

## TECHNICAL MEMORANDUM TASK 3: POLICY ISSUES AND SCENARIOS

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### Acknowledgements

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## EXECUTIVE SUMMARY

### Background

The fundamental task is to identify a future Interstate system concept that responds to relevant national transportation issues and performance objectives as they may evolve over the next 50 years. The value and nature of a future Interstate Highway System will depend on its responsiveness to issues of national significance related to context - such as changes in economic geography and related passenger and freight demand – but also to the means of responding in terms of system evolution and the various technologies used to develop and operate the systems.

There is a significant proportion of freight and passenger travel that benefits from a well-connected, continental, high capacity system which is capable of high speeds and reliability. Even if the proportion of all travel on the Interstate remains at 25% percent (the current proportion of total VMT utilizing the Interstate), this will require a significant increase in capacity and in the coverage of this premier system. Furthermore, the higher level of demand of contemporary logistics, the just-in time manufacturing and package delivery, and higher values of time, etc., suggest that higher standards would be expected to apply. This could occur through capitalizing on advanced technology and advanced operating concepts. A unique role of the Interstate, therefore will be to continue to be the bellwether system, embodying the best available technology and concepts – fully and consistently deployed on a nationwide basis – in a way that would be inappropriate and unaffordable for other systems (such as the NHS). At the same time, such a system must be responsive to varying regional needs, sensitive to environmental and community context, and sustainable over a long-term horizon.

### Process

There are a large number of policy issues that bear on the future role and impact of the interstate system including commerce, defense, mobility, safety, technology, and the environment. These will interact with the future context for travel demand that may evolve, and there is a large spectrum of possible future Interstate options that could evolve in response to these factors. Therefore a systematic approach is taken, which is designed to bracket the implications of the key issues and provide insights that might help to shape a future Interstate program. This process includes six steps:

1. Identification of the key policy issues;
2. Interpretation of the issues in terms of how they impact a future Interstate system including its configuration, extent, connections, design standards, operations, technology, etc.;
3. Development of alternative issue-responsive system options (each one a combination of network and systems management regime) to demonstrate implications of ranges;

4. Testing of “scenarios” -- alternative systems in the context of three future time horizons: 2020, 2035 and 2050 -- with their related demands on the system, based on population, regional development, etc for the short, middle and long-term;
5. Evaluation of the alternative interstate system scenarios in terms of performance, cost, and other issues;
6. Interpretation of evaluation to determine the implications for future Interstate policy and program options.

As a point of departure, therefore, a broad array of national transportation issues are reviewed – both existing and emerging -- and analyzed in terms of their implications for a future interstate systems.

### **Issue-related Interstate system objectives**

The key evolving issues in transportation policy have national and/or interregional implications. These issues can be interpreted in terms of how they may address a future national Interstate highway program. Some issues are directly addressable as network functions, such as the intent to provide various types of improved connectivity (to newly urbanized, areas, intermodal terminals, etc.) Other issues are related to system physical and operational characteristics such as maximally efficient operations, elimination of bottlenecks, or the use of life cycle pavement approaches. Exhibit 1 indicates how the program level dimensions (standards, extent, distribution and applications) of the various system elements can be built into Interstate scenarios.

### **Scenarios**

These issues are then interpreted in terms of future Interstate system “scenarios” -- used as a device to test the conditions, performance, cost and other implications of alternative interstate system program approaches.

The key scenario components are:

- *Alternative future Interstate Systems* -- Future interstate system concept options are developed in response to key transportation issues. Alternative system concepts with their key characteristics are hypothesized at a program level (without maps) in terms of incremental combinations of network extent and configuration assumptions (extent, connections, types of additional lanes, design and technical features) together with related network operations assumptions (systems operations and management, ITS, pricing, etc). In combination, the physical and operations elements define a future alternative Interstate system.
- *Future time horizon demand settings* -- The above Interstate system concepts are tested in future travel demand contexts of 2020, 2035, and 2050, based on forecasted socio-economic growth on a regional basis.

## **System Network Alternatives**

The key issues represented in the alternative network will be twofold: first, incremental additions to accommodate future demand in terms of level of service and connectivity; and, design and technology features regarding specific functions. Each of the two network increments will be specified in terms of the functional orientation of added capacity (or functional conversion) in terms of center line (CL) miles, number of lanes and lane miles classified in reference to the following policy related rationales for system additions by region:

- Metropolitan “mainline” links within existing metro areas and non-metro “mainline” links connecting existing metropolitan areas (includes rural);
- Intermodal connections linking major nodes (seaport or inland) and the existing interstate as a selection from the current FHWA NHS related intermodal connectors for routes with more than a specified level of freight gross tonnage;
- Links to urbanized areas with a current or expected population greater than certain thresholds (e.g. 50, 75, or 100k) currently unserved by a direct linkage with the existing Interstate
- New corridors- e.g. trade corridors -- border or port-related -- with CVO ADT greater than specified threshold, recreation access, etc.;
- Fort to port connections for rapid mobilization currently below the level of criteria specified by MTMC;
- Improvements relieving specific major Interstate bottlenecks such as major interchanges, lane discontinuities and grades that are listed in the current FHWA study of bottlenecks;
- Cost adjustments for the use of life cycle methods and context sensitive designs.

Types of lane additions will be classified as either changes or additions to the existing Interstate (widening or operational changes such as pricing) or as new Interstate links, either derived from upgrades to the existing NHS or new centerline mileage. Two incremental network alternatives will be specified to represent a logical network incremental path from the system of the previous time period (including the current Interstate System) and to be reasonably achievable in the time period. The quantities represented by these combinations will be related to the four major census regions of the US.

## **Systems Management Options**

Based on the policy vision rationale, there will be two specific alternative systems management regimes reflecting incrementally more widespread and rigorous application of these features. Each set will embody assumptions about the type, level and location application of these features including:

- *Systems Management and operations regimes* (supported by ITS) will be embodied in a “Moderate” systems management option including consistent applications of best practice on congested links with best practices in incident management, ramp metering and traveler information. The “Aggressive” option will add lane and speed management,

automated enforcement and Vehicle-infrastructure Integration. The potential performance and safety impacts of these regimes will be incorporated into the systems evaluation.

- *Pricing* via express toll lanes and/or full facility pricing (on congested metro area existing or new facilities) will be consistently applied as part of the Aggressive regime on a network basis

### **Other cost and performance related characteristics**

Certain scenario features of the future Interstate will not be included directly in the systems descriptions as they are exogenous to the highway supply/demand relationship. These will be separately introduced in the analysis as they affect unit costs and assertions about the intent of the scenarios. These exogenous features include:

- Safety features and their impact on presumed accident/fatality rates (descriptive/qualitative – ex: crash avoidance systems such as Vehicle-Infrastructure Integration)
- Security features including critical link (selected bridge and tunnel) hardening (in terms of some external cost impacts to be added)
- Assumptions about rail freight service impacts on truck volumes
- Value of certain network components to tourism (such as scenic highway treatment)
- Construction technologies and materials and their impact on unit costs
- Innovative project development procedures such as Public Private Partnerships (PPP) – these will impact the discussion of scenarios with modest/high tolls, pricing.

Unit costs and revenues (where tolls are applied) will be used to reflect these characteristics. Presumptions about other performance features – such as crash and fatality rates (such as might be the result from vehicle-infrastructure integration) will be handled externally by applying appropriate rates to miles and VMT/VHT quantities.

### **Evaluation**

The combinations of network and systems management options comprise the “future interstate system” options to be evaluated in the context of future travel demand. There are a range of possible logical combinations of networks and operational regimes that could make up a future “system”.

The future demand for highway service for the 15, 30 and 50 year time frames will be based on the future national economic, geographic and population characteristics assumptions embodied in the existing FHWA highway needs analysis process and extensions to the long term based on projections of population and the economy. The principal components of each system alternative will be interpreted from the defined system alternative policy in quantitative terms of added capacity, capacity type, and functions for each US region.

