Policy Summary No. 305

HOT Networks: A New Plan for Congestion Relief and Better Transit

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Introduction

Today's High Occupancy Vehicle (HOV) lanes represent a valiant but largely unsuccessful effort to reduce traffic congestion in America's large metropolitan areas. Evidence is growing that, despite billions of dollars worth of capital investment and many years of rideshare promotion, HOV lanes have not changed Americans' driving habits. Instead of gradually gaining strength, carpooling has been slowly eroding. The fraction of commuters sharing the ride to work declined in the decade of the '90s from a nationwide average of 13 percent in 1990 to 11.4 percent in 2000 according to the *2000 Census*. Similar declines were observed in most of America's largest urban areas (Table 1), where investment in HOV lanes and mass transit has been greatest. Although HOV lanes reduce travel time for the remaining small percentage of commuters who are able to carpool, a vast proportion of the traveling public does not benefit from them.

Meanwhile, the traffic congestion that HOV lanes were supposed to alleviate has continued to mount. Congestion in America's 75 largest urban areas cost travelers $68 billion in lost time and wasted fuel in 2000, an all-time high. In just the eight most congested metropolitan areas (excluding New York), the congestion cost totaled $30.7 billion—and there is no relief in sight. But America's investment in HOV facilities is too great and their potential too valuable for these facilities to be ignored.

A Better Approach

HOV lanes could be transformed into a more effective component of the urban transportation system by turning them into premium lanes that would serve as high-speed guideways for express buses, while providing a faster and more reliable

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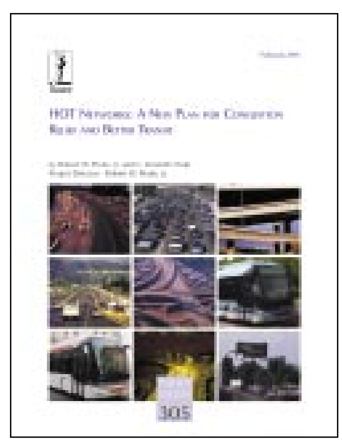


Table 1: Changes in Commuter Mode Choice in the Most Congested Metro Areas								
		Drive-alone %**			HOV %**		Transit %**	
Name	Person-hrs delay per peak traveler*	Rank*	1990	2000	1990	2000	1990	2000
Los Angeles-Orange County	136	1	72.3	72.4	15.5	15.2	4.6	4.7
San Francisco-Oakland	92	2	68.3	68.1	13.0	12.9	9.3	9.5
Washington DC-MD-VA	84	3	66.1	70.4	15.5	12.8	11.0	9.4
Seattle-Everett	82	4	73.1	71.6	12.1	12.8	6.1	6.8
Houston	75	5	76.1	77.0	14.6	14.2	3.8	3.3
Dallas-Ft. Worth	74	6	78.6	78.8	13.9	14.0	2.3	1.8
San José	74	6	68.3	68.1	13.0	12.9	9.3	9.5
New York-NE NJ	73	8	55.4	56.3	10.4	9.4	24.8	24.9
Atlanta	70	9	77.9	77.0	13.0	13.6	4.5	3.7
Miami-Hialeah	69	10	75.3	76.6	14.5	13.4	4.4	3.9

* Source: TTI *2002 Urban Mobility Report*, Exhibit A-2, 2000 Urban Mobility Conditions.

**Source: U.S. Census Bureau, "Journey-to-Work Trends for Selected Metropolitan Areas," available at www.census.gov. Note that the Census figures are based on the MSA, a larger geographic unit than used by TTI. Thus, for example, the Census defines a single MSA encompassing the entire San Francisco Bay Area, while TTI uses a separate urbanized area for San Francisco-Oakland and San José.

travel option to individual motorists traveling in personal automobiles. Buses and vanpools would use the premium lanes free of charge, while other motorists would pay a variable toll. Tolls would be debited electronically from users' smart cards, thus doing away with tollbooths and cash transactions. In effect, our proposal marries two promising transportation innovations receiving growing attention in the transportation community: High Occupancy Toll (HOT) lanes and Bus Rapid Transit (BRT).

