NCHRP Project 20-24(52) — Task 10

FUTURE OPTIONS FOR THE NATIONAL SYSTEM OF INTERSTATE AND DEFENSE HIGHWAYS

TASK 10 FINAL REPORT

Prepared for:

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EXECUTIVE SUMMARY

"It was not our wealth that made our highways possible. Rather, it was our highways that made our wealth possible."

America's Highways 1776-1976, FHWA

BACKGROUND

The objective of NCHRP Project 20-24(52) was to develop a potential vision for the future of the U.S. Interstate Highway System. The report was prepared by a study team led by PB and including Cambridge Systematics, Inc., Kevin E. Heanue and Alan E. Pisarski.

This project Summary Report is based on a 10-task program-of-work carried out by the study team under the direction of the NCHRP panel and staff. The study team also benefited from advice and insight provided by three AASHTO Technical Advisory Groups, and AASHTO staff. The work of these tasks has been published in previous technical memos to the NCHRP Panel and other parties designated by the NCHRP Panel and AASHTO advisory groups. The content of this Executive Summary is discussed in greater detail in the full report that follows.

A NEW INTERSTATE FOR A NEW CENTURY

The Interstate Highway System has been a key enabler of the Nation's economic growth since construction began in 1956. At that time, there were 65 million vehicles generating 600 billion annual vehicle miles of travel (VMT). Vehicle ownership had just resumed its strong growth after World War II, and long-distance trucking was still in its infancy. Today, by contrast, there are over 240 million vehicles generating 3 trillion vehicle miles of travel on a network little changed since its original conception over fifty years ago, and the Interstate System itself carries over 700 billion annual VMT, more than the entire road system when it was authorized in 1956.

Substantial economic growth and population increases are likely in the coming decades. In the next 30 years, the U.S. population will grow to 380 million from 300 million today. Absent major disruptions such as global sustained recessions, increased trade barriers, and major global conflicts, the U.S. economy will quadruple in real terms and household wealth will increase in real terms from $37,000 per capita to about $66,000. Even with major modal improvements and demand management measures, annual VMT may reasonably be expected to increase to 5 trillion by 2035. This larger, richer and more mobile Nation cannot ride into such a future on our grandfathers' Interstate.

THE CHALLENGES OF FUTURE DEMAND FOR TRAVEL

A nationwide, interconnected, high-standard highway system has been important to national economic development in the past and will be even more critical in the future, often in ways not previously anticipated. However, the challenges of the future *go beyond an increase in scale alone, to creating a new mix in the type of improvements needed* if the system is to serve as the Nation's premier upper level highway network, and the core of an increasingly intermodal transportation system.

In the past, transportation efficiency has been this Nation's "ace in the hole" in competing in the global marketplace, offsetting significantly higher costs of labor and regulatory compliance. This U.S. mobility advantage for freight and passenger traffic continues to erode, however, as the performance of our transportation system suffers due to underinvestment, and as our global competitors invest in duplicating within their own borders the air, rail and highway networks vital to economic competitiveness.

Since the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991, the Nation's major surface transportation challenges have become more evident. Several recent analyses done for AASHTO, ARTBA, the U.S. Chamber of Commerce, TRB, the National Surface Transportation Policy and Revenue Commission, and major interest groups find common ground in the identification of key issues that must be addressed in the development of any new transportation strategy. This consensus was recently exhibited at an AASHTO-led Visioning conference that noted three major challenges to be met in the next 30-50 years:

- *Global economic integration.* The national economic dependency on global trade patterns continues to increase. Since the Interstate era was launched in 1956, imports and exports as a share of GDP (including NAFTA trade) have doubled to over 25 percent of GDP, and are projected to increase to an equivalent of 60 percent of GDP in 2035. This will intensify the flow of imports and exports, especially intermodal container movements by truck and rail, moving through the ports and border trade gateways to major areas of consumption hundreds of miles away. *Reliable service is critical in a "just-in-time" era of higher value commerce and competitive lean production*. Yet both global and domestic supply chains are hampered by key gaps in the highway network and by bottlenecks and low levels of service in key Interstate corridors.

- *Metropolitan Congestion.* Urban mobility is challenged by congestion and unreliability. In the top 70 urbanized areas alone, the total annual cost of congestion to both businesses and households has been estimated by USDOT to be $168 billion. The dispersal of economic activities and residential opportunities in all major metropolitan regions has led to demands for a more complete network that can serve both urban and interregional needs. The expansion of metropolitan areas, with their edge cities and exurban sprawl where much of congestion occurs, poses a complex challenge for urban transportation. Increasingly, intercity movements among "mega-regions" are also becoming a problem. In all these settings the community and environmental context requires *new mixes of modes and systems management schemes to support the metropolitan economies while still maintaining an attractive quality of life*.

- *Post-Industrial geography.* The pattern of development and population in the country has shifted dramatically since the 1950s. Sunbelt growth is largely a “post-Interstate” development. Nationwide, there are now 70 urbanized areas with a population of 50,000 or more that are not connected to the Interstate System. Which of those will be the Las Vegas or Phoenix of the next 50 years? The next 50 years will see further regional dispersion of growth and the addition of 150 million people, including major population increases in several states. Tourism has expanded dramatically, attracting large volumes of both domestic and international travelers to our widely dispersed natural and cultural resources. ***Maintaining connectivity is essential not only to serve rural communities, but also to support the shifting agricultural and energy extraction and production needs of a growing population and economy***.

A NEW VISION

A contemporary, forward-looking vision is presented in this study. This vision continues the American tradition of providing a high level of highway service, safety and physical integrity. But it recognizes important new realities: shifts in context in terms of the emerging transportation challenges, changes in the types of improvements that are relevant, and innovations in the technological, operational and financial features that are needed. New capacity options are at the core of this vision, but this capacity is tailored to needs and contexts, and combined in many cases with systems management and multimodal features that provide the flexibility to provide service in constrained settings.

Highway Travel and Global Climate Change. The future of surface transportation is likely to take place in a context of significant policy and technology changes regarding the contribution of human activity to global climate change and energy supply and related technology. The surface transportation contribution to CO2 emissions represents about 20 percent of the total. Given the concern with global climate change and foreign energy dependency, significant adjustments in fuels and efficiency-related vehicle technology were also analyzed in terms of their operating cost implications on future travel demand. Options under discussion include alternative fuels (which may cost more per gallon), CAFÉ standards for cars and light duty vehicles (up to 35 mpg) or market solutions such as cap-and-trade or carbon tax. An analysis of the current range of options does not indicate that they alone will significantly dampen travel, for a variety of reasons:

- European experience already demonstrates that dynamic modern societies can coexist with vastly higher fuel prices and with much more fuel efficient vehicle fleets. Fuel prices in Europe are more than twice US prices and have resulted in average vehicle fuel economy of approximately 40 mpg while VMT continues to grow.

- Based on current European experience, the estimated carbon cap-and-trade price of $30-40 /ton translates into approximately 30-35 cents/gallon—an increase that is not likely to impact travel behavior significantly—based on recent experience.

While there may be short-term impacts, in the long term, given the range of energy price forecasts and the ability of fuel mixes and vehicle efficiencies to absorb changes, no dramatic impacts on VMT growth rates are expected due to these factors. However, additional policies to reduce the rate of VMT growth may be imposed by state and local jurisdiction for energy, traffic and modal policy reasons. Therefore, this project has presumed aggressive use of transit and freight rail – consistent with the most optimistic state, MPO and freight industry thinking.

Highway Safety and Security. Any future national highway program must incorporate a significant set of actions to reduce highway crashes and fatalities, long stalled out in the 40,000-plus level of annual fatalities on the highway system. National leadership in the highway safety field recently developed a road map of strategies to halve this number by 2035. The future Interstate, as a major component in the system, will play a key role in meeting this goal. In addition to ongoing highway and driver safety initiatives, the application of vehicle-highway integration (VII), by offering vehicle–to-vehicle and vehicle-to-infrastructure communications, is expected to produce further major reductions in crash rates not obtainable through conventional technology. Some of the same advanced surveillance, detection and communications technology supporting safety and mobility is also being employed to enhanced security in both emergency evacuation and defense mobility situations.

Community Impacts and New Capacity. The difficult task of expanding the nation's vital transportation network's capacity to handle increased population and freight must be accomplished while simultaneously reducing the environmental footprint of the system. This study presumes incorporation of practices such as:

- Appling the principles and practices of Context Sensitive Solutions to achieve program and project outcomes that fit into and enhance their settings while fulfilling transportation objectives.
- Use of recycled materials to a significantly greater extent, providing more in wetland reserves and wildlife habitats, etc.
- Conservation of materials and energy by applying asset management principles that improve durability and minimize the frequency of maintenance and repairs.
- Improve the drainage and the water quality of runoff from transportation facilities.

Innovative Applications of Systems Operations and Management Technology. The future Interstate would not be at full cost-effectiveness unless the full range of intelligent transportation systems technology (ITS) and aggressive systems operations and management strategies are applied. For example, recent analysis has shown the importance of managing non-recurring congestion that causes about one-half of total delay and which is not substantially eliminated by capacity increases. In addition, the highway infrastructure can also play a critical role in supplying key safety functionality to reduce road-related crashes supplied though the continuing development of vehicle-infrastructure Integration (VII) or its equivalent, providing vehicle, road system and information network links that support stability control, crash avoidance, run off the road avoidance systems, and complete probe-based traffic information for management purposes.

In addition, applications of tolling and pricing offer an opportunity to provide guaranteed levels of service in both congested corridors and for key freight routes, while providing an important supplementary source of revenue.

A National Solution for a National Problem. Any major national highway improvement program will be controversial, since the impacts are often local while the benefits may be regional or even national. Nevertheless, the realities of growth in population (already substantially here) and economic activity (universally desired) commit the Nation to providing a supporting level of mobility (essential) for the people and goods that will be an inevitable part of that future. While every effort must be made to minimize unnecessary road expansion with negative impacts, there is no alternative to highway service in providing a substantial portion of that mobility. A vision of the future Interstate System is needed, therefore, that is equal to these future challenges.

It is imperative to recognize that these are true *national* challenges that require *national* solutions. To serve national freight patterns, connect major new urban areas and disentangle metropolitan congestion, a set of improvements are needed that transcend the borders of individual states or regions. Providing a well-connected, continental, high-capacity system capable of high speeds, high reliability and improved safety for both freight and passenger travel is a key national challenge.

It is not too early to begin. Major increases in infrastructure take a significant period to develop (a decade or more), but they subsequently provide better service for many decades. It has been 75 years since the Interstate System was conceived, and 15 years since the Interstate was completed.

KEY STRATEGIC SERVICE COMPONENTS

However, the needs on the existing system extend well beyond what can be done with improved utilization of existing capacity. The backlog and future growth of freight and passenger travel, together with the changing needs for highway service critical to the national economy and quality of life, provide the rationale for several key strategies that may be considered "components" of a future Interstate Highway System, and priority areas for improved service. These strategic components of the new vision are:

- <u>Aggressive Congestion Management and Asset Management as a Point of Departure.</u> Any program to improve highway service for passengers and freight must begin with ensuring that current highway assets are being used as efficiently as possible. New technology and systems concepts are beginning to have a major impact on the existing system through asset management, multimodal flexibility, and advanced systems operations. A point of departure, therefore, is the presumption and inclusion of full applications of state-of-the-practice asset and operational management techniques.

- A national freight-logistics network. This is critical to maintaining America's competitiveness in the global marketplace. It would consist of extending Interstate connections to the Nation's major gateways, intermodal terminals, other modes, and other major generators as part of an interconnected system. These improvements would provide a system capable of supporting efficient freight transportation and advanced intermodal logistics. Elements of this system also provide the opportunity to offer dedicated toll supported lanes in key truck corridors, enhancing trucking productivity and improving highway safety.

- Metropolitan mobility and congestion management. This is essential to the efficient functioning of urban areas and to quality of life in the growing urban regions and "mega regions." Significant increases in capacity are needed—especially in suburban and exurban areas, and to provide for inter-metropolitan passenger and freight travel while simultaneously meeting a range of other local and commuter travel needs—often in the same corridor. New capacity constraints in larger metropolitan areas suggest the critical importance of supplying "manageable" facilities with an appropriate configuration of lanes for HOV, HOT, and transit, and in some cases with strategies that provide premium service, demand management and revenue generation through tolls and pricing.

- The new geography connectivity component. This would extend the existing Interstate System to regions and resources currently not served at Interstate standards, including a range of significant urban areas and destinations that have emerged since the Interstate was designated over fifty years ago. This approach would ensure that these areas have the same Interstate service as older urban areas. It would also provide the rural access that is important to expanded coverage, freight service and network redundancy, and would support access to key rural resources and attractions.

CONVERTING SERVICE COMPONENTS INTO A SYSTEM: A SYSTEMATIC APPROACH

This project is the first systematic analysis of issues, network and performance implications, and improvement needs related to the future of the Interstate Highway System. Supported by NCHRP and AASHTO and utilizing the best available USDOT data and analytic methods, the analysis identified broad national objectives, analyzed those objectives to develop an appropriate vision, and grounded this vision in a quantitative estimate of improvement needs and their investment implications. Key steps in the process included:

- Reviewing the implications of long-term growth in population, economy and related factors including saturation in vehicle ownership and use, changing demographics, modal options, and fuel prices.

- Forecasting expected growth and change in highway travel – freight and passenger – in fifteen year increments over the next 30 years, based on the current FHWA and AASHTO analytics and data.

- Identifying key national objectives that require the support of a high standard, interconnected highway network.
- Developing performance criteria, both user cost and function-based, reflecting strategies by which an future Interstate System could best meet the challenges.
- Dimensioning the improvement needs generated by the criteria in each of the three major strategic areas – in terms of types and amount of interstate expansion and extensions and their costs.
- Indicating the potential of options relating to tolls, pricing and multimodal systems management options on travel demand and related infrastructure costs.

SCALING THE SYSTEM: THE GROWTH IN FUTURE DEMAND FOR TRAVEL

As appropriate, this analysis takes a long-term view. It started with a forecast of travel expected over the next 30 years, when both the demand for travel and the economic capacity to respond will have increased dramatically. With the Nation's population growing at about 1 percent per year and GDP growing at about 2.8 percent per year in real dollars (not inflated dollars); national highway travel is expected to grow at less than the historic 2.7 percent rate.

