 1-Pass. Cars	Total Cars	Ridership (people/car)
120	20	80	100	1.2
120	30	60	90	1.3
120	40	40	80	1.5
120	50	20	70	1.7

Thus, if we can increase average ridership from 1.2 people/car to 1.7 people/car, we will cut the number of cars on the freeways by 30 percent.

2. Shifting demand to off-peak periods. Assuming that freeway pricing varied by time of day (higher during peak periods, lower at off-peak times), it would tend to shift demand away from peak periods, thereby spreading out the traffic to times when the freeway could handle it better. Thus, peak-hour pricing would enable us to get more use out of a given number of freeway lanes. With differential pricing, employees would be more willing to work staggered work hours, in order to save money on tolls. Employers would be more willing to make such adjustments if there were strong employee demand. But in addition, peak-hour pricing would cause many people to shift non-essential trips away from the peak commuting hours. Some indication of the potential gain from such shifts is given in Table 2, which reveals that some 64 percent of all peak-hour trips are not work-related. A large fraction of these trips would be shifted to off-peak times if peak-hour prices were being charged.

Table 2

Work Trips vs. Non-Work Trips
in Major Metropolitan Areas

	1977 (billion)	1983 (billion)	Percent Change
WORK TRIPS			
A.M. Peak	3.113	3.025	-2.8%
P.M. Peak	2.354	2.373	0.8%
Off-Peak	2.553	3.208	+25.6%
NON-WORK TRIPS			
A.M. Peak	2.602	3.651	+40.3%
P.M. Peak	5.009	6.176	+23.3%
Off-Peak	15.347	19.484	+27.0%

Source: Prof. Peter Gordon, U.S.C. (compiled from U.S.D.O.T. Nationwide Personal Transportation Study data tapes)

3. Raising revenue for increased capacity. Pricing would generate revenues that could be used to expand and maintain the freeway system. We hear a great deal today about how governmental funding sources are hard-pressed to properly maintain our existing freeways, let alone build new capacity. Direct pricing could generate added revenues for improving the system, adding new lanes (and possibly entirely new routes), as well as covering the costs of the pricing system itself.

B. Economic Studies

Transportation experts have been studying road pricing for the past three decades. One of the pioneers was William Vickrey, a Columbia University economist. He set forth the basic economic case for road pricing in the late 1950s, and for many years conducted research on both the technologies required and the political feasibility of direct pricing. British engineers and economists (such as former World Bank researcher Gabriel Roth) began writing about road pricing in the early 1960s. By the late '60s, a consensus had developed that for urban areas, alternatives to toll booths were essential in making direct pricing acceptable.

In the 1970s, the Washington, DC-based Urban Institute was a major center of road-pricing research. With funding from the Urban Mass Transportation Administration, Urban Institute researchers further developed the economic case for direct pricing. They also researched various alternatives to toll booths, such as the purchase of stickers (as implemented in Singapore in 1975, with dramatic results in reducing congestion) and various higher-technology alternatives. The latter included both on-vehicle meters (analogous to postage meters or taxi meters) and various forms of Automatic Vehicle Identification (AVI) systems, using either optical or electronic scanning. The

Urban Institute even worked out designs for demonstration projects, which UMTA intended to fund in several cities. But no cities came forward, and the idea was eventually dropped.

When Jerry Brown was elected governor of California, he appointed a Transportation Task Force to develop a new State Transportation Plan. Among the members were several economists, including Ross Eckert and Ward Elliott, who were familiar with the road-pricing literature. The first draft of the Task Force's report made a strong case for putting "congestion charges" on the state's freeways, to mitigate both air pollution and congestion. Unfortunately, fierce political opposition caused this language to be dropped from the final draft.

Today, interest in road pricing remains strong among economists and transportation researchers. Gabriel Roth, recently retired from the World Bank, continues to research and consult on road-pricing around the world. Prof. Elliott, at Claremont McKenna College, also continues to write on this subject. They are joined by a number of younger economists and transportation experts, including Peter Gordon and Dennis Aigner at the University of Southern California. The Transportation Research Board (of the National Academy of Sciences) has published papers on road pricing and AVI technologies. And research on AVI has continued steadily over the past decade.

3. TOLL-ROAD PRACTICE TODAY

A. Public Toll Roads in the United States

Toll roads are relatively common in the eastern part of the United States, especially as intercity routes. When the Interstate Highway system was created in the 1950s, Congress looked with disfavor on the toll concept, and effectively banned the use of toll financing on all new Interstate projects. Grandfathered in, however, were numerous already-existing toll roads, such as the Connecticut and Massachusetts Turnpikes, the Pennsylvania Turnpike, the New York State Thruway, etc. which became part of the Interstate system.

Overall, 25 states have significant toll road facilities, accounting for some 5,000 miles (see Table 3). The great majority of this route mileage is intercity, rather than urban. But an important trend in recent years has been the development of tollways in urban areas. Because of the ban on federal funding of toll roads, these tollways have not been part of the Interstate system. Among the major cities with relatively recent urban tollway projects are the suburban Virginia suburbs of Washington, DC (Dulles Toll Road), Miami (Southwest Expressway and others), Orlando (Northeast Beltway and others), Houston (Sam Houston Toll Road and Hardy Toll Road), Dallas (North Tollway and Extension), Chicago (North-South Tollway and three others), and Denver (E-470 Eastern Beltway).