The costs and benefits associated with each alternative system will be based on future performance (travel time and conditions impacts for users) related to systems extent and use - and to system physical conditions – (capital and maintenance costs) related to systems extent, use, age, and technology. The measurement of performance and cost implications will

use the FHWA NBIAS and HERS models including the service and cost adjustments implied by systems management regimes (ITS, tolls/pricing). These models will establish baseline relationships using today's Interstate and performance/cost relationships and will extrapolate those relationships to reflect the new additions to the systems and the increased demand of the future scenarios.

Evaluation will focus on the costs and benefits associated with varying extents and types of Interstate system improvements in terms of basic performance such as levels of service to automobile and truck travel, safety implications, pavement conditions, and the related costs for improvements, preservation and operations. The conditions and performance and other evaluation measures will be related back to the initial future interstate system issues



1956 - 2006

**Exhibit 1 Reflecting Key Issues in Interstate Scenarios**

<b>Interstate Issues</b>	<b>Reflection in Alternative Future Interstate Scenarios (Extent, Performance Implications, Capital and Operating Costs)</b>
1) improvement/extension of the network-wide high level of service and safety offered by the Interstate standards of design and service	Lane additions (widening/upgrades and both interstate and NHS extensions) to meet capacity standards and design standard costs for system improvements
2) Improved connectivity and level of service to the major existing intermodal terminals including seaports, airports, rail terminals, ports of entry and inland intermodal terminals	Connection lane mileage focused on these needs -- by region
3) Extension of Interstate to provide connections to new and emerging centers of population and commerce such as rapidly growing urbanized areas, recreation centers	Connection lane mileage focused on these needs by region
4) Provision of improved service to major commercial vehicle movements concentrated on critical interstate trade corridors (NAFTA and port related)	Selected exclusive truck lane corridor mileage by region (widening and extensions, new corridors)
5) Provision of rapid defense mobilization capability by upgrading special connections to MTMC standards and improved facility security for critical links	Lane mileage focuses on specific corridors by region related to MTMC identified facilities and possible BRAC readjustments Security countermeasures costs at key structures/chokepoints (bridges and tunnels)
6) Provision of maximum level of operational performance and reduction of non-recurring congestion to minimize delay and improve reliability	Remediation of major bottlenecks (interchanges, merges, climbing lanes) Operations regime assumptions (ITS and operating costs) to maintain constructed capacity and safety assumptions at warranted level – urban and rural -- applied to mileage
7) Selected provision of preferential service via managed lanes (while preserving “free” alternatives) for congestion free service to HOV users and price-paying SOVs in congested corridors	Priced lanes (ETL lane additions or new facilities) and/or HOV/HOT lanes on congested urban corridors (with assumptions about associated costs and revenues) applied to mileage
8) Reduced vehicle-infrastructure and vehicle-vehicle crashes via new technology-based integrated vehicle-highway systems	Assumption of costs of equipping and operating infrastructure component of vehicle-infrastructure systems
9) Minimization of energy impacts through improved operations and reduced circuitry	Adjusted fuel use per mile for Interstate versus other systems
10) Utilization of context sensitive approach to Interstate additions related to community and environmental compatibility	Unit costs of upgrades and their variation by urban and non-urban unit costs
11) Provision of high standards of physical condition to minimize vehicle operating costs and minimize construction disruption	Life cycle –oriented construction/maintenance unit costs assumed for all new construction, reconstruction
12) Presumption of toll financing as a component of the revenues available for systems development	Toll assumptions (with and without) for all new lanes and LOS assumptions

## **Background**

The value and nature of a future Interstate Highway System will depend on its responsiveness to shared issues of national significance related to context, such as changes in economic geography and related passenger and freight demand – but also to the means of responding in terms of system evolution and the various technologies used to develop and operate the systems. A key task is to test the implications of key issues and related policies and what they might imply for future interstate systems.

In this context, the Interstate System has-- and should continue -- to play a unique role. The distinction between the Interstate and the rest of the upper level highway system (such as the NHS) -- in terms of its proposed role -- must be identified if it is to be given special program status. Given the evolved scale of the nation's highway network, this new role too, will be more than simply an extension of the it's past. There is a significant proportion of freight and passenger travel that benefits from a well-connected, continental, high capacity capable of high speeds and reliability. Accommodating this need and the expanded demand for it -- has taken on even greater significance in a globalized, just-in-time high tech world. With these distinctions in mind, various future interstate options can be hypothesized and evaluated. The implications of this process can be used as the basis for developing a consensus on a future Interstate program

*.A fundamental task is to identify a future interstate system concept that responds to relevant national transportation issues and performance objectives as they may evolve over the next 50 years. A systematic approach is being utilized. Alternative system concepts with their key characteristics are hypothesized at a program level (without maps) in terms of objectives, functions, network extent and configuration, design and technical features and system management regimes. These alternative concepts are then "tested" in the context of the future demand for travel on a region basis in the 15, 35 and 50 year time frames. This provides the basis for evaluation in terms of their transportation performance, conditions and related costs and benefits. This process provides the basis for defining the essential features of a future interstate program responsive to the broad array of issues of national significance.*

## **The Scenario Concept**

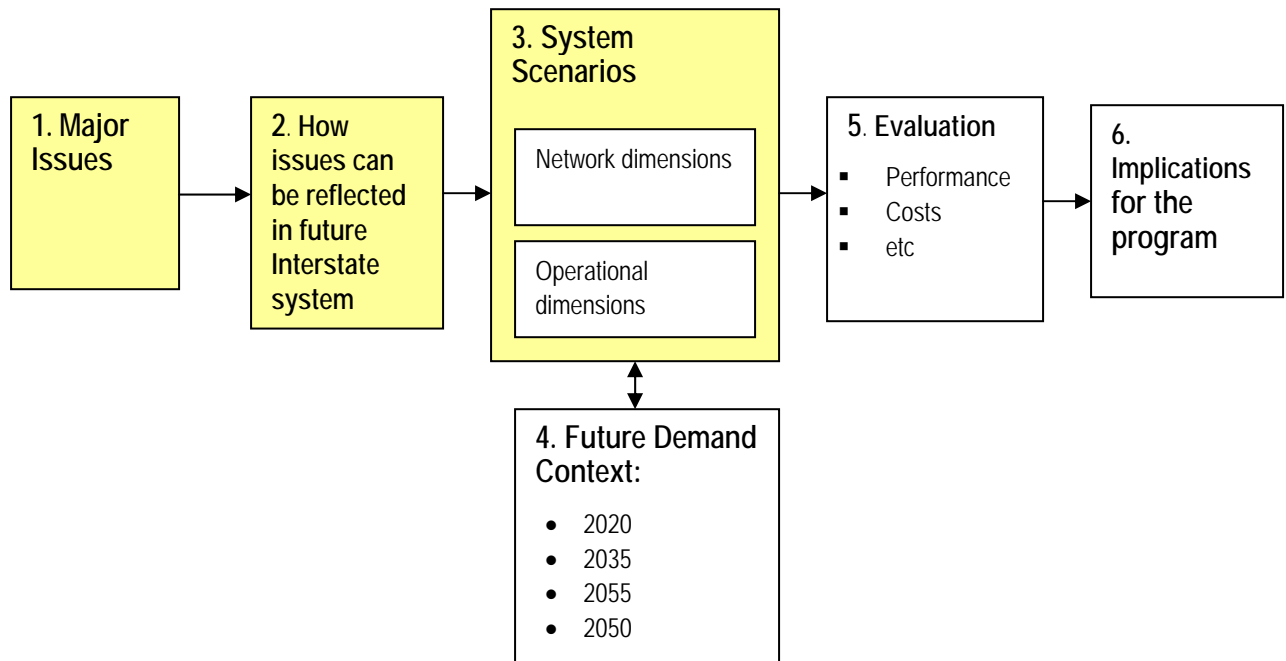
There are a large number of policy issues that bear on the future role and impact of the interstate system including commerce, defense, mobility, safety, technology, and the environment. These will interact with the future context for travel demand that may evolve, and there is a large spectrum of possible future Interstate options that could evolve in response to these factors. Therefore a systematic approach is taken, which is designed to bracket the implications of the key issues and provide insights that might help to shape a future Interstate program. This process includes six steps:

7. Identification of the key policy issues;
8. Interpretation of the issues in terms of how they impact a future Interstate system including its configuration, extent, connections, design standards, operations, technology, etc.;
9. Development of alternative issue-responsive system options (each one a combination of network and systems management regime) to demonstrate implications of ranges;

10. Testing of “scenarios” -- alternative systems in the context of three future time horizons: 2020, 2035 and 2050 -- with their related demands on the system, based on population, regional development, etc for the short, middle and long-term;
11. Evaluation of the alternative interstate system scenarios in terms of performance, cost, and other issues;
12. Interpretation of evaluation to determine the implications for future Interstate policy and program options.

