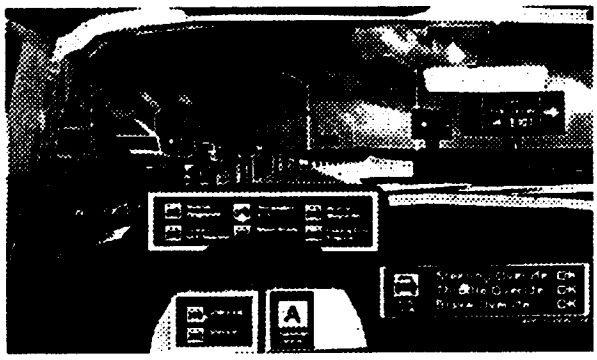
U.S. Department of Transportation

Federal Highway Administration

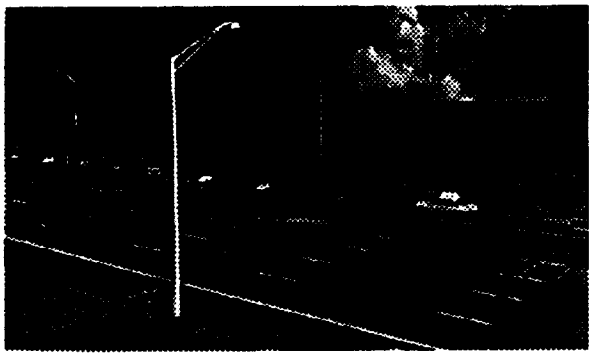
Automated Highway System

Milestone One: Establishment of Performance and Design Objectives

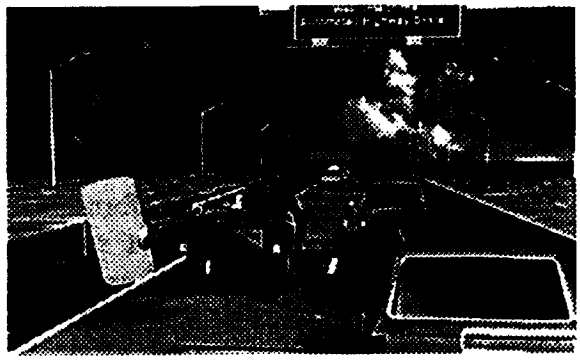


Improved Safety

Enhanced Mobility



Increased Efficiency



Automated Maintenance Operations

National Automated Highway Systems Consortium
Suite 500 3001 W. Big Beaver Road Troy, Michigan 48084

November 9, 1995

NAHSC Milestone #1

Foreword

This document is prepared and submitted in fulfillment of the required deliverable for Milestone #1 as defined in the Automated Highway System Cooperative Agreement Number: DTFH61-94-X-00001, Amendment 3.

This document satisfies Automated Highway System (AHS) Milestone 1, Establishment of Performance and Design Objectives. It contains:

- AHS Program Plan
- Identification of AHS system performance objectives
- Identification of AHS system design objectives
- Measures of effectiveness
- Measures of performance

The document is divided into two sections, the NAHSC Program Plan and the AHS System Objectives and Characteristics document.

The NAHSC Program Plan is an internal Consortium document that defines the structure, task plans and schedules established for NAHSC. It is used by the Consortium to plan and manage the AHS Program. The Program Plan is divided into seven sections: Introduction, Program Description, Work Breakdown Structure, Task Leader Assignments, Task Plan Summaries, Master Integrated Schedule and Program Management Description.

The AHS System Objectives and Characteristics document was created as a stand-alone document to define performance objectives and to identify design objectives, measures of effectiveness (MOE) and measures of performance (MOP). This is an NAHSC working document. It has gone through three iterations with the stakeholder community in Workshop #1, System Requirements Review #1 and Workshop #2. The System Objectives and Characteristics Document will continue to evolve as the program progresses, but now forms a solid baseline and is under formal change control.

NAHSC Milestone #1

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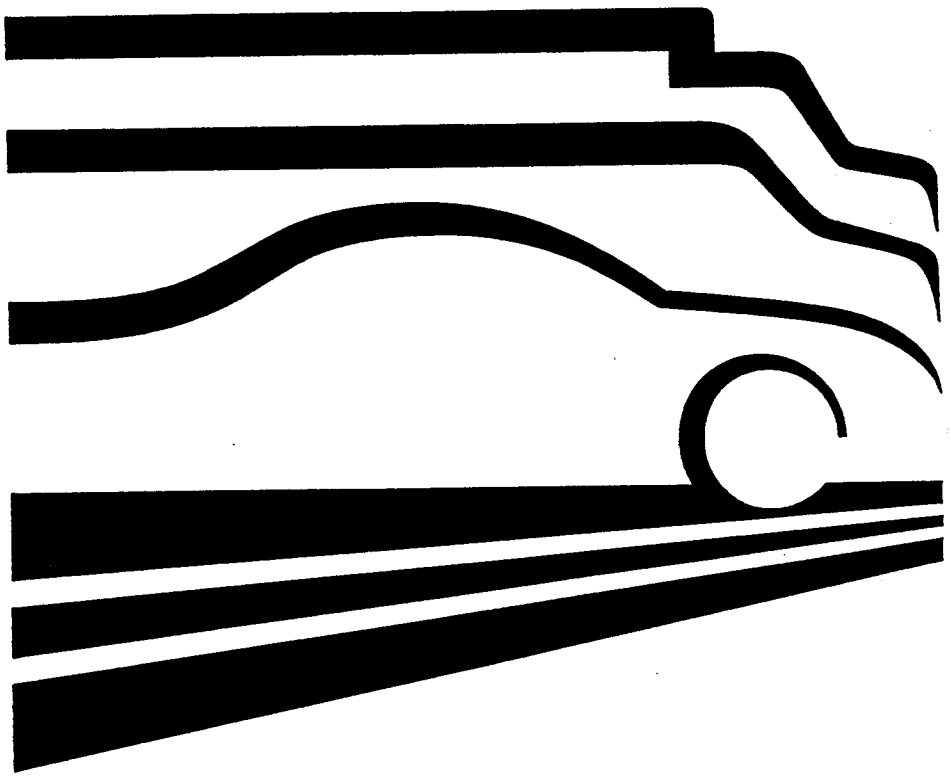

MILESTONE ONE

NAHSC Program Plan

1.0 INTRODUCTION

1.1 Scope

This Program Plan defines the structure, task plans and schedules established for a disciplined, effective management approach to the System Definition Phase of the Automated Highway System (AHS) Program. It covers the Work Breakdown Structure (WBS), Task Leader assignments, Task Plans, and Program schedules that will be used to guide the Automated Highway System program as it progresses through its milestones.

This Plan will guide the AHS Program activities throughout the program.

1.2 Program Overview

The Automated Highway System (AHS) program is a broad national effort to provide the basis for the next major performance upgrade of the nation's vehicle-highway system through the use of automated vehicle control technology. The goal of this performance upgrade is to significantly improve the safety and efficiency of the nation's surface transportation system, in many cases using the existing highway infrastructure. The efficiency of automated highways will also help conserve energy resources and reduce adverse environmental effects of highway travel. The approach for accomplishing this is a national public/private partnership to determine the feasibility, benefits and costs of automated vehicle control technologies in both interim partially, and eventual fully automated systems.

If this system definition phase shows automation to be a safe, realistic and cost-effective approach with significant benefits, then an AHS will be built for operational test and evaluation beginning sometime after prototype testing is complete in 2002.

There will be vehicle safety and control components preceding AHS that will act as stepping stones in the planned evolution to AHS. These will likely include collision warning, and avoidance, adaptive cruise control (to maintain a safe distance from the vehicle ahead), lane keeping (to keep the vehicle in the center of its lane) and drowsy-driver sensing devices. AHS-equipped vehicles will be able to provide many of these services, either individually or together, when operating on non-AHS roadways, or roadways that are less than fully instrumented for AHS. The fully operational AHS will be designed to accommodate automated cars, buses, and trucks.

The AHS program will incorporate developing technologies from the motor vehicle, highway and aerospace communities. The program will encourage the early spin-off of AHS technologies to produce early safety and convenience benefits to surface transportation users.

The AHS will be comprised of at least two major subsystems. The Vehicle Subsystem will contain that portion of the system that actually moves through the AHS. In addition to the vehicle itself, this will include sensors, processing, and vehicle communications equipment. The Infrastructure Subsystem will contain all other aspects of the AHS not contained in the Vehicle Subsystem. This may include communications equipment, roadways, control centers and maintenance facilities. The proper balance between the two subsystems will be determined through both technical analysis and a cost-benefit analysis of the vehicle-borne systems and the infrastructure-borne systems.

The AHS will be capable of being tailored to meet the needs of the individual states, regions and localities that choose to implement the system; however, there will be overall national standards so that an AHS-equipped vehicle from one region will be compatible with an AHS anywhere in the nation assuming that local vehicle size and performance restrictions are met (e.g., some cities may not allow AHS-equipped heavy trucks to operate in the Central Business District).

1.3 Reference Documents

The following documents form a part of this document.

Automated Highway System Cooperative Agreement Number: DTFH61-94-X-00001, Amendment 3.

2.0 NAHSC WORK BREAKDOWN STRUCTURE - WBS

A Work Breakdown Structure (WBS) is the top down, logical structuring of the project scope that defines and displays all of the work to be performed in accomplishing the project objectives.

A Work Breakdown Structure is developed to satisfy the following:

- Facilitate a systematic planning process through which the inadvertent omission of key project activities will be avoided.
- Reduce the complexity of the project by dividing it into manageable units.
- Provide a framework for:
  - defining specific tasks within a project from which schedules can be developed,
  - linking activities with resources,
  - facilitating communication and,
  - allowing integration of project plans (schedule, resources, costs).

Rules for developing a Work Breakdown Structure are:

- All WBS elements at any given level must be comparable.
- Each WBS element must have a definable beginning and end.
- Each WBS level must be easily rolled up to the next higher level.

The AHS Work Breakdown Structure was developed by utilizing the following steps:

- Level 1 - the end product of the project (e.g., AHS prototype and system documentation)
- Level 2 - the phase of the project (i.e., Program Management, System Definition, Concept Development, Exhibits & Demonstrations, AHS prototype)
- Level 3 - based on the nature of the end product, establish and define all of the major components or systems that are required to describe it. For example:
  For BX, System Definition
  - Establish Performance & Design Objectives
  - Develop Critical Enabling Technologies
  - Access Enabling Technologies

  The Level 3 WBS provides a solid reference point to which cost and other budget information can be summarized (rolled up) to be compared to schedule activities for tracking performance.
- Level 4 - for each component at Level 3, define the sub-components required to support the major components.

Program charge numbers are assigned for Work Breakdown Structure (WBS) tasks identified in the WBS. Program Management reviews the cost accounts as they are defined and correlates them with demonstrable task performance objectives. The critical path is then identified and analyzed and associated WBS elements that are forecast to fall short of required performance are identified. Timely corrective actions are generated and task logic structure is replanned, rescheduled, and reprocessed to bring projected deficient performance within acceptable levels.

Specific Core Participant roles within tasks are identified by suffix letters applied to the WBS task designator. Figure 2-1 below illustrates WBS Task E3AX - Prepare Test Plans & Workshop #7, where nine (9) Core Participants are involved in the accomplishment of that task.

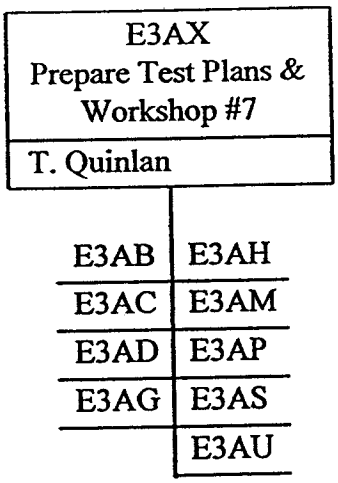

Figure 2-1 Example WBS Task Suffixes

The suffixes to the WBS designator are defined as follows:

B	Bechtel
C	Caltrans
D	Delco Electronics
G	General Motors
H	Hughes Aircraft
M	Lockheed Martin
P	University of California Berkeley - PATH
S	Parsons-Brinckerhoff
U	Carnegie Mellon University

This designation process allows for accountability at the Core Participant level for all task within the program.