All but the Dulles and Houston projects are operated by independent toll authorities; the Dulles project is operated by the Virginia Department of Transportation and the Houston project by a department of the county government. According to the U.S. General Accounting Office, one of the major advantages of an independent public authority (compared with a government department) is that an authority is able to focus exclusively on building, operating, and maintaining the tollway. Generally, revenues from a tollway operated by an independent authority are required by law to be dedicated solely to the project. This prevents them from being diverted to other uses by the political process, ensuring that funds are available both to pay back bondholders and for a proper level of ongoing maintenance. In 1978 the National Transportation Policy Study Commission concluded that "by and large, toll roads are better maintained than other roads." A 1985 report of the Congressional Budget Office cited dedicated financing as one of the greatest advantages of the toll-road approach.

Congress took a major step towards greater use of toll financing in the 1987 Surface Transportation Act. This legislation permits up to seven new federally aided (non-Interstate) highway projects to employ tolls. An earlier pro-tolls provision (which did not pass) would have repealed Section 129, Title 23 of the U.S. Code, which effectively bans tolls on federally aided highways (by requiring the repayment of all federal monies spent on a highway if it is converted to a toll road). This provision remains in force, with the exception of the

Table 3
Current U.S. Public Toll Roads

COLORADO

Pikes Peak Auto Highway

CONNECTICUT

Connecticut Turnpike

Merritt Parkway

Wilbur Cross Parkway

DELAWARE

John F. Kennedy Memorial Parkway

FLORIDA

East-West Tollway (Miami)

Alligator Alley (Everglades Parkway)

36th Street Expressway (Miami)

Airport Expressway (Miami)

Bucaneer Trail (Ocean Highway)

South Dade Expressway

South Crosstown Expressway (Tampa)

Florida's Turnpike

Bee Line Expressway

East-West Expressway (Orlando)

Jacksonville Toll Road

ILLINOIS

Chicago Skyway

Northwest Tollway

Tri-State Tollway

East-West Tollway

INDIANA

Indiana East-West Toll Road

KANSAS

Kansas Turnpike

18th Street Expressway

KENTUCKY

Western Kentucky Parkway

Western Kentucky Parkway Extension

Mountain Parkway

Bluegrass Parkway

Jackson Purchase Parkway

Pennyrite Parkway

Audubon Parkway

Daniel Boone Parkway

Cumberland Parkway

Green River Parkway

MAINE

Maine Turnpike

MARYLAND

John F. Kennedy Memorial Highway

MASSACHUSETTS

Massachusetts Turnpike

NEW HAMPSHIRE

New Hampshire Turnpike

F. E. Everett Turnpike

Spaulding Turnpike

NEW JERSEY

Atlantic City Expressway

Garden State Parkway

New Jersey Turnpike

NEW YORK

Thomas E. Dewey Thruway

Berkshire Section

Niagara Section

New England Section

Garden State Parkway Connection

OHIO

Ohio Turnpike

OKLAHOMA

Turner Turnpike

Will Rogers Turnpike

H. E. Bailey Turnpike

Indian Nation Turnpike

Muskogee Turnpike

Cimarron Turnpike

PENNSYLVANIA

Pennsylvania Turnpike

Northeastern Extension

TEXAS

Dallas North Tollway

Hardy Toll Road (Houston)

West Belt Toll Road (Houston)

VIRGINIA

Powhite Parkway (Richmond)

Downtown Expressway (Richmond)

Richmond-Petersburg Turnpike

Norfolk-Virginia Beach Toll Road

Dulles Toll Road

WEST VIRGINIA

West Virginia Turnpike/Toll Road

seven projects authorized by the 1987 act, and is a significant barrier to widespread expansion of the toll-road approach.

B. Private Toll Roads in Europe and the Pacific Rim

In the post-World War II era, toll roads have become far more common in Europe and Asia than they are in the United States. A 1977 study by the International Bridge, Tunnel, and Turnpike Association found that Belgium, France, Italy, Spain, and the United Kingdom alone had 8,868 miles of toll roads, compared with only 4,416 miles in the United States. Most of the national network of major roads in Western Europe are toll roads, built to standards at least the equal of the U.S. Interstate system. Most of the major bridges and tunnels in England, Portugal, and other European countries have also been built with toll financing.

What distinguishes the majority of European toll projects from their American counterparts is that the former are built, owned, and operated by private enterprise. The basic model is for government to award a franchise or "concession" to a commercial entity, for a period of time long enough to amortize its investment--typically 25 to 35 years. Some 5,300 miles of toll highways in France, Italy, and Spain have been built by concessionaire firms, such as Italy's Autostrade (a division of IRI) and Fiat. Nine-tenths of Italy's motorway system has been built by this "build-operate-transfer" (B-O-T) model. France lagged behind the rest of Europe in developing motorways under de Gaulle, until it adopted the B-O-T approach in the late 1960s. Nine semi-private and private firms built and now operate the major motorways, such as the Paris-Strassberg A-4 and the Autoroute de L'Est. French toll roads generate approximately \$2 billion a year in toll revenues.