However, these trends in VMT growth are not expected to continue. Long-range rates are expected to flatten, owing to a slowing rate of demographic growth, saturation in licensing and vehicle ownership, rising gasoline prices, an aging population, increased congestion, and limits to individuals' daily travel time budgets in the future . For this study a rate of 2 percent per year has been used for the next 20 years. Beyond that it has been reduced to about 1.5 percent growth per year.

In addition, aggressive assumptions have been made about the increased role of transit and private freight rail:

- The transit assumptions utilized by MPOs in state-level VMT forecasts have been used in forecasting highway travel share and needs.
- Similarly, aggressive assumptions for future freight rail share from the AASHTO Rail Freight Bottom Line are used for the long-term VMT projections.

PERFORMANCE CRITERIA FOR THE FUTURE INTERSTATE SYSTEM

The major national strategic surface transportation components identified above—national freight network performance and continuity, metropolitan congestion management, and enhanced interregional connections—have been analyzed to determine their strategic implications for improving or extending interstate service levels to meet the needs of the 21st century. A systematic technical process has been used to convert the strategies into a dimensioned program concept based on functional and performance criteria As detailed in the full report, modest performance targets were used in developing options:

- Maintaining current user costs (travel time, operating and safety) and cost-effective levels of service on the existing systems, despite an 80 percent increase in VMT.
- Providing upgraded Interstate-standard connections and improved services to key underserved destinations.
- Indicating the opportunities for management applications, both multimodal and pricing, to provide for improved service in selected congested contexts and major freight corridors.

These criteria were used to delineate a set of expansion and extension concepts capable of responding to anticipated long-term demands in terms of adding capacity and lanes to the existing 47,000 mile Interstate System, through extending the Interstate (largely by upgrading existing non-Interstate facilities) in order to meet a set of key national transportation functions, and by applying systems management to improve levels of service and safety. These strategies were then dimensioned and analyzed for the extent of new system required, together with their costs and performance implications.

SCENARIO OPTIONS

Two different scenarios were evaluated at different system extents (lane and route mile additions) that involved contrasting levels of service and costs of provision:

- *Maintain Performance.* This scenario combined two assumptions: add capacity to the existing interstate at a level to maintain current average user costs (time, operating costs, safety), and upgrade key functionally-defined inks at Interstate standards to provide important connections and services
- *Reduce Service/Lower Investment.* This scenario looked at the implications of an Interstate System improvement program presumed at exactly one half of the cost-effective lane additions of the Maintain Performance scenario. Such a system would not maintain current level of service or provide the needed connectivity.

Analysis of the Reduce Service/Lower Investment scenario suggested that while it provided a valuable point of comparison to the Maintain Performance scenario, it had little value as national policy. Costs per user mile for users would be 10 cents higher than today, a number that seems small until one considers that 1.3 trillion VMT per year would be impacted, with user costs per year by 2035 being $130 billion higher for the just for users of the existing Interstate – but would save only $18 billion per year compared to the Maintain Performance scenario). And this considers only the user cost side, without including the broader types of benefits that DOT has estimated in productivity terms. This reduced investment scenario clearly makes no sense for the nation's economy and was not analyzed further.

THE FUTURE INTERSTATE SYSTEM PROPOSAL

The Maintain Performance scenario incorporates the system improvement implications of the three improvement strategic concepts. The implications of providing improvements consistent with the three strategies have been analyzed in quantitative terms relating to amount of new capacity, capital costs and performance. While these three strategies have been combined for analytical purposes, each may be considered on its own merits for mixing and matching as part of a future Interstate System.

System Extent. The application of performance criteria in the context of the growth in demand and the specific functional needs of connections and continuity has indicated the need for an additional 173,000 lane miles of capacity to be added to the 210,000 lane miles of the existing Interstate System. As shown in Table 1 below, this new capacity would be achieved in two ways:

- *Expansion of the existing Interstate System*, adding 88,600 lane miles within its existing 212,000 lane miles on 46,800 route miles.
- *Extensions of the existing Interstate* System, through upgrades of the national highway system (NHS) and related corridors, converting 15,000 route miles to the Interstate, involving an additional 84,400 lane miles.

In total, the future Interstate System would supply 385,000 total lane miles of capacity along a total system length of nearly 62,000 route miles. Accommodating the forecasted travel at the performance level used in this analysis implies the addition of about 5,760 lane miles per year.

Table 1: Present and Future Interstate Systems

Present and Future Interstate Systems						
	Interstate			**Non-Interstate NHS**		
	Miles	Lane miles	VMT	Miles	Lane Miles	VMT
Existing system	47k	212k	24%	115	347K	20 %
Future Interstate	62K	385k	37%	100*	289*	10%*

***** *There will likely be some growth in miles and lane miles on the non Interstate NHS system but they have not been estimated for the purposes of this study.*

System Efficiency. The new 62,000 mile Interstate System would handle 1.8 trillion VMT of the year 2035 total of nearly 5 trillion annual VMT on all public roads. Despite an 80 percent increase in VMT on the existing Interstate, the current level of service and related operational standards would be maintained on the existing Interstate System, with the addition of less than 40 percent expansion in lane miles and a 32 percent increase in route miles. The efficiency of these improvements is indicated by the fact that the expanded and extended Interstate would handle almost 37 percent of the VMT, on only 1.6 percent of the route miles and only 1.9 percent of the lane miles.

Attracting this share of travel to the Interstate would allow for much more productive and much safer travel and would provide a high level of service in terms of speeds and connectivity. This also provides the opportunity for a focused application of aggressive systems operations and management to reduce the portion of delay that is related to non-recurring congestion as a result of traffic incidents, weather and construction. Applying the full array of management strategies provides a potential reduction in this non-recurring component of delay by almost 34 percent, with a cost-benefit ratio of 19:1 at a cost of approximately $4.5 billion per year over 30 years. Since non-recurring delay is fifty percent of current delay, these very modest investments provide enormous benefits.

System Cost. Cost estimates were made in constant dollars on an annual basis over the next 30 years for comparability with current levels of expenditure. The improvement costs of the new Interstate -- 385,000 lane miles of interstate capacity on nearly 62,000 route miles -- is made up of two components:

- *Expansion* of the existing Interstate alone (88,600 lane miles over 30 years) costing $47 billion per year, the rate of investment in new capacity (and preservation) required to keep average operating costs per mile on the existing Interstate the same at the end of the 30 year period as they are today, as the Interstate VMT grows 80 percent from just over 700 billion annual to almost 1.3 trillion annual VMT over the 30-year period. The $47 billion per year may be compared to about $17 billion invested per year in the Interstate system today, heavily oriented to preservation rather than system expansion. (Over the last 10 years only about 500 new lane miles per year have been added to the existing system) Of the $47 billion, $13 billion per year is the already inescapable investment required just to preserve the existing Interstate. The capacity addition implies a rate of about 2,950 improved lane-miles per year, or 1 percent per year which is more than 5 times the current rate -- but well within the rate of improvements made during the peak period of Interstate construction from 1960 to 1980.

- *Extension* of the existing Interstate System through selected upgrades of key NHS and other corridors, accounting for an additional 84,400 new lane miles at an additional $58 billion per year.

Together these two components combine to a total annual expenditure of $103 billion per year over the 30 years. This level of expenditure for the expanded and extended Interstate System may be compared with the most recent C&P figures of an estimated $70.3 billion (2004) currently spent for highway capital outlays and $147.5 billion total highway expenditures.

Role of Tolls and Pricing. Congested metropolitan facilities and high volume truck routes both offer important opportunities to provide guaranteed levels of service and generate needed revenue to supplement conventional sources through toll and pricing approaches. The thirty year forecast of truck volumes indicates that there may be over 6,000 miles of high volume interstate truck routes that offer significant toll potential. In metropolitan areas, travel forecasts on the existing urban interstate suggests there would be up **to** 8,000 route miles of existing urban Interstate (28,000 lane miles) that are potential candidates for High Occupancy Toll lanes (HOT) or other pricing and management schemes -- based on near-capacity-level traffic volumes forecast

RELATIONSHIP TO STRATEGIES

This improvement program, required to maintain current performance, can be viewed in terms of its relationship to the vision strategies that are its components as indicated in Table 2 below.

Table 2: Future Interstate Program Breakdown

Interstate System Component	Lane miles	Percent of total	Annual cost ($B)	Total 30 year cost ($ B)
Freight logistics network improvement	68,600	26	27	835
Metropolitan mobility program	73,600	68	71	2,156
New geography connections	30,700	5	4	113
TOTAL			103	3,105

*The above costs include $386 billion for preservation of the existing Interstate.

The $105 billion per year investment must be put in perspective. Looking out into the 30- and 50-year time frame to be served by the next increment of the Interstate Highway System, it is clear that future transportation investment needs will be higher than historical needs, because of near universal auto ownership and vastly increased economic activity in the society. A more prosperous society will demand much higher quality transportation services, transportation options, and increased reliability in goods movement. At the same time however, the Nation's ability to afford good transportation will increase markedly. Today, travelers are spending about 2.5 cents per vehicle mile for travel for infrastructure, out of a total cost of 50 - 60 cents per mile for a mid-sized car. The incremental cost for the Interstate improvements (carrying 40 percent of the total VMT) would be another 2 cents per vehicle mile.   A society that is on average more than twice as wealthy as it is today will demand better service and will not be satisfied with low service levels.

BENEFITS EVALUATION

An optimistic vision of the future of surface transportation in the U.S. over the next generation incorporates a mix of aggressive policies to moderate the demand for vehicular travel with multiple modes, management, and pricing—all requiring substantial departures from recent trends. However, meeting the needs of an expanding population and a healthy economy will also require a major investment in new highway capacity.

Indeed, an analysis of the "do nothing" scenario for the Interstate indicated a 20 cents-per-mile loss to the average user in the 30-year time frame. Obviously, this is also not a course of action that the society would consider desirable.

The Interstate Highway System represents an investment in expanding and improving a high-speed, safe, low-cost-per-mile system; capable of creating the new envelope of space, time, cost and technology that our changing economy needs in support of a global economy with changing patterns of production and distribution, settlement and lifestyle.

State-of-the-art econometric studies have indicated that, on average, U.S. industries realized production and distribution cost savings averaging 24 cents annually for each dollar invested in the non-local road system. In terms of the more measurable direct economic impacts, the reductions in user costs (time, safety, operating) can be estimated and such an approach was used in this analysis. Determination of a reasonable level of investments in capacity and management improvements in this project was based on maintaining existing user costs for the Interstate together with an acceptable level of service (V/C =1.0) on the existing NHS. The additional improvements—upgrades of connections to newly urbanized areas, intermodal connectors and trade corridors—were based on the presumed benefits of establishing new or improved connections to these economic generators at Interstate standards, tied into the Interstate network.

The investments driven by connectivity criteria (urban areas, intermodal connectors, trade corridors) cannot be evaluated directly. However, the recent rise in logistics costs reflecting freight movement, and premiums placed on reliability, suggest the importance of investing in a system related to contemporary global economic organization. The scale of these benefits is only suggested by the Nation's $620 billion truck freight bill. Similarly, the value of capitalizing on economies of scale and wider market access associated with tying in many major urban areas not now served by the Interstate System is multiples of travel cost savings.

Safety is another key source of benefits. While historic fatality rates have declined on all systems, the Interstate has by far the safest highways, as shown in Table 3. However, this decline in total numbers has flattened in recent years. USDOT has now adopted aggressive goals that will be heavily dependent on technology but which can receive a substantial assist from the shift of a greater percentage of VMT to the higher standard Interstate. In 2004, non-Interstate NHS fatality rates are estimated at about 1.3 fatalities per 100 million miles of travel versus 0.8 on the Interstate portion of the NHS. This implies almost a 40 percent reduction in fatality rates for NHS VMT that is shifted onto the higher standard Interstate routes under expansion options examined in this report. The addition of separate truck lanes would further support such an improvement.

Clearly a more detailed analysis of the relative benefits of differing levels and types of highway investments would provide additional insight on their impacts.

Table 3: Trends in Highway Fatality Rates

	Interstates			Non-Interstates		
	Fatalities	**VMT**	**Fatality Rate /100 Mil VMT**	**Fatalities**	**VMT**	**Fatality Rate /100 Mil VMT**
1969	4,215	145,016	2.91	50,828	916,775	5.54
1979	4,444	293,049	1.52	46,649	1,236,084	3.77
1989	5,003	461,820	1.08	40,579	1,634,667	2.48
1999	5,583	643,190	0.87	36,134	2,048,145	1.76
2004	5,762	721,381	0.80	36,874	2,241,132	1.65

THE FUTURE INTERSTATE PROGRAM DEVELOPMENT PROCESS

Elements of the strategies set forth above would comprise a systematic, relevant, consistent, scaled basis for more detailed development of a future Interstate System. But moving from strategic concept to system reality poses the substantial challenge of establishing policy consensus and an effective cooperative process. Experience over the last two decades indicates that forging a consensus around national objectives will not be easy. It has become clear that that a 50-state program is not the same thing as a true national program. The manner in which competing interests, national, state, and regional, are balanced is likely to be central to the development of a significant future Interstate System.

A systematic yet politically viable cooperative process must also be established to formulate and gain support for a common vision, define the necessary policies and strategies, and implement the resulting programs. Clearly, this must involve both federal and state partners as well as local government, metropolitan and other planning organizations, and key private sector stakeholders. Given the key national interests at stake, the interstate nature of the system, and the strategic transportation issues requiring national policy resolution, it is essential that Congress establish both the basic policy principles and the general process to be followed to provide a strong partnership framework.

An important point of departure will be gaining broad consensus on the critical relationship of national-level concerns to national, interstate and interregional-scale highway improvements, recognizing the traditional voluntary nature of federal aid and the importance of accommodating differing state interests, and providing relevant incentives for broad participation.

This reconciliation will involve grappling with tough trade-offs between national and state/local priorities, including:

1. Provision of funds and financing adequate to support a meaningful level of interstate improvements and flexibility in implementation process.