The following Figures 2-2 through 2-7, reflect the Work Breakdown Structure for the Automated Highway System Program.

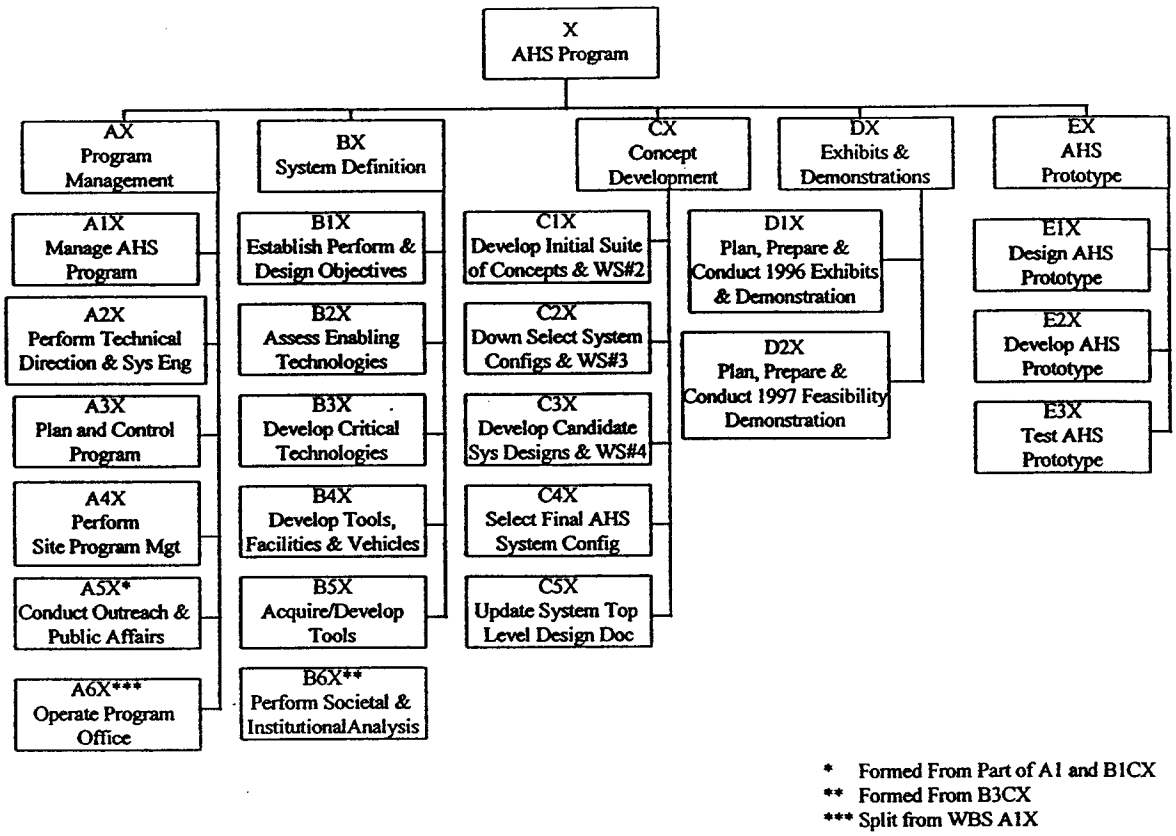

Figure 2-2 Summary Level 2 Work Breakdown Structure

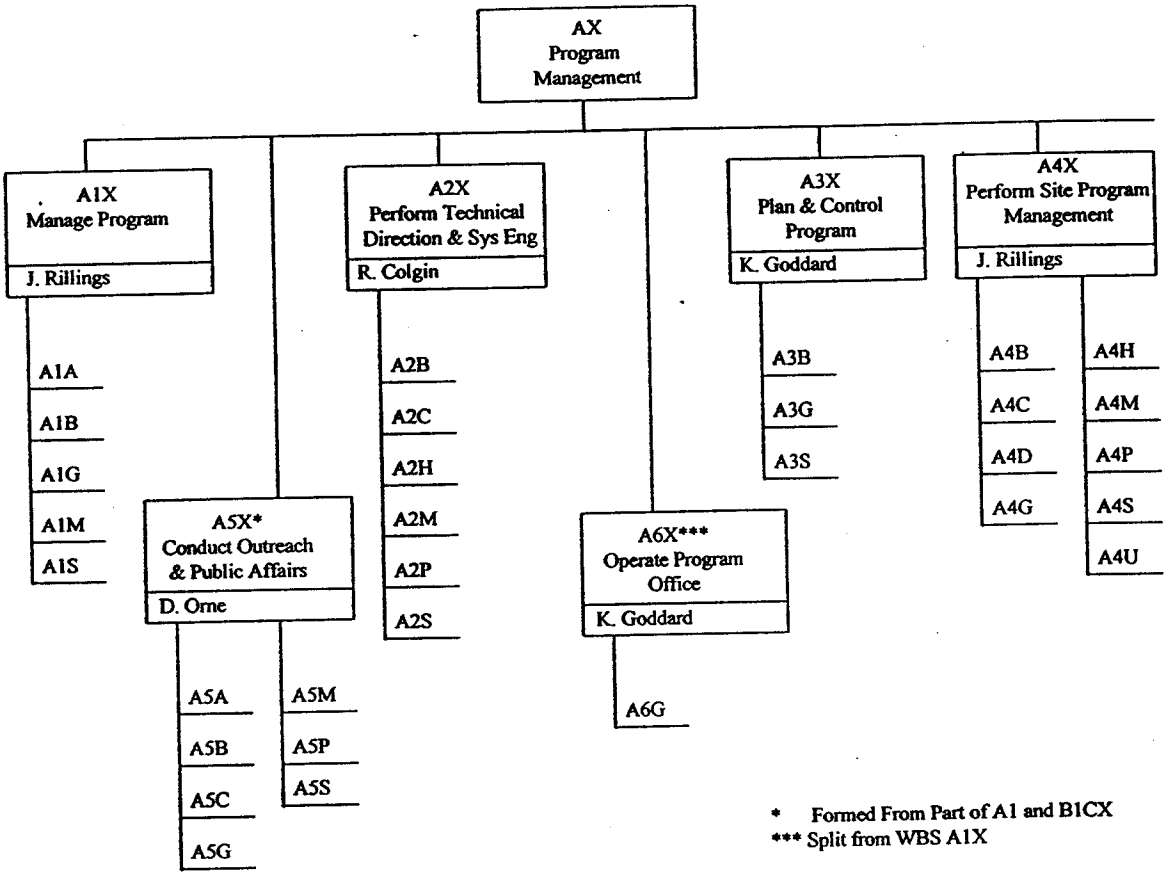

Figure 2-3 Program Management Work Breakdown Structure

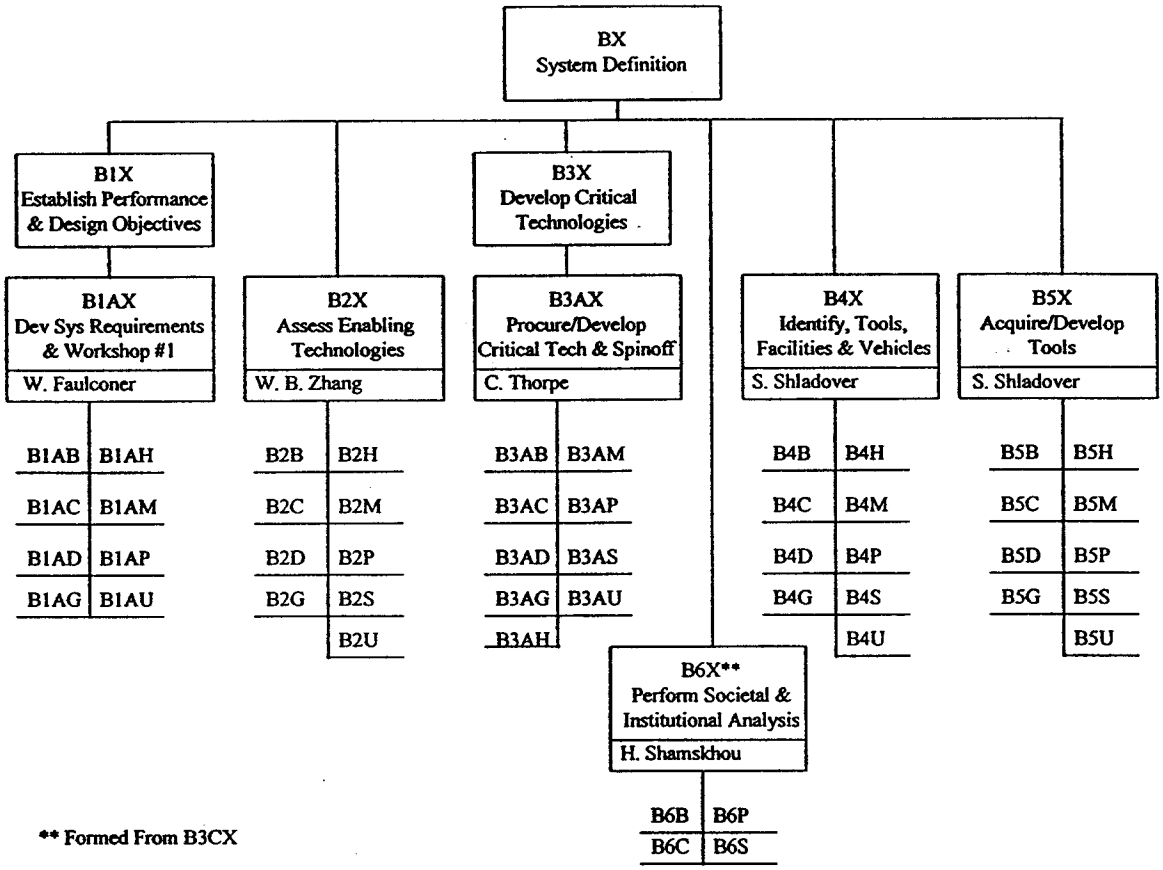

Figure 2-4 System Definition Work Breakdown Structure

AHS Work Breakdown Structure (WBS) (Continued)