These steps are shown in Exhibit 1 below:

### Exhibit 1: Scenario Logic Steps



This memo, which documents task 3 of this project, provides a first draft for steps 1-3. Subsequent tasks will undertake the remaining steps as well as refine tasks 1-3. Throughout this process, an effort is also being made to track the issues and ideas generated throughout the other components of the AASHTO process.

### Scenario Components

“Scenarios” are combinations of future interstate system alternatives with a given geo-socio-economic future (population, economic growth) that constitutes the context it must serve. The scenarios are used as a device to test the conditions, performance, cost and other implications of alternative interstate system program approach. The key scenario components are:

- Alternative future Interstate Systems -- Future interstate system concept options are developed in response to key transportation issues. The system options consist of

incremental combinations of network extent and configuration assumptions (extent, connections, types of additional lanes) together with related network operations assumptions (systems operations and management, ITS, pricing, etc). In combination, the physical and operations elements define a future alternative Interstate system visions

- Future time horizon demand settings -- The above Interstate system concepts are tested in future travel demand contexts of 2020, 2035, 2050 based on forecasted socio-economic growth

The combined scenario elements are then used to evaluate the relative performance and conditions achieved by the interstate system concepts as well as the general costs and other key features.

### **Evaluation Process**

The evaluation process, that is to be applied in later tasks of this project uses the scenarios -- not to pick a system -- but to learn about the performance and cost implications of different system extents, configurations and operational implications. The scenarios are designed to provide a range of variation in system dimension to support the subsequent steps in this project that will include:

- Systems Analysis -- The costs and benefits associated with each alternative system will be based on future performance (travel time and condition impacts for users) related to systems extent and use -- and to system physical conditions – (capital and maintenance costs) related to systems extent, use, age and technology. Costs for systems implementation will be based on a set of specified unit costs for the system element involved (lane additions, new centerline miles, special facilities, etc.) adjusted for assumed engineering characteristics. The condition and performance analysis is not a conventional network model approach, but operates on a sample and link class basis extrapolating from state HPMS data and the HERS analytical and evaluation framework utilized in the FHWA Conditions and Performance Report analyses. The approach is further described in the working plan of this project and will be summarized in tasks 6, 7, and 8. Judicious combinations of system and demand levels will allow some sensitivity testing of the incremental benefits of modifying supply assumptions for any given time horizon.
- Program implications – Each scenario to be evaluated represents a logical combination of time frame, system extent and management, and demand context. The scenarios are not intended to produce a “recommended system”. The results of this analysis will be designed to provide an evaluation of the costs and benefits associated with varying extents and types of Interstate system improvements in terms of basic performance such as levels of service to automobile and truck travel, safety implications, pavement conditions, and the related costs for improvements, preservation and operations.

This information will provide a basis for developing a future Interstate program as well as describe the implications for funding and program structure.

### **Step 1: Future Interstate Policy Framework**

As a point of departure for scenario development, the key policy issues that would influence the focus, configuration, extent and physical and operations characteristics of the future of the Interstate have been considered and a broad list has been assembled. The initial focus has been on issues with national and interregional scale or that otherwise has national significance. Within the context of the federal aid program, such issues tend to be related to interstate commerce, national defense, or the regulation of externalities such as safety and environmental protection, as well as other conventions of federalism such as collective, federally coordinated involvement in the promotion of the efficient use of resources or of new technologies, etc.

The objective of this step is to identify general directions for future system development that are both policy-responsive and cost-effective -- given the significance of the objectives.

Many of the key policy issues have their roots in the legacy of the existing Interstate system development that is described in the Task 1 memorandum or white paper. These include:

- Urban connections and urban access
- General interregional connectivity
- Support of defense needs and continental logistics (in an intermodal context)
- Improved safety
- International border connections.

Since the period of Interstate system development there have been substantial changes in context – including the growth and changes in the basic generators of transportation demand: the economy, population, geography, logistics, etc., as well as externality issues (pollution, energy, and social and community impacts). A set of modified and new issues have arisen. Some of these issues were reflected in the NHS dialogue in 1987-1995 around development and implementation of ISTEA, including the addition of STRAHNET, intermodal connectors, tourism access, key port-to-port links and a series of special interstate “high priority” corridors. In the 1990s and up until the present, policy discussions (such as the FHWA/ENO workshop on the “Federal Role in Surface Transportation”) and the most recent dialogues on reauthorization and the future of the federal aid program have added to the issue agenda.

### **Interstate-Related Issues – Then and Now**

Key issues have related to the intended function of Interstate highways as related to objectives and outputs, the services provided, unintended external impacts and the process and methods for system development. The key issues categories include:

1. Economic Growth/Competitiveness
2. Regional Development Patterns
3. Freight Logistics
4. National Defense/Security
5. Congestion
6. Basic Mobility
7. Safety
8. Energy & Environmental Sustainability
9. Construction Technology

## 10. Project Development

## 11. Finance

Exhibit 2 compares the original Interstate System issues with their 21<sup>st</sup> Century counterparts within each general category. Not surprisingly, many of current issues are contemporary versions of the WW II era, while others reflect substantial differences that must be accommodated. There is a broader array of issues in each category reflecting a wider range of values brought to bear in the public policy arena including those related to the externalities of highway development and operations. Legacy issues take on new forms, and new issues are introduced. Some of the key differences for the current period versus the past include:

- Capacity is now critical as congestion is endemic and widespread in time and space;
- The larger scale and finer grain of the overall highway network may suggest a more specialized role for the highest level network – although its share of total travel might remain equivalent;
- Technologies have changed, providing a new range of opportunities – with imperatives for retrofit as well as for new development application;
- The role of goods movement and intermodal interchange with high value goods and just in time logistics (containerization, package express) is more predominant in both interstate and international dimensions;
- Population patterns include substantial metropolitan expansion and exurban development reversing the trends of the first Interstate era;
- The fatality rate has improved, but the absolute number remains too high and is not improving in relation to other countries.