2. The ability of the program to accommodate a broader array of funding approaches including innovative finance and public-private partnerships.
3. Program adjustments to accommodate equity among states where investment to satisfy the national objectives will not necessarily be evenly distributed among states.
4. The availability of funds for continuing preservation and operations of the built system.
5. Procedures to work out continuity requirements that involve the need to bridge certain states and for multi-state cooperation and compromise.
6. The importance of applying common national standards regarding design, asset management and systems operations.

RECOGNIZING THE NEED TO RESPOND TO UNIQUE ISSUES ASSOCIATED WITH STRATEGIES

It appears that even with a national vision and nationally focused transportation policies and strategies, a more multifaceted approach to program development, multi-modal integration, and financing will be necessary with the future Interstate than the uniform approach adopted in funding and developing the original Interstate System. With conventional funding at the core, a range of innovative funding and program development options must be encouraged and accommodated. At the same time, an important consideration will be to maintain, in program design, a criteria-driven focus on the unique role to be played by the Interstate.

In addition, the strategies for metropolitan capacity, freight networks and new connections have unique characteristics that must be built into a future Interstate System Development process. Considerations are likely to include:

- Metropolitan improvements require increased programmatic flexibility regarding alternative approaches to providing improved highway service in highly constrained contexts. The Interstate program must therefore accommodate a broad range of multimodal systems management options. However, this must be coupled with a commitment to provide for the longer-distance interstate travel that distinguishes the Interstate Program from a range of other federal and state investments targeting general metropolitan mobility. Such a program approach will require a combination of incentives and constraints to balance these considerations.

- Freight-oriented network improvements for significant impacts need to include provisions for larger combination vehicles and, in high-traffic corridors, possibly separate facilities. The economic significance of improvements in freight transportation to the commercial community suggests the potential of a range of innovative beneficiary-based funding opportunities to support this program (in addition to convention fuel tax funding), including new sources that may be at the national level. Reaching consensus on such an approach will also involve consideration of deregulating the currently frozen truck size and weight regulation to address productivity issues.

- Increased connectivity, urban and rural, is not likely to be evenly distributed nationwide given the disparities in regional growth rates. Special provision will have to be made for states and regions with fewer needs.

- In general, the diverse and capable state DOTs and their partners will benefit from reduced restrictions on innovation – in funding, systems operations, use of tolls, new technology, and context sensitive design. Flexibility in the federal aid program to support and incentivize new forms of institutional sponsorship for facility development, finance and operations (such as public-private partnerships) will substantially extend the capacities of state and local transportation agencies to produce the program levels implied by the findings of this study—including innovative approaches. The strong commitment to national interest should be at the performance level.

KEY STEPS IN A FUTURE INTERSTATE SYSTEM DEVELOPMENT PROCESS

Given the considerations noted above, key steps in the process for the development of the Future Interstate Systems must include:

Defining Future Interstate Policy. The initial step must be making the policy case by generating a broad national consensus among key stakeholders of the need for a significant investment in terms that are relevant to key stakeholder constituencies, including definition of the objectives and related performance criteria that would define the appropriate improvements and the related eligibility criteria. However, unlike the original Interstate and current highway programs, components of the future Interstate may require a mix of funding resources involving a range of public and private interests. Tapping new sources will require providing a reasonable certainty that declared objectives will be met and that the Interstate Program is capable of providing the type of coherent national improvements suggested in this study.

In all cases, the funding program must be:

- Efficient in its focus on the priority national system-related improvement needs.

- Equitable so that states with limited future Interstate System improvements that meet the criteria would receive some form of compensation.

- Affordable for the overall investment scale.

- Flexible to provide an incentive for innovative finance and development options.

Designing a Program Implementation Process. The next step is developing a process to convert the national objective-related criteria into a process for identifying location-specific investments in each jurisdiction that fulfill the criteria and meet system requirements. A special challenge is developing improvements that are consistent with those “national” features and still make sense in the state/regional/local context. It is presumed that “business as usual,” based on the current categorical programs and needs-based apportionments, is not capable of providing the degree of focus on interstate needs. This has been demonstrated by the history of the Interstate System since ISTEA.

However, the history of the federal aid program has included two other approaches, network mapping and use of criteria, which have been used with considerable success and could be adapted in some combination to provide the basis for a consensus implementation process. The existing NHS could provide a logical point of departure if combined with criteria and priorities that would establish a set of specific priorities relating to level of service and function. Using the NHS as a template, these criteria would be applied by the states to determine project eligibility. In addition, special processes may be necessary to resolve both interregional-local priorities as well as multi-state continuity issues.

Under this process, apportionments might be made to a categorical Interstate Program according to overall highway transportation needs (as with the current NHS) with a minimum guarantee for states that could certify they had no improvements consistent with the criteria.

REPORT STRUCTURE

The detailed report that follows this Executive Summary has been organized into the following sections:

- Chapter 1 presents a discussion of past versus future role of the Interstate and the major national surface transportation issues and their implications for the future Interstate.
- Chapter 2 presents the objectives-driven performance approach used to identify future Interstate Needs.
- Chapter 3 describes key strategies used in developing the future interstate vision.
- Chapter 4 presents a total vision for the future Interstate.
- Chapter 5 suggests a process for a cooperative development of the Next Interstate concept.
- Chapter 6 presents a summary vision.

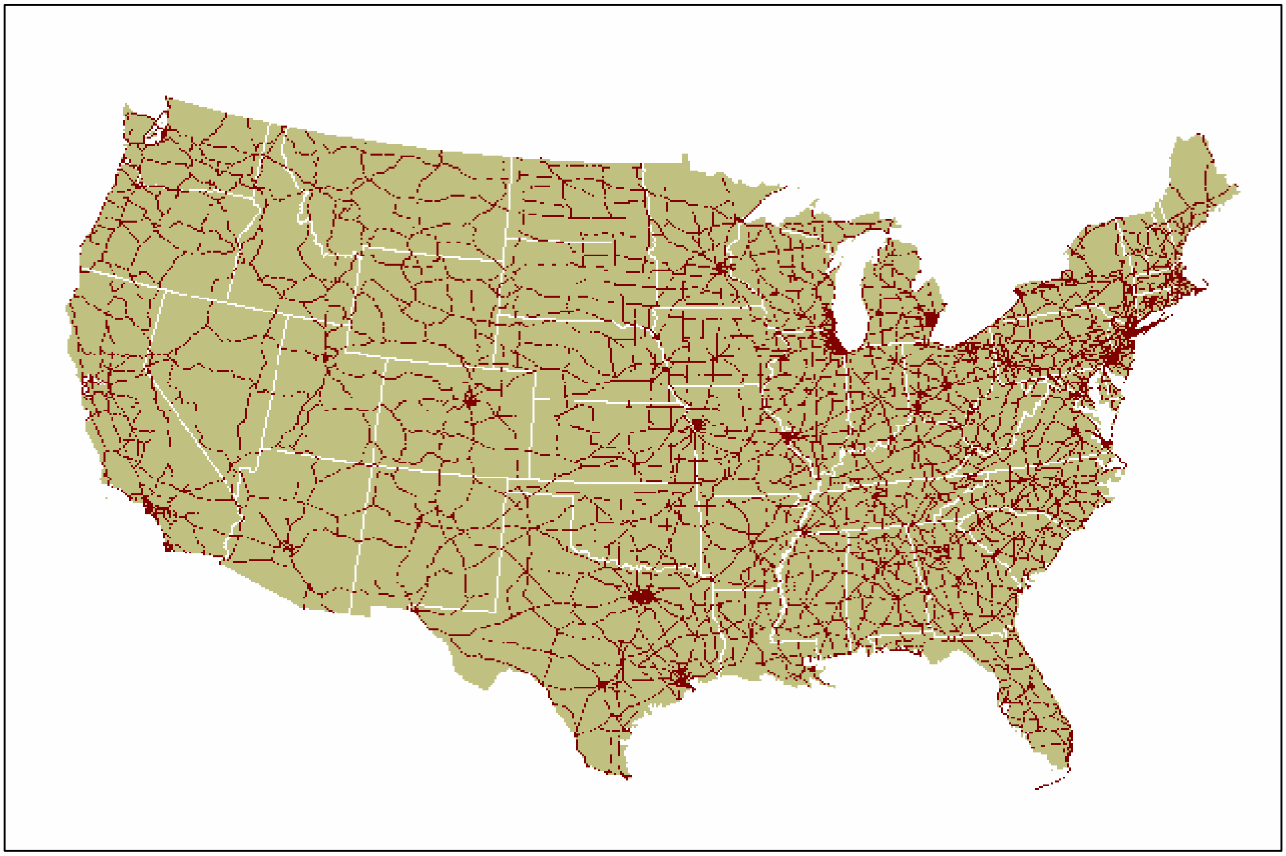
Chapter 1: PAST vs. FUTURE CHALLENGES TO INTERSTATE HIGHWAY TRANSPORTATION

1.1 THE INTERSTATE LEGACY

Original Role. The Interstate has served as the backbone of the Nation's highway and intermodal system since construction began in 1956. It was conceived as, and has functioned as, the premier highway network serving the need for longer-distance travel that is a key component of a continental-scale national economy and a mobile society. In addition, it has served the needs of growing metropolitan regions. As documented at its recent 50th Anniversary, the original Interstate System had important catalyzing impacts. National, multi-state, regional, and local economies reorganized to capitalize on capabilities provided by the system's connections, speed, capacity, and safety advantages. Regions that were previously not well connected with the national economy became more closely linked for both goods movement and personal travel. Metropolitan growth was supported by Interstate access, although this had negative as well as positive impacts.

As the Interstate System moved toward completion in the late 1980's, the following question emerged: what surface transportation program should follow the completion of the Interstate System? Many options were considered. The Interstate program was clearly a success, as demonstrated by its high utilization (though accompanied by congestion). But functional and connectivity needs had evolved in such a way that the system no longer provided the underpinning for additional dynamic growth. A consensus emerged that the post-Interstate highway program should have as a major component a "system of national significance" that would include an expanding Interstate System and a much smaller primary system. The new program came to be titled the National Highway System and it was enacted as a part of the Intermodal Transportation Efficiency Act of 1991 (ISTEA). As shown in Figure 1, its 165,000 route miles include a range of facilities (only 6 percent of the non-Interstate portion is access controlled) reflecting a broad range of state and national needs, but its extent is obviously well beyond the Nation's ability to upgrade to full Interstate standards. Under the provisions of ISTEA, states would be able to use their NHS funds to evolve the Interstate System though through widening as appropriate to overcome congestion and preserve system operations, upgrading existing routes where growth or economic conditions warrant, and extending on to new locations where state priorities and national interests coincide.

Figure 1: National Highway System (source: AASHTO Highway Freight Bottom Line 2007)



Today, just over 15 years since its enactment, it is clear that that ISTEA, so successful in other ways, did not allow the Interstate System to continue its vital role as the backbone of the Nation's highway system. The good news is that the investment level in Interstate pavement and bridge has been sufficient to preserve the existing capital stock. The bad news is that the investment level has not been sufficient to prevent increases in travel times and the loss of reliability that is inherent in congested operations. Since ISTEA only 36 route miles per year have been added, concentrated in only a few states.

In the past, transportation efficiency has been this Nation's "ace in the hole" in competing in the global marketplace, offsetting significantly higher costs of labor and regulatory compliance. This U.S. mobility advantage for freight and passenger traffic continues to erode as the performance of our transportation system suffers due to underinvestment, and as competitors invest in duplicating within their own borders the air, rail and highway networks vital to economic competitiveness.

1.2 21ST-CENTURY OBJECTIVES

Since ISTEA (1991), the Nation's major surface transportation challenges have become clearer. In fact, broad consensus already exists regarding key strategic issues related to the importance of developing an Interstate System appropriate to the 21st century. Several recent analyses done for AASHTO, the U.S. Chamber of Commerce, TRB, the Policy and Revenue Commission, and major interest groups have, in common, identified the key challenges that must be addressed in the development of any new transportation strategy. Figure 2 summarizes three key strategic issues and the issue-related transportation needs.

Figure 2: Emerging National Transportation Challenges

21st Century Issues	Issue-related Needs
1. Global economic competitiveness	• Accommodate increase in high value/low bulk truck movement including special treatment for more efficient configurations and operations • Improvements and extensions of the network-wide high level of service and safety offered by the Interstate standards of design and service • Improved connectivity and level of service to the major intermodal terminals including seaports, airports, rail terminals, ports of entry and inland intermodal terminals • Provision of improved service to major commercial vehicle movements concentrated on critical Interstate trade corridors including potential for dedicated lanes and longer combination vehicles • Provision for national defense-related rapid deployment/mobilization by upgrading critical fort to port STRAHNET connectors to enhance deployment time frames and improve facility security
2. Metropolitan Mobility and Congestion Reduction	• Accommodate expanded metropolitan areas and serve increase in suburb to suburb movement with flexible capacity options • Apply congestion management concepts (ITS, VII) and operations to improve system efficiency and reliability • Apply managed lane options for high occupancy vehicle and bus rapid transit operations and for "premium" tolled and priced services • Eliminate major bottlenecks (at interchanges, grades, merges, etc.)
3. The new Geography -- Regional and rural development and equity	• Extensions of the Interstate to provide connections to new and emerging centers of population and commerce such as rapidly growing urbanized areas, recreation centers • Preservation of rural access and connectivity • Service to tourism • Improved connectivity to and among urbanized areas for security access and redundancy

In addition to these strategic transportation needs, three other cross-cutting concerns represent issues to be accounted for in considering transportation systems of national significance:

- The contribution to achieving lower fatality and accident rates through the conversion of highways to Interstate design standards, separation of heavy truck traffic, and application of advanced vehicle-infrastructure technology for crash avoidance.
- Support of improved security through provision of system redundancy, evacuation capacity and key asset security countermeasures.
- Consideration of energy related issues including energy security and global climate change through improved system efficiency and management opportunities.

The vision for a future Interstate must respond to the key needs associated with these major strategic issues. As discussed below, the needs suggest an important focus of a strategy for the future Interstate System by which they can be addressed—with special dimensions that have implications for the location, amount and type of highway improvements implied.