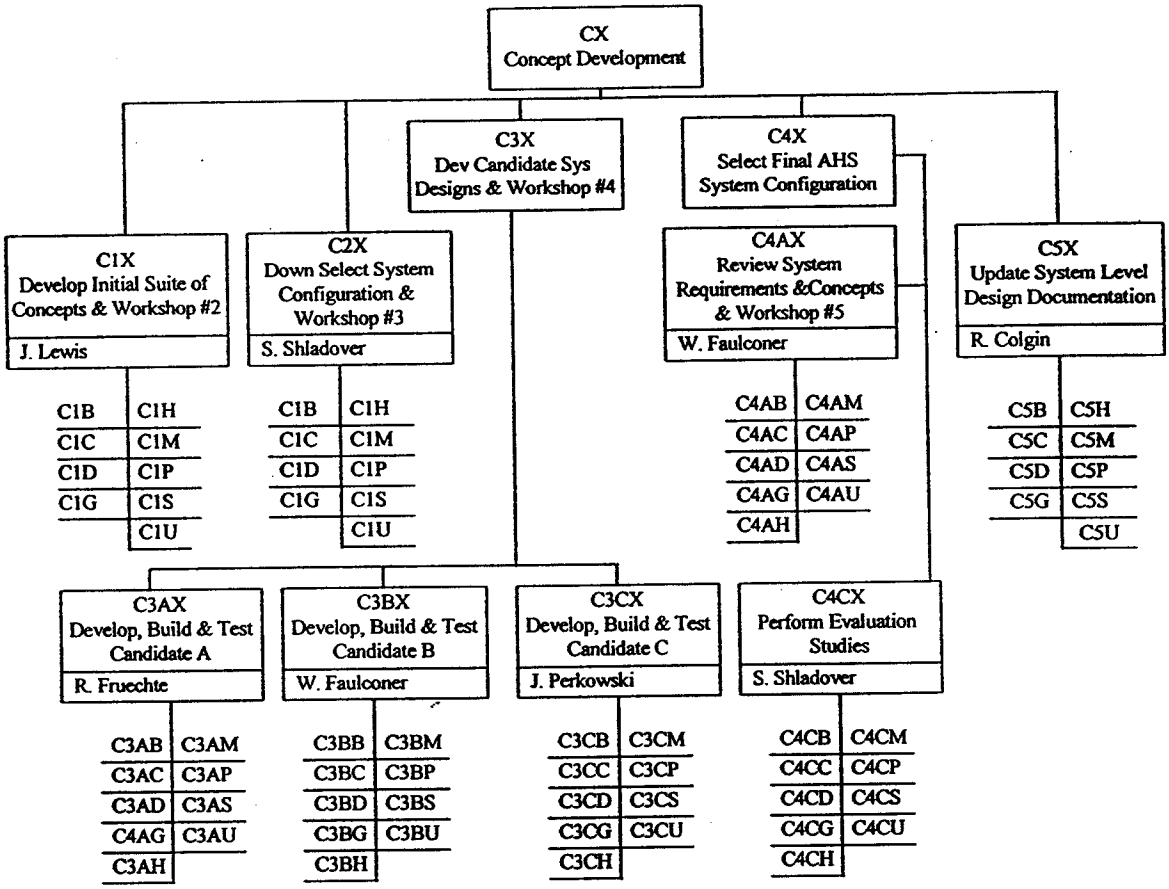

Figure 2-5 Concept Development Work Breakdown Structure

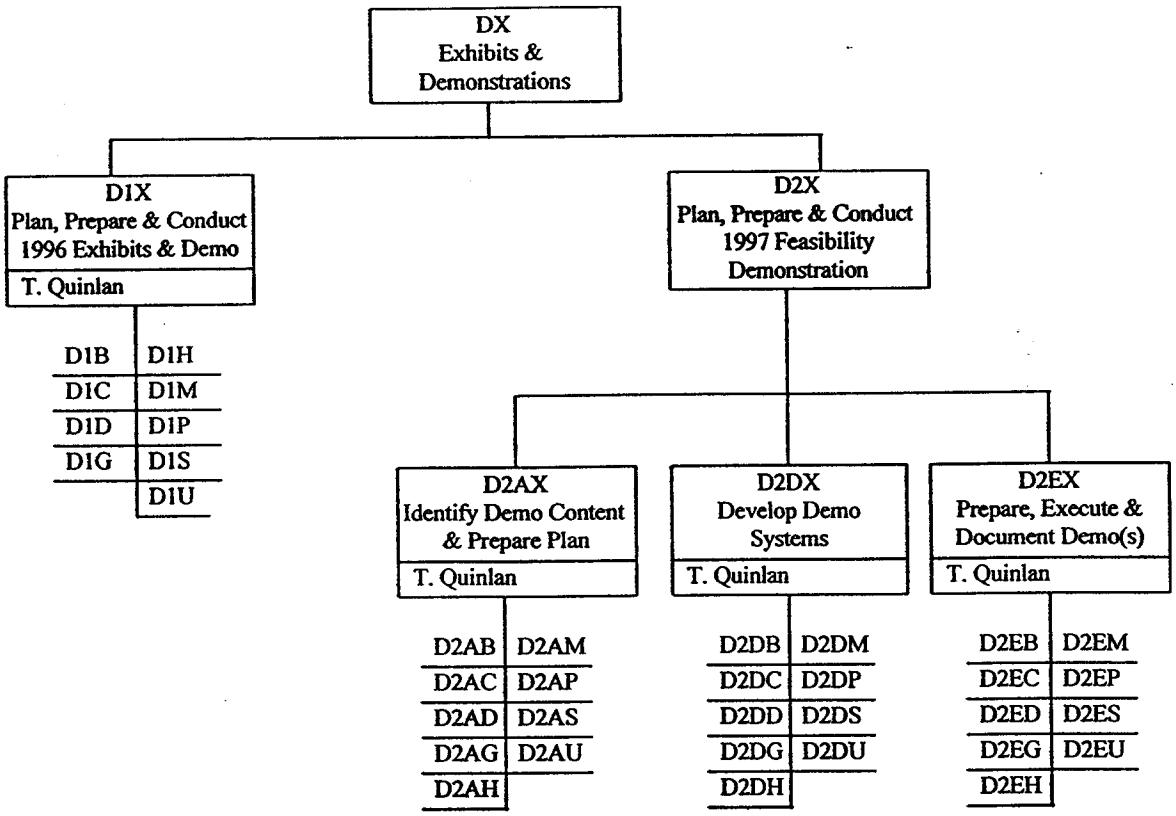

Figure 2-6 Exhibits and Demonstrations Work Breakdown Structure

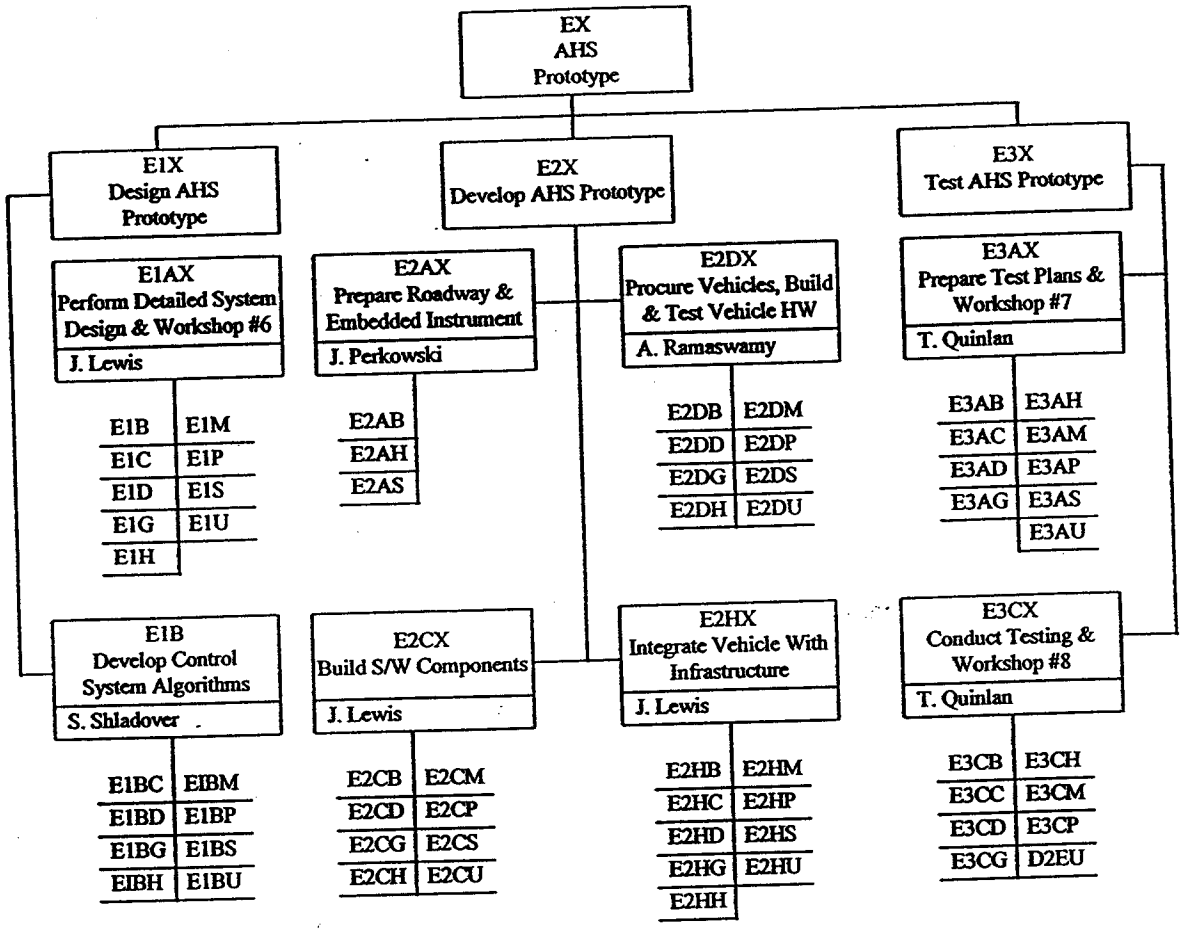

Figure 2-7 AHS Prototype Work Breakdown Structure

3.0 AHS WBS TASK LEAD ASSIGNMENT MATRIX

Each Task within the AHS Program has been assigned a Task Leader. The Task Lead Assignment Matrix designates the person responsible for the top level coordination and execution of all sub-tasks within each summary task even though various sub-tasks may be lead by different individuals.

The Task Leader has overall responsibility for planning, scheduling, coordinating and executing all tasks under the designated summary task. The Task Leader coordinates with all participants within the task for the development of the sub-task schedules and plans. The Task Leader coordinates the development and provides an integrated statement of work (SOW) for the task, including individual SOWs from each individual company/contractor/participant. The Task Leader serves as the single point of contact for the Program Office on matters related to the designated task. The Task Leader:

- Coordinates the planning and execution of his/her assigned task(s) across organizational boundaries.
- Develops, submits to the Program Manager and maintains the Task Plan(s) including:
  - Detailed statement of work (SOW) incorporating inputs from all participating organizations.
  - Inputs required and their expected sources.
  - Deliverables and their expected customers.
  - Schedule and milestones including external dependencies.
  - Task budget by organization.
  - Contracting plan.
  - Support required from Associate Participants.
- Exercises responsibility for the task deliverables, schedule and budget.
- Provides monthly report on progress to Program Manager's Council.
- Submits quarterly reports on the task(s) to the Program Manager in the prescribed format.
- Serves as technical liaison to Associate Participants.