**Exhibit 2-- INTERSTATE VISION ISSUES – THEN AND NOW**

Issues	1930s-50s Version	21 <sup>st</sup> Century Version
<b>1. Economic Growth/Competitiveness</b>	<ul style="list-style-type: none"> <li>• Basic interstate commerce (farm to market, urban to rural)</li> <li>• Border connections</li> </ul>	<ul style="list-style-type: none"> <li>• National/global commerce connections</li> <li>• Tourism as major auto dependent industry</li> </ul>
<b>2. Regional Development Patterns</b>	<ul style="list-style-type: none"> <li>• Initial Interregional/intercity connections (Old geography, pre sunbelt)</li> <li>• Connecting unconnected cities</li> </ul>	<ul style="list-style-type: none"> <li>• New geography of recent regional growth</li> <li>• Suburban–suburban commutation</li> </ul>
<b>3. Freight Logistics</b>	<ul style="list-style-type: none"> <li>• Limited interregional truck use</li> </ul>	<ul style="list-style-type: none"> <li>• Just-in-time logistics</li> <li>• High value/low bulk trucks</li> </ul>
<b>4. National Defense/Security</b>	<ul style="list-style-type: none"> <li>• Limited (rail-based) from some dispersed forts to ports</li> </ul>	<ul style="list-style-type: none"> <li>• Rapid mobilization for defense needs</li> <li>• Containerization of freight</li> <li>• Emergency response &amp; security needs</li> </ul>
<b>5. Congestion</b>	<ul style="list-style-type: none"> <li>• Establishment of uncongested new capacity</li> </ul>	<ul style="list-style-type: none"> <li>• Congestion management</li> <li>• Performance focused capacity additions</li> </ul>
<b>6. Basic Mobility</b>	<ul style="list-style-type: none"> <li>• Growing car ownership and Urban access</li> </ul>	<ul style="list-style-type: none"> <li>• Demographics-based special mobility needs</li> </ul>
<b>7. Safety</b>	<ul style="list-style-type: none"> <li>• Impact of access control, high design standards</li> </ul>	<ul style="list-style-type: none"> <li>• High fatalities</li> </ul>
<b>8. Energy &amp; Environmental Sustainability</b>	<ul style="list-style-type: none"> <li>• Resources not yet challenged</li> </ul>	<ul style="list-style-type: none"> <li>• Air quality standards</li> <li>• Global climate change concerns</li> <li>• Community/environmental quality</li> <li>• Energy supply/costs</li> </ul>
<b>9. Construction Technology</b>	<ul style="list-style-type: none"> <li>• New highway design standards</li> <li>• Contemporary vehicle mechanical limitations</li> <li>• Low cost/high maintenance economy</li> </ul>	<ul style="list-style-type: none"> <li>• Growing pavement preservation burden</li> <li>• Impact of construction disruption</li> </ul>
<b>10. Project Development</b>	<ul style="list-style-type: none"> <li>• State highway agencies with federal technical assistance</li> </ul>	<ul style="list-style-type: none"> <li>• Support federal-state technical partnership</li> <li>• Capitalize on private sector capabilities</li> </ul>
<b>11. Finance</b>	<ul style="list-style-type: none"> <li>• Fuel taxes, highway trust fund and high federal match on pay as you go, reimbursable basis</li> <li>• Toll roads incorporated</li> </ul>	<ul style="list-style-type: none"> <li>• Innovative finance and mixes</li> <li>• Toll and concession financing</li> <li>• Private sector technology (information/navigation/safety)</li> </ul>



## **Step 2: Implications of Issues for Scenario development**

### **Issue-Related Interstate System Objectives**

The key evolving issues in transportation policy have national and/or interregional implications. These issues can be interpreted in terms of how they may address a future national Interstate highway program. Some issues are directly addressable as network functions, such as the intent to provide various types of improved connectivity (to newly urbanized, areas, intermodal terminals, etc.) Other issues are related to system physical and operational characteristics such as maximally efficient operations, elimination of bottlenecks, or the use of life cycle pavement approaches. Exhibit 3 indicates how the current issues of exhibit 2 can be translated into future Interstate functional objectives.



**Exhibit 3 -- INTERSTATE VISION ISSUES – THEN AND NOW**

21 <sup>st</sup> Century Issues	Related Interstate Functional Objectives
<b>1. Economic Growth/Competitiveness</b> <ul style="list-style-type: none"> <li>▪ National/global commerce connections</li> <li>▪ Tourism as major auto dependent industry</li> </ul>	<ul style="list-style-type: none"> <li>• Create/upgrade Intermodal connections and gateway improvements</li> <li>• Create/upgrade major NAFTA Trade Corridors</li> <li>• Improve major recreation access routes</li> </ul>
<b>2. Regional Development Patterns</b> <ul style="list-style-type: none"> <li>▪ New geography of recent regional growth</li> <li>▪ Suburban–suburban commutation</li> </ul>	<ul style="list-style-type: none"> <li>• Extend Interstate connections to serve new/expanded population centers</li> <li>• Identify multi-state corridors</li> </ul>
<b>3. Freight Logistics</b> <ul style="list-style-type: none"> <li>▪ Just-in-time logistics</li> <li>▪ High value/low bulk trucks</li> </ul>	<ul style="list-style-type: none"> <li>• Create/upgrade intermodal connections and gateway improvements</li> <li>• Create/upgrade major NAFTA Trade Corridors</li> <li>• Create truck lanes, truck ways in high truck volume corridors and accommodate LCVs</li> </ul>
<b>4. National Defense/Security</b> <ul style="list-style-type: none"> <li>▪ Rapid mobilization for defense needs</li> <li>▪ Containerization of freight</li> <li>▪ Emergency response &amp; security needs</li> </ul>	<ul style="list-style-type: none"> <li>• Upgrade key port to port where no rail service exists</li> <li>• Apply key asset security countermeasures applications (bridges, tunnels)</li> <li>• Create infrastructure for emergency operations capacity</li> </ul>
<b>5. Congestion</b> <ul style="list-style-type: none"> <li>▪ Congestion management</li> <li>▪ Performance focused capacity additions</li> </ul>	<ul style="list-style-type: none"> <li>• Eliminate major bottlenecks (interchanges, grades, merges)</li> <li>• Apply warranted congestion management technology (ITS) and operations</li> <li>• Consider applications of congestion pricing in congested metropolitan corridors</li> <li>• Support development of vehicle–infrastructure integration (VII) systems for traffic management</li> </ul>
<b>6. Basic Mobility</b> <ul style="list-style-type: none"> <li>▪ Demographics-based special mobility needs</li> </ul>	<ul style="list-style-type: none"> <li>• Advanced bus/HOV operations accommodation</li> <li>• Vehicle-infrastructure integration for driver support</li> </ul>
<b>7. Safety</b> <ul style="list-style-type: none"> <li>▪ High fatalities</li> </ul>	<ul style="list-style-type: none"> <li>• Support development of vehicle–infrastructure integration (VII) systems for crash avoidance</li> <li>• Establish separate truck facilities where warranted</li> </ul>
<b>8. Energy &amp; Environmental Sustainability</b> <ul style="list-style-type: none"> <li>▪ Air quality/Global climate change concerns</li> <li>▪ Community/environmental quality</li> <li>▪ Energy supply/costs</li> </ul>	<ul style="list-style-type: none"> <li>• Apply efficient vehicle operating regimes for energy efficiency</li> <li>• Provide context sensitive ROW treatment in terms of, landscaping, architectural treatment</li> </ul>
<b>9. Construction Technology</b> <ul style="list-style-type: none"> <li>▪ Growing pavement preservation burden</li> <li>▪ Impact of construction disruption</li> </ul>	<ul style="list-style-type: none"> <li>• Advanced materials/design for life cycle cost and disruption minimization</li> <li>• Non-disruptive construction process/management as traffic disruption cost issues</li> </ul>
<b>10. Project Development</b> <ul style="list-style-type: none"> <li>▪ Support federal-state technical partnership</li> <li>▪ Capitalize on private sector capabilities</li> </ul>	<ul style="list-style-type: none"> <li>• Compressed project development processes impact on costs</li> <li>• Public private partnerships &amp; outsourcing impact on cost/schedule</li> </ul>
<b>11. Finance</b> <ul style="list-style-type: none"> <li>▪ Innovative finance and mixes</li> <li>▪ Toll and concession financing</li> <li>▪ Private sector technology</li> </ul>	<ul style="list-style-type: none"> <li>• Federal match assumptions; 4R eligibility; etc.</li> <li>• Combinations of direct user charges and beneficiary fees leveraged via debt and private equity ?</li> <li>• Incorporation of tolling and pricing and potential direct VMT charging in future</li> <li>• Privatization of development process</li> </ul>

### **System Objectives Translated Into System Characteristics**

Each of the issue-related objectives that are relevant to a future Interstate can have one or more implications for the specific features of a future Interstate system. That is, there are elements of a future Interstate system, related to the configuration, extent, design and operations standards that can be specified and configured to respond to the presumed objectives and incorporated into scenarios at a generic level sufficient to evaluate their performance and cost implications.