In the past ten years the B-O-T model has been applied to many new projects in Europe and the Pacific Rim. Indonesia is linking its islands of Java, Bali, and Sumatra with a network of toll roads and bridges. Korea has developed a toll road network to bring farm products to the cities. Hong Kong has developed private harbor tunnels using this model. Malaysia is also employing the B-O-T model, to build the final 310-mile link in a 560-mile motorway from Singapore to the Thai border. And the New South Wales (Australia) government announced in 1987 a \$310 million project in which a private consortium (consisting of a Japanese contractor and an Australian civil engineering firm) will finance, build, own, and operate a 1.4 mile harbor tunnel in Sydney. The concession runs for 30 years.

Perhaps most dramatic of the new Pacific Rim projects is under construction today in China. Hong Kong entrepreneur Gordon Wu broke ground in April 1987 for a \$1 billion, 155-mile private toll road linking Canton with Hong Kong and Macao. Wu, who was educated at Princeton, says he got the idea for the project from the New Jersey Turnpike. Wu's franchise is for a 30-year period, at which point ownership will revert to the Chinese government.

In early 1988 Britain's Costain Group (one of the country's largest construction firms) announced plans for three projects using the B-O-T model, totaling \$12 billion. One is a 16-mile motorway beneath the Thames River, connecting Chiswick in west London with Blackwell, east of the city. A second project is to build a second deck on the M25 motorway, which circles London. The third project is a high-speed rail line from London to the entrance of the Channel Tunnel.

The historic \$10.6 billion Channel Tunnel (Chunnel) goes one step beyond the B-O-T model, in that ownership will not revert to government. Though the project does have the authorization of both the French and British governments, it involves neither government financing nor government guarantees. Eurotunnel PLC has secured a credit accord of \$8.75 billion from 198 international banks. It raised an additional \$1.36 billion as equity capital from its initial public offering last November.

C. American Private Toll Road Projects

The past two years have seen the beginning of serious interest in private toll-road projects in the United States, employing the successful B-O-T model from overseas. Interest in this concept has been fostered by such important bodies as the Eno Foundation for Transportation, the Transportation Research Board, and the Federal Highway Administration, all of which have held conferences on the subject during the past five years. One reason for this interest is the scheduled termination of the federal Interstate Highway program in 1991. With the winding down of this major revenue source, transportation planners see the need to develop mechanisms to make use of equity financing from private investors to develop and maintain America's transportation infrastructure.

Three major private tollway projects have been announced thus far:

(1) Dulles Toll Road Extension

Parsons Brinckerhoff and Municipal Development Corporation have formed a joint venture to finance, build, own, and operate this \$135 million, 15-mile extension of the existing toll road. The extension will link Leesburg with Dulles Airport, relieving major congestion on the parallel Route 7. Twenty major land-owners along the proposed right-of-way have agreed to donate the required land, in anticipation of greatly increased market value for their adjoining parcels once the tollway is completed. The project required state legislation to remove a ban on private ownership of highways; a bill to accomplish this passed both houses of the Virginia legislature early in 1988. The company's franchise agreement with the state provides for ownership to revert to the state after 30 to 40 years.

(2) Front Range Toll Road

Far more ambitious than the Virginia project is the proposal of the Front Range Toll Road Company of Denver. Their proposed project is an \$800 million, 200-mile route from Pueblo to Fort

Collins, running parallel to congested I-25 (which passes through Denver). The tollway would bypass Denver but would run adjacent to the planned replacement for Denver's Stapleton airport. The company hopes to attract other users to its right-of-way, such as railroads, pipelines, and fiber-optic communications lines, so as to maximize revenues. No authorizing legislation is required, since private roads are legal in Colorado. Existing law gives each county the authority to regulate toll rates, however, and the road would pass through seven counties.

(3) Chicago-Kansas City Toll Road

This proposed \$2.2 billion, 400-mile private tollway is the most ambitious such project announced to date. It is intended to stimulate development along a corridor in Illinois and Missouri. A \$300,000 feasibility study is planned for 1988-89, to be conducted jointly by the Illinois Department of Transportation and the University of Illinois. Prudential-Bache Capital Funding has concluded that the project makes sense on the basis of travel-time savings and that the project can be financed via 70 percent equity/30 percent debt funding, with several classes of shares sold to the public, affected firms (including the trucking industry), and state and local government entities. Interestingly, Prudential-Bache sees the equity financing model as "a forerunner of how we envision large U.S. public works projects being financed in the future, given the scarcity of Federal capital."

Thus, the private tollway model which originated in Europe, has spread to the Pacific Rim, and is now being applied to such ambitious projects as the Channel Tunnel and the double-decking of London's M25, is now beginning to be applied in the United States, as well.

4. ELECTRONIC ROAD PRICING

A. Road-Pricing Alternatives

Toll booths are unlikely to be acceptable as the principal means of implementing road pricing on urban tollways. Interest has therefore focused on alternative methods of charging directly for road use.

The simplest method is to require the purchase of stickers which must be displayed on the vehicle in order to use certain roads at certain times of day. Singapore introduced a crude version of this system in 1975, to alleviate chronic traffic congestion in its downtown area. Access to this area between 7:30 and 10:15 AM was restricted to vehicles displaying special stickers, priced at about \$1.67 per day. (Stickers could be purchased by the day or by the month.) The response was dramatic. A World Bank study found that the number of cars entering the city core at rush hour decreased by 65 percent, cutting overall traffic by 40 percent.