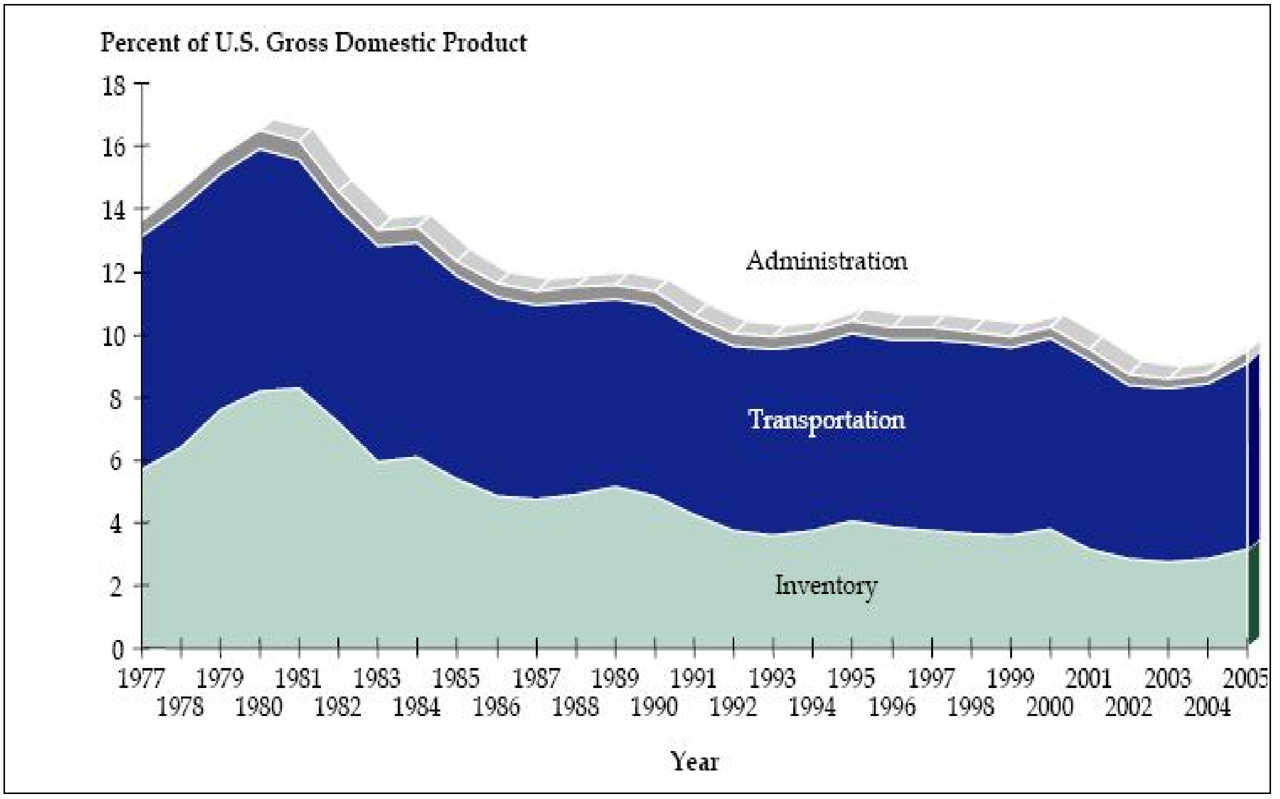
1.3 GLOBAL ECONOMIC COMPETITIVENESS: THE FREIGHT CHALLENGE

The growing integration of the global economy has placed U.S. production and consumption in an increasingly competitive framework with Asia and the European Union. In addition, trade and production interaction with Mexico and Canada constitute a significant proportion of the U.S. economy. A substantial portion of this movement is continental in scale, from points of entry to major production and consumption centers in the upper Midwest and Northeast. At the same time, the value of the Nation’s output has become increasingly related to high-value products such as electronics and automotive products. An increasing portion of these goods move in an intermodal fashion, often using two or more modes (large and small trucks, rail, ship), with trucks handling 92 percent of goods by value and 77 percent by weight.

But the existing Interstate was conceived before the truck-dependency of the U.S. economy, the widespread use of intermodal technology, and the importance of supporting global intermodal commercial patterns within the U.S. including key connections to ports, border crossings and major areas of production and consumption. Little net new capacity related to freight has been added in highways or freight rail. Despite rate deregulation and increased price competition, regulations of size and weight have not been changed since 1982. While freight railroads have been successful in upgrading track weight allowances, trucking in more efficient longer combination vehicles (LCVs), are confined to a limited network of highways and toll roads mostly in the west and are subject to a regulatory freeze due to a long-standing debate about the safety and physical impacts of such vehicles.

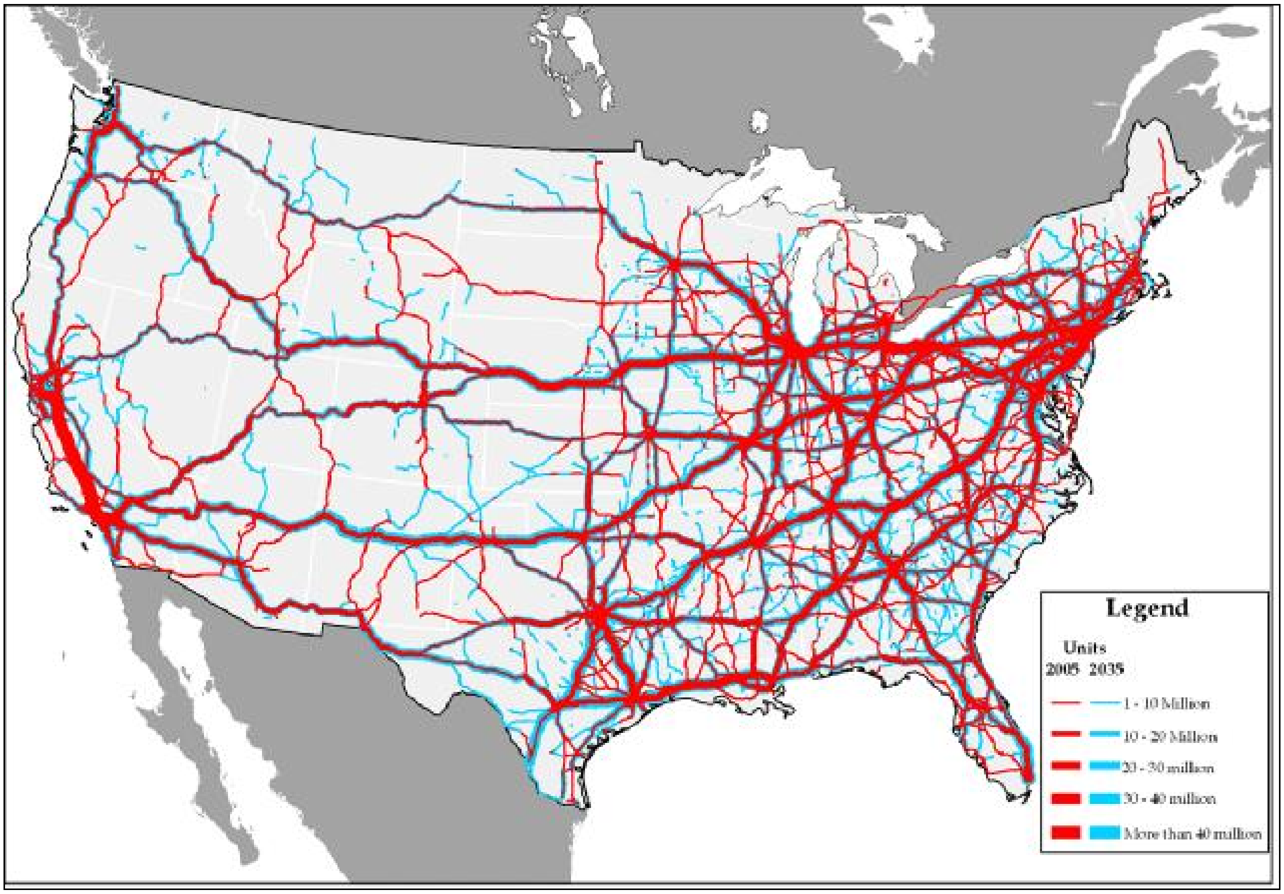
As suggested in Figure 3, total logistics costs as a percent of GDP have recently plateaued and are starting to increase. While a combination of commodity, modal and network mismatches plus higher fuel prices are partly to blame, highway congestion and less reliable travel times were nearly as important, causing freight carriers to spend more on drivers and trucks, and shippers and receivers to hold larger inventories than in prior years. Congestion and unreliable travel times may have accounted for a third of the increase in inventory carrying costs in 2005. There is concern that the productivity of the highway freight system will continue to drop and that logistics costs will rise further in light of this growing freight capacity shortfall.

Figure 3: Total US Logistics Costs (Source: Rosalyn A. Wilson, *State of Logistics Report*, Council of Logistics Management, 2006)



Given the doubling of freight volumes expected over the next 30 years, all freight modes will be struggling to increase productivity and handle the movements. Figure 4 shows the major truck freight corridors and volumes today and in 2035. Where there are 10,500 trucks per day per mile on the system, in 2035 there will be 22,700 trucks per day per mile, with the most heavily used portions of the system seeing upwards of 50,000 trucks per day per mile.

Figure. 4: Comparison of Freight Truck Flows 2005-2035 (source: AASHTO Highway Freight Bottom Line (2007)



In light of the above trends, it is apparent that future freight-related productivity gains will be substantially dependent on a set of Interstate functional and service improvements that can link the nation's key gateways into the Interstate System and provide the appropriate degree of truck freight capacity on key corridors and connections. In addition, a potential opportunity for efficiencies would be selective use of separated truck lanes for larger vehicles to provide productivity for the Nation's commerce while at the same time improving safety through elimination of conflicts with passenger cars. Several recent studies have proposed special truck toll lanes and suggest the necessary improvements could be financed as separate truck toll lanes or through related freight-related fees.

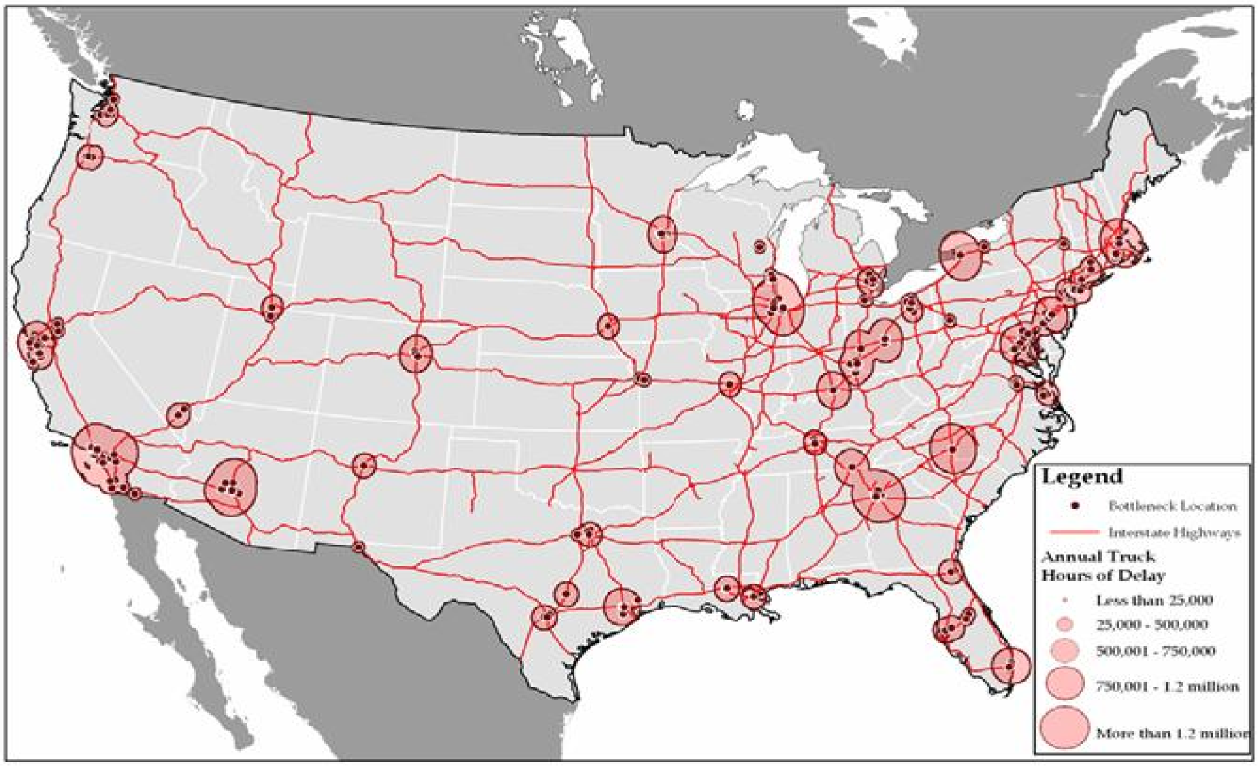
1.4 METROPOLITAN MOBILITY: CONGESTION REDUCTION AND SYSTEMS MANAGEMENT

The primary national purpose role of the Interstate highway in metropolitan areas is to serve regional and interregional-level travel needs, not to support local travel and commutation within existing metropolitan areas. These trip types are supported by other state and federal programs, both highway and transit, custom-tailored to each metropolitan area. Nevertheless, the necessarily multi-purpose role of metropolitan Interstate links entangles them in ordinary urban congestion.

The general declining state of urban mobility has been thoroughly documented. Over the last 20 years, urban vehicle miles of travel (VMT) has increased by about 80 percent while highway lane mile increases have been only about 4 percent, with little of that on the Interstate. The amount of traffic experiencing congested conditions in the peak travel periods (three hours in the morning and three hours in the afternoon) in the Nation’s largest urban areas has doubled in the last 25 years from 32 percent to over 67 percent in 2003. Congestion is increasing not only in severity but also extent and duration. Currently congestion is causing nearly 4 billion hours of annual travel delay and over 2.3 billion gallons of wasted fuel. According to the chief economist of the USDOT, the nation is already paying nearly $170 billion per year for congestion and unreliability, both urban and rural, and the cost is growing at more than twice the rate of growth of the overall economy. This constitutes a significant drag on the national economy, global competitiveness and the quality of life.

The growth of “mega-regions,” or clusters of metropolitan areas, represents an unrecognized transportation need impacting freight, business and recreational travel. As shown in Figure 5, the most congested bottlenecks for freight occurred on the Interstate System in and around the larger urban areas. These highest level facilities, originally intended for connecting and thru traffic, now serve the complete range of often conflicting functions including commutation and daily business. Average daily traffic volumes on urban Interstates have increased by over 18 percent in the last decade.