Exhibit 4 takes the objectives of Exhibit 3 and indicates how the program level dimensions (standards, extent, distribution and applications) of the various system elements can be built into Interstate scenarios. Key characteristics of future interstate programs for each scenario will include:

- Total extent in terms of lane miles added and new centerline miles added;
- Definition of the overall physical condition standards used to determine preservation costs;
- Number of new connections to activities of significant transportation concern such as urbanized areas of a certain size, intermodal terminals with a certain tonnage;
- Number and extent and region of special truck facilities in metropolitan or intercity corridors experiencing truck traffic above a certain volume and percentage of trucks;
- Presumptions about reconstruction of major interstate interchange bottlenecks experiencing a delay of more than a given threshold;
- Selected addition of express toll lanes with peak period pricing in urban interstate corridors experiencing delays greater than a specified threshold of vehicle hours per mile;
- Across the board equipping and retrofitting of all congested Interstates with technology to support probe based traffic management;
- Across the board equipping and retrofitting of all congested Interstates with technology to support probe based crash avoidance systems;
- Presumptions of states' ability to utilize higher speed limits as conditions warrant;
- Provision of specific port to port route improvements to accommodate military vehicles.

Any combination of the above assumptions (and others) regarding the extent and – at a regional level – the location of such additions and improvements can be combined into network and management features of an interstate system for evaluation.



**Exhibit 4: Reflecting Key Issues in Interstate Scenarios**

Interstate Issues	Reflection in Alternative Future Interstate Scenarios (Extent, Performance Implications, Capital and Operating Costs)
1) improvement/extension of the network-wide high level of service and safety offered by the Interstate standards of design and service	Lane additions (widening/upgrades and both interstate and NHS extensions) to meet capacity standards and design standard costs for system improvements
2) Improved connectivity and level of service to the major existing intermodal terminals including seaports, airports, rail terminals, ports of entry and inland intermodal terminals	Connection lane mileage focused on these needs -- by region
3) Extension of Interstate to provide connections to new and emerging centers of population and commerce such as rapidly growing urbanized areas, recreation centers	Connection lane mileage focused on these needs by region
4) Provision of improved service to major commercial vehicle movements concentrated on critical interstate trade corridors (NAFTA and port related)	Selected exclusive truck lane corridor mileage by region (widening and extensions, new corridors)
5) Provision of rapid defense mobilization capability by upgrading special connections to MTMC standards and improved facility security for critical links	Lane mileage focuses on specific corridors by region related to MTMC identified facilities and possible BRAC readjustments Security countermeasures costs at key structures/chokepoints (bridges and tunnels)
6) Provision of maximum level of operational performance and reduction of non-recurring congestion to minimize delay and improve reliability	Remediation of major bottlenecks (interchanges, merges, climbing lanes) Operations regime assumptions (ITS and operating costs) to maintain constructed capacity and safety assumptions at warranted level – urban and rural -- applied to mileage
7) Selected provision of preferential service via managed lanes (while preserving “free” alternatives) for congestion free service to HOV users and price-paying SOVs in congested corridors	Priced lanes (ETL lane additions or new facilities) and/or HOV/HOT lanes on congested urban corridors (with assumptions about associated costs and revenues) applied to mileage
8) Reduced vehicle-infrastructure and vehicle-vehicle crashes via new technology-based integrated vehicle-highway systems	Assumption of costs of equipping and operating infrastructure component of vehicle-infrastructure systems
9) Minimization of energy impacts through improved operations and reduced circuitry	Adjusted fuel use per mile for Interstate versus other systems
10) Utilization of context sensitive approach to Interstate additions related to community and environmental compatibility	Unit costs of upgrades and their variation by urban and non-urban unit costs
11) Provision of high standards of physical condition to minimize vehicle operating costs and minimize construction disruption	Life cycle –oriented construction/maintenance unit costs assumed for all new construction, reconstruction
12) Presumption of toll financing as a component of the revenues available for systems development	Toll assumptions (with and without) for all new lanes and LOS assumptions

### STEP 3: CREATE GENERAL INTERSTATE VISION AND SCENARIOS

#### General Vision

It is presumed in this task that future interstate policy is based on a search for a reasonable and affordable balance between costs and benefits for the highest level network within the overall national highway system (including the remainder of the NHS). It is also assumed that the Interstate policy will incorporate the best available technology while being mindful of safety, environmental and community impacts. It is also presumed that the future system will continue in its traditional role of assuring that all regions and parts of the nation have access to economic opportunities and social services, and will provide the backbone of both our domestic and international logistics system.

Generic Interstate vision statements can be crafted, incorporating such aspirations, but nevertheless accommodating a relatively wide range of future interstate system programs. One all-purpose vision might be:

*An Improved and expanded interstate highway system able to maintain its national network role as the highest system in terms of level of service, safety, connectivity and systems operations; and the system will meet the changing national needs of interstate and interregional commerce and travel, national defense and security mobilization, intermodal transfer, international commerce and border crossings.*

The response to this vision and the range of interstate functions implied by the related system objectives as described in Step 2 above will be interpreted in terms of the dimensions of the alternative systems to be evaluated. As there is more than one interstate option consistent with responding to the issue-related functions and the vision, systems to be tested will incorporate a range of responses in terms of future interstate networks – their extents, their components and their principal physical and operational features. Each of the key issue-related functions will be reflected as appropriate in a dimension of an interstate test system alternative.

Key vision issues and their reflections in the future Interstate system will include:

#### Interstate System Scenarios

As described in the introduction, scenarios are combinations of future interstate system alternatives with a given geo-socio-economic future (population, economic growth) that constitutes the context it must serve. The scenarios are used as a device to test the conditions, performance, cost and other implications of alternative interstate system program approach. The scenario components are:

- *Alternative Future Interstate System Concepts* consisting of combinations of network extent and configuration assumptions (together with related network operations assumptions. Network concepts are described in terms of two increments of network features (upgrades and widening of existing NHS routes to Interstate standards) additions/extensions (to the existing Interstate or NHS), and additions of special purpose design or operational features (HOT, express, truck lanes). The network concepts are combined together with a two alternative systems management regimes (systems operations, lane management, ITS, pricing, etc.) at increasing level of application. The

application of best available technology and appropriate design concepts will be reflected in the concepts. Together, the physical and operations elements define a future alternative Interstate system. *A matrix of two network increments and two operational regime options may produce up to four discrete system options.*

- *Future Travel Demand Contexts* of assumed future traffic volumes at 15, 30 and 50 year time horizons. Each future demand context is based on census derived assumptions about population distribution, Global Insight economic forecasts, and related growth in VMT on a regional basis – as well as assumptions regarding vehicle characteristics such as truck size and weight.

### **The Evaluation Process**

The principal components of each system alternative will be interpreted from the defined system alternative policy in quantitative terms of added capacity, capacity type, and functions for each US region. The costs and benefits associated with each alternative system will be based on future performance (travel time and conditions impacts for users) related to systems extent and use -- and to system physical conditions – (capital and maintenance costs) related to systems extent, use, age, and technology. The alternative systems will be evaluated in the context of 2020, 2035 and 2050. The measurement of performance and cost implications will be based on adjustments made to the FHWA NBIAS and HERS models that will display the costs and performance associated with various levels of network supplied in combination with the systems management regime applied to the network.

It is important to note that this process is not designed to designate or map a future Interstate system in terms of specific geographically-identified links, mileage or route locations. The scenarios are not “mapable” nor meant to be program recommendations or best policy. Rather, they are tools for learning about the potential costs and benefits of various generic system specifications as travel demand grows and evolves in the future. The scenarios will illustrate the differing levels of service offered by the systems as travel demand grows and shifts through the three time horizons.