Table 3-1 provides an overview of the AHS task and assigned task leaders:

Table 3-1 AHS WBS Task Lead Assignment Matrix

W B S	Task Name	Task Leader
A 1 X	**Manage Program**	**J. Rillings**
	Manage Program Handle Legal & Environmental Affairs Provide Document & Configuration Management	
A 2 X	**Perform Technical Direction & System Engineering**	**R. Colgin**
	Direct Technical Activities Provide Systems Engineering	
A 3 X	**Plan and Control Program**	**K. Goddard**
	Manage Schedule Manage Cost Manage Procurement & Subcontracts	
A 4 X	**Perform Site Program Management**	**J. Rillings**
	Establish Program Baseline Site Program Management Office by Organization	
A 5 X	**Conduct Outreach and Public Affairs**	**D. Orne**
	Canvass State DOTs & Other Stakeholders Receive, Assess & Integrate Responses Perform Policy Coordination Conduct Outreach & Public Affairs Conduct Public Forums Conduct Government Liaison	
A 6 X	**Operate Program Office**	**K. Goddard**
	Provide Program Office Support Establish and Manages Program Office Building Lease Establish Program Office Computer and WAN Systems Provide Program Office Administrative Staff Contract	
B 1 A X	**Develop System Requirements & Workshop #1**	**W. Faulconer**
	Develop System Requirements Develop Program Metrics & Measures Develop Program Objectives Obtain USDOT Approval Prepare Draft Test Plan Conduct Workshop #1 - Requirements Review	
B 2 X	**Assess Enabling Technologies**	**W. Zhang**
	Identify Technical Categories Assess State of the Art In Each Critical Technology Compare State of the Art to Requirements Document Development Plan for Cross-Cutting Technology Develop Technical Inputs to Risk Management Plan	
B 3 A X	**Procure/Develop Critical Technologies**	**C. Thorpe**
	Procure/Develop Critical Technologies Identify & Facilitate Potential Spin-off Technologies	
B 4 X	**Identify Tools, Facilities & Vehicles**	**S. Shladover**
	Identify Tool Needs Identify Subject Area Experts Identify Facility Needs & Survey Sites Identify Requirements, Types & Sources of Vehicles	

Table 3-1 AHS WBS Task Lead Assignment Matrix (Continued)

W B S	Task Name	Task Leader
B 5 X	**Acquire / Develop Tools**	S. Shladover
	Acquire Computing Assets Acquire/Develop Simulation Tools Acquire/Develop Tech Analysis Tools Acquire Computer Aided Software Engineering Tools Acquire Cost Analysis Tools Acquire Networking Infrastructure Acquire/Develop Other Tools	
B 6 X	**Perform Societal & Institutional Analysis**	H. Shamskhou
	Address Societal & Institutional Issues Perform Environmental Analysis	
C 1 X	**Develop Initial Suite of Concepts & Workshop #2**	J. Lewis
	Identify Candidate Concepts Solicit Concepts Nationally Reduce to Basic Concept Families Conduct. Workshop #2 - Concept Development Review	
C 2 X	**Down Select System Configurations & Workshop #3**	S. Shladover
	Review System Requirements Analyze & Evaluate Surviving Concepts Select Developmental Concept(s) Prepare System Description Document for Each Concept Document Decision Process Conduct Workshop #3 Concept Evaluation. Review	
C 3 A X	**Develop, Build & Test Candidate A**	R. Freuchte
C 3 B X	**Develop, Build & Test Candidate B**	W. Faulconer
C 3 C X	**Develop, Build & Test Candidate C**	J. Perkowski
	Develop Candidate System Designs Outreach & Receive Feedback Refine Designs Based on Outreach Refine Selection Criteria/Weights Prepare Estimated Timeline Select Components & Subsystems for Build & Test Build Critical Units of 3 System Concepts Test Critical Units of System Concepts Conduct Workshop #4 - Concept Design Review	
C 4 A X	**Review System Requirements & MOEs & Workshop #5**	W. Faulconer
	Review System Requirements & Measures of Effectiveness Perform Specification Compliance Checks Compare Concepts Select or Synthesize Configurations Conduct Workshop #5 - Concept Specification Review	
C 4 C X	**Perform Evaluation Studies**	S. Shladover
	Perform Evaluation Studies	

Table 3-1 AHS WBS Task Lead Assignment Matrix (Continued)

W B S	Task Name	Task Leader
C 5 X	**Develop System and Support Documents**	**R. Colgin**
	Update System Top Level Design Document Maintain System Specifications Identify Standards & Preliminary Guidelines Prepare Evaluation Roadmap Estimate Future Costs & Benefits Develop Preliminary Plan for Operational Test & Evaluation Prepare Final Report	
D 1 X	**Plan, Prepare, Conduct Exhibits & Demonstrations**	**T. Quinlan**
	Plan & Prepare Exhibits & Demonstrations Conduct Exhibits & Demonstrations	
D 2 A X	**Identify '97 Demonstration Content & Prepare Plan**	**T. Quinlan**
	Identify 1997 Demonstration Content Prepare Demonstration Plan Identify Required Test Facilities & Infrastructure	
D 2 D X	**Develop Demonstration Systems**	**T. Quinlan**
	Develop Demonstration Systems	
D 2 E X	**Plan, Execute, Document Demonstration(s)**	**T. Quinlan**
	Prepare and Execute Demonstration(s) Document Results and Feedback	
E 1 A X	**Perform Detailed System Design & Workshop #6**	**J. Lewis**
	Perform Detailed System Design Conduct Workshop #6 - AHS Preliminary Design Review	
E 1 B X	**Develop Control System Algorithms**	**S. Shladover**
	Develop Control System Algorithms	
E 2 A X	**Prepare Roadway & Embedded Instruments**	**J. Perkowski**
	Prepare Roadway Enhance Procurement Enhance Roadway & Embedded Instruments	
E 2 C X	**Build Software Components**	**J. Lewis**
	Build Software Components	
E 2 D X	**Procure Components for Vehicles**	**A. Ramaswamy**
	Procure Components for 25 Vehicles Build First Vehicle Prototype Hardware Perform Unit/Module Level Test for Vehicle Integrate Vehicle System for Vehicles 2-25	
E 2 H X	**Integrate Vehicles With Infrastructure**	**J. Lewis**
	Integrate Vehicles With Infrastructure	
E 3 A X	**Prepare Test Plans & Workshop #7**	**T. Quinlan**
	Prepare Test Plans Conduct Workshop #7 - Test Plan Review	
E 3 C X	**Conduct Testing & Workshop #8**	**T. Quinlan**
	Conduct Testing Reduce & Analyze Test Results Prepare Summary Documentation Conduct Workshop #8 - Test Results	

4.0 AHS TASK PLAN SUMMARY

The following Task Plan summaries provide an overview of each of the tasks within the AHS Program. Each summary identifies the Task Leader, tasks encompassed within the task plan, period of performance, allocated labor and contract budgets, and a summary of the task's objective.

WBS: A1X **Task Name:** Manage Program

Task Leader: James Rillings

Sub-Task Name
Manage Program
Handle Legal & Environmental Affairs
Provide Document & Configuration Management

Period of Performance: September 1994 - December 2001

Labor Budget $3.3 M

Contract Budget: $0.0 M

Relocation: $0.9 M

Task Objectives:

Manage the AHS Cooperative Program to ensure the Program achieves its objectives while meeting its budget and schedule.

NAHSC Program Plan

WBS: A2X **Task Name:** Perform Technical Direction & System Engineering

Task Leader: Ron Colgin

Sub-Task Name
Direct Technical Activities
Provide Systems Engineering

Period of Performance: October 1994 - January 2002

Labor Budget $6.4 M

Contract Budget: $0.0 M

Relocation: $0.2 M

Task Objectives:

To provide a Technical Director and Systems Engineering staff to do the following:

Technical Director

- Provides technical oversight for the AHS Program
- Leads the Systems Engineering Process and the Program Office Systems Engineering Staff
- Leads the assessment of critical enabling technologies
- Provides recommendations to the Program Manager and the PMC on which technologies should be acquired and/or developed for the AHS Program and what resources should be allocated to each
- Assists the task leader(s) to plan, budget, execute and report acquisition and development of technologies
- Monitors the entire portfolio of AHS technology development projects to ensure a proper balance
- Provides technical review and oversight of the acquisition and development of technologies for AHS, making regular reports and recommendations to the Program Manager and the PMC
- Coordinates the acquisition and development of technologies to ensure proper interfacing, synergy and mutual support

WBS: A2X **Task Name:** Perform Technical Direction & System Engineering

Task Leader: Ron Colgin

Task Objectives: (Continued)

Program Office Systems Engineers

- Coordinate engineering activities of the program
- Ensure a consistent level of engineering methods and discipline are being applied by the task teams
- Develop the Systems Engineering Management Plan
- Develop requirements and specifications templates
- Maintain configuration control of system and subsystem requirements
- Develop system validation plan
- Organize and schedule technical reviews at major technical milestones
- Support the systems engineering tea and task leader(s) as required
- Organize and schedule workshops
- Support technical liaison with Stakeholders
- Review all deliverable documents for quality and content
- Assist the Program Manager to provide program management and technical guidance for the program

The Program Office Systems Engineering staff consists of representatives from PATH, Lockheed Martin, Hughes Aircraft Company, Bechtel, Parsons-Brinckerhoff and Caltrans.

NAHSC Program Plan

WBS: A3X **Task Name:** Plan and Control Program

Task Leader: Kurt A. Goddard

Sub-Task Name
Manage Schedule
Manage Cost
Manage Procurement & Subcontracts

Period of Performance: October 1994 - January 2002

Labor Budget $4.8 M

Contract Budget: $0.0 M

Relocation: $0.1 M

ODC Budget: $0.9 M

Task Objectives:

Perform overall management of Program cost, schedule, and contracting. This includes monitoring of all Core Participants' budgets, actual vs. forecast, work accomplished vs. work forecast, and contracting issues such as meeting small, small disadvantaged , WBE, and HBCU participation goals, and assisting Core Participants in securing DOT approval, when required, for contracts. The Business Team assists all Core Participants in the development of their annual budgets, detailed schedules and contracting plans. The Business Team receives monthly Cost Performance Reports (consisting of budget summary data, detailed monthly budget data and narratives tasks accomplished) to perform this overall management. The Business Team also submits all funding requests to DOT for the NAHSC. The Business Team serves as the agreement manager for the NAHSC. Provide a full time Business Manager to the Program Office.

WBS: A4X **Task Name:** Perform Site Program Management

Task Leader: James Rillings

Sub-Task Name
Establish Program Baseline
Site Program Management Office by Organization

Period of Performance: October 1994 - January 2002

Labor Budget $13.7 M

Contract Budget: $0.0 M

Travel: $7.0 M *

Task Objectives:

Provide for the internal program management functions at each of the Core Participants. This requires each Site Program Manager to coordinate and monitor the progress of his/her organization's work, identify potential problems and solutions, prioritize activities, and provide the needed administrative support to the other NAHSC Core Participants. This task also covers the Site Program Manager's role as a member of the Program Manager's Council in planning and executing the entire AHS Program.
This task provides for the technical leads for each Core Participant, called Site Program Managers. Each Site Program Manager (SPM) is responsible for writing the detailed statements of work for their organization, detailed scheduling of their organizations work, the performance of technical work, and the coordination and monitoring work progress for their organization. They identify potential problems and solutions, prioritize their organization's activities, and provided needed administrative support.

* **Note:** Reflects total travel budget for entire program.

NAHSC Program Plan

WBS: A5X **Task Name:** Conduct Outreach and Public Affairs

Task Leader: Don Orne

Sub-Task Name
Canvass State DOTs & Other Stakeholders
Receive, Assess & Integrate Responses
Perform Policy Coordination
Conduct Outreach & Public Affairs
Conduct Public Forums
Conduct Government Liaison

Period of Performance: October 1994 - January 2002

Labor Budget $5.8 M

Contract Budget: $4.3 M

Task Objectives:

- Create Consortium "voice" using key messages, internal communication networks and external communication policies and guidelines.
- Create awareness of AHS and its potential benefits
- Educate the public that AHS is an extension of ITS technologies and will be based upon ITS architecture
- Segment stakeholder categories and identify their issues. Address those issues with clear, concise and accurate communications, both to the groups as a whole and to concerned/interested individuals.
- "Package" the efforts of the Consortium and regularly communicate the progress, current issues and future tasks/timing.
- Speak to technical community through "niche" publications, speakers bureau, workshops.
- Inform transportation users through the media; convey the vision of an AHS and how societal and institutional issues are being addressed.
- Build support and encourage the participation of a wide variety of stakeholders in the development of the plan for an AHS.
- Pursue Associate and Outreach Participation
- Hold public forums to streamline the gathering of specific feedback and facilitate its incorporation into the AHS plan
- Create and maintain an active dialogue between the Consortium and likely AHS system implementors and operators. (In most cases this includes, but isn't limited to state, regional and local governments.)

WBS: A5X **Task Name:** Conduct Outreach and Public Affairs

Task Leader: Don Orne

Task Objectives: (Continued)

- Review of key messages and their perception by the Consortium's publics will be required periodically throughout the program.
- Long-term objective is the incorporation of stakeholder feedback/consensus into the system's design and implementation.

NAHSC Program Plan

WBS: A6X **Task Name:** Operate Program Office

Task Leader: Kurt A. Goddard

Sub-Task Name
Program Office Support
Program Office Building Lease
Program Office Computer and WAN Systems
Program Office Administrative Staff Contract

Period of Performance: October 1994 - January 2002

Labor Budget $0.0 M

Contract Budget: $3.0 M

Task Objectives:

Provide the Program Office facilities, office equipment and supplies, computer and communications equipment and services and administrative support staff. These supplies, equipment, services and staff support the Program Office staff operations.