Figure. 5: Location of Major Highway Bottlenecks for Trucks *2004* (source: AASHTO Highway Freight Bottom Line 2007)



The most recent statistics show that the current rate of transportation improvement is not sufficient to keep pace with even a slow growth in travel demands in the largest urban areas. Despite large investments in transit for commuters, especially those centrally oriented in major metropolitan areas, transit cannot substitute for the Interstate highway purposes of accommodating the longer-distance passenger and freight movements and thru trips that continue to grow. At the same time, given the high cost and other difficulties regarding urban interstate expansion, especially in the face of limited transportation resources, few of the largest areas have developed significant expansion plans for their current urban Interstate. Moreover, the unique role that the interstate plays as part of a metropolitan and inter-metropolitan network is difficult to preserve in the face of local stakeholder interest in serving more local needs. Some states and MPOs are developing flexible, multimodal, multipurpose alternatives to the use of their major Interstate corridors to accommodate a combination of freight and passenger needs for local and long distance trips.

1.5 THE NEW GEOGRAPHY: REGIONAL AND RURAL CONNECTIONS

There is a new geography within the national patterns of development that have taken shape since WW II. First, there was a general redistribution of population, including rural-to-urban migration and the growth of metropolitan areas. These expanding metropolitan areas grew into sprawling metroplexes of central city, suburbs, edge cities and exurban nodes that are increasingly dependent on highway service. At the same time there was a significant national redistribution of population from the Frost Belt to the Sunbelt. Regions in the Sunbelt that had been less developed in the pre-air conditioning, pre-expressway era grew rapidly—faster than the rest of the country—into sprawling, auto-dependent metroplexes.

Much of the post-World War II growth around major metropolitan areas and especially in the Sunbelt was not anticipated by the pre-war planners of the original Interstate. As a result, significant regions in the Southwest and Southeast are substantially unserved by the existing Interstate. In addition, many of the smaller urban areas nationwide have grown to significant size producing 70 urbanized areas with a population of more than 50,000 unconnected to the Interstate Highway System.

These patterns will persist into the future. Sunbelt states that are not well served by Interstates will account for one-half of the future national total. Nevertheless, the Northeast and Midwest continue to redistribute population and create the demand for new transportation facilities, especially those able to support their expanding suburban and exurban development. The new post-industrial economy has also dispersed location of employment into exurban areas, and new rural resource-based activities such as tourism, agriculture, and energy extraction and production have created new patterns for both production and consumption. These “new geography” issues provide a complex agenda for improved connectivity.

1.6 STRATEGIES TO MEET THE CHALLENGES

These challenges make it clear that a premier “national” highway system is needed now, more than ever. However, they also highlight the importance of functions that are very different from those that existed during the original Interstate development over 50 years ago. What is needed, therefore, is not “more of the same,” but an entirely new vision for the future Interstate highway development and service provision—one that recognizes the distinctive challenges to be met, the specific mix of roles involved, and the technology, financial, operational and intermodal systems opportunities available.

In light of the broad national significance of the challenges outlined above, a systematic process has been adopted to determine appropriate strategies for interstate improvements, expansions, extensions, connections, operations and multimodal flexibility that would produce a future interstate highway system capable of meeting those challenges. This process is discussed in the next section.

Chapter 2: AN OBJECTIVE-DRIVEN, PERFORMANCE-ORIENTED APPROACH

The three major national surface transportation strategic issues discussed above—national freight network performance and continuity, metropolitan congestion, and enhanced interregional connectivity—have been analyzed to determine their strategic improvement implications for creating an Interstate System that meets 21st-century needs. A systematic approach was used to convert the three issues into system improvement strategies, including:

- Forecasting expected growth and change in highway travel, freight and passenger, over the next 30 years.
- Identifying key national objectives that require the support of a high-standard, high-performance interconnected highway network.
- Developing performance criteria that would suggest strategies by which a future Interstate System could best meet the challenges.
- Dimensioning the improvement needs generated by the criteria in each of the three major strategic areas in terms of types and amount of interstate expansion and extensions and their costs.

2.1 FUTURE GROWTH IN TRAVEL

The determination of future priority Interstate System needs started with a forecast of expected total growth in population and the economy. Forecasts of the related amount of future vehicle travel by automobiles and truck, in terms of annual VMT are then used as the basis for determining the need for additional interstate highway capacity, as expressed in new lane miles. The process is based on the data, models and procedures used by both FHWA and AASTHO in their needs, conditions and performance analyses and incorporate the highway performance monitoring system data base (HPMS), the Highway Economic Requirements System (HERS) and the National Bridge Investment Analysis System (NBIAS) processes.

Long-Term Reduction in Growth Rate. Forecasts for the expected increase in vehicle travel for the first 20 years were consistent with the approach used by the USDOT Conditions and Performance Report process using the 2004 state-provided 20-year growth rates. Historic relationships used for the short term suggest just over 2 percent annual growth in VMT, reflecting a 2.41 percent rate for rural Interstates and 1.95 percent on urban Interstates.

However, the factors behind these historic trends are not likely to continue, and this was reflected in several adjustments made to ensure that growth in highway travel was not over-forecasted:

- Highway VMT for automobile travel is not expected to continue to grow at historic rates. Long range rates are expected to flatten, owing to a slowing rate of demographic growth, saturation in licensing and vehicle ownership, rising gasoline prices, an aging population, increased congestion, and limits to individuals' daily travel time budgets in the future.

- Interregional transportation will continue to be multimodal, with aggressive programs assumed to maintain modal shares, as a matter of policy. Neither passenger nor freight accessibility can be efficiently provided by highways alone and new highway development can be designed explicitly to accommodate other modes. In this analysis, aggressive assumptions about transit and private freight rail were made assuming that:

  - ü The transit assumptions utilized by MPOs in state-level VMT forecasts have been used in forecasting highway travel share and needs.
  - ü Similarly, aggressive assumptions for future freight rail share from the AASHTO Rail Freight Bottom Line are used for the long-term VMT projections.

- Given the concern with global climate change and foreign energy dependency, it was presumed that advances and change will occur. In the long term, adjustments in fuel and efficiency-related vehicle technology are expected to substantially reduce carbon-based fuel impacts as well as dependency on global oil imports. To determine the impact of such potential changes on future travel demand, historic and recent impacts of energy price changes on VMT were examined together with the interaction of prices and fleet economy domestically and internationally. Based on the range of energy price forecasts and the ability of fuel mixes and vehicle efficiencies to absorb changes, no dramatic impacts on VMT are expected.

In combination, the above assumptions support a forecast that essentially dampens total annual U.S. VMT growth from just over 2 percent per year (as used in the current C&P 20 year forecast) to just under 1.6 percent in subsequent years, growing faster than population, but less than economic growth. Despite these conservative estimates, VMT will increase by about 66 percent to almost 5 trillion VMT by 2035 and to about 7 trillion VMT by 2055.

Fifty-Year Forecasts. Fifty-year forecasts were also conducted. However, the uncertainties in travel demand, travel behavior and technology limit their value. The 50-year forecasts using the HERS and NBIAS models are well beyond the periods for which these procedures are normally used and would require further analysis to indicate the implications of both the magnitudes and the uncertainties including likely trends in modal use, freight technology, advanced systems operations, replacement or reconstruction costs, etc.

2.2 A PERFORMANCE-ORIENTED APPROACH

Given the growth in total highway travel for freight and passenger travel, performance criteria were utilized to indicate the types of improvements that would constitute a reasonable and efficient strategy to deal with each of the three transportation strategic issue areas identified in the previous section: a national freight network, metropolitan mobility and interregional connectivity. Three types of criteria were used to indicate the amount and type of improvements implied for each issue area:

- *User-performance related.* Where future congestion-related level of service is the key issue (for example promoting metropolitan mobility), HERS model user costs (delay, safety and vehicle operating) on the existing Interstate were compared with improvement costs to indicate the need for additional capacity that would be cost-effective. For improvements on non-Interstate facilities, especially current NHS, a level of service criteria (volume capacity ratio) was employed. Level of service was also used to indicate where managed lanes and/or pricing might be effective.

- *Function-specific.* Where future network connectivity or functional interconnection is the key issue (for example connecting to intermodal terminals or newly developed unconnected urbanized areas), the needed amount of center line miles of upgraded highway to make the connection was used as a determinant of needs. For truck-related improvements, truck volume was the operational criteria for upgrading NHS routes in key corridors; network completion was the consideration for additional LCV treatment.

- *Cross cutting performance assumptions.* The future Interstate must incorporate the best available technology and operational management both for asset management systems and for real time systems operations. The costs and performance standards used in this analysis are assumed to include:

    - ü Upgrades to interstate standards and incorporation of systems operations and management best practice for safety and capacity
    - ü Minimization of energy/air quality impacts through improved operations and reduced circuitry
    - ü Advanced materials/design for pavement life cycle cost and disruption minimization

2.3 DEVELOPMENT OF STRATEGIC IMPROVEMENT NEEDS AND COSTS

The HERS and NBIAS models utilized by FHWA in their conditions and performance analyses activities have been utilized to determine the capacity increases implied by the performance criteria applied to the growth in VMT. Applications of criteria to the existing highway network links identified the types and amounts of improvements necessary to meet both the performance and functional criteria each of the three national strategic issue challenges. Improvement options have been dimensioned in terms of potential Interstate additions as centerline miles and lane miles, along with their related costs; although no geographic-specific links have been identified. The new Interstate capacity falls into two general categories:

- Expansions of the existing Interstate. Expansions of the existing Interstate, both metropolitan and rural, in terms of added lanes in existing corridors was based on the performance criteria described above including cost adjustments for the use of life cycle methods and context sensitive designs. As shown in Table 3 below, existing Interstate VMT was forecast to increase by 80 percent over the 30 years as shown below. Expansions of over 88,600 lane miles (including 8,000 lane miles for special HOT and truck lanes) would be needed to supplement the existing 212,000 Interstate lane miles to accommodate the needs associated with the three themes and are indicated by HERS to be cost-effective. As indicated, early funding periods involve significant investments to "catch up" with the preservation backlog.

Table 1: Additions to the Existing Interstate -- Not including HOT lanes
(Costs in $Millions -- Constant and Current (year of expenditure) estimates)

Funding Period (FP)	VMT (Total) (in millions)	Lane Miles Added (Total)	Preservation and Capacity	Bridge Capital	Other* Capital	Total Capital Needs ($ constant)	Total Capital Needs ($ current)
Initial Condition	712,184						
FP #1	803,181	21,571	$278,404	$28,893	$18,580	$325,877	$350,970
FP #2	894,443	6,115	$111,096	$11,333	$7,402	$129,831	$158,134
FP #3	985,294	9,988	$147,710	$13,051	$9,720	$170,481	$235,093
15 Year Summary		**37,674**	**$537,210**	**$53,277**	**$35,703**	**$626,190**	**$744,197**
FP #4	1,080,900	13,342	$185,349	$8,506	$11,721	$205,576	$320,699
FP #5	1,182,816	15,632	$212,544	$14,804	$13,746	$241,094	$425,531
FP #6	1,282,012	13,947	$199,539	$17,476	$13,121	$230,136	$459,351
30 Year Summary		**80,895**	**$1,134,642**	**$94,063**	**$74,291**	**$1,302,996**	**$1,949,778**

- Extensions of the existing Interstate. Both congestion and specific functional criteria (connections, continuity) were used to identify needed extensions of the Interstate in response to the three strategic issue areas. Together these criteria generated an additional 15,000 route miles at interstate standards totaling 84,400 new lane miles. As described in greater detail in chapter 4 below, many of these extensions are upgrades of existing NHS or in NHS corridors as well as some new corridors on new alignment.

Cost Caveats. Other analyses of reconstruction needs have suggested the desirability of refining estimates of needs for reconstruction due to condition reasons. In addition, AASHTO, FHWA and others have identified the desirability of more detailed analysis of needs for interchanges, safety, security, environmental and other factors which impact on future Interstate needs. While the estimates presented here are state-of-the-practice, further refinements may suggest that there are more reconstruction and interchange needs than those that have been estimated using current modeling procedures.

2.4 POINT OF DEPARTURE: MAKING BEST USE OF THE CURRENT INTERSTATE

Given the investment costs involved in developing the needed future Interstate System, it is essential that the existing Interstate be operated and maintained at its full efficiency. The cost estimates associated with future needs over the full 30-year period all include the full cost of preservation including estimates of the existing Interstate System's restoration, rehabilitation, reconstruction, and resurfacing needs, as well as the preservation needs associated with the expansions and extensions starting in the time periods when they are indicated as "needs" from the performance criteria. In addition, advanced design and life cycle construction involving long-life cycle pavement, rapid setting materials and high speed construction techniques will minimize traffic disruptions and provide long term savings.

The capacity assumptions (and related costs) also assume application of the full range of ITS and systems operations and management strategies consistently on both the urban and rural interstate. It also involves an assumption that any future increase in capacity will include evolving best practice based on new technologies such as vehicle infrastructure integration being applied.

Chapter 3: THE VISIONS AND THEIR KEY ELEMENTS

A contemporary, forward-looking vision is presented in this study. This vision continues the American tradition of providing a high level of highway service, safety and physical integrity. But it recognizes important new realities, changes in context in terms of the emerging transportation challenges, the types of improvements that are relevant, and the technological, operational and financial features that are needed. New capacity is at the core of this vision, but this capacity is tailored to needs and contexts and in many cases is combined with management and multimodal features that provide the flexibility to provide service in constrained settings.

The technical process described above was applied to provide the basis for the development of the vision-based improvement programs in each of the three key national transportation strategic areas:

- A National Freight Logistics Network
- Metropolitan mobility Management
- New Geography Connections

Each of the three strategies is described below in terms of its basic concept and the dimensions of need implied, in terms of route and centerline miles and associated costs.

3.1 A NATIONAL FREIGHT LOGISTICS NETWORK

The Nation's economic growth and competitiveness is dependent on investments to provide an interconnected system supporting improved freight transportation. Network improvements to address these strategic issues would include Interstate connections with the major intermodal freight nodes, upgraded trade corridors and major truck routes and improved defense-related fort-to-port connectors.