HOT lanes are limited-access lanes reserved for buses and other high occupancy vehicles but open to single occupant vehicles upon payment of a toll. The number of cars using the reserved lanes can be controlled through variable pricing (via electronic toll collection) so as to maintain free-flowing traffic at all times, even during the height of rush hours. California's two HOT lane projects, which have been in operation for several years, have demonstrated convincingly the ability of electronic variable pricing to maintain congestion-free conditions even during peak hours. Moreover, surveys in California have shown widespread public acceptance of the HOT lane concept. People of all income levels use the HOT lanes when saving time is an important consideration. Indeed, utility vans and delivery trucks are a far more common sight on California's HOT lanes than the proverbial Lexus.

Bus Rapid Transit (BRT) refers to frequent bus service operating in special lanes. BRT aims to provide performance and service qualities comparable to those of rail transit but at a cost that is considerably lower than that of light rail systems (an average of $9 million/mile for buses on HOV lanes versus $34.8 million/mile for light rail transit according to U.S. General Accounting Office estimates). Because of its favorable economics, BRT is receiving increased attention from the U.S. Department of Transportation and is picking up support in the transit community. Transit officials realize that the federal New Starts program can only fund a small fraction of the rail candidate projects currently in the pipeline. They see BRT as offering a new generation of less costly transit systems that would extend the benefits of rapid transit to a much larger number of communities.

However, to fully realize the potential of these two innovative concepts, the fragmented and unconnected HOV facilities that already exist in metropolitan areas today must be extended, linked and interconnected so as to create seamless region-wide networks of unobstructed lanes. Only then would transit riders and motorists be able to take full advantage of the benefits of time savings and increased travel reliability of premium lanes.

In one sense, our proposal calls for a return to an earlier

concept, in which special reserved lanes were developed primarily as uncongested guideways for regional express bus service. But instead of offering the significant remaining capacity of these premium lanes to carpool vehicles at no charge, our proposal would open these lanes to all personal vehicles that choose to pay a fee. Charging such vehicles serves two purposes: it generates the funds needed to pay for the network and it manages traffic flow to preserve the time-saving advantages necessary for high-quality express bus service.

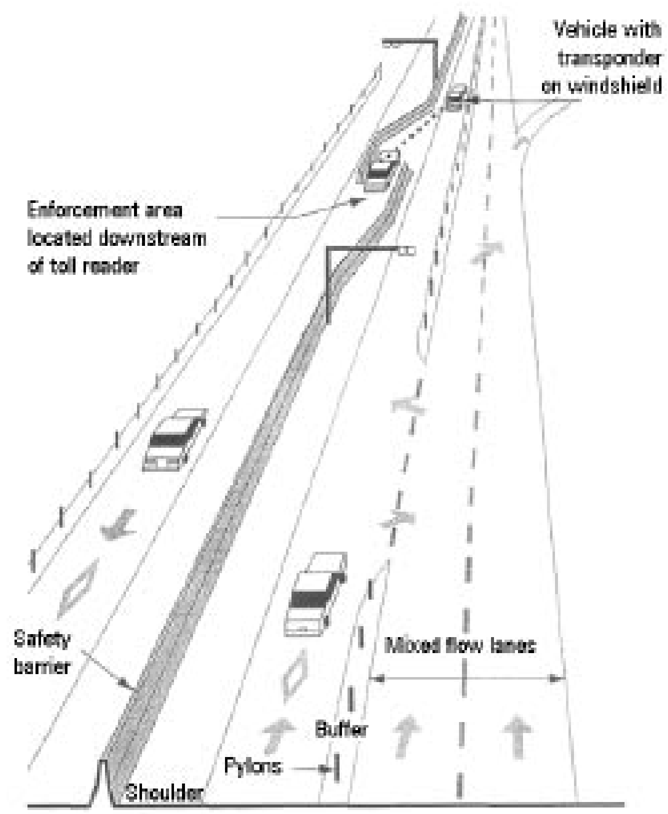
We believe there is a way to accomplish this vision without drawing heavily on public sector funds. Experience with California's two HOT lane facilities has shown that motorists are willing to pay tolls to save time even if there is a free highway alternative. These facilities have further demonstrated that tolls paid by motorists can generate a significant annual revenue stream. Our proposal is to use these revenues as the basis for issuing tax-exempt toll revenue bonds to finance the build-out of the HOT Networks.