WBS: B1AX **Task Name:** Develop System Requirements & Workshop #1

Task Leader: Walt Faulconer

Sub-Task Name
Develop System Requirements
Develop Program Metrics & Measures
Develop Program Objectives
Obtain USDOT Approval
Prepare Draft Test Plan
Conduct Workshop #1 - Requirements Review

Period of Performance: October 1994 -November 1995

Labor Budget $1.0 M

Contract Budget: $0.0 M

Task Objectives:

Develop the AHS system requirements and objectives. This includes:

- Establish the initial AHS objectives and characteristics,
- Define the AHS program metrics and measures,
- Conduct the first AHS workshop to receive feedback from stakeholders on the requirements baseline,
- Establish the AHS program objectives, initial system requirements and specification,
- Prepare a draft Test and Evaluation Master Plan including the '97 demo objectives,
- Obtain USDOT approval of the AHS system objectives and program plan.

WBS: B2X **Task Name:** Assess Enabling Technologies

Task Leader: Wei Bin Zhang

Sub-Task Name
Identify Technical Categories
Assess State of the Art In Each Critical Technology
Compare State of the Art to Requirements
Document Development Plan for Cross-Cutting Technology
Develop Technical Inputs to Risk Management Plan

Period of Performance: January 1995 - May 1995

Labor Budget $0.6 M

Contract Budget: $0.0 M

Task Objectives:

Review and assess the state-of-the-art of critical enabling technologies for the Automated Highway System. The most promising enabling technologies are selected and a written plan for development of those technologies is delivered to the task lead of B3AX (Procure/Develop Critical Technologies). Provide assessment of technical risks and amelioration measures for the Program Risk Management Plan.

WBS: B3AX **Task Name:** Procure/Develop Critical Technologies

Task Leader: Chuck Thorpe

Sub-Task Name
Procure/Develop Critical Technologies
Identify & Facilitate Potential Spin-off Tech

Period of Performance: May 1995 - March 1999

Labor Budget $9.3 M

Contract Budget: $15.4 M

Task Objectives:

Based on the specifications and timetables developed under WBS B2 (Assessing Enabling Technologies), the Consortium will build and/or procure critical enabling technologies identified under WBS B2. The technologies will include components and subsystems, both hardware and software, that are generally agreed to be important to more than one likely AHS concept. This effort will be going on in parallel with the development of specifications, the development of concepts, and the development of the 1997 demonstration. The intention of the Critical Enabling Technology effort is to get early start on long lead time items, even before concept selection and specifications are complete. This should position the Consortium to be able to build concepts, demonstrations, and prototypes as the designs mature. This WBS element is not designed to cover specific technology needed by only one concept, nor complete systems, nor analyses and tools. This element is, however, the prime candidate for generating spin-off technologies. The work in this WBS element will be handled both within the Consortium and through contracting.

NAHSC Program Plan

WBS: B4X **Task Name:** Identify Tools, Facilities & Vehicles

Task Leader: Steve Shladover

Sub-Task Name
Identify Tool Needs
Identify Subject Area Experts
Identify Facility Needs & Survey Sites
Identify Requirements, Types & Sources of Vehicles

Period of Performance: October 1994 -August 1995

Labor Budget $0.8 M

Contract Budget: $0.0 M

Task Objectives:

Identify the Program's analytical and simulation" infrastructure" for use in many of the subsequent tasks. A variety of analytical tools will be needed to support the design and evaluation of the AHS alternatives.
The first subtask is to identify what relevant tools already exist and are available for use by the Program and what tools are not available and will therefore need to be developed under the auspices of the Program.
A variety of special-purpose facilities are needed in the course of the Program. Selection of which facilities to use will require careful consideration of relative costs and benefits to the Program, particularly when evaluating the trade-offs between leasing an existing facility and acquiring one specifically for Consortium use.
The third subtask is to identify such facility needs and select the most cost-effective ones based on site surveys.
The Program will need numerous test vehicles for a variety of purposes. It is necessary to carefully consider the relative advantages and disadvantages of different models of vehicles for the different test purposes.
The fourth subtask is to identify the test purposes and needs and select particular vehicle models to meet the needs.

WBS: B5X **Task Name:** Acquire / Develop Tools

Task Leader: Steve Shladover

Sub-Task Name
Acquire Computing Assets
Acquire/Develop Simulation Tools
Acquire/Develop Tech Analysis Tools
Acquire Computer Aided Software Engineering Tools
Acquire Cost Analysis Tools
Acquire Networking Infrastructure
Acquire/Develop Other Tools

Period of Performance: March 1995 - November 1997

Labor Budget $7.5 M

Contract Budget: $3.4 M

Task Objectives:

The objective of this task is to develop and modify analysis tools of sufficient fidelity and utility for the design and evaluation of AHS concepts. This task builds on the results of B4X (Identify Tools, Facilities and Vehicles) and subsequent input from other tasks.
The success of analytical and simulation tools hinges on a detailed knowledge of the intended use of the models early in the development process. The intended use of the models are determined by three major factors: the AHS designs to be evaluated and compared, the performance measures and the "benchmark scenarios" for performance testing. The tools development team will be informed of major contending design alternatives in detail (user requirements) as early as possible so that accurate tools can be developed while a balance between model accuracy and robustness can also be achieved. The models and tools will support tasks from Task C2 - Down Select System Configurations onward, including C3 - Develop, Build & Test Candidate and C4 - Review System Requirements and Measures of Effectiveness (MOEs) & Workshop #5 tasks.

NAHSC Program Plan

WBS: B6X **Task Name:** Perform Societal & Institutional Analysis

Task Leader: Habib Shamskhou

Sub-Task Name
Address Societal & Institutional Issues
Perform Environmental Analysis

Period of Performance: May 1995 - March 1999

Labor Budget $0.3 M

Contract Budget: $1.4 M

Task Objectives:
Address institutional issues and societal issues, risks and concerns, particularly areas of needed additional research identified during the AHS precursor studies. Assure that outreach efforts are informed and sensitive to stakeholder interests in and concerns about societal and institutional issues. Incorporate findings system requirements in demonstrations and in the development of prototypes through development of societal and institutional criteria. Contribute to definition of demonstration and prototype goals.

The following tasks will lead to the accomplishment of the above stated task objective:

- Integrate S & I issues in system requirements, concept evaluations, tools, acquisition and development, demonstration activities, prototype development, outreach efforts and Program Management
- Perform environmental analysis task
- Monitor R &D programs of the USDOT, EPA and other government agencies
- Research institutional issues
  - Implementing Agency/State DOT/MPO/ planning and decision-making process
  - Public and private sector roles
  - Constraints and considerations for operations and maintenance
  - Liability legal issues
- Research Societal Issues
  - Sustainable development
  - User needs and market demands
  - The human in the system
  - Transit operations
- Institutional and Societal Costs, Benefits, Tradeoffs
- Social Equity Considerations for AHS in View of Findings from Other Societal and Institutional Considerations and Concept and other Program Recommendations
- Respond to Other Environmental, Jurisdictional and Communications Issues

WBS: C1X **Task Name:** Develop Initial Suite of Concepts & Workshop #2

Task Leader: James Lewis

Sub-Task Name
Identify Candidate Concepts
Solicit Concepts Nationally
Reduce to Basic Concept Families
Conduct. Workshop #2 - Concept Development Review

Period of Performance: April 1995 - October 1995

Labor Budget $1.6 M

Contract Budget: $0.9 M

Task Objectives:

Develop and evaluate an initial suite of AHS concepts by identifying an initial list of candidate concept dimensions and options for each dimension, developing a set of representative concepts spanning the range of these options, conducting a national solicitation for additional concepts from outside the Consortium, evaluating these concepts against the performance and design objectives of WBS Task B1AX (Develop System Requirements & Workshop #1), and based on this effort, identify a set of six concept families to be used in further study and development of the final AHS concept.

The Consortium will document the entire process leading to the selection of the six concept families and will conduct Workshop #2 to present the results and to obtain feedback from the stakeholder community. This feedback will be incorporated into the follow-on concept development task.

NAHSC Program Plan

WBS: C2X **Task Name:** Down Select System Configurations & Workshop #3

Task Leader: Steve Shladover

Sub-Task Name
Review System Requirements
Analyze & Evaluate Surviving Concepts
Select Developmental Concept(s)
Prepare System Description Document for Each Concept
Document Decision Process
Conduct Workshop #3 Concept Evaluation Review

Period of Performance: September 1995 - June 1996

Labor Budget $1.9 M

Contract Budget: $0.0 M

Task Objectives:

Define specific AHS concepts for further development by applying, documenting and achieving consensus with objective down selection following task C1X (Develop Initial Suite of Concepts & Workshop #2). Specifically:

- down select system configurations by reviewing each concept family against the system requirements for consistency, completeness and reasonableness
- analyze and evaluate the six surviving concept families from C1X
- down-select to three developmental concepts
- prepare a System Description Document for each surviving concept
- conduct Workshop #3 to obtain feedback on the selection of the top three concepts for development, to reach agreement on that selection with the stakeholder community, and to obtain buy-in to the process from them.

This task will provide a credible down selection from six AHS concept families to the three AHS concepts to be carried forward for detailed design, analysis and evaluation work.

WBS: C3AX **Task Name:** Develop, Build & Test Candidate A & Workshop #4

Task Leader: Roger Freuchte

Sub-Task Name
Develop Candidate System Designs
Outreach & Receive Feedback
Refine Designs Based on Outreach
Refine Selection Criteria/Weights
Prepare Estimated Timeline
Select Components & Subsystems for Build & Test
Build Critical Units of 3 System Concepts
Test Critical Units of System Concepts
Conduct Workshop #4 - Concept Design Review

Period of Performance: June 1996 - July 1998

Labor Budget $5.7 M

Contract Budget: $1.6 M

Task Objectives:

This task develops one of the concepts resulting from task C2X (Down Select System Configurations & Workshop #3) to the point that a detailed evaluation can be made against the AHS system requirements. Doing this encompasses the following activities:

- Develop a concept plan including schedule and budget.
- Develop a detailed design for the concept based on satisfying AHS system requirements.
- Review design with stakeholders and incorporate feedback as appropriate.
- Identify technical risks to the design, then build and test any unique high risks elements to evaluate feasibility.
- Carry out analyses and simulations to characterize the remaining elements of the concept.
- Compare expected concept performance against AHS system requirements.
- Prepare top level deployment plan.
- Report results.

NAHSC Program Plan

WBS: C3BX **Task Name:** Develop, Build & Test Candidate B & Workshop #4

Task Leader: Walt Faulconer

Sub-Task Name
Develop Candidate System Designs
Outreach & Receive Feedback
Refine Designs Based on Outreach
Refine Selection Criteria/Weights
Prepare Estimated Timeline
Select Components & Subsystems for Build & Test
Build Critical Units of 3 System Concepts
Test Critical Units of System Concepts
Conduct Workshop #4 - Concept Design Review

Period of Performance: June 1996 - July 1998

Labor Budget $6.3 M

Contract Budget: $1.6 M

Task Objectives:

This task develops one of the concepts resulting from task C2X (Down Select System Configurations & Workshop #3) to the point that a detailed evaluation can be made against the AHS system requirements. Doing this encompasses the following activities:

- Develop a concept plan including schedule and budget.
- Develop a detailed design for the concept based on satisfying AHS system requirements.
- Review design with stakeholders and incorporate feedback as appropriate.
- Identify technical risks to the design, then build and test any unique high risks elements to evaluate feasibility.
- Carry out analyses and simulations to characterize the remaining elements of the concept.
- Compare expected concept performance against AHS system requirements.
- Prepare top level deployment plan.
- Report results.