Stickers have the advantage of being simple and low in cost. But it is difficult to vary the effective price by time of day, without ending up with numerous types of stickers. Visual monitoring of the display of stickers, for enforcement purposes, would become increasingly difficult as the number of different types of stickers (for different times and prices) increased. Most road-pricing analysts therefore favor more high-tech alternatives.

A second approach is on-vehicle meters, analogous to taxi-meters or postage meters. One version would require the driver to activate the meter on entering the priced zone by plugging in a timer, purchased in advance and good for a specified number of hours. Another type of meter would be turned on electronically, when triggered by a roadside device. This type would also need to be "recharged" periodically, like a postage meter. Both types of meter would require that a visible light be displayed on the exterior of the vehicle when the meter was in operation, for enforcement purposes.

Meters have the advantage of anonymity--they do not record the passage of a specific vehicle past each monitoring point in the system. So a meter system would allay concerns about privacy which arise in AVI systems (see below). But recharging the meters would be an ongoing inconvenience for motorists. Time-varying pricing would be difficult to accomplish with meters. And enforcement, as with stickers, would be difficult.

Most road-pricing advocates have concluded that systems using automatic vehicle identification (AVI) are the most feasible solution. Each vehicle is equipped with an electronic number plate (ENP)--a passive unit containing an integrated circuit encoded with the vehicle's unique identification number. The roadway is equipped, at various "toll" points, with a power loop buried in the road which energizes the ENP as the vehicle passes,

causing its identification number to be read. The number is recorded by a microcomputer at the toll point, and transmitted to a central accounting computer. The price being charged at each location, in each time period, is displayed beside or above the roadway to inform motorists as they drive. The AVI system's central computer calculates the charges owed for each use of the system, and the system operator sends the user an itemized monthly bill, exactly as telephone companies do (see Figure 1).

Early AVI systems experimented with visual detection, using a bar-code system similar to the Universal Product Code on consumer products. But the bar-codes proved difficult to read at high speeds, and can become obscured by dirt and rain. The preferred technology today is the electronic number plate.

B. AVI Demonstration Projects

The pioneer agency in testing and developing AVI for toll collection was the Port Authority of New York and New Jersey. It began conceptualizing such systems in the early 1960s, and in 1972 ran its first tests. Systems from four different firms, all using radio-frequency transmission, were tested on Port Authority buses. Similar experiments were carried out by the bus system of Lyons, France and by the Golden Gate Bridge, Highway, and Transportation District. By 1981, Port Authority researcher Robert S. Foote reported in Traffic Quarterly that "the essential front-end hardware needed for the fully automatic non-stop toll collection system is essentially available now." What remained was to develop the remaining computer system hardware and software to produce a complete AVI toll-collection system.

The first large-scale pilot test of a complete AVI system took place in Hong Kong in 1985. The British government's Transport and Road Research Laboratory had been developing both the theory of direct road pricing and the AVI technology during the 1970s. To exploit this technology, the government set up a company called Transpotech, Ltd., and the Hong Kong Electronic Road Pricing project was its first major contract, awarded in 1983. The project involved 18 toll sites, and over 2,500 vehicles were equipped with Electronic Number Plates.

The system was operated for 18 months, permitting the collection of extensive data by the MVA Consultancy (Hong Kong) and Transpotech. Technically, the AVI system was a success. The equipment achieved the required accuracy rates and held up well under strenuous operating conditions. The security systems for enforcement also worked well. Politically, however, the system proved highly controversial. The major objections were cost and privacy. Drivers considered the electronic tolls as a new tax, at a time when vehicle registration fees had recently been tripled. And people voiced major concern about the government obtaining records of their vehicular movements via the system.

These political problems contributed to the Hong Kong government's decision not to implement a full-scale, citywide system once the pilot test was concluded. It was realized, as

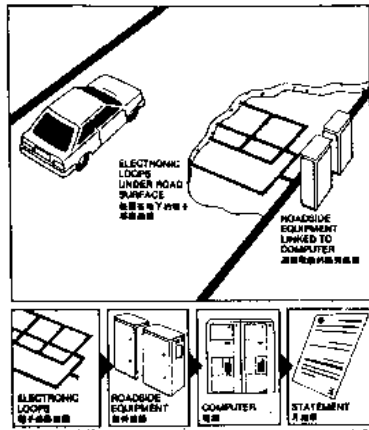


FIGURE 1

Electronic Road Pricing
via Automatic Vehicle Identification

(Illustrations are from the
1985 Hong Kong demonstration project)

Road Use Statement PPH - 6152
道路使用月結單

6533294 0001

11/11/90 09/10/90 08/11/90

BALANCE B/F \$104.50

19/10/90 PAYMENT \$104.50CF

10.00

BY B&O 32 \$77.00

11/10/90	4	\$13.00
12/10/90	1	\$9.00
13/10/90	1	\$3.00
16/10/90	6	\$17.00
21/10/90	2	\$5.00
25/10/90	2	\$1.00
26/10/90	4	\$11.00
28/10/90	3	\$10.00
09/11/90	4	\$5.00
08/11/90	3	\$4.00

IN-ARREARS \$77.00

127.00

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well, that the timing was wrong for citywide implementation of the system. Because of the recent tripling of auto registration fees, the number of private cars in Hong Kong had declined sharply. In addition, as the project was winding down, two new transportation projects came on line--the Mass Transit Railway Island Line and the Hong Kong Island Eastern Corridor. Both were seen as further relieving roadway traffic congestion. Given these factors, plus the political objections to the ERP scheme, the government's decision not to implement the system citywide in 1986 is understandable.