The National Freight-Logistics Strategy. The basic concept is to create, as part of an improved Interstate, interconnections to accommodate the range of 21st- century highway freight/logistics needs at the national scale, by extending connections to the Nation's major gateways, intermodal terminals and other major generators that are currently unserved. The network would also provide the opportunity to offer premium service in major truck corridors and would thereby enhance trucking productivity, improve highway safety, decongest existing Interstates and serve to enhance the critical role of a modern freight transportation system in maintaining America's competitiveness in the global marketplace. This integrated system would include five related components:

- Intermodal connections linking major intermodal freight nodes (seaport or inland) and the existing Interstate selected from the current FHWA NHS related intermodal connectors for routes with high freight demand adding 400 lane miles that would include 100 new center line miles of interstate. These are primarily short connections from terminals to the Interstate on existing NHS connector routes.

- New or upgraded trade corridors serving major gateways and NAFTA routes (as designated by Congress in ISTEA), in some cases implying special truck lanes (and tolls) where warranted by potential truck traffic, adding 14,000 lane miles that would include 3,500 new center line miles of interstate primarily on existing NHS routes.

- Potential upgrades to Interstate standards of key fort-to-port STRAHNET connections for rapid military deployment/mobilization pending further review by USDOT/Surface Deployment and Distribution Command (SDDC), adding up to 1000 new center line miles of Interstate primarily on existing NHS routes.

- In addition to these connections, increases in future freight demand would contribute to the capacity-related justification for Interstate additions including:

  - ü Expansion of he existing urban interstate and upgrades of urban NHS (to Interstate standards), equivalent to 8,100 lane miles and 10,200 lane miles respectively, representing a 20 percent share
  - ü Expansions of the existing rural Interstate and upgrades of rural NHS (to Interstate standards) equivalent to 24,200 lane miles and 3,700 lane miles respectively, representing an 60 percent share

This freight strategy suggests that the national new freight capability could be achieved with an addition of 68,600 lane miles contributing to the need for Interstate upgrades and supporting upgrades to existing NHS routes. The estimated cost of this freight vision over a 30 year period (including capital and maintenance) would be $835 billion.

Toll Truck Lane Options. The economic significance of improvements in freight transportation to the commercial community suggests the potential of a range of innovative beneficiary-based funding opportunities to support this program in addition to conventional fuel tax funding. For example, based on forecast future truck volumes (over 10,000 vehicles per day) there is the potential for conversion of up to 6,700 center line miles of high truck volume lanes to truck toll lanes involving about 8,000 unduplicated new lane miles above and beyond other truck-related improvements. This includes an extension of the existing LCV “subnetwork” east and south to complete national accessibility, including NAFTA considerations, and capitalize on the productivity gains based on converting a limited set of existing largely Interstate routes into a small interconnected system, utilizing separated truck toll lanes to provide improved productivity and safety at an estimated cost of $123 billion (which might be substantially recoverable from tolls).

3.2 METROPOLITAN MOBILITY MANAGEMENT

The proper functioning and quality of life in the nation's major metropolitan areas requires the provision of urban highway and transit systems with both the capacity and operational management to meet growing travel and service needs, including highway capacity improvements, with the flexibility to provide multimodal and high-occupancy lane options and apply management such as tolls and congestion and pricing. A central challenge is to preserve the distinct function of the Interstate to serve the longer-distance, network-related passenger and freight purposes within the context of competing metropolitan and local needs and constrained new capacity opportunities.

The Metropolitan Mobility Strategy. The basic concept consists of a combination of flexible capacity expansion and management opportunities that would provide metropolitan areas with the ability to serve the national network needs of longer-distance passenger and freight travel by highway, while simultaneously meeting a range of other metropolitan (local and commuter travel) needs. This expansion would often be in the same corridor or on the same facility. A key feature of this concept is the flexible use of the Interstate to accommodate a range of possible transit and systems management options (HOV, HOT, BRT, congestion pricing) while still providing specific improvements that accommodate longer-distance travel. The components of this strategy include:

- Congestion-based improvements to the existing urban Interstate, consisting of expansion in existing corridors where clearly cost-effective (the determination of cost-effectiveness is based on individual state DOT right of way evaluation and unit costs embodied in HERS). In cases of extreme right of way constraints, improvements to parallel facilities would be a viable option to achieve equivalent level-of-service. Multimodal management and pricing-based approaches might be considered. These congestion-based improvements would involve an addition of the equivalent of approximately 32,400 new lane miles of capacity to the existing urban Interstate.

- Congestion-based extensions of the Interstate in terms of upgrading existing multilane NHS routes to Interstate standards where the V/C ratio is expected to exceed 1.0. This implies an additional 41,200 lane miles over 9,000 miles of urban NHS arterials to full interstate standards including full access control.

This metropolitan mobility strategy suggests that current service levels could be maintained with an addition of 73,600 lane miles to the existing urban Interstate and NHS. This needs estimate incorporates the recognition that there is some overlap between general purpose capacity increases for metro mobility and those required to accommodate freight needs. The estimated cost of this metropolitan vision over a 30-year period (including capital and maintenance) would be $2,156 billion.

Managed Lane Options. A level-of-service criteria as applied to the 30-year travel forecast on the existing urban interstate suggests there would be up to 8,000 centerline miles of existing urban Interstate (28,000 lane miles) that are potential candidates for HOT lanes based on near-capacity-level traffic volumes forecast. This would add an additional $112 billion, some of which might be covered by toll and pricing revenues.

A separate limited analysis was conducted of the impact of tolling on need for added Interstate capacity in terms of revenue raised and presumed diversion to lower level parallel facilities. Since added new lanes in urban areas can rarely be financed by tolls on the new lanes alone, for purposes of this analysis it was assumed that when new lanes were added to meet level of service criteria under the tolling scenario, all the lanes would be converted to toll at a level that is sufficient to pay for the added toll lanes (while the continuing preservation costs would be financed from conventional sources). This constitutes the “mixed finance” approach now being used on several toll projects. Spreading the cost of the new capacity, rather than supporting it only via new lane tolls, reduces the cost per traveler, but still generates the maximum revenue with the minimum diversion to other facilities. The limited impact is indicated in the modest reduction (5 percent) in cost-effective lane miles to meet the forecasted demand.

3.3 THE NEW GEOGRAPHY CONNECTIONS

A range of improvements are needed to interconnect regions and new urbanized areas developed since the original Interstate, including new capacity to provide continuity improvements in rural areas.

The New Geography Connections Strategy. The basic concept consists of a set of additions and improvements in rural areas to extend the interstate standard network to areas currently not served at Interstate standards. This would include responding to the substantial portion of long-distance travel that is devoted to tourism and recreation. To achieve this, the future Interstate must accommodate a set of related functions that together comprise an integrated system. These include two related components:

- Upgrading to Interstate standards links from the existing Interstate network to unconnected urbanized areas with a current or expected population greater than 50K population. This would add 12,000 lane miles, primarily at a 4-lane cross section, on 3,100 centerline miles of existing, mostly rural, NHS.

- In addition to the new connections, increases in demand for rural travel would contribute to the capacity-related justification for Interstate additions (shared with freight) consisting of expansions to the existing rural interstate of 16,200 lane miles and existing multilane rural NHS upgrades (to Interstate standards) of an additional 2,500 lane miles, representing a 40 percent share.

This strategy, based on the full criteria, suggests that the new connectivity functionality could be achieved with the addition of 30,700 lane miles to the Interstate. This estimate incorporates the recognition that there is some overlap between freight-related improvements and those defined here as specifically related to connectivity needs. The estimated cost of this connectivity vision over a 30 year period (including capital and maintenance) would be $113 billion.

3.4 THE NECESSITY OF ASSET AND SYSTEMS MANAGEMENT

The three strategies suggest a vision for a future Interstate that involves substantial highway capacity expansion construction. However, the major investment in new capacity expansion and additions can only be justified if the current Interstate is being utilized at its fullest efficiency in terms of asset management and full systems operational management. Therefore, the vision requires that both the existing interstate and all improvements will incorporate the best available technology and procedures in two key areas:

- Advanced design and life cycle construction. The future Interstate will embody significant advances in design configuration, pavement and construction technology. The impact of long-life cycle pavement, rapid setting materials and high-speed construction techniques will minimize traffic disruptions due to both initial construction and preservation cycles, and will provide cost-effective approaches. Context sensitivity in design will also play a key role—not just in Interstate expansion, but also in reconstruction of the current Interstate, as it reaches the end of its useful life that can be extended through conventional 3-R strategies.

- Full applications of Systems Operations and Management. The future Interstate would not be at full cost-effectiveness unless the full range of ITS and systems operations and management strategies are applied. Concepts and technology are now available that allow highways to operate more closely to their maximum designed intent in terms of capacity, speed, safety, navigation, logistics, and convenience. Recent analysis has shown the importance of managing non-recurring congestion that causes about one-half of total delay and which is not substantially eliminated by capacity increases. The 30-year–plus time frame suggests that current best practice regarding ITS and systems management and operations—supported by consistent probe data and advanced vehicle-infrastructure communications—will be routine. The highway infrastructure can also play a critical role in supplying key safety functionality to reduce road-related crashes supplied though the continuing development of vehicle-infrastructure Integration (VII) or its equivalent, providing vehicle, road system and information network links that support stability control, crash avoidance, run off the road avoidance systems, and complete probe-based traffic information for management purposes.

Using the experience from current deployment on the Interstate and the modeling procedures employed by FHWA, this project compared the costs and benefits of current trends regarding the pace of implementation of ITS and systems and management strategies with full deployment of all strategies using aggressive criteria. The aggressive scenario at a cost of $141 billion over the 30 years reduced non-recurring delay by almost 34 percent and showed a cost-benefit ratio of 19:1.

Chapter 4: THE TOTAL VISION FOR A FUTURE INTERSTATE

Chapter 3 presented a vision for the future Interstate in terms of a set of strategies for future Interstate expansions and extensions, based on the national objective-related performance criteria for capacity, connections and systems management applied in the context of 30-year travel forecasts. This approach yielded estimates of needed lane miles and their related costs. Table 4 presents a quantitative summary as in terms of new capacity and related costs as allocated to the three improvement strategies.

Table 2: FUTURE INTERSTATE IMPROVEMENT/EXPANSION/EXTENSION		
Improvement elements	**Lane miles (000)**	**Cost ($B current)**
`1. Freight Logistics Network Improvements		
• Freight related improvements to urban Interstate	8,100	219
• Freight related Interstate upgrades to urban NHS and related corridors	10,200	292
• Freight related improvements to rural Interstate	24,200	124
• Freight related improvements to rural NHS and related corridors	3,700	7
• Separated truck toll lanes with LCVs (unduplicated Interstate additions)	8,000	123
• NAFTA trade corridors as defined in current legislation	14,000	58
• Intermodal links (“last mile connections”)	400	12
• Upgraded US DOT designated fort-to-port connections	TBD	TBD
Total Freight Logistics Improvements	**68,600**	**$835B**
2. Metropolitan Mobility Improvements		
• Congestion-based expansions of the existing Interstate.	32,400	876
• General purpose vehicle- driven congestion-based upgrades of urban NHS segments to Interstate standards	41,200	1,168
• Possible HOT (priced) lane treatment – also accommodating HOV and BRT	(28,000)	112
Total Metropolitan Improvements *Note: Additional urban area lane mile needs related to freight are shown in*	**73,600**	**$2,156B**
3. New Geography Connectivity Improvements		
• Capacity-related improvements to rural Interstate	16,200	83
• Capacity- related improvements to rural NHS and related corridors	2,500	4
• Upgrades of NHS connections to currently unconnected urbanized areas > 50,000 population and rural regions	12,000	26
Total Connectivity Improvements	**30,700**	**$113B**
4. Preservation -- Preservation of existing Interstate (4-R program) on long life cycle basis	NA	Included above
TOTAL NET NEW MILEAGE AND COSTS	**173,000**	**$3,105B**

4.1 THE DIMENSIONS

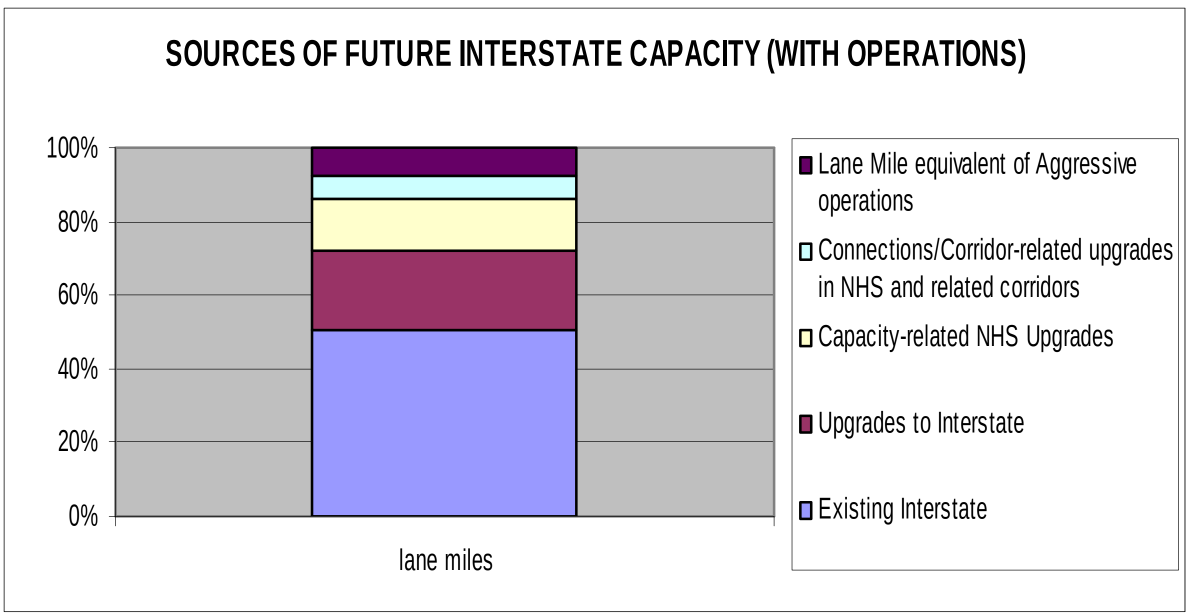
The implications of providing improvements consistent with these three strategies has been analyzed in quantitative terms relating to amount of new capacity, capital costs and performance implications.