Defining HOT Networks

We have defined a HOT Network as an interconnected set of limited access lanes on an urban freeway system. These lanes may be used by buses and vanpools at no charge and by automobiles and light trucks (SUVs, pickups, etc.) upon payment of a variable toll. The prices would be varied so as to limit the number of vehicles per lane per hour to the maximum consistent with free-flow conditions. Tolling would be all-electronic, using dashboard-mounted transponders to debit pre-paid toll accounts. Enforcement would be via video camera imaging of the license plates of vehicles either lacking a transponder, having an insufficient account balance, or whose accounts had expired.

Like HOV lanes, HOT Networks would be designed for relatively long-haul travel. Thus, they would have far fewer entrance and exit points than the freeways themselves. In most cases, the HOT Network would be composed of existing freeway HOV lanes (converted to operate as HOT lanes)

Figure 1: Typical At-Grade HOT Network Lanes



Source: Parsons Brinckerhoff, 1998.

linked with additional lanes planned as HOV but now built as HOT instead. Most of these lanes would be at-grade, like the freeway of which they are a part. But in some core portions of metro areas where right of way is very expensive (and where land takings would be politically difficult) those portions requiring lane additions would be built as elevated sections. The majority of initial HOT Networks would be configured as a single lane in each direction, separated from each other by a concrete Jersey barrier (and from adjacent general purpose lanes by plastic pylons, as used on the 91 Express Lanes and as illustrated in Figure 1). But some portions would include two lanes in each direction, and other portions—where commuting is heavily directional—would use reversible lanes.

Key to the definition of a HOT Network is its being a *network*. Unlike most of today's freeway HOV lanes, which do not make the transition from one freeway to another, our approach would provide for seamless connections at interchanges. Only a handful of transportation agencies have given priority to HOV-to-HOV connectors, because these elevated flyovers are very costly to build. But it is only these connectors that make a true network possible.

Effectiveness of HOT Networks

We expect that HOT Networks will attract more patronage than HOV lanes, for several reasons. First, precisely because they will be both *uncongested* and *networks*, they will provide much greater time-saving (congestion-avoidance) benefits than today's mostly fragmentary HOV lanes. Second, they will be open to all motorists (except heavy trucks), not just to the few who can arrange their lives so that they can carpool. Third, if implemented as we recommend, with strong participation by the Federal Transit Administration, they will enable local transit agencies to run greatly increased express bus service. That will dramatically increase the lanes' overall person throughput compared with typical HOV lanes today.

Table 2 illustrates the performance of typical HOV lanes in large metro areas, compared with an idealized high-performing HOV lane and our hypothetical HOT Network. The "typical" large metro area HOV-2 facility carries about 950 vehicles per hour, yielding a person throughput of 2,275 per lane per hour (compared with perhaps 1,800-1,900 persons/lane/hour in a general purpose lane). But there is still considerable unused *vehicular* capacity in this lane, of perhaps 750 vehicles/hour. This under-utilization—even for "well-performing" HOV lanes—is a source of political opposition to HOV lanes, and is a genuine waste of capacity. Also note the low use of the lane by express buses. In most metro areas (except Houston), running express buses in HOV lanes has not been a high transit agency priority.

Because assembling three people to carpool together on a regular basis is difficult for most people, most HOV-3 lanes are greatly under-utilized, as shown in the second column. One of the handful of exceptions is the El Monte Busway on I-10 in Los Angeles County, the inspiration for the "ideal HOV-3" shown in the third column. Congestion is so bad in this corridor that a relatively large number of 3+ carpools can be maintained. But what really makes the difference in this case is the large number of express buses using this facility.