Meanwhile, testing of AVI systems has continued in the United States. In 1983-84 the transportation departments in Arizona and Oregon began seriously investigating AVI to automate truck weighing stations (so that trucks would not have to come to a stop at scales). Based on an Arizona feasibility study by Castle Rock Consultants and an Oregon demonstration project, a multi-state Heavy-Vehicle Electronic License Plate (HELP) project was created. Participating states include Alaska, Arizona, California, Idaho, Iowa, Minnesota, Nevada, New Mexico, Oregon, Pennsylvania, Texas, Virginia, and Washington. The project is developing generic AVI system specifications, and will involve the outfitting of 10,000 test vehicles from 200 trucking companies with ENPs. Power loops to read the number plates will be installed along I-5 and I-10 in Washington, Oregon, California, Arizona, New Mexico, and Texas. The target date for these installations is 1988, with the project due to be completed by mid-1989.

In a related study, the National Cooperative Highway Research Program is studying the feasibility of a national heavy-vehicle monitoring system. Arthur D. Little, Inc. is managing this effort, whose aim is to determine the feasibility of using AVI nationwide.

Caltrans has also been exploring AVI systems. In 1985 it selected Science Applications International (SAI) to test and evaluate an AVI system on the Coronado Bay Bridge in San Diego. The first phase of the project, which was recently concluded, demonstrated the accuracy of the system's ENP and power loop components. The second phase will focus on the central computer and billing system elements.

AVI took a major step forward last fall when the first contract for an operational installation was signed. On November 12, 1987, the Virginia Department of Transportation signed a contract with Britain's Castle Rock Consultants for an AVI system for the Dulles Toll Road. The firm is to design and install an AVI/electronic toll collection system at the main toll plaza and ramp collection points of the Dulles Toll Road. The system is expected to be operational by December 1989.

Also last year, in December 1987, Antech Systems Corporation in Dallas signed a contract to equip the Dallas North Tollway with an AVI system for full-scale toll collection, due to be operational by October 1988. Thus, AVI is about to arrive in the United States.

C. Potential AVI Problems and Solutions

While it appears that AVI technology is well in hand, a number of questions remain to be answered. Are there enough suppliers ready to produce such systems, or are we talking about prototypes which will still require years of additional development? How will out-of-the-area vehicles be handled? What about enforcement against those who attempt to cheat the system? And what about the privacy question?

(1) Suppliers. While a complete survey is beyond the scope of this study, a preliminary review indicates that numerous firms have developed the technologies involved in AVI and that a number of them are able to offer complete systems at this time. Among the firms which have been involved in AVI component development over the past 15 years are such major players as General Electric, Westinghouse, Phillips, Siemens, RCA, and Toshiba. General Motors and BMW are among the auto companies using AVI transponders to identify vehicle chassis on their assembly lines. BMW is using a Phillips system, while GM is using systems from Identronix and Allen-Bradley. Firms that are marketing complete AVI systems for electronic toll collection include Amtech Systems Corp., General Railway Signal, and Science Applications International.

(2) Enforcement. The Hong Kong system employed a closed-circuit television system for enforcement purposes. If a vehicle passed a toll-collection point and the detector failed to read an ID number, the system snapped a photograph of the vehicle's license plate. The researchers found that the system worked--it delivered legible photographs, and achieved a high enough success rate overall to not require 100 percent probability of detecting every violation at every location (because an offending vehicle will very likely pass by more than one toll point).

The City of Pasadena recently began using a somewhat similar system for speed-limit enforcement. Their new radar units, made by Zellweger Uster (Switzerland), photograph both the driver and the license plate of speeding vehicles, in addition to recording the time, place, and speed. This system provides a precedent for automated enforcement activity, in that the speeding vehicle is not pursued. Instead, the driver is mailed a citation, and the photographic record is available as evidence.

(3) Out-of-Area Vehicles. Efforts to develop national, generic AVI standards have begun. But it is unlikely that these will be finalized for a number of years. Moreover, even after national standards exist, AVI will be implemented in some cities and/or states before others. Hence, for a long time we will be faced with the problem of how to cope with vehicles from outside the equipped area. It is therefore essential that any electronic pricing system provide some degree of "manual" capability--e.g., stickers, rental ENPs, electronically-read "smart cards," or even a conventional toll-booth lane--for vehicles not equipped with ENPs.

(4) Privacy. Because of the problem of out-of-the-area vehicles, any AVI-based electronic toll system will have to provide a manual alternative. Thus, motorists who object to the record-keeping involved in the AVI system may opt out by using the manual mode. In addition, it should be noted that the Hong Kong system was owned and operated by the city government. The objections voiced in Hong Kong were to the government obtaining records of people's travels. Were the system operated by private firms, it is unlikely that such serious concerns would be raised. Equally detailed records are gathered by America's telephone companies but are accepted as the price we pay for the tremendous convenience of telephone service. Americans would probably have more serious concerns about these billing records if the government were running the telephone system. Thus, from the standpoint of political acceptability, the privacy issue is likely to be much less of a problem if electronic toll collection is operated by private firms rather than by a government agency.