WBS: C3CX **Task Name:** Develop, Build & Test Candidate C & Workshop #4

Task Leader: Joseph Perkowski

Sub-Task Name
Develop Candidate System Designs
Outreach & Receive Feedback
Refine Designs Based on Outreach
Refine Selection Criteria/Weights
Prepare Estimated Timeline
Select Components & Subsystems for Build & Test
Build Critical Units of 3 System Concepts
Test Critical Units of System Concepts
Conduct Workshop #4 - Concept Design Review

Period of Performance: June 1996 - July 1998

Labor Budget $5.7 M

Contract Budget: $1.6 M

Task Objectives:

This task develops one of the concepts resulting from task C2X (Down Select System Configurations & Workshop #3) to the point that a detailed evaluation can be made against the AHS system requirements. Doing this encompasses the following activities:

- Develop a concept plan including schedule and budget.
- Develop a detailed design for the concept based on satisfying AHS system requirements.
- Review design with stakeholders and incorporate feedback as appropriate.
- Identify technical risks to the design, then build and test any unique high risks elements to evaluate feasibility.
- Carry out analyses and simulations to characterize the remaining elements of the concept.
- Compare expected concept performance against AHS system requirements.
- Prepare top level deployment plan.
- Report results.

NAHSC Program Plan

WBS: C4AX **Task Name:** Review System Requirements and Measures of Effectiveness (MOEs) & Workshop #5

Task Leader: Walt Faulconer

Sub-Task Name
Review System Requirements and Measures of Effectiveness (MOEs)
Perform Specification Compliance Checks
Compare Concepts
Select or Synthesize Configurations
Conduct Workshop #5 - Concept Specification Review

Period of Performance: January 1998 - March 1999

Labor Budget $1.3 M

Contract Budget: $0.0 M

Task Objectives:

This task is the culmination of all the preceding activities, building on all the knowledge gained from the analysis, design and experimental work, to determine the best AHS concept and configuration for intensive development and testing in the rest of the Program. The concept to be chosen could be one of the three concepts tested in the earlier stages, or it could represent a synthesis of elements from more than one concept and from the 1997 Demonstration. The completion of this task represents Milestone 4. Because this represents a culmination of preceding activities, a series of public forums will be conducted at this time to keep the community at large informed of AHS developments and future directions and to provide an opportunity for public input before moving on to the prototype development stage.

WBS: C4CX **Task Name:** Perform Evaluation Studies

Task Leader: Steve Shladover

Sub-Task Name
Perform Evaluation Studies

Period of Performance: March 1998 - September 1998

Labor Budget $2.8 M

Contract Budget: $2.0 M

Task Objectives:

At the conclusion of the design and development of the three alternative AHS concepts in Task C3 (Develop, Build & Test Candidates A, B, C & Workshop #4), it is important to have comprehensive and fair cross-cutting evaluations of the strengths and weaknesses of the three concepts. These evaluations will be performed as part of this WBS element C4C, and the results of these evaluations will be used to support the definition of the final concept to be developed in the prototype system. The evaluations will address the full range of issues that are expected to be important to the selection of an AHS concept, including technical performance (safety, throughput, "ilities", etc.) economics, societal and institutional issues, etc. The majority of these evaluations will be done by contractors from outside the NAHSC core membership in order to maximize the independence of the evaluators from the concept developers. A limited number of the evaluations are expected to be done by the Core Participants where some of their particular skills or experience are expected top be necessary,

The evaluation may indicate the most appropriate final AHS concept would incorporate elements of the three concepts from Task C3. In that event, a hybrid concept will be formulated during the Task C4C, to try to capture the best combination of attributes for the AHS prototype system.

The concept evaluations and re-concepting will be brought forward for stakeholder input throughout Task C4C, and particularly in the later stages, when it will be necessary to assign weights to the different evaluation criteria.

WBS: C5X **Task Name:** Develop System and Support Documents

Task Leader: Ron Colgin

Sub-Task Name
Update System Top Level Design Document
Maintain System Specifications
Identify Standards & Preliminary Guidelines
Prepare Evaluation Roadmap
Estimate Future Costs & Benefits
Develop Preliminary Plan for Operational Test & Evaluation
Prepare Final Report

Period of Performance: December 1999 - January 2002

Labor Budget $1.9 M

Contract Budget: $0.0 M

Task Objectives:

This task provides the major program output, the AHS System Specifications and supporting documentation. This task includes all the effort in support of Milestone 6, Completion of System and Supporting Documentation. The output of this task is a set of specifications and plans to guide a follow-on Operational Evaluation phase to explore the widespread implementation and use of Automated Highway Systems in the United States. The final series of public forums will be conducted as this task and the AHS System Definition Phase nears completion. Material presenting Program activities, outcome and future direction will be presented to the public. Community response will be sought regarding future AHS developments and the AHS Program in general.

WBS: D1X **Task Name:** Plan, Prepare & Conduct Exhibits & Demonstrations

Task Leader: Theresa Quinlan

Sub-Task Name
Plan & Prepare Exhibits & Demonstrations
Conduct Exhibits & Demonstrations

Period of Performance: September 1995 - October 1996

Labor Budget $0.4 M

Contract Budget: $0.4 M

Task Objectives:

Plan and prepare AHS exhibits and demonstrations for the October, 1996 ITS World Congress. Items will be selected to represent typical enabling technologies under development for application to AHS. Static and dynamic displays, computer animation and video presentation of technology tests will be used to provide a vision of a mature AHS.

WBS: D2AX **Task Name:** Identify '97 Demonstration Content & Prepare Plan

Task Leader: Theresa Quinlan

Sub-Task Name
Identify 1997 Demonstration Content
Prepare Demonstration Plan
Identify Required Test Facilities & Infrastructure

Period of Performance: February 1995 - July 1997

Labor Budget $1.1 M

Contract Budget: $0.0 M

Task Objectives:

Identify 1997 Demonstration Content The Consortium, in concert with the USDOT, will identify the scope of the 1997 Demonstrations. The selection of technologies for demonstration will focus on existing systems. The demonstration content document will include the following: Preliminary selection of concepts and technologies, demonstration site and scenarios, content of static displays and computer animation use of heavy trucks and buses, types and number of vehicles, the level of functionality for live vehicle demonstrations, driver interfaces, fault tolerant systems and safety issues, and observer accommodations and facilities.

Prepare Demonstration Plan A detailed demonstration plan for the 1997 Demonstration will be developed. This plan will indicate the elements to be demonstrated based on the desire to show the benefits and the technical, social and environmental feasibility of an AHS. This will be tempered by the need to ensure that the elements are sufficiently mature that they can be demonstrated safely and with an extremely high probability of success. The items it will contain include: Full description of the products to be demonstrated, detailed test objectives, validation plan, demonstration schedule and budget, description of test facilities, integration plan, including partitioning of work for core, associates and other participants, marketing plan including level of observer participation, accommodations and facilities.

WBS: D2AX **Task Name:** Identify '97 Demonstration Content & Prepare Plan

Task Leader: Theresa Quinlan

Task Objectives: (Continued)

Identify Required Test Facilities & Infrastructure Completion of this task will provide a review of the adequacy of the test facilities, identified in WBS B4 (Identify Tools, Facilities and Vehicles), to meet the requirements of the 1997 demonstration. This review will ensure that all demonstration requirements are met by the test facilities, or that any requirements not met by the test facilities are identified, documented, and resolved. This review will also ensure availability of adequate facilities for demonstrations and any testing performed prior to the 1997 demonstrations.

The 1997 AHS demonstration will take place on a segment of I-15 in San Diego County, California. This is an exclusive, ten mile, two-lane, high-occupancy roadway with barriers to separate median lanes from normal traffic.

Safety of test personnel and observers is of the highest priority. There are several sites along the length of the I-15 facility suitable for safe viewing of the roadway. The sites are isolated from traffic and are typically off to the side and above the roadway. In addition, Caltrans has written safety procedures and guidelines for use of the I-15 facility which are strictly enforced. Test personnel are required to review safety guidelines before entering the facility and to abide by them. Safety procedures include the use of protective clothing, spotter vehicles at all access points of the facility and radio communication with emergency personnel through the local Traffic Management Center.

The I-15 facility has been successfully used to perform testing of advanced AHS and IVHS technologies with no threat to the safety of technical personnel, observers or the traveling public.

WBS: D2DX **Task Name:** Develop Demonstration Systems

Task Leader: Theresa Quinlan

Sub-Task Name
Develop Demonstration Systems

Period of Performance: January 1996 - July 1997

Labor Budget $11.1 M

Contract Budget: $11.9 M

Task Objectives:

Detailed development plans will be created for all components of the AHS systems to be demonstrated. This will include vehicle based components, infrastructure based components, communication components, system control components, and software. Development plans will include development description, schedule, critical paths, milestones, resources, costs, and responsibilities. Each development plan will result in the creation, acquisition, or fabrication of the system component, or the combining/installation of several components.

A detailed marketing plan will be developed to ensure that the 1997 Demonstration is a successful means of favorably positioning the consortium to garner the necessary funding, and achieve the needed institutional, and public support and involvement to the AHS a practical reality. The success of the 1997 Demonstration will depend not only on the technical contents but also on how they are presented. Careful consideration will be given to the development of the demonstration scripts and to rehearsals of those scripts well in advance of the demonstration dates. These will be reviewed with USDOT to ensure that the desired messages are conveyed by the demonstrations. Similar attention will be devoted to the static demonstrations, video displays and computer animation that convey the future vision for AHS.

The components, subsystems and systems will be subjected to functional testing to ensure conformance to performance specifications. Development of the demonstration systems will be complete when all components are integrated into their respective systems, or subsystems, and the systems and components are functioning as designed in an actual or simulated AHS environment.

WBS: D2EX **Task Name:** Plan, Execute, Document Demonstration(s)

Task Leader: Theresa Quinlan

Sub-Task Name
Plan, Execute, Document Demonstration(s)
Document Results and Feedback

Period of Performance: July 1997 - September 1997

Labor Budget $1.0 M

Contract Budget: $0.0 M

Task Objectives:

Execute the 1997 Demonstration presenting AHS concept alternatives, system and subsystem designs, and key AHS technologies and functions. This task encompasses final preparations prior to the demonstration, the actual performance of the 1997 Demonstration, and related post-demonstration activities. This task also includes detail documentation of the event.

WBS: E1AX **Task Name:** Perform Detailed System Design & Workshop #6

Task Leader: James Lewis

Sub-Task Name
Perform Detailed System Design
Conduct Workshop #6 - AHS Preliminary Design Review (PDR)

Period of Performance: March 1999 - December 1999

Labor Budget $4.3 M

Contract Budget: $0.5 M

Task Objectives:

The process for developing the design of the prototype will focus on producing a written description of the system architecture at the system and subsystem level, identifying and describing the hardware and software architecture and components, and specifying the functions of this hardware and software. The major subsystems include the vehicles, the infrastructure, and the communications links. The output of this task is a series of design descriptions and specifications of the system, the subsystems, and their components, including internal and external interfaces, hardware and software design components, and subsystem and component performance and functionality. With this set of documents, the Consortium will be able to produce or procure all subsystem components, both hardware and software, of the prototype AHS system. The documents will support competitive procurement of subsystems and components. Concurrent with the design process, the Consortium will perform a safety and hazard analysis to ensure that system hazards are being addressed and that the cause and effects of component failures are understood and do not lead to unsafe system states. The system reliability model will also be maintained to ensure that the design always meets its reliability and availability goals.
The final activity of this task is Workshop #6 to present the detailed AHS design. The workshop will be a detailed design review to solicit comments by stakeholders before the AHS prototype is built. Key design documents will be distributed prior to the workshop to enable informed participation. This workshop will provide the final opportunity for the stakeholder community to influence the specific development plans prior to implementation of the prototype.