The last column shows that nearly as great throughput can be achieved by the proposed HOT Network in high-demand corridors. With a comparable commitment of express bus service, the cost-sharing among carpoolers to split the toll, and active patronage by single occupant vehicles, a full 1,700 vehicles/lane/hour can be accommodated, with passenger throughput 80 percent as high as the ideal HOV-3 case. But in contrast with HOV lanes, the HOT Network lanes generate significant amounts of toll revenue.

Table 2 : Comparative Throughput of HOV Lanes and HOT Network

	Typ. HOV-2	Typ. HOV-3	Ideal HOV-3	HOT Network
SOVs (avg.1.1 person/veh.)	0	0	0	1100
HOV-2s (avg. 2.1 person/veh.)	788	0	0	300
HOV-3s (avg. 3.2 person/veh.)	150	350	1200	200
Vanpool (avg. 7.0 person/veh.)	10	20	20	60
Express bus (avg. 35 persons/veh.)	2	3	40	40
Vehicles/hour	950	373	1260	1700
Persons/hour	2275	1365	5380	4300

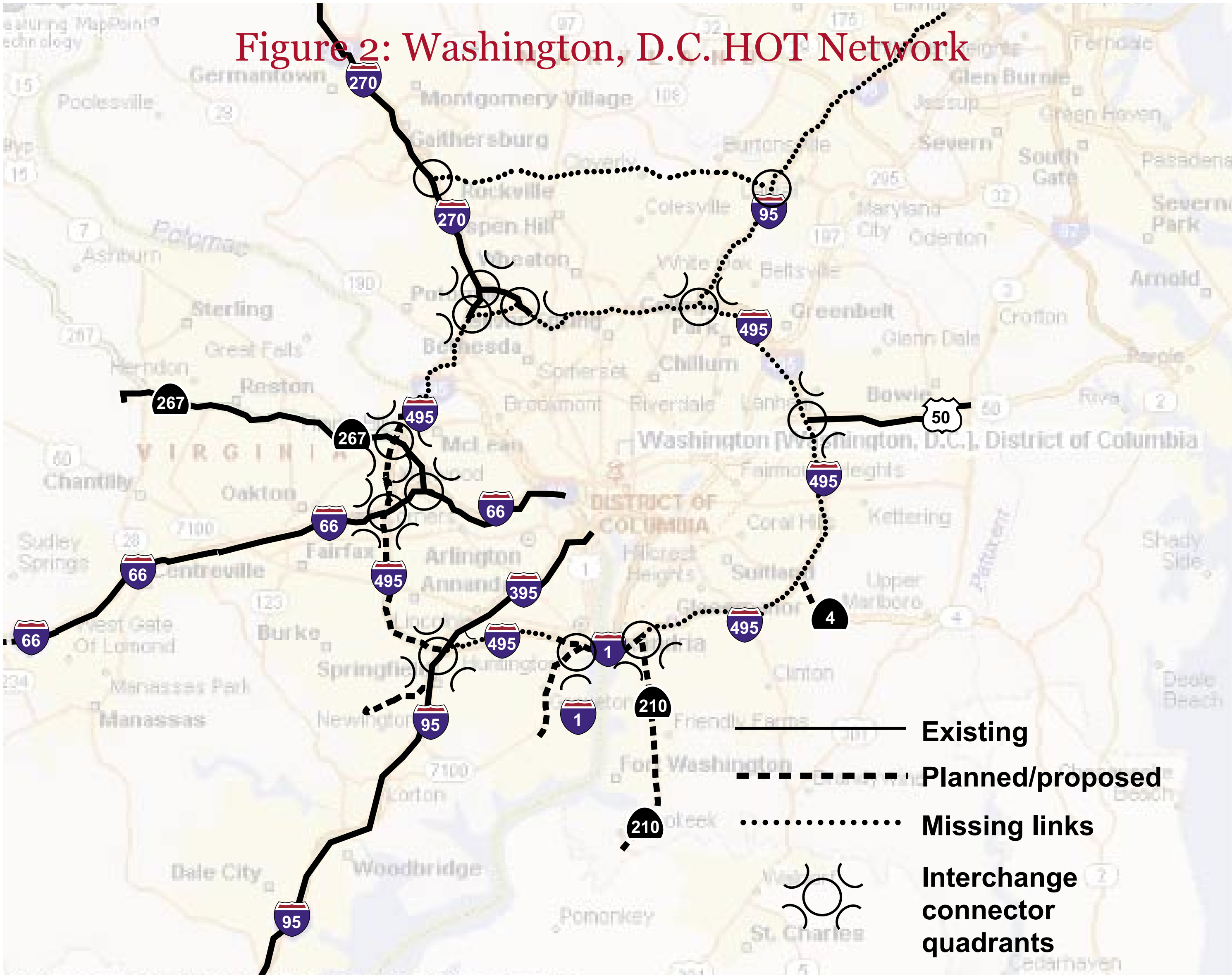


Figure 2: Washington, D.C. HOT Network

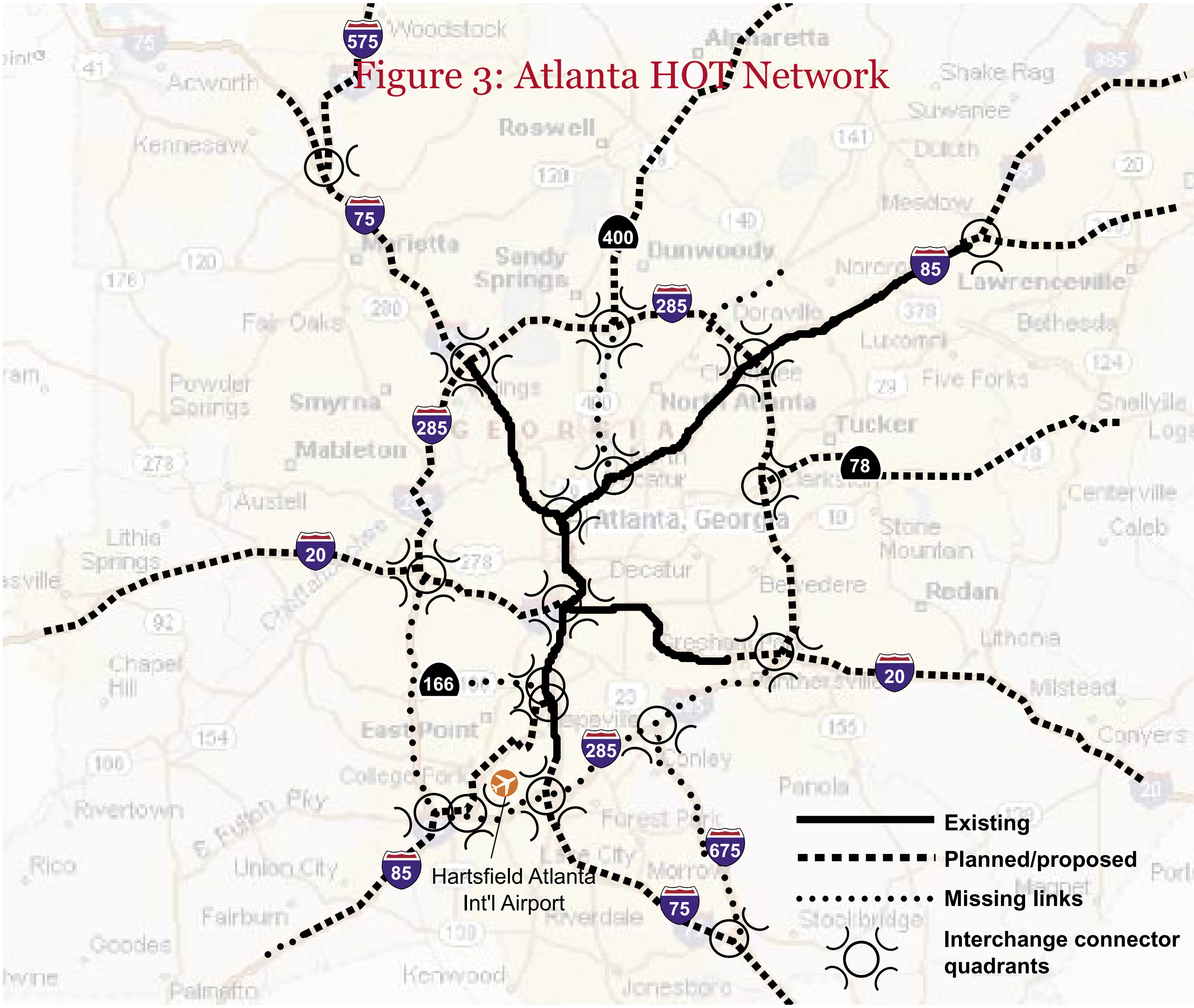
Economics of HOT Networks

In this study we defined potential HOT Networks for eight of the most congested metropolitan areas (Miami, Atlanta, Dallas/Ft. Worth, Houston, Seattle, Washington, D.C., the San Francisco Bay Area, and Los Angeles/Orange County). In each case, we used the official long-range transportation plan of the local metropolitan planning organization, including all HOV lanes and interchange connectors it plans to add over the next 20 to 30 years. To this we added some missing links—and especially missing interchange connectors. Examples of the resulting networks are shown in Figures 2 and 3.