System Extent. Interpreting these strategic concepts in the context of the growth in demand has indicated the need for an additional 173,000 lane miles of capacity to be added to the 210,000 lane miles of the existing Interstate. As show in Figure 5 below, this new capacity would be achieved in two ways:

- *Expansion of the existing Interstate*, adding 88,600 lane miles within its existing 46,800 route miles.
- *Extensions of the existing Interstate* through upgrades of the national highway system (NHS) and related corridors, converting 15,000 route miles to the Interstate and adding 84,400 lane miles.

Figure 6 below indicates the contribution of Interstate expansion, NHS capacity upgrades to Interstate standards and other new NHS corridor lane mile improvements. In addition, the lane mile equivalent of aggressive operations including full applications of state of the practice systems operations and management has also been included.

Figure 6: Sources of Future Capacity



As shown in Table 5 below, in total, the future Interstate would supply 385,000 total lane miles of capacity along a total system length of nearly 62,000 route miles. Accommodating the forecasted travel at the performance level used in this analysis implies the addition of about 5,760 lane miles per year.

Table 3: Present and Future Interstate Systems

Present and Future Interstate Systems						
	Interstate			Non-Interstate NHS		
	Miles	Lane miles	VMT	Miles	Lane Miles	VMT
Existing system	47k	212k	24%	115	347K	20 %
Future Interstate	62K	385k	37%	100*	289*	10%*

** There will likely be some growth in miles and lane miles on the non Interstate NHS system but they have not been estimated for the purposes of this study.*

System Efficiency. The new 62,000 mile Interstate would handle 1.8 trillion VMT of the year 2035 total of nearly 5 trillion annual VMT on all public roads. Despite an 80 percent increase in VMT, the current level of service and related operational standards would be maintained on the existing Interstate with the addition of less than 40 percent expansion in lane miles and a 32 percent increase in route miles, plus the application of best practices in systems operations and management. The efficiency of these improvements is indicated by the fact that the expanded and extended Interstate would handle almost 37 percent of the VMT only 1.6 percent of the route miles and only 1.9 percent of the lane miles. Attracting this share of travel to the Interstate would yield a more productive and safer travel activity and would provide a high level of service in terms of speeds and connectivity. A separate estimate of the impacts and costs of aggressive systems operations and management indicates a potential reduction in non-recurring component of delay by almost 34 percent and showed a cost-benefit ratio of 19:1.at a cost of $141 billion over the next 30 years.

System Cost. Cost estimates were made in constant dollars for comparability with current levels of expenditure. The total 30 year cost of $3,105 billion would support the 385,000 lane miles of interstate capacity on nearly 62,000 route miles, providing the basis for the needed 21st Century high quality highway transportation system. This cost is made up of two types of improvements:

- Expansion of the existing Interstate alone, (88,600 lane miles over 30 years) implying an average of about 2,950 lane-miles per year, one percent per year—more than 5 times the current rate at a cost of $1,303 or $47 billion per year compared to about $17 billion invested per year today. While today's investment is heavily oriented to preservation rather than system expansion, the $47 billion per year rate is the rate of investment in new capacity required to keep average operating costs per mile on the existing Interstate the same at the end of the thirty year period as they are today as the Interstate VMT grows 80 per cent from just over 700 billion annual to almost 1.3 trillion annual VMT over the 30 year period.

- Additional 84,400 new lane miles that extend the Interstate through selected upgrades of key NHS and related corridors, add an additional $1,802 billion.

Together they combine to a total annual expenditure of $105 billion per year (constant dollars) over the thirty years. This level of expenditure for the expanded and extended Interstate maybe compared with an estimated $80 billion (2004) currently spent for highways from federal and state revenues.

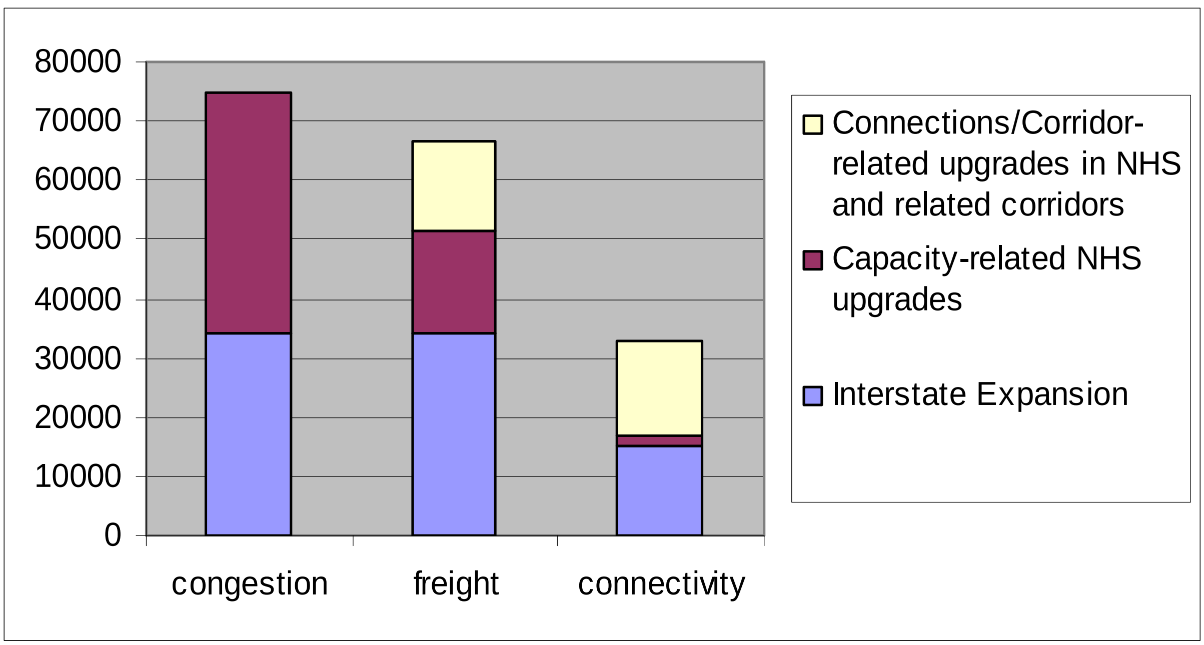
Relationship to Strategies. These improvements and their related costs can be viewed in terms of their relationship to the three vision strategies as the additions have been derived though strategic criteria from which they were derived:

- Freight logistics network improvement: 68,600 lane mile additions -- $835 billion
- Metropolitan mobility program: 73,600 lane miles -- $2,156 billion
- New geography connections: 30,700 lane miles -- $113 billion.

The above costs include $386 billion for preservation of the existing Interstate.

Figure 7 indicates the contribution in terms of additional lane miles of the three improvement strategies discussed in the previous chapter.

Figure 7: Contribution of Three Strategies to Future Interstate Capacity Additions



These totals must be put in perspective. The total 30 year cost of $3,105 billion would support 385,000 lane miles of interstate capacity on nearly 62,000 route miles, providing the basis for the needed 21st -century high quality highway transportation system—in the form of a 40 percent increase in lane miles and a 32 percent increase in route miles, handling an 80 percent increase in VMT at the highest safety levels. Looking ahead into the 30- and 50-year time frame to be served by the next increment of the Interstate Highway system, it is clear that future transportation investment needs will be higher than historical needs, because of near universal auto ownership and vastly increased economic activity in the society. A more prosperous society will demand higher quality transportation services, transportation options, and increased reliability in goods movement. At the same time, the Nation's ability to afford good transportation will increase markedly. A society that is, on average, more than twice as wealthy as today will demanding better service and will not be satisfied with low service levels.

4.2 BENEFITS EVALUATION

The Interstate Highway System represents an investment in expanding and improving a high-speed, safe, low–cost-per-mile system; capable of creating the new envelope of space, time, cost and technology that our changing economy needs in support of a global economy with changing patterns of production and distribution, settlement and lifestyle.

State-of-the-art econometric studies have indicated that, on average, U.S. industries realized production and distribution cost savings averaging 24 cents annually for each dollar invested in the non-local road system. Contributions to overall productivity are not well understood, but strong economic growth in an environment of congestion is the classic indicator of an investment opportunity. This is emphasized by the global trade and supply-chain integration patterns increasingly dependent on long-distance transportation.

In terms of the more measurable direct economic impacts, the reductions in user costs (time, safety, operating) can be estimated, and such an approach was used in this analysis. Determination of a reasonable level of investments in capacity and management improvements was based on maintaining existing user costs for the Interstate together with an acceptable level of service (V/C =1.0) on the existing NHS. The additional improvements, upgrades of connections to newly urbanized areas, intermodal connectors and trade-corridors, were based on the presumed benefits of establishing new or improved connections to these economic generators at Interstate standards, tied into the Interstate network.

A test of the incremental gains of maintaining existing performance over a more modest approach was conducted by analyzing an Interstate improvement program presumed at exactly one half of the cost-effective lane additions and assumed to include tolling. Over 30 years, this implies an investment level of about $26 billion annually; adding 1,300 lane miles would be added each year (below the average rate of addition 1,800 during the construction of the original Interstate). This level of improvement would not maintain current user costs or level of service. Speeds would continue to decline, as investment does not keep pace with demand. Congestion would increase considerably as shown by the Travel Rate Index (TRI) which is the ratio of peak period travel time compared to free flow. The HERS model estimates that user costs under this scenario increase by 10 cents per mile over today's conditions. There is no indication that this scenario is realistic or acceptable to the public. In fact, it can be argued that a richer society in the future will demand much better service, not worse.

Table 4: Comparison of Level of Investment Impacts (Existing Interstate only) over 30 Years						
Funding Period (FP)	**VMT (millions)**	**Total Investment ($B)**	**Lane Miles**	**Total TRI**	**Avg. Speed mph)**	**User Cost ($ per mile)**
Initial Condition	712,184	NA	210,000	1.78	58.17	$0.948
Assuming no additions	1,101,025		210,000	2.84	41.39	1.156
Example Investment for 50 % C/E only	1,189794	700 B	250,000	2.32	50.18	$1.054
Investment to maintain user costs	1,282,012	1,303 B	290,000	1.87	57.75	$0.950

The Investments driven by connectivity criteria (urban areas, intermodal connectors, trade corridors cannot be evaluated directly. However, the recent rise in logistics costs reflecting freight movement and the premium placed on reliability suggest the importance of investing in a system related to contemporary global economic organization. The scale of these benefits is only suggested by the nation's $620 billion truck freight bill. Similarly, the value of capitalizing on economies of scale and wider market access associated with tying in many major urban areas not now served by the Interstate is multiples of travel cost savings. Clearly a more detailed analysis of the relative benefits of differing levels of amounts and types of highway investments, and their impacts on various leading sectors of the economy, would provide improved insights on how these benefits accrue to the economy.

As shown in Table 7, while historic fatality rates have declined on all systems, the Interstates have been by far the safest highways. However this decline in total numbers has flattened in recent years. USDOT has now adopted aggressive goals that will be heavily dependent on technology, but which can receive a substantial assist from the shift of a greater percentage of VMT to the higher standard Interstate. The addition of separate truck lanes and facilities would further support such an improvement.

Table 5: Trends in Highway Fatality Rates						
	Interstates			**Non-Interstates**		
Year	**Fatalities**	**VMT**	**Fatality Rate /100 Mil VMT**	**Fatalities**	**VMT**	**Fatality Rate /100 Mil VMT**
1969	4,215	145,016	2.91	50,828	916,775	5.54
1979	4,444	293,049	1.52	46,649	1,236,084	3.77
1989	5,003	461,820	1.08	40,579	1,634,667	2.48
1999	5,583	643,190	0.87	36,134	2,048,145	1.76
2004	5,762	721,381	0.80	36,874	2,241,132	1.65

Sources: Highway Statistics & FARS

Clearly a more detailed analysis of the relative benefits of differing levels of amounts and types of highway investments, and their impacts on various leading sectors of the economy, would provide additional insight.

Chapter 5: THE INTERSTATE PROGRAM DEVELOPMENT PROCESS

Elements of the strategies set forth above would comprise a systematic, relevant, consistent, scaled basis for the more detailed development of a future Interstate System. But moving from strategic concept to system reality poses the substantial challenge of establishing policy consensus and an effective cooperative process. Experience over the last two decades indicates that forging a consensus around national objectives will not be easy. It has become clear that that a 50-state program is not the same as a true national program. The manner in which competing interests, national, state, and regional, are balanced is likely to be central to the development of a significant future Interstate.

A systematic yet politically viable cooperative process must be established to formulate and gain support for a common vision to define the necessary policies and strategies, and implement the resulting programs. Clearly, this must involve both federal and state partners as well as local government, metropolitan and other planning organizations, and key private sector stakeholders. Given the key national interests at stake, the interstate nature of the system, and the strategic transportation issues requiring national policy resolution, it is essential that Congress establish both the basic policy principles and the general process to be followed to provide a strong partnership framework.

The future Interstate System concept developed and dimensioned by this project is only the beginning of a challenging process of converting a need into a practical program. Based on previous experience, it has been assumed that this is a multi-step process taking a number of years as an increasingly number of interests become familiar with what is at stake. On the other hand, the current concern over the status of the existing federal aid funding system may drive this consideration more quickly as the future interstate constitutes an appropriate and major component of any future changes in the federal aid process.

5.1 PROGRAM DEVELOPMENT CHALLENGES

Defining and Implementing a truly national program is increasingly difficult in a context where many of the more agreed-upon basic “national” needs appear to be satisfied and focus is substantially on state and regional differences. Therefore, an important point of departure will be gaining broad consensus on the critical relationship of national-level concerns to national, interstate and interregional-scale highway improvements, recognizing the traditional voluntary nature of federal aid, the importance of accommodating the range of differing state interests, and providing relevant incentives for broad participation.

This reconciliation will involve grappling with tough trade-offs between national and state/local priorities, including:

1. Provision of funds and financing adequate to support a meaningful level of interstate improvements and flexibility in implementation process.