5. PRIVATE TOLLWAYS FOR SOUTHERN CALIFORNIA

Peak-hour pricing would bring about a significant reduction in congestion, were it to be implemented on Southern California's freeways. Toll roads are growing in popularity in Europe and the Pacific Rim countries and are making a comeback in parts of the United States. Moreover, state-of-the-art tollways can largely dispense with congestion-causing toll booths, substituting electronic pricing via Automatic Vehicle Identification systems. How can these lessons best be applied in Southern California?

A. Avoiding Political Gridlock

The disastrous Santa Monica Freeway diamond lane experiment, and the recent rejection of a diamond lane on the Ventura Freeway, both suggest the perils which face political leaders who propose actions which can be perceived as taking away a benefit which people believe they are entitled to. It appears unwise, as well as unlikely, to advocate adding tolls--even electronically charged tolls--to Southern California's existing freeway lanes. People will argue, as they did in Hong Kong, that they have already paid user taxes for the freeways we have and should not be forced to pay "again."

Thus, if we are to begin to reap the congestion-cutting benefits of peak-hour pricing, the place to begin is with new capacity. When new freeway routes are planned, as is the case today in Orange County and the San Fernando Valley, it makes sense to plan them as tollways from the outset. That way, instead of quickly filling with traffic to the point of stop-and-go congestion, their traffic levels can be fine-tuned by pricing which varies by time of day, and from year to year, in accordance with traffic levels.

But the greatest benefits for Southern California's motorists will come from adding second decks to our busier freeways and making this additional capacity tollways, as well. That way, these new routes will also remain free-flowing rather than quickly filling up to stop-and-go conditions. Those opposed to any new freeway construction will object, but their standard argument--that adding new capacity is futile--will carry little weight against new capacity which comes equipped with a supply-demand balancing mechanism. Indeed, the opponents are right in one respect: no more freeways should be built in Southern California--only tollways.

What is called for is a grand political compromise. Traditional highway interests have long been pitted against no-growth interests--the Auto Club versus the Sierra Club. The Auto Club side must come to realize that its desire to have more miles of highway is unlikely to be achieved unless it comes as part of an overall solution to the traffic congestion problem--not a temporary palliative. And the Sierra Club side must come to realize that its goal of making people pay the full price for their automobile use can best be realized by putting direct pricing into place on as much of the system as possible. This

will force motorists to weigh the consequences of choosing a 1.2 person vehicle rather than car-pooling or using some form of mass transit. Both sides will achieve some of their goals, which is the nature of a political compromise. But in the process, our incipient gridlock will be avoided.

Some may object to the idea of a "two-tier" freeway system, literally and figuratively. Egalitarian objections are certain to be raised about some people being able to pay more to get premium (congestion-free) service, while those less able to pay must make do with congestion. Fortunately, there are ready answers to these objections.

First, we already accept this two-tier approach in many other services, the classic example being postal service. If you want to mail a letter, you can choose the low-cost, mass-market service offered by the U.S. Postal Service. It's slow and not always reliable, but it eventually gets the job done. But if your letter absolutely has to be there overnight, you can choose to pay a premium and use Federal Express. The tollway alternative proposed here is to give people a "Federal Express"-type alternative.

More important, the addition of tollways to our existing freeway system would be a win-win solution. Those who choose to pay the toll and use the new tollways would clearly win, because they would be willingly paying a high price to obtain what they viewed as superior service. And those "left behind" on the freeways would win, as well. That's because every car attracted to the new tollways is one less car congesting the existing freeways. Even though they would not be paying anything more than they are paying now, users of the existing freeways would be made better off by the existence of the tollway alternative.

B. Why Private Tollways?

Much of the tollway mileage in Europe and the Pacific Rim has been developed by private enterprise, on the build-operate-transfer (B-O-T) model. This same model, in which private firms design, finance, construct, own, and operate the tollway (with title eventually reverting to the government) is now being applied to new tollway projects in Virginia and Colorado. And large-scale infrastructure projects like the Channel Tunnel and the Chicago-Kansas City Tollway are taking privatization one step further, by remaining private enterprises on a permanent basis.

The B-O-T model is also being applied to other forms of capital-intensive infrastructure, such as wastewater treatment plants, correctional facilities, and solid-waste-to-energy plants. Among the principal advantages, compared with conventional public-sector financing and operation, are the following:

- o Faster procurement. The total time from drawing board to operation can be as much as 50 percent less with private-sector, "turnkey" projects. Corrections Corporation of America built an Immigration & Naturalization Service detention facility in Houston in six months, compared with the 2 to 3 years that is normal INS

practice. Parsons Corporation's Gilbert, Arizona wastewater plant was completed six months ahead of schedule. Private firms generally have far less red tape to deal with than government agencies.

o Lower construction cost. A shorter procurement cycle means capital is tied up for less time, saving interest costs. Private firms are generally more efficient than public agencies, leading to generally lower unit costs. And if public/private cooperation leads to tax-exempt revenue bonds being used, interest rates on the private project will be no higher than on a public-sector project.

o Lower operating costs. When the same corporate entity which builds the facility is also to become the operator, it has stronger incentives to design and build it for lower operating costs. CCA and other private corrections firms design facilities to minimize the number of personnel needed to monitor prisoners, by designing jails with cell blocks extending as spoke-like appendages from a circular guard station. Guards may thereby monitor numerous cells from a single vantage point. We can expect similar cost-reducing features on privately owned tollways.

o Innovations. The private sector is far more likely to be creative in coming up with innovative design concepts and operating principles (see below for examples).