Using current engineering cost data, we then developed the estimated cost to complete each network. We used conservative cost estimates for each of four components: lane-miles added at-grade, lane-miles of elevated construction, interchange connector quadrants, and the cost of converting from HOV to HOT (basically: gantries, transponders, video equipment, changeable message signs, computers, etc.) Based on demand data from California's two operational HOT lanes, we estimated the annual premium toll revenue that each HOT Network would produce. Finally, we translated that annual revenue stream into hypothetical toll revenue bond issues. The costs and revenues for the eight HOT Networks are summarized in Tables 3 and 4.

Overall, our estimates show that toll revenue bonds could cover about two thirds of the $43 billion in capital costs over the eight metro areas. The percentage covered by toll revenue bonds varies from city to city, depending how extensive a set of HOV lanes already exists versus how much

Figure 3: Atlanta HOT Network



has to be added to complete the network in each case. The balance of the capital cost, in each case, would come from conventional federal and state transportation trust fund sources.

Implementing HOT Networks

To implement this plan we recommend that Congress authorize a multi-year program of HOT Network development to be jointly implemented by the Federal Highway Administration and the Federal Transit Administration. Specifically, the program would aim to encourage states and metropolitan jurisdictions to:

(1) Incrementally create networks of premium toll lanes (HOT Networks) by extending, linking, interconnecting and filling in gaps in existing metropolitan HOV systems;

(2) Implement Bus Rapid Transit services on the completed parts of the HOT Networks as soon as practicable; and

(3) Develop innovative public-private financing arrangements involving tax-exempt toll revenue bonds to help fund a significant portion of the capital cost of these projects.

Funds to support the federal portion of the program would come from special fund allocations drawn from the FHWA's National Highway System or Surface Transportation Program. The FTA's New Starts program would provide funds for bus acquisition and related BRT system components. The proportion of funds to be contributed by each agency would be determined by congressional action in the authorizing legislation.

HOT Networks: An Idea Whose Time Has Come

Two basic notions underlie our proposal. The first is that high occupancy lanes are a scarce resource for which there is growing demand as urban roads become ever more congested and as highway travel becomes increasingly slower and less reliable. Confining the use of these lanes, as we have been doing, to those who are lucky enough to find travel companions going to the same destination is not, in our judgment, the fairest and most productive use of this scarce resource. The second notion is that the traditional revenue source used to finance transportation infrastructure—the gasoline tax—may prove to be insufficient to keep pace in the longer run with the nation's growing transportation needs. Our proposal responds to both of these concerns. Pricing high occupancy lanes would ensure the most productive use of this scarce road space, and the fees collected in this manner would provide a significant supplementary source of transportation revenue.