There will be no “correct” network/management match at any given time horizon. But there are levels of performance and costs at specific levels of system development that are more/less cost-effective in the context of any demand level/time horizon.

### **Differences between the Future Interstate and the Historic Interstate**

The array of current Interstate-related issues and functions -- as developed in the steps discussed above -- suggest that the future Interstate will be both similar to, and different from the existing interstate. Basic assumptions include important similarities with the Interstate and NHS concepts:

- The future Interstate will build on both existing Interstate and non-Interstate (largely NHS) network improvements made since the original Interstate designation. Widening to the existing interstate and extensions on existing NHS routes or new right of way will be integral elements;

- The future Interstate will continue as the highest level interregional backbone network with key continuity functions connecting states and regions -- especially for long distance movement;
- Connectivity to generators – passenger and freight -- are key features, recognizing that some issues are truly interregional and interstate and must be addressed on a multi-state or national basis;
- Significant bottlenecks in terms of lane continuity or capacity shortfalls (within reason) will be remediated and state of the practice systems operations will be installed on congested facilities.

However, extending the interstate concept ahead fifty years must accommodate the reality that technology is changing and impacting highway transportation. While these changes may seem slow (mediated by conservative public institutions), they are continuous and are increasingly pushed by advances in other sectors and by customer expectations. The alternative scenarios for the future Interstate all involve substantial expansions in highway construction. However, the future interstate will not simply be “more of the same” – a straight line extension of the civil and traffic engineering concepts of the 1950s.

As the US economy becomes both more integrated and globalized there is an every increasing premium place on rapid, reliable transportation for goods and passengers – especially on an interregional basis. There is a significant proportion of freight and passenger travel that benefits from a well-connected, continental, high capacity capable of high speeds and reliability. Even if this proportion of all travel remains at 25 percent (the proportion of VMT utilizing the current Interstate) this requires a significant increase in capacity and coverage of the premier system. Furthermore, the higher demands of contemporary logistics, the just-in time manufacturing and package delivery, higher values of time, etc., suggest that higher standards would be expected – capitalizing on advancing technology and advanced operating concepts. A unique role of the Interstate, therefore will be to continue to be the bellwether system, embodying the best available technology and concepts – fully and consistently deployed on a nationwide basis – in a way that would be inappropriate an unaffordable for other systems (such as the NHS). Key expectations that would be part of this vision are described below.

*Advanced operations* -- 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. The future Interstate is expected to be the pioneer site for the increasing applications of these improvements, as appropriate for the Nation’s highest level roadway system

In the scenarios these features are represented principally in the assumption that, during the next 10-20 years most of the higher volume segments will be instrumented with communications, surveillance, and technology systems. Together with vehicular on-board technology that is already available, these features will impact “what the Interstate is”. Most of these features are based on advances in probe technology (based on several technologies), combined with high-speed communications.

These systems may come about via a variety of institutional scenarios with potentially different mixes of initiative from the original equipment manufacturers (OEMs) and related service provider industry and by the USDOT and state and local governments. Key features, already embodied in cooperative USDOT and industry development and demonstration include:

- *Active safety applications* facilitated by real-time communications among vehicles and between vehicles and including collision avoidance, violation warning, turn conflict warning, run-off-road departure warning, vehicle-to-vehicle collision avoidance/mitigation, etc.;
- *Mobility management* facilitated by the probe data “landside” backhaul communications with regional and state wide TMCs. Examples of these use cases include the provision of road weather conditions data, displays of routing and navigation information, active construction zones, probe-based congestion management, dynamic ramp metering, improved incident warnings and diversion and incident clearance, electronic tolling and payment, and intelligent ramp metering. This technology also supports the application of congestion pricing;
- *Road maintenance applications* – also facilitated by transmission of data from vehicular systems related to pavement conditions;
- *Other Driver/consumer convenience services* – while not related to highway operations, these will impact the driver experience include vehicle diagnostics, and a range of location-related consumer services such as service outlet information and electronic payment for services, etc.

These future characteristics will be embedded in the scenario evaluation. In the short-term, (to 2020, the impacts can be expected to be modest as the first generation of probe-based systems is rolled out by OEMs and pioneer states. However, by 2035, the first generation can reasonably be expected to be fully in place on the Interstate (and other principal arterials). The impacts of these technologies on the overall performance of the Interstate include”

- The ability to maintain the roadway design capacity more closely during variations in operations conditions due to traffic incidents, disruptive weather and peak volumes;
- The ability to increase roadway speed limits – consistent with safe operating conditions, particularly for long-distance rural travel;
- Dramatic reductions in accidents and fatalities.

The cost of the systems supporting these improvements is trivial compared to the capital cost of the system capacity increases involved – in the order of single digit percentages.

*Advanced life cycle construction* - Advances in pavement design and construction technology, facilitated by the SHRP programs and lead states will be central to the decision to make a major investment in expanding the Interstate System – just as it was in the 1950s with the development of the AASHO design standards and road tests. The impact of long-life cycle pavement and rapid setting materials and high speed construction techniques will minimize traffic disruptions due to both initial construction and preservation cycles.

### **Future Interstate System Alternative Components**

Each alternative future interstate system will be designed in terms of logical combinations of:

- *Network extent and configuration* in terms of two size increments over the do-nothing in terms of increments in the several categories of functionally-specified links and facility types;

- *Operational management* in the form of two increases in intensity of applications will be defined for combination with the network options.
- *Other non-network assumptions* related to features not reflected in network or management -- such as materials and construction, and application of new technologies -- that are considered integral to the description of the systems side of the scenarios will be included in the specification to be reflected in unit costs or condition and performance analysis. A key element will be assumptions about the standard of physical condition to be maintained;
- *Geographic breakdowns* will be limited to four geographic regions of the US.

### **Network Extent and Configuration Components**

The key issues represented in the alternative network will be twofold: first, incremental additions to accommodate future demand in terms of level of service and connectivity; and, second, different policy emphasis in network function. Each of the two network increments will be specified in terms of the functional orientation of added capacity (or functional conversion) in terms of CL miles, number of lanes and lane miles classified in reference to the following policy related rationales for system additions by region:

- Metropolitan "mainline" links within existing metro areas and non-metro "mainline" connecting existing metropolitan areas (includes rural);
- Intermodal connections linking major nodes (seaport or inland) and the existing interstate as a selection from the current FHWA NHS related intermodal connectors for routes with more than a specified level of freight gross tonnage;
- Links to urbanized areas with a current or expected population greater than certain thresholds (e.g. 50, 75, or 100k) currently unnerved by a direct linkage with the existing interstate (see Appendix A);
- New corridors- e.g. trade corridors -- border or port-related -- with CVO ADT greater than specified threshold, recreation access, etc.;
- Fort to port connections for rapid mobilization currently below the level of criteria specified by MTMC;
- Improvements relieving specific major Interstate bottlenecks such as major interchanges, lane discontinuities and grades that are listed in the current FHWA study of bottlenecks;
- Cost adjustments for the use of life cycle methods and context sensitive designs.

Types of lane additions will be classified as either changes or additions to the existing Interstate (widening or operational changes such as pricing) or as new Interstate links, either derived from upgrades to the existing NHS or new centerline mileage.

*Logical Increments* -- The two incremental network alternatives will be specified to represent a logical network incremental path from the system of the previous time period (including the current Interstate System) and to be reasonably achievable in the time period. The quantities represented by these combinations will be related to the four major census regions of the US.

### **Systems Management Options**

Based on the policy vision rationale, there will be two specific alternative systems management regimes consisting of alternative applications of:

- systems operations and management strategy packages,
- vehicle preferential treatments (HOV, HOT)
- exclusive truck lanes
- tolls and pricing.