Another reason for preferring private tollways is the privacy issue. Public resistance to AVI systems is likely to be far less when a number of private enterprises are operating the tollways, rather than a monolithic government agency. Americans are strongly protective of their privacy when it comes to government agencies and data banks. Yet any number of commercial enterprises maintains detailed records of people's personal activities: telephone companies, travel agencies, video stores, pharmacies, banks, credit card companies, etc. The monthly AVI bills from several tollway firms would probably be of no more concern to most people than their transaction records with these other service providers.

Ultimately, we need private enterprise to build tollways because the public sector cannot afford to build them. Caltrans simply does not have the funds available to double-deck Southern California's principal freeways over the next 10 years. It will be surprising if Caltrans can muster the capital to build a single new freeway in the San Fernando Valley within this time frame. The Little Hoover Commission estimates the shortfall in highway revenues between 1988 and 2000 to be between \$800 million and \$1.8 billion per year.

The classic answer to a shortage of something is to make it profitable to provide the item that is in short supply. We need to make it profitable to be in the tollway business. The French did it, in 1969, and saw the swift development of an intercity motorway network. The Australians and the Indonesians are doing it, and even the Chinese have begun to follow suit. The State of

Virginia has just decided to do so, as well. Given the magnitude of our traffic problems, can Southern California afford to be left behind?

C. Possible Tollway Innovations

If Caltrans were to offer franchises to private tollway firms, what sorts of innovations, besides AVI, might we expect? The following are just a few suggestions.

o Light-vehicles-only. Certain commuter routes might well be designed and built only for cars and vans--vehicles up to a maximum weight limit. This would permit narrower lanes, thinner pavements, and less massive elevated structures. Those design differences would mean both lower construction costs and lower operating costs (since heavy vehicles account for the majority of the wear and tear on our highways). Cars-only tollways would prove quite popular with most motorists, as the East Coast's popular parkways clearly demonstrate.

o One-way commuting. In certain locales, commuting patterns may be heavily directional, with much greater traffic flows in one direction during the morning rush and in the opposite direction during the afternoon rush hour. In such cases it might be far more cost-effective in relieving congestion to build a second deck that was operated in the predominant direction during each rush hour.

o New Tunnels. Given the extent of congestion in the Sepulveda and Cahuenga Passes, and the availability of state-of-the-art tunneling equipment, it might turn out to be cost-effective for private firms to build one or more tunnel tollways between the San Fernando Valley and the Basin. If they offered a smoothly flowing alternative to the San Diego and Hollywood Freeways, such tollways might find a ready market at surprisingly high prices.

o Other revenue sources. Private firms acquiring and developing their own rights of way (as opposed to leasing air rights from Caltrans above an existing freeway) would be motivated to seek out a multitude of revenue sources, rather than relying only on tolls collected from vehicles. A right of way is an extremely scarce and valuable resource, especially in urban areas. Thus, one might expect the tollway firms to lease space to pipelines, telecommunications firms (for cable and fiber-optic lines), power lines, water lines, and transit lines. They would probably also be more aggressive than Caltrans in leasing air rights above and below the tollway to other users. Development of these other revenue sources is an integral part of the plans for the Illinois and Colorado private tollway projects.

6. TAKING THE NEXT STEPS

The case for adding private tollways to Southern California's freeway system is compelling, on paper. Yet it is a long way from being a reality. For this traffic-congestion solution to move from idea to reality, it must become widely known to the Southland's policy makers and opinion leaders. The key interest groups whose positions shape transportation policy will have to be persuaded that private tollways will accomplish enough of their goals to be worth supporting. A pro-tollways coalition will have to come into being.

In addition, a number of technical and legal questions will have to be resolved before policy makers can be persuaded that the private-tollways concept is truly viable. Hence, there is a need for further, more detailed research on the private-tollways approach.

A. Coalition-Building

Is a private-tollways coalition conceivable? At first blush, this may sound like a quixotic quest. There are so many interest groups involved in transportation, and their interests appear to conflict in many ways. Yet a preliminary assessment suggests the possibility of a convergence of interests:

- o Auto Club of Southern California--Historically opposed to tolls, but also committed to major expansion of the freeways. The latter is highly unlikely, unless the new capacity comes equipped with built-in demand limitation, as provided by tolls.

- o Transit advocates--Historically opposed to more freeways, but many (e.g., the California Transit League) are on record supporting tolls, peak-hour pricing, etc. as ways of making auto users pay the full cost of their transportation decisions.

- o Environmental groups--Opposed to more freeways, but some (e.g., the Environmental Defense Fund) are on record favoring user-pays approaches and market pricing.

- o Anti-growth activists--Opposed to more freeways, but much of their political support on this issue (as in Orange County) is based on growth being equated with traffic congestion. They might follow the lead of transit and environmental organizations if the latter support tollways.

- o Trucking industry--Already testing AVI systems; also, concerned about rush-hour bans on trucks, so they might be willing to support alternative solutions such as tollways.

- o Highway builders--Should support the concept, since it means significant new construction projects.