The HOT Networks concept is an approach by which nearly everyone would win. Transit riders would win because many cities that could not afford to build a large-scale rail system would be able to implement effective region-wide express transit service. Individual motorists would benefit by having the option of faster and more reliable travel on a network of congestion-free lanes when a predictable arrival time is really of importance to them. Users of regular lanes would gain because regular lanes would become less congested as some motorists switched to the toll lanes. And, importantly, HOT Networks could be built without the need for major new public funds by using the revenue stream from toll charges paid by individual motorists.

In the 2003 surface transportation reauthorization, Congress will have an opportunity to make this vision a reality. A congressionally authorized program of HOT Networks—built to benefit motorists and transit users alike—would constitute a powerful expression of the increasingly intermodal nature of our federal surface transportation program. And at a time when the need for transportation capital investment greatly exceeds traditional sources of funding, HOT Networks would give America's metropolitan areas both congestion relief and improved transit service without the need for major new tax revenues.

About the Authors

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Table 3: Estimated Capital Costs of Proposed HOT Networks

	Miami	Atlanta	Dallas/ Ft. Worth	Houston	Seattle	Washington	San Francisco	Los Angeles
Existing Lane-Miles	20	128	80	133	205	170	332	624
New Lane-Miles, At-grade	183	358	416	307	231	230	240	154
New Lane-Miles, Elevated	34	--	4	7	69	210	58	231
Total Lane-Miles	237	486	500	447	505	610	630	1,009
New Connector Quadrants	11	55	40	27	19	26	32	93
HOV-HOT Conversion ($M)	$28	$58	$60	$54	$61	$73	$76	$121
At-grade Construction ($M)	$1,354	$2,649	$3,078	$2,272	$1,709	$1,702	$1,776	$1,140
Elevated Construction ($M)	$850	$0	$100	$175	$1,725	$5,250	$1,450	$5,775
Connector Construction ($M)	$440	$2,200	$1,600	$1,080	$760	$1,040	$1,280	$3,720
Total Cost ($M)	$2,673	$4,908	$4,838	$3,580	$4,255	$8,065	$4,582	$10,756

Table 4: Estimated Revenues of Proposed HOT Networks

	Miami	Atlanta	Dallas/Ft. Worth	Houston	Seattle	Washington	San Francisco	Los Angeles
Vehicles/lane/hour	1350	1350	1350	1350	1350	1350	1350	1350
Average peak toll	$0.2250	$0.2250	$0.2350	$0.2350	$0.2590	$0.2590	$0.2600	$0.3000
Peak hours/day	5	5	5	5	6	6	6	7
Lane miles	237	486	500	447	505	610	630	1009
Peak revenue/day	$359,944	$738,113	$793,125	$709,054	$1,059,440	$1,279,719	$1,326,780	$2,860,515
Peak revenue/year	$89,985,937	$184,528,125	$198,281,250	$177,263,438	$264,859,875	$319,929,750	$331,695,000	$715,128,750
Off-peak revenue	$26,095,922	$53,513,156	$57,501,563	$51,406,397	$76,809,364	$92,779,628	$96,191,550	$207,387,338
Total revenue/year	$116,081,859	$238,041,281	$255,782,813	$228,669,834	$341,669,239	$412,709,378	$427,886,550	$922,516,088
Size of bond issue	$1,160,818,594	$2,380,412,813	$2,557,828,125	$2,286,698,344	$3,416,692,388	$4,127,093,775	$4,278,865,500	$9,225,160,875
Cost of Network	$2,673,000,000	$4,908,000,000	$4,838,000,000	$3,580,000,000	$4,255,000,000	$8,065,000,000	$4,582,000,000	$10,756,000,000
Percent Covered by Revenue Bonds	43%	49%	53%	64%	80%	51%	93%	86%
Total Annual Revenues	$2,943,357,041							
Total Bonds	$29,433,570,413							
Total Cost	$43,657,000,000							
Percent Covered	67.42%