The systems management regimes will reflect incrementally more widespread and rigorous application of these features. Each set will embody assumptions about the type, level and location application of these features including:

- *Systems Management and operations regimes* (supported by ITS) will be embodied in a “Moderate” systems management option including consistent applications of best practice on congested links with best practices in incident management, ramp metering and traveler information. The “Aggressive” option will add lane and speed management, automated enforcement and Vehicle-infrastructure Integration. The potential performance and safety impacts of these regimes will be incorporated into the systems evaluation.
- *Pricing* via express toll lanes and/or full facility pricing (on congested metro area existing or new facilities) will be consistently applied as part of the Aggressive regime on a network basis

Each of the three networks will be matched with one or more of three demand management policy sets.

### **Other Cost and Performance Related Characteristics**

Certain scenario features of the future Interstate will not be included directly in the systems descriptions as they are exogenous to the highway supply/demand relationship. These will be separately introduced in the analysis as they affect unit costs and assertions about the intent of the scenarios. These exogenous features include:

- Safety features and their impact on presumed accident/fatality rates (descriptive/qualitative – ex: crash avoidance systems such as Vehicle-Infrastructure Integration)
- Security features including critical link (selected bridge and tunnel) hardening (in terms of some external cost impacts to be added)
- Assumptions about rail freight service impacts on truck volumes
- Value of certain network components to tourism (such as scenic highway treatment)
- Construction technologies and materials and their impact on unit costs
- Innovative project development procedures such as Public Private Partnerships (PPP) – these will impact the discussion of scenarios with modest/high tolls, pricing.

Unit costs and revenues (where tolls are applied) will be used to reflect these characteristics (see Tasks 7 and 8). Presumptions about other performance features – such as crash and fatality

rates (such as might be the result from vehicle-infrastructure integration) will be handled externally by applying appropriate rates to miles and VMT/VHT quantities.

### **The Test Network and Systems Management Elements to be Combined into Systems**

The network alternatives and systems management regimes as described above are combined into three basic system alternatives as shown in Exhibits 5 and 6.

*Do nothing Option* -- For analytical purposes a do nothing network and management regime – reflecting today's conditions -- will be specified and simulated. This will provide base line volumes and performance and costs by system functional element that will be used as the basis for future extrapolations.

*Future Interstate Network options* -- There are two network options proposed, each made up of incremental additions in each of the link types from the link typology, based on the issue-related functions to be served

The two network options are incremental in scale and each of the options is logically incremental on the previous option and involves wider or more intense application of the networks responsiveness to vision features as described above. While the specific parameter values are yet to be determined, the increments in the network dimension of the system alternative will be based on selected criteria that can logically be related to increasing demand for each different type of network component in response to expected demand over time. For example, metropolitan Interstate lane miles will be related to lane-miles per population; trade corridors (since there are a limited number) will be "in " or "out"; intermodal connectors may be represented as "added capacity to intermodal connector routes with more than a specified number of TEUs. The timing of network options is related to implementation time period realities. Therefore the larger network is more relevant to the longer time frames.



**EXHIBIT 5 -- ALTERNATIVE FUTURE IS NETWORK SPECIFICATIONS**

(numbering keys to functions in exhibit 4)

**N-O -- Do Nothing Alternative (Existing Interstate)**

**This network represents a point of departure from which to measure the improvements and costs of the incremental networks**

1a. Existing metropolitan "mainline" links within existing metro area increased from xx CL miles to YY CL miles totaling xxxx lane

1b. Existing non-metro "mainline connecting existing Metropolitan areas (includes rural)

2. Existing intermodal connections linking major port or inland nodes

3. No links to newly urbanized areas currently un-served

4. Trade corridors as identified and under development

5. Existing fort-to-port connections for rapid mobilization as designated by MTMC

6. Active projects treating major bottlenecks (baseline in this alternative)

10/11. Active extent of use of life cycle methods and context sensitive designs and condition standards

**N-M -- Modest increase in capacity and connections.**

**This network represents a significant but logical increment over N-O of X thousand lane miles**

1a. Metropolitan "mainline" links within existing metro area increased by a given percentage based on decision criteria TBDx

1b. Non-metro "mainline connecting existing Metropolitan areas (includes rural) increased by a given percentage based on decision criteria TBD

2. Intermodal connections linking major port or inland nodes and the interstate based on criteria related to tonnage or truck traffic TBDx

3. Links to urbanized areas with population greater than 100K currently un-served by the Interstates

4. Development of trade corridors -- border or port-related -- with CVO ADT exceeding threshold TBD

5. Fort to port connection upgrades for rapid mobilization as designated by MTMC

6. Treatment of major bottlenecks with annual delay costs exceeding threshold TBD

10/11. Cost adjustments for use of life cycle methods and context sensitive designs for lane miles added and condition standards

**N-H -- Major connections with modest demand management**

**This network represents a significant but logical increment over N-O of 2X thousand lane miles**

1a. Metropolitan "mainline" links within existing metro area increased by a given percentage over network N-M, based on decision criteria TBDx

1b. Non-metro "mainline connecting existing Metropolitan areas (includes rural) increased by a given percentage based on decision criteria TBD

2. Intermodal connections linking major port or inland nodes and the interstate based on criteria related to tonnage or truck traffic with an increment over network N-M

3. Links to urbanized areas with population greater than 50 or 75K currently un-served by the Interstates

4. Development of trade corridors -- border or port-related -- with CVO ADT exceeding threshold increment over network N-M

5. Fort to port connection upgrades for rapid mobilization as in N-M

<b>EXHIBIT 6: ALTERNATIVE FUTURE IS MANAGEMENT REGIME SPECIFICATIONS</b> (numbering keys to functions in exhibit 4)
<b>M-O – Current Trends – reflecting current levels of ITS and toll applications on the IS</b>
6. Current application of ITS and freeway management on selected links – with representation on a percent of links as reported in FHWA ITS deployment survey (ramp metering, incident management, traveler information)
7. HOT lane mileage on IS as reported in PB survey for FHWA
12. Current Toll mileage on IS by region as reported by FHWA
<b>M-L – Current tolls/Moderate ITS – presuming consistent IS applications of full array of ITS plus the addition of toll and managed lanes as per trends</b>
6. Consistent application of ITS and freeway management on all congested IS links – as reflected in increased LOS and capacity for those links (ramp metering, incident management, traveler information) ,
7. HOT lane mileage on IS as reported in PB survey for FHWA
12. Toll mileage increased as per utilization on all new capacity in current toll states
<b>M-H – Aggressive Management applied via tolls (including time of day pricing) on new capacity and express toll lanes on existing IS corridors plus intensive ITS including presumption of VII implementation</b>
6. Consistent application of ITS and freeway management on all congested links – as reflected in increased LOS and capacity for those links (ramp metering, incident management, traveler information, lane management, variable speed limits) and full implementation of vehicle-infrastructure integration for crash avoidance and traffic management
12. Application of tolls to develop all new Interstate links -- as reflected in assumed LOS and capacity for those links
7. All major metro areas with ETL?? network on congested metro Interstate links-- as reflected in assumed LOS and capacity for those links

### **System Option Specifications**

The systems concepts will be specified in terms of quantities of network and management regime reflected in Exhibits 5 and 6 in a consistent data framework for purposes of assembling the quantitative scenario parameters needed to test the systems. Exhibit 8 below illustrates this concept. Data responding to these dimensions will be developed during subsequent tasks.