- o Construction unions--Should also support it, because of numerous construction jobs.

o Downtown business interests--Should be supportive if seen as a pro-transit approach (which it is).

o Major employers--Should support the concept, given the potential of meaningful reductions in congestion and avoidance of major new tax-funded spending.

o Developers--Should support the concept, as a means of defusing anti-growth measures.

o Business/Taxpayer organizations--Should support the private tollways concept as a means of financing major infrastructure improvements without increases in taxation.

Government agencies are more knowledgeable about the tollway concept than are most of the major interest groups:

o Southern California Association of Governments--Has recently recommended a toll road upper deck for the Ventura Freeway and a portion of the San Diego Freeway; may support private tollways as more cost-effective way of bringing tollways into being.

o Caltrans--Studying double-decking and generally favorable to this element; position on tolls is unclear.

o South Coast Air Quality Management District--Knowledgeable about pollution-reduction effects of peak-hour tolls, but has been unwilling to support implementation in the past; may support tollways approach if other support exists.

o Local officials--Several members of the Los Angeles City Council and County Board of Supervisors have expressed interest in double-decking, with the second decks operated as toll roads. Orange County officials planning the three new freeway routes are pursuing toll-road/AVI approaches.

o Assembly Office of Research--Has endorsed toll roads as one possible solution to new-capacity needs.

o Legislative Analyst--Has endorsed toll roads as possible traffic-congestion solution.

This degree of official support for elements of the private-tollways concept could play a significant role in gaining the attention of the major interest groups. What is needed is a systematic effort to explain the concept to the major organizations. It would point out the advantages of the private-tollways concept compared with other congestion-reduction approaches, and relate the concept to each organization's transportation goals.

A public information campaign would also be important in generating support for the private tollways approach. It is not realistic to expect the leadership of major interest groups to endorse a new concept such as this, unless it has become a subject of serious public discussion, with which opinion leaders are

familiar. Thus, there would need to be a systematic effort to present the concept, via op-ad articles in local newspapers, speeches to civic groups, interviews on radio and TV talk shows, and so forth.

B. Research Agenda

For initial familiarization with the private-tollways concept, a preliminary report such as this document is sufficient. However, to move toward serious consideration of implementing this approach on a large scale requires that numerous details be researched and many questions resolved. Among the items on such a research agenda are the following:

o Potential Providers: While three private tollway projects have been proposed in other parts of the country, it is not clear to what extent private firms and investors would be seriously interested in financing, building, owning, and operating such projects in Southern California. In addition, further information is needed as to the actual availability of fully functioning AVI systems (as opposed to components) for electronic toll collection.

o Gasoline Tax: A completely unresolved question concerns the relationship of federal and state gasoline tax revenues to private tollways. Motorists who choose to use the tollways will still be paying these gasoline taxes every time they refuel. Should the funds collected from tollway users (1) be spent by Caltrans only on public roads, as they are today? (2) be paid to the private tollway operators to help pay for construction and operation? or (3) be rebated to tollway users, in proportion to their documented use of the tollways? A case can be made for each alternative; the full policy implications of each will need to be researched.

o Federal Funding: Federal highway funding policies still generally exclude new toll projects. If this prohibition continues, how serious a barrier will it pose to implementation of either public or private tollways? Would the federal ban be a decisive factor in making private tollways more feasible than public tollways? How likely is repeal of the federal ban within the next five years?

o Regulatory Regime: A key factor in attracting private investment for tollways will be the anticipated regulatory climate. Few investors will be willing to purchase bonds underwritten by toll revenues unless stringent guarantees exist that the regulatory regime will permit an adequate rate of return. Experience from overseas and the proposed private tollway regulatory structures in other states need to be researched, to develop a workable model for California.

o Double-Decking Feasibility: Many aspects of the double-decking approach remain to be researched. While there are major cost savings on right-of-way, the added cost of totally elevated construction is not well-defined. Potential cost savings for cars-only upper decks are also not yet known. Neither are the

noise impacts or the below-deck air pollution impacts well-quantified.

o AVI Issues: Several technological alternatives exist for AVI system hardware, with different levels of performance and cost. The issue of generic specifications is also unresolved at this point. And the privacy issue requires serious research to determine (1) what degree and type of alternative system is most cost-effective, and (2) what degree of record-keeping is optimum in an AVI system that meets legitimate business needs while minimizing privacy concerns.

o Legal Issues: The legal status of private tollways in California is not completely clear. Section 30800, Chapter 3, Div. 17 of the California Streets and Highways code permits Caltrans to authorize public or private toll roads. Prospective public toll road operators must pay a fee and obtain a license; at least one interpretation of the law holds that for private operators, no fee is required. Despite this provision, a bill by Assemblyman Nolan Frizzelle to permit private toll roads in California passed the Assembly but died in the Senate Transportation Committee last session. This legal status needs to be clarified, and any potential local or federal barriers researched as well.

o Policing: Should the California Highway Patrol have primary responsibility for traffic enforcement and other services on private tollways? The Ohio Turnpike has its own police force, but it is not a private, for-profit firm. The legal and policy implications a private patrol service on private tollways should be explored.

o Bibliography: An extensive literature on toll roads and AVI exists, but has not been organized into a usable bibliography. Continued research on these issues would be facilitated were such a bibliography assembled and published.

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Nothing in this study is intended to influence any legislation at local, state, or federal levels. Additional copies of this report are available from the Reason Foundation for \$5.00.