WBS: E1BX **Task Name:** Develop Control System Algorithms

Task Leader: Steve Shladover

Sub-Task Name
Develop Control System Algorithms

Period of Performance: March 1999 - December 1999

Labor Budget $3.6 M

Contract Budget: $0.0 M

Task Objectives:

The purpose of this task is to develop the control system algorithms for the prototype AHS configuration. There are several layers of control that must be designed including both roadway master control and vehicle control algorithms. At the highest level, overall system decisions are made to command and monitor traffic flow. At a lower level, vehicle control algorithms will ensure safe vehicle to vehicle separation and lane tracking, as well as lane change and entry/exit control. These control algorithms will be developed with malfunction management, including fault detection and fault tolerant performance for fail-safe operation.

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WBS: E2AX **Task Name:** Prepare Roadway & Embedded Instruments

Task Leader: Joseph Perkowski

Sub-Task Name
Prepare Roadway Enhance Procurement
Enhance Roadway & Embedded Instruments

Period of Performance: November 1999 - September 2000

Labor Budget $0.6 M

Contract Budget: $7.7 M

Task Objectives:

The selected AHS concept and resulting design identified in WBS C4 (Select Final AHS System Configuration) and WBS E1 (Design the AHS Prototype) will be used to construct the AHS prototype system. All elements of the selected concept will be created including hardware, software, and infrastructure. These elements will be integrated into a complete functioning system to allow a thorough evaluation of the performance of the selected AHS concept on a fleet of 25 test vehicles.
The site for the prototype AHS system will be selected from the test facilities previously identified in WBS B4X (Identify Tools, Facilities and Vehicles). Maximum effort will be made to utilize one of the existing facilities, including the 1997 Demonstration site. Although the AHS system configuration is being developed to demonstrate at one test site due to time and budget considerations, additional test sites may be determined necessary and may be addressed either at the initial stages of the Program or during the research effort, based on the recommendations of the USDOT. The selected site(s) will need to be able to demonstrate that an AHS can be operated in areas with weather conditions such as wind, rain, snow, ice and fog.
In developing the many components comprising the AHS prototype system, emphasis will be placed on early identification of long lead time items so their acquisition can start early in the Program to prevent later delays.
As this task nears completion, the fifth series of public forums will be conducted to present the prototype system and development strategy. The Consortium's prior incorporation of earlier public input acquired through the first four public forums will help ensure user acceptance of the prototype design.

The Consortium will compare the roadway requirements for the prototype system to the available facilities of the selected test site. Necessary enhancements to the test facility will be identified and planned.

WBS: E2AX **Task Name:** Prepare Roadway & Embedded Instruments

Task Leader: Joseph Perkowski

Task Objectives: (Continued)

Enhancements will include modification of existing test site infrastructure and the construction of new infrastructure to accommodate elements of the AHS system. Site enhancements will also be performed to accommodate instrumentation necessary for the monitoring of system performance during testing of the prototype system. Safety of personnel will be emphasized during all phases of test site evaluation and enhancement.

Preparation for the enhancement of the test site facilities will include the following:

- Develop facility enhancement specifications
- Prepare subcontract terms and conditions
- Organize and hold pre-bid meetings
- Develop and issue RFP
- Review proposals submitted in response to RFP
- Select preferred proposal and issue subcontract

In the event that the private sector rather than a public agency is the prime provider of a roadway site, it is anticipated that negotiations between the Consortium and interested bidders may be conducted offering candidate real estate sites for the entire facility. The design, construction, and continued on-going operations of such a facility carry a large implicit value as a focal point for integrated real estate resources development. Because many interested bidders from the private sector would view the roadway and test facility in this manner, negotiations with these bidders would include a requirement for them to indicate areas of cost-sharing related to site improvements. Examples of such contributions potentially include provision of common site services, full site access that is pre-installed, and designations of specific adjacent parcels at no cost for project support facilities.

WBS: E2CX **Task Name:** Build Software Components

Task Leader: James Lewis

Sub-Task Name
Build Software Components

Period of Performance: March 1999 - February 2000

Labor Budget $7.7 M

Contract Budget: $7.0 M

Task Objectives:

Software based on the subsystem designs identified in WBS E1AX (Perform Detailed System Design and Workshop #6) and E1BX (Develop Control System Algorithms) will be developed for the prototype AHS. The software development specifications and other system requirements identified in WBS E1 (Design AHS Prototype) will be utilized. Where appropriate, code from previous tests, demonstrations, and research will be integrated. The end result will be a total system software package capable of coordinating and controlling all elements of the prototype AHS system. Software development will include the following:

- Software architecture development
- Software validation plan
- Software design review
- Coding, testing, and integrating software
- System software validation

WBS: E2DX **Task Name:** Procure Components for Vehicles

Task Leader: Ashok Ramaswamy

Sub-Task Name
Procure Components for 25 Vehicles
Build First Vehicle Prototype Hardware
Perform Unit/Module Level Test for Vehicle
Integrate Vehicle System for Vehicles 2-25

Period of Performance: August 1999 - November 2000

Labor Budget $6.0 M

Contract Budget: $7.1 M

Task Objectives:

The sensors, actuators, electronics and communications equipment needed for installation on a fleet of twenty-five vehicles for AHS prototype testing will be procured. These vehicles will include passenger cars, vans and light trucks. The addition of other types of vehicles, such as buses and heavy trucks, depends on the acceptance by USDOT of the Heavy Vehicle Option to the original NAHSC application. Other parallel activities involving automation of heavy trucks (e.g. for pavement testing) will be followed closely to seek synergy's with the AHS Program.

One prototype vehicle will be completely equipped for operation in the AHS prototype system. Prior to installation in this first vehicle, components will be assembled into subsystems, where possible, and tested. Upon integration of all components and subsystems into the vehicle, the vehicle will be subjected to thorough testing and evaluation. Any performance discrepancies will be identified, documented, and resolved. Modifications and redesign will be performed as necessary and documented. Configuration control will be maintained. This task will be considered complete when the vehicle performance conforms to all pertinent design specifications and exhibits the specified level of reliability.

Prior to, and during the building of the first vehicle, mechanical, electrical, and electronic design drawings will be created as necessary. All drawings will be subject to configuration control to ensure an accurate and complete development history. All designs and design revisions will be subjected to design review.

WBS: E2HX **Task Name:** Integrate Vehicles With Infrastructure

Task Leader: James Lewis

Sub-Task Name
Integrate Vehicles With Infrastructure

Period of Performance: August 2000 - November 2000

Labor Budget $1.5 M

Contract Budget: $0.0 M

Task Objectives:

The infrastructure electronics will be installed at the selected prototype test site and will be debugged to ensure that they function properly. Their interactions with the vehicle electronics will then be tested, as soon as the first fully operational prototype vehicle is available for this testing. As additional vehicles are completed, they will be brought to the test site to verify proper integration with the infrastructure systems and with each other for multiple vehicle operations.

WBS: E3AX **Task Name:** Prepare Test Plans & Workshop #7

Task Leader: Theresa Quinlan

Sub-Task Name
Prepare Test Plans
Conduct Workshop #7 - Test Plan Review

Period of Performance: July 1999 - September 1999

Labor Budget $0.8 M

Contract Budget: $0.0 M

Task Objectives:

The prototype AHS system testing will be sufficiently thorough to provide the basis for defining the detailed AHS specification, the ultimate deliverable in the Program. The 25 prototype vehicles will be tested for a full year, providing exposure to a full range of weather conditions as well as acquiring sufficient operating mileage and hours to identify any potential problems of reliability or system safety. Test objectives and validation requirements identified in WBS E2 will provide the basis for further development under E3A (Prepare Test Plans & Workshop #7) and support testing under E3C (Conduct Testing & Workshop #8).

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WBS: E3CX **Task Name:** Conduct Testing & Workshop #8

Task Leader: Theresa Quinlan

Sub-Task Name
Conduct Testing
Reduce & Analyze Test Results
Prepare Summary Documentation
Conduct Workshop #8 - Test Results

Period of Performance: October 2000 - January 2002

Labor Budget $3.5 M

Contract Budget: $2.6 M

Task Objectives:

AHS prototype tests will be conducted according to the test plans from WBS E3 (Test AHS Prototype). Completion of the testing will satisfy Milestone 5. Results from the AHS prototype tests will be reduced and analyzed. A technical group will be formed to prepare an analysis plan and evaluate the test results. Analysis will be performed on the preferred system configuration and the capabilities of individual subsystems of the prototype AHS. A final report will be prepared and presented with detailed results of the AHS prototype test. Accomplishments will be clearly identified and recommendations will include suggested improvements to the preferred system configuration based on the results of the analysis and evaluation. Documentation will contain information aimed at providing a basis for transition into the Operational Test and Evaluation Phase. At the conclusion of the prototype testing, a final workshop will be held to review the results of the testing and consider their implications for the design of the AHS operational test system.

5.0 AHS PROGRAM DOCUMENTS

The table below provides a listing of internal and program deliverable AHS documents and the associated tasks and AHS Program Milestones.

Table 5-1 AHS Program Documents

Deliverable	Milestone	WBS
Final Agreement		A4
Detailed Program Plan		A4
Program Objectives Document	1	B1A
Assessment of State of the Art in Critical Technologies		B2
Critical Technologies and Components Development Plan		B3A
Spin-off Technologies and Products Report		B3A
Documentation of AHS Concepts Families		C1
System Description Documents for Developmental Concepts	3	C2
1996 World Congress Exhibit		D1
Plan for 1997 Proof of Technical Feasibility Demonstration		D2A
1997 Demonstration	2	D2E
1997 Demonstration Final Report		D2E
Evaluation Studies Technical Reports		C4C
Documentation of Final Concept Synthesis	4	C4A
Prototype Vehicles and Infrastructure		E2H
Documentation of Prototype System Testing	5	E3C
Final System Specifications	6	C5
Evolutionary Deployment Roadmap		C5
Operational Test and Evaluation Plan		C5
AHS System Definition Final Report		C5
Quarterly Progress Reports		A3
Quarterly Financial Reports		A3
Exhibits and Papers at ITS America Annual Meetings		A5
Exhibits and Papers at ITS America World Congress		A5

6.0 NAHSC PLANNING, SCHEDULES AND MILESTONES

An integrated AHS Master Schedule has been developed from program milestones, intermediate and lower level detailed schedules, and other data required to status and control the program. As the program matures, program management personnel will refine the granularity of this schedule and map work breakdown elements to work packages and build products. Changes to the master schedule which affect the dates of the baseline major milestones are highlighted to program management. This planning and control

system provides cost measurement performance and reporting generation. This system is maintained on an automated tool and mapped back to the program WBS.