2. The ability of the program to accommodate a broader array of funding approaches including innovative finance and public-private partnerships.
3. Program adjustments to accommodate equity among states where investment to satisfy the national objectives will not necessarily be evenly distributed among states.
4. The availability of funds for continuing preservation and operations of the built system.
5. Procedures to work out continuity requirements that involve the need to bridge certain states and for multi-state cooperation and compromise.
6. The importance of applying common national standards regarding design, asset management and systems operations.

In addition**,** given the level of investment implied, the future Interstate may require a mix of funding resources involving a range of interests, both public and private. Tapping new sources will require providing a reasonable certainty that declared objectives will be met, and that the Interstate Program is capable of providing the type of coherent national improvements suggested in this study.

5.2 RECOGNIZING THE NEED TO RESPOND TO UNIQUE ISSUES ASSOCIATED WITH STRATEGIES

It appears that even with a national vision and nationally focused transportation policies and strategies, a more multifaceted approach to program development, multi-modal integration, and financing will be necessary with the future Interstate than the uniform approach that was adopted in funding and developing the original Interstate System. With conventional funding at the core, a range of funding and program development options must be encouraged and accommodated. At the same time, an important consideration will be to maintain, in program design, a criteria-driven focus on the unique role to be played by the Interstate.

In addition, the strategies for metropolitan capacity, freight networks and new connections each have unique characteristics that must be built into a future Interstate System Development process. These considerations are likely to include:

- Metropolitan improvements require increased programmatic flexibility regarding alternative approaches to providing improved highway service in highly constrained contexts. The Interstate program must therefore accommodate a broad range of multimodal systems management options. However, this must be coupled with a commitment to provide for the longer-distance interstate travel that distinguish and Interstate Program from a range of other federal and state investments targeting general metropolitan mobility. Such a program approach will require a combination of incentives and constraints to balance these considerations.

- Freight-oriented network improvements for significant impacts need to include provisions for larger combination vehicles and, in high traffic corridors, possibly separate facilities. Such treatments may involve special fees including new sources that may be at the national level. Reaching consensus on such an approach will also involve consideration of deregulating the currently frozen truck size and weight regulation to address productivity issues.

- Increased connectivity, urban and rural, is not likely to be evenly distributed, nationwide, given the disparities in regional growth rates. Special provisions that maintain reasonable program equity will have to be made for states and regions with fewer such needs.

- Important corridors for freight and connectivity are likely to involve multi-state continuity challenges. A special process may be necessary to resolve such conflicts.

- In general, the diverse and capable state DOTs and their partners will benefit from reduced restrictions on innovation in funding, systems operations, use of tolls, new technology and context sensitive design. Flexibility in the federal aid program to support and incentivize new forms of institutional sponsorship for facility development, finance and operations (such as public-private partnerships) will substantially extend the capacities of state and local transportation agencies to produce the program levels implied by the findings of this study, including innovative approaches. The strong commitment to national interest should be at the performance level.

5.3 KEY STEPS IN THE FUTURE INTERSTATE DEVELOPMENT PROCESS

A systematic cooperative process must be conducted involving, at various stages, both federal and state partners as well as metropolitan planning organizations (MPOs), local government and key private sector stakeholders. Initially this process can be developed informally among the participants as in the past, but must ultimately be embodied in Congressional legislation to establish both the basic policy principles and the general procedures to be followed, to ensure that the basic objectives are met. Key steps in the process are set forth below:

Developing an Interstate Policy Consensus. The initial step must be making the policy case generating a broad national consensus among key stakeholders for the need for a significant investment in terms that are relevant to key stakeholder constituencies including:

- *Defining the Objectives.* Gaining consensus on the national objectives and related highway transportation strategy to be supported through a set of specific types of improvements to be provided. The project has developed a reasonable starting set with the three strategies discussed in this report.

- *Establishing Performance Criteria.* A mechanism must be established to ensure investments are consistent with the basic policy objectives. These may include:

    - ü Criteria or maps that define the types of improvements needed to fulfill the objective-related functions related to both level of service and specific functions. This project has developed a first cut at such criteria in Chapter 3.

- ü Basic system criteria such as connectivity and continuity with the existing Interstate system, consistent high level design and asset management standards, systems and intermodal flexibility.

Criteria take on special importance recognizing competing needs for improvements within the policies and programs of state, regional and local entities. The justification for a major national investment will be substantially dependent on preserving the national orientation in such a context

Establishing Interstate Program Funding. Sufficient funds must be available to support the needed Interstate improvements as well as for their maintenance and operations as part of an overall federal aid program funding program. Insofar as new funding sources are tapped for interstate improvements at the national level, other than fuel taxes, participants will have to receive reasonable assurance that the funds will be used as set forth in program policy.

At the same time, the future funding approach must be flexible and include providing an incentive for innovative finance or development options. Some future interstate segments may benefit from tolls and pricing. If it is part of the national interest to encourage toll funding, there are various conditions that can be set to deal with:

- Matching tolls with federal aid.
- Rules regarding conversion of toll-free federal-aid facilities to toll facilities.
- Incentivizing states to use tolls by compensating them for the federal-aid substitution.

Regardless of the sources and levels, accommodation of the Interstate System component requires that the program funding approach be:

- Efficient – in its focus on the priority national system-related improvement needs.
- Equitable – so that state with limited future Interstate System improvements that meet the criteria would receive some form of compensation.
- Affordable – relating the program needs to overall investment scale.

Interstate Program Design. A program development process is needed to convert national objectives into location-specific investments in each jurisdiction that fulfill the criteria and meet system requirements. This approach must bridge two competing traditions: a federal aid system tradition increasingly oriented towards apportioning federal aid back to the state from which they are collected, versus a resource allocation scheme based on incidence of national system components within that state. A special challenge is the development of improvements that are consistent with those “national” features and still make sense in the state/regional/local context. These are discussed in more detail below.

5.4 PROGRAM DESIGN OPTIONS

It is presumed that "business as usual" based on the current categorical programs and needs-based apportionments are not capable of providing the degree of focus on interstate needs. This has been demonstrated by the history of the Interstate since ISTEA. However, the history of the federal aid program has included two other approaches, network mapping and use of criteria, each of which has been used with considerable success and could be adapted in some combination to provide the basis for a consensus implementation process.

Map-based Approaches. A mapping process has been successfully used for the original Interstate in the 1950's and for the National Highway system in the 1990's:

- *Interstate cost to complete.* A map-based approach would be based on a predefined network with indicated routes and connections as a system of eligibility for Interstate categorical funds. This approach was used in the development of the original Interstate System in which Congress and the President requested the federal Bureau of Public Roads (predecessor to FHWA) to work though a special technical committee, and develops a set of criteria that eventually evolved into a specific mapped system—the 46,800 Interstate System. The system was then implemented over a 25-year period, based on funds allocated from the system-dedicated Highway Trust Fund on a cost-to-complete basis with a modest equity-oriented minimum for states not participating at any given point in system build out.

- *NHS Map-based Eligibility.* A map-based approach was also used, in a modified and more cooperative form, to develop the NHS, the need for which had been identified by a broad collation of national interest groups during the late 1980s. A consensus-based process used functional classification to identify the appropriate extent of a national system using typical state principal arterial proportions as a control total. Extensive federal/state interaction on the issues of accommodating connectivity needs while allowing for an equitable distributing of mileage resulted in a 155,000 mile "illustrative system." As subsequently embodied in ISTEA (1991), a formal cooperative process was established for final designation of the system which was to consist of "an interconnected system of principal arterial routes which will serve major population centers, international border crossings, ports, airports, public transportation facilities, and other major travel destinations; meet defense requirements; and serve interstate and interregional travel." Metropolitan routes and intermodal connectors were added through a subsequent process and the final 161,000 mile system was formally established in 1995. Unlike the Interstate, however, there is no connection between system extent and funding apportionment.

Criteria-based Approach. A criteria-based approach would use specific criteria to focus investment on national interest improvements but without using a systems map as the basis for allocating investment. Criteria can be developed (such as those used in this project) that focus on national interest-related functions such as specific levels of congestion reduction, truck volumes, or specific node connections. Application of such criteria would identify links that would be eligible for funding from an Interstate funding program. This would ensure investment to meet certain goals but would not necessarily constitute an interconnected system. In order to extend the Interstate on a network basis specific connectivity criteria would have to be added. Furthermore, interstate connectivity would require a process for resolving conflicts across states where differing criteria posed problems and might require a separate process to resolve such conflicts and apply some kind of priority weighting. Given the differences in criteria relevant to needs related to metropolitan mobility (typically demand-based) and those related to freight or connectivity that related to specific functions, separate subprocesses might be necessary to be later resolved in some overriding process.

5.5 BUILDING ON THE EXISTING FRAMEWORK: COMBINING MAPS WITH CRITERIA

The existing NHS could provide a logical point of departure if combined with functional investment criteria and priorities. Program eligibility would use the existing NHS map on which states have already agreed (which could be updated as necessary through a separate process). However the difference in size between the total NHS (162,000 miles) and a future Interstate System, such as developed in this project (62,000 miles) would have to be accommodated. One approach would be to establish a set of specific priorities relating to level of service and functional criteria. Using the NHS as a template, these criteria would be applied by the states to determine project eligibility. Eligible projects would be those that:

- Are connected to the existing Interstate System.
- Meet any one of several national interest criteria (such as those used in this study) related to level of service on existing Interstate or NHS or function such as connections to eligible nodes such as intermodal, fort-to-port, urban areas of specific size.
- Commit to appropriate facility and systems operation and management standards.

5.6 KEY PROCESS ISSUES

It is likely that there will be intense and understandable pressure to compromise the importance of improving long-distance network service and continuity with more localized priorities. It may be necessary to establish a special cooperative process (involving a national commission?) to develop appropriate “rules” or provide a process for resolution of such issues. Similarly, a special process would have to be established to resolve multi-state continuity issues. Under this process apportionments might be made to a categorical Interstate program according to overall highway transportation needs (as with the current NHS) with a minimum guarantee for states that could certify they had no improvements consistent with the criteria.
In addition, given the scale of the Interstate effort and the related planning and programming process implied and the accumulation of applicable federal and state regulations, a special approach to national environmental regulatory compliance might be considered involving national scale action, coordination and streamlining.

It is evident that a process that fulfills strategies related to the national interest must combine features of mapping, criteria and a mechanism for conflict resolution and regulatory compliance. The ease of developing a consensus process will also be substantially influenced by the overall structure and funding levels of the future total federal aid surface transportation program.

Chapter 6: BOTTOM LINE—NOT YOUR GRANDFATHER'S INTERSTATE

6.1 THE PROCESS USED

The technical process applied in this study started with the long view—the supply of a national system at a scale to meet anticipated national needs. It illustrates that specific transportation objectives can be developed that reflect key national interests. It is based on reasonable assumptions about future growth in population, the economy, and mode share, combined with realistic capital, operating and maintenance costs to provide a sense of scale of the improvements needed. It has demonstrated that practical criteria can be developed that reflect the transportation objectives and specify the type of relevant and cost-effective improvements needed. Finally, it has developed a high-level estimate of the extent of such need improvements and their costs.

The suggested strategies are more than simply illustrative. Together, they establish "proof of concept" that an improved Interstate System is relevant, justifiable and needed to meet key national objectives. They also show that a truly "national" system requires features that are different from improvements designed to meet local and intra-state needs. These features include:

- Responding to national-level transportation needs—freight and passenger, urban and rural.
- Focusing on inter-regional and interstate travel that justifies national investment while recognizing that there are other travel needs that may share use of the system.
- Imposing system continuity and connectivity perspective to form an interconnected system including both heavily traveled links (for congestion alleviation purposes) or essentially connecting in function and more lightly traveled (for network purposes).
- Providing uniform standards and reasonable uniform level of service despite differences in context.
- Implying federal-state and multi-state cooperation involving compromise to achieve shared national objectives.

These objectives place a burden on federal-state cooperation to reconcile common interests with local prerogatives.

6.2 THE FUTURE INTERSTATE SYSTEM

The needed functions identified above suggest a vision of the 21^{st}-century Interstate that will resemble the existing Interstate in some respects, but still have important differences.

First, congestion-based expansions of the existing Interstate will not simply add general purpose capacity. Much of this new capacity will be in the form of "managed lanes" utilizing the latest advanced technology and systems operations concepts to provide HOV, HOT, and BRT services, and to provide the opportunity for pricing and toll schemes aimed at managing congestion and generating additional revenues. Similarly, even in non-urban areas, corridors with forecasted heavy truck volumes may be candidates for special truck lane treatment to improve productivity and safety.

Nevertheless, the 80 percent increase in VMT means that the capacity of the existing Interstate, urban and rural, must be expanded if the key national objectives discussed are to be accommodated.

Second, extensions of the Interstate network are also critical. Much of the extension of the Interstate will consist of capacity-driven or connectivity-based lane additions as upgrades to the existing National Highway System routes, the 115,000 miles of other (non-Interstate) expressways and arterials already identified by FHWA, State DOTs and MPOs in a formal process pursuant to ISTEA in the early 1990s. In addition, there will be new routes on new alignments such as the NAFTA trade corridors and other major state corridor initiatives.

Finally, the proposed interstate improvements will embody significant advances in design configuration, pavement and construction technology. The impact of long-life cycle pavement, rapid setting materials and high speed construction techniques will minimize traffic disruptions. Context sensitivity in design will also play a key role not just in Interstate expansion, but also in reconstruction of the current Interstate System as it reaches the end of its useful life that can be extended through conventional 3-R strategies.

Together, these expansions, extensions, enhanced standards, operations and other improvements to the existing Interstate network will serve as an expanded backbone of high-capacity, high-service-level facilities for major interregional and interstate movements, and provide connections to major generators including intermodal facilities for passenger and freight movements.

The Future Interstate as the Bellwether for the Rest of the Federal Aid System. The future context for highway development and use is likely to be considerably different than it is today. The higher demands of contemporary logistics such as "just-in-time" manufacturing and distribution, increased general wealth, a greater premium placed on time, and new technologies of vehicle-infrastructure integration all suggest that substantially higher standards will be expected as part of a world-class highway system. A unique aspect of the Interstate System will be its embodiment of the best available technology and concepts, fully and consistently deployed on a national basis. This deployment may not be appropriate or affordable for other systems, but it shapes the Interstate System's role as a genuine bellwether system.