Exhibit 7: INTERSTATE SYSTEM OPTIONS TEMPLATE												
Link Type/Function	Criteria	Existing Interstate Lane miles/CL miles		Additional Interstate Lane miles/CL miles		Total IS System lane miles/CL miles		Regions (lane miles)				
		GP	Tolled/ Priced	GP	Tolled/ Priced	GP	Tolled/ Priced	1	2	3	4	5
<b>Metro mainline</b>	<b>Within existing metro area</b>											
• Exist		12,515 XXXXX	985 XXXX			12,515 XXXXX	985 XXXX					
• Mod												
• Maj												
<b>Non-metro mainline</b>	<b>Existing Metro linkage (includes rural)</b>											
• Exist		31,208 XXXX	1892 XXXX			31,208 XXXX	1892 XXXX					
• Mod												
• Maj												
<b>Links to new urbanized areas</b>	<b>New links to UA&gt;50K</b>											
• Exist												
• Mod												
• Maj												
<b>Trade corridors</b>	<b>O-Ds with CV vol &gt; 20K ADT</b>											
• Exist												
• Mod												
• Maj												
<b>Intermodal connections</b>	<b>Links btwn IS and nodes &gt; XXK GTs</b>											
• Exist												
• Mod												
• Maj												
<b>Fort to port connections</b>	<b>17 designated F-P corridors &amp; MTMC specs</b>											
• Exist												
• Mod												
• Maj												

### **The Test Systems – Combining Network and Systems Management**

The combinations of network and systems management options comprise the “future interstate system” options to be evaluated in the context of future travel demand. There are a range of possible combinations of networks and operational regimes that make up a future “system”. Some are more logical than others in terms of the ability to impose new regimes on existing systems and the lead times involved in the application of new policy.

A start up selection of systems is shown in Exhibit 7 suggesting that some combinations are less likely than others

Option 1. M-O/N-O reflects the existing situation as a base line for measurement of impacts and costs

Several options appear to be of limited interest in terms of their limited responsiveness to the objectives reflected in Exhibit 4:

- Option 3. N-O/M-M and Option 6. N-O/M-H, are essentially a continuations of the current trend of very little interstate expansion are of limited interest for evaluation over and above Option 1
- Option 2. N-M/N-O and Option 4. N-H/N-O, both reflect an absence of a significant effort to improve operational performance. They does not appear to be best policy and may not merit direct evaluation

Other options reflect significant targets in terms of both network development and systems management applications. These include:

- Option 5. The N-M/M-M system option reflects a moderate interstate expansion option combined with a consistent application of current best practice regarding systems management and operations and ITS
- Option 7. N-H/M-M reflects a major network expansion and moderate systems management
- Option 8. N-M/M-H reflects a moderate network expansion option combined with an aggressive systems management
- Option 9. N-H/M-H reflects a moderate network expansion option combined with an aggressive systems management



**Exhibit 8 INTERSTATE SYSTEM OPTIONS**

Network Alternatives	Systems Management Regimes		
	M-O: Existing management regime	M-M: Moderate management regime	M-H: High Management Regime
N-O: Existing IS network	1. This system will be used to establish baseline	3. This system may be of interest as a kind of "do nothing" option for the first 15 years	6. Not likely since it implies considerable conversion of free to toll roads
N-M: Moderate Increase in IS network	2. This system is possible – but maybe less likely than MM	5. This system is possible	8. This system is possible
N-H: Major Increase in IS network	4. This system is not likely owing to impacts C/E and affordability without tolls	7. This system is possible	9. This system is possible

The selection of combinations will not be made a priori, but will be developed in the light of the analytical work of subsequent Project Tasks -- in order to accommodate not only program development and feasibility logic, but also in response to their cost and service implications when evaluated in the context of the time horizon-related travel demands

**Full Scenario Development**

The full scenarios consist of the Interstate system alternatives described above combined with the alternative future time frames with their geo-socioeconomic settings and related travel demand contexts (currently under development as Task 6). There is the potential for more than one system option in any given time frame, but not all options are practically achievable or likely to be within a broad level of service level acceptability. As suggested above there are four systems of special interest for testing in the various future demand settings. Each involves at least a moderate increase in Interstate mileage (to be defined) with moderate or aggressive systems management. The combinations of systems and time frame will be selected strategically to illustrate key performance and cost trade-offs with other issues of feasibility and program requirements. There is no single "correct" combination of system and time frame, since any system's practicality will depend on a range of financial and policy realities, although lead time issues and ability to cope with demand levels at given time horizons is an important consideration.

To illustrate these issues a first cut set of scenarios is presented below for refinement and is illustrated in exhibit 9:



*Year 1-15 Scenario* – There are limited options involving network increments during this time period given project development cycle lengths. Scenarios in this time frame will not be distinctly different from the current situation – although the lead times will be implicit in the scenarios for the subsequent time frames

*Year 15- 30 Scenarios* -- There are three possible scenarios during this period. The scenarios in the 15-30 year time frame depend on the previous period. Systems 2, 3 and 5 are feasible and all represent logical departures from scenario 1.

*Year 30-50 Scenarios* -- Beyond Year 30 there are many paths depending on the point of departure from year 30. These scenarios will depend on the scenario point of departure from the previous era. Scenarios 7, 8, 9 are logical increments

<b>Exhibit 9 INTERSTATE SYSTEM OPTIONS</b>			
<b>Network Alternatives</b>	<b>Systems Management Regimes</b>		
	<b>M-O: Existing management regime</b>	<b>M-M: Moderate management regime</b>	<b>M-H: High Management Regime</b>
<b>N-O: Existing IS network</b>	1. This system will be used to establish baseline  <b>TODAY</b>	3. This system may be of interest as a kind of “do nothing” option for the first 15 years  <b>2020-2035</b>	6. Not likely since it implies considerable conversion of free to toll roads
<b>N-M: Moderate Increase in IS network</b>	2. This system is possible – but maybe less likely than MM  <b>2020-2035</b>	5. This system is possible  <b>2020-2035</b> <b>2035-2050</b>	8. This system is possible  <b>2020-2035</b> <b>2035-2050</b>
<b>N-H: Major Increase in IS network</b>	4. This system is not likely owing to impacts and C/E and affordability without tolls	7. This system is possible  <b>2035-2050</b>	9. This system is possible  <b>2035-2050</b>

**Scenario Evaluation Process**

The future demand for highway service (developed in task 4), for the 15, 30 and 50 year time frames. will be based on the future national economic, geographic and population characteristics assumptions embodied in the existing FHWA highway needs analysis process and extensions to the long term based on projections of population and the economy.

Not all the scenarios need to be evaluated to develop an understanding of the relationship between the expected growth and change in the demand for transportation and the levels of system condition and performance that can be expected with different levels of investment in network improvements, network preservation and operations and the resulting system conditions and performance and related implications for the issues of relevance to the future Interstate. As subsequent tasks proceed, these scenarios will be modified and specified and an appropriate short list identified.

For the time horizon beyond the normal 20 year HPMS forecast period, extrapolation will be used combined with limited sensitivity testing in the long term period. In effect, HPMS converts underlying socio economic and vehicle mix assumptions into VMT that are then “assigned to links to determine performance. The existing HERS framework makes a set of additional assumptions that reflect vehicle operating and costs characteristics that impact costs and benefits of various future Interstate systems alternatives. These include:

- Vehicle mixes
- Operating costs
- Fuel price
- Value of time
- V/C characteristics that determine levels of service and speeds.

The principal components of each system alternative will be interpreted from the defined system alternative policy in quantitative terms of added capacity, capacity type, and functions for each US region. The costs and benefits associated with each alternative system will be based on future performance (travel time and conditions impacts for users) related to systems extent and use -- and to system physical conditions – (capital and maintenance costs) related to systems extent, use, age, and technology. The measurement of performance and cost implications will use the FHWA NBIAS and HERS models including the service and cost adjustments implied by systems management regimes (ITS, tolls/pricing). These models will establish baseline relationships using today’s Interstate and performance/cost relationships and will extrapolate those relationships to reflect the new additions to the systems and the increased demand of the future scenarios.

The analysis will display the costs and performance associated with various levels of network supplied in combination with the systems management regime applied to the network. There will be no “correct” network/management match at any given time horizon, but there are varying levels of performance and costs at specific levels of system development in the context of any given time horizon. Judicious combinations of system and demand levels will allow some sensitivity testing for indications of incremental benefits of modifying supply assumptions for any given time horizon.