6.1 Master Integrated Schedule

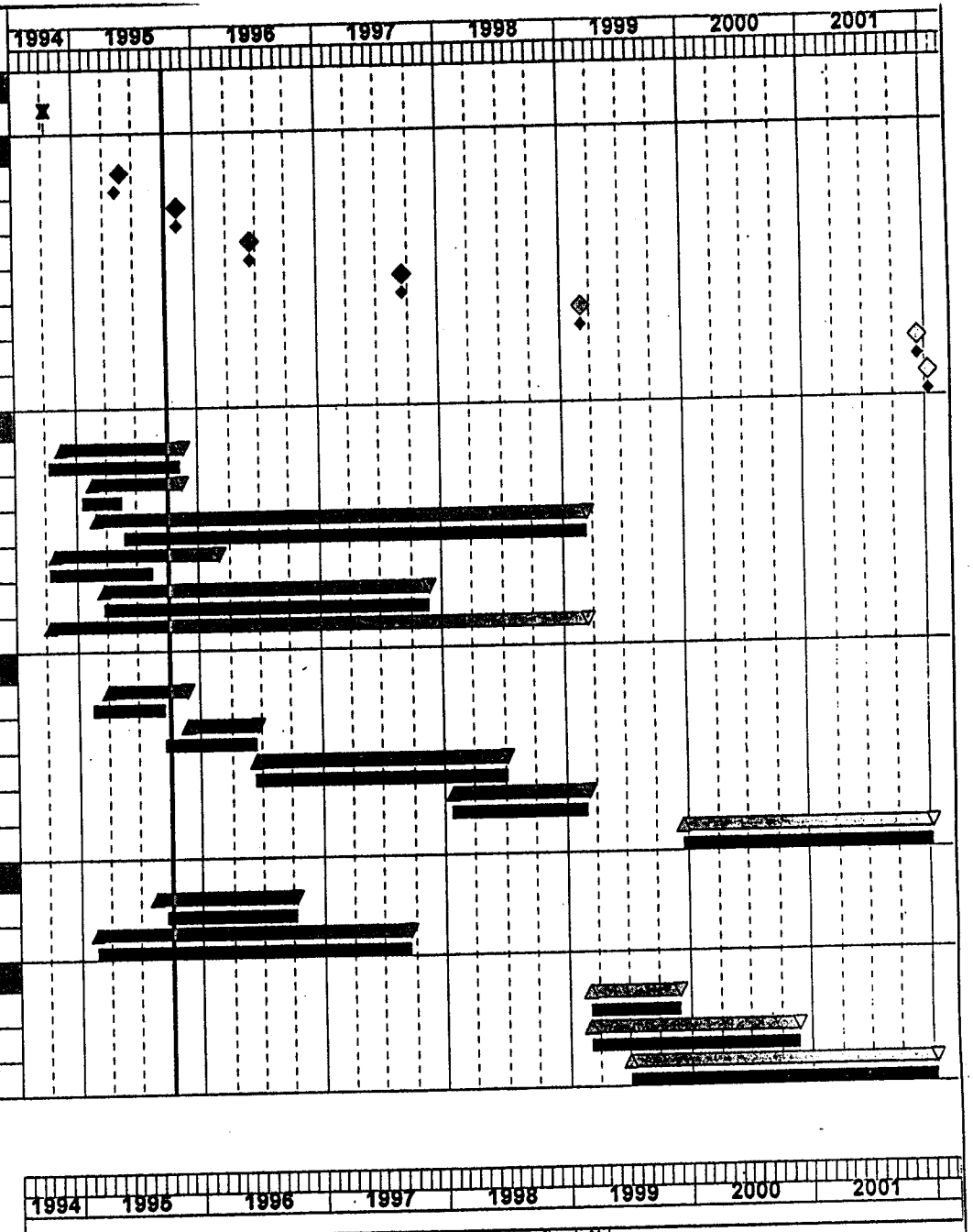
The Master Integrated Schedule represents a summary level plan for the work breakdown structure scope of program work and consists of time-scaled logic diagrams that define the sequence, duration, and general inter-discipline restraints of activities. The intent of the Master Integrated Schedule is to establish more of a detail plan or route map for the program than the Milestone Summary Schedule and to provide a complete picture of the overall project. All subsequent detailed schedules are developed and evaluated within the constraints established by the Milestone Summary Schedule and Master Integrated Schedule.

The Master Integrated Schedule reflected in the following pages is organized by work breakdown structure with the major scope activities of the work breakdown structure scheduled below. Beside the activity description are the current start and finish dates of the activity. If an activity has started or completed an "A" will appear after these dates. The schedule shows overall activity progress with two separate bars. The top bar shows the current schedule and forecast dates for the activity . The bottom bar shows the baseline schedule in place at the inception of the program. Overall progress is measured by a comparison of the current schedule (top bar) with the baseline schedule (bottom bar).

6.2 Critical Path Schedule

The Critical Path Schedule represents a continuous line of activities running from the start to the finish of the program schedule, whose start and finish dates cannot be significantly delayed without impacting the program finish date. Program Critical Path may vary as to specific activities depending on critical and near critical activities' progress, hence the requirement of periodic analysis of program critical path after each update.

WBS	Activity Description	Start	Finish
Notice to Proceed			
.	Notice to Proceed	10/07/94A	10/07/94A
Milestones			
.	MS#1: Prel. Sys Rqmts Obj Est		05/24/95A
.	MS#1: Final Sys Rqmts Obj Est		11/09/95*
.	MS#3: Feasible AHS Concepts Selected		06/13/96*
.	MS#2: Proof-of-Feasibility Demonstration		09/15/97*
.	MS#4: Preferred AHS Configuration Selected		03/04/99*
.	MS#5: AHS Prototype Testing Completed		12/13/01*
.	MS#6: Sys Doc Completed		01/10/02*
B SYSTEM DEFINITION			
B1	Establish Performance & Dsn Obj.	11/14/94A	11/16/95
B2	Assess Enabling Technologies	02/16/95A	11/10/95
B3	Develop Critical Technology	03/01/95A	03/19/99
B4	Identify Tools, Facilities & Vehicles	10/26/94A	03/01/96
B5	Acquire/Develop Tools	03/20/95A	11/21/97
B6	Perform Societal and Institutional Analysis	10/07/94A	03/19/99
C CONCEPT DEVELOPMENT			
C1	Develop Initial Suite of Concepts & W.S. #2	04/03/95A	11/20/95
C2	Downselect Sys Config. & W.S. #3	11/21/95	06/19/96
C3	Dev Candidate Sys Designs & W.S.#4	06/14/96	07/09/98
C4	Select Final AHS System Configuration	01/26/98	03/10/99
C5	Develop Sys & Supporting Doc	12/16/99	01/10/02
D EXHIBITS & DEMONSTRATIONS			
D1	Pln,Prep,& Conduct '96 Exhts & Demos	08/15/95A	10/07/96
D2	1997 Feasibility Demonstration	02/15/95A	09/15/97
E AHS PROTOTYPE			
E1	Design AHS Prototype	03/05/99	12/02/99
E2	Develop AHS Prototype	03/05/99	11/23/00
E3	Test AHS Prototype	07/02/99	01/10/02



Project Start 10/01/94
Project Finish 01/10/02
Data Date 10/01/95
Plot Date 11/09/95

Early Bar
Baseline Sched.
Progress Bar

AHSD

National AHS Consortium
Summary Schedule
Update as of 10/01/95

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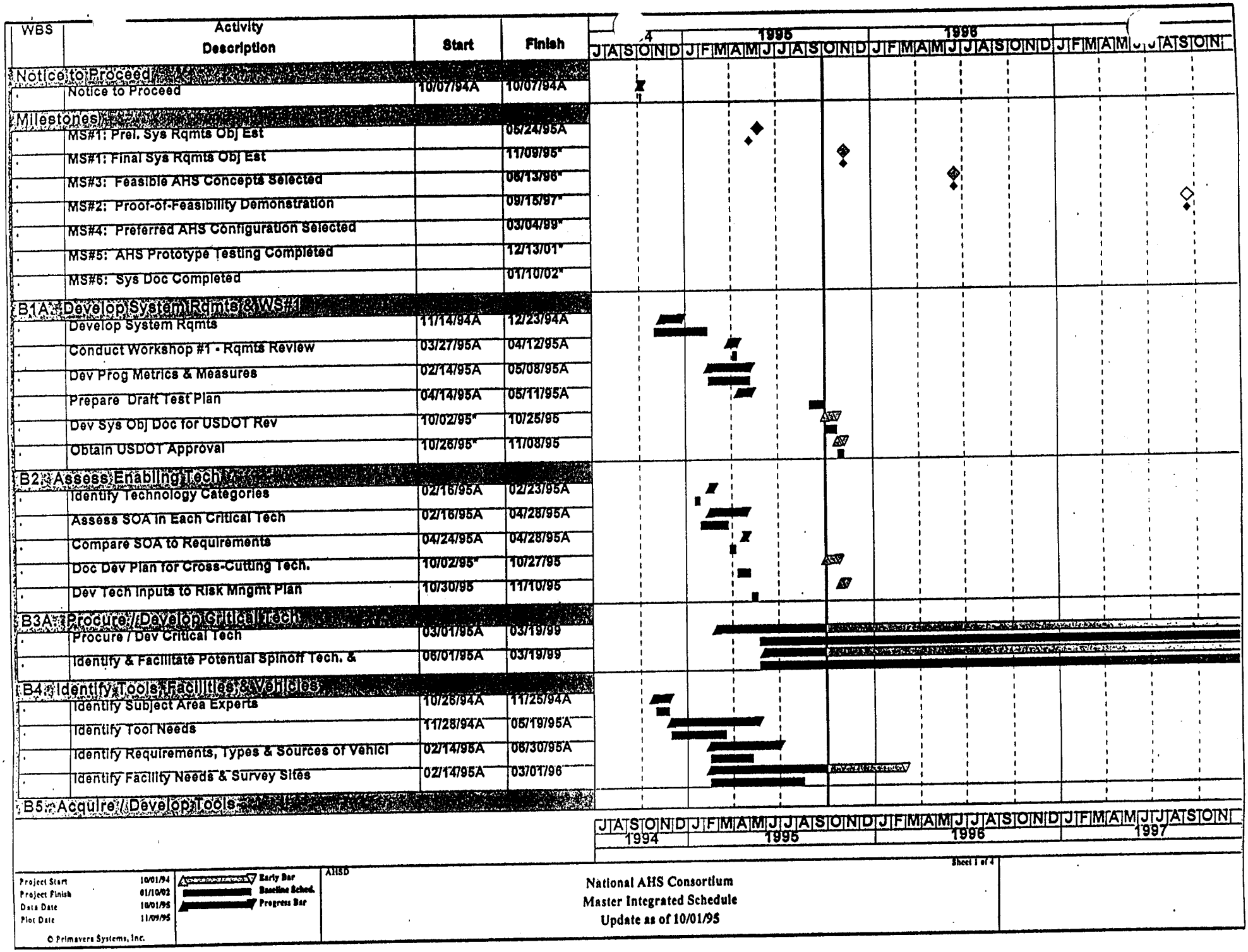
WBS
Activity Description
Start
Finish
1995
1996
Notice to Proceed
Notice to Proceed 10/07/94A 10/07/94A
Milestones
MS#1: Prel. Sys Rqmts Obj Est 05/24/95A
MS#1: Final Sys Rqmts Obj Est 11/09/95*
MS#3: Feasible AHS Concepts Selected 06/13/96*
MS#2: Proof-of-Feasibility Demonstration 09/15/97*
MS#4: Preferred AHS Configuration Selected 03/04/99*
MS#5: AHS Prototype Testing Completed 12/13/01*
MS#6: Sys Doc Completed 01/10/02*
B1A: Develop System Rqmts & WS #1
Develop System Rqmts 11/14/94A 12/23/94A
Conduct Workshop #1 - Rqmts Review 03/27/95A 04/12/95A
Dev Prog Metrics & Measures 02/14/95A 05/08/95A
Prepare Draft Test Plan 04/14/95A 05/11/95A
Dev Sys Obj Doc for USDOT Rev 10/02/95* 10/25/95
Obtain USDOT Approval 10/26/95* 11/08/95
B2: Assess Enabling Tech
Identify Technology Categories 02/16/95A 02/23/95A
Assess SOA in Each Critical Tech 02/16/95A 04/28/95A
Compare SOA to Requirements 04/24/95A 04/28/95A
Doc Dev Plan for Cross-Cutting Tech. 10/02/95* 10/27/95
Dev Tech Inputs to Risk Mngmt Plan 10/30/95 11/10/95
B3A: Procure / Develop Critical Tech
Procure / Dev Critical Tech 03/01/95A 03/19/99
Identify & Facilitate Potential Spinoff Tech. & 06/01/95A 03/19/99
B4: Identify Tools, Facilities, & Vehicles
Identify Subject Area Experts 10/26/94A 11/25/94A
Identify Tool Needs 11/28/94A 05/19/95A
Identify Requirements, Types & Sources of Vehicl 02/14/95A 06/30/95A
Identify Facility Needs & Survey Sites 02/14/95A 03/01/96
B5: Acquire / Develop Tools
J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N
1994
1995
1996
1997
Project Start 10/01/94
Project Finish 01/10/02
Data Date 10/01/95
Plot Date 11/09/95
Early Bar
Baseline Sched.
Progress Bar
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Master Integrated Schedule
Update as of 10/01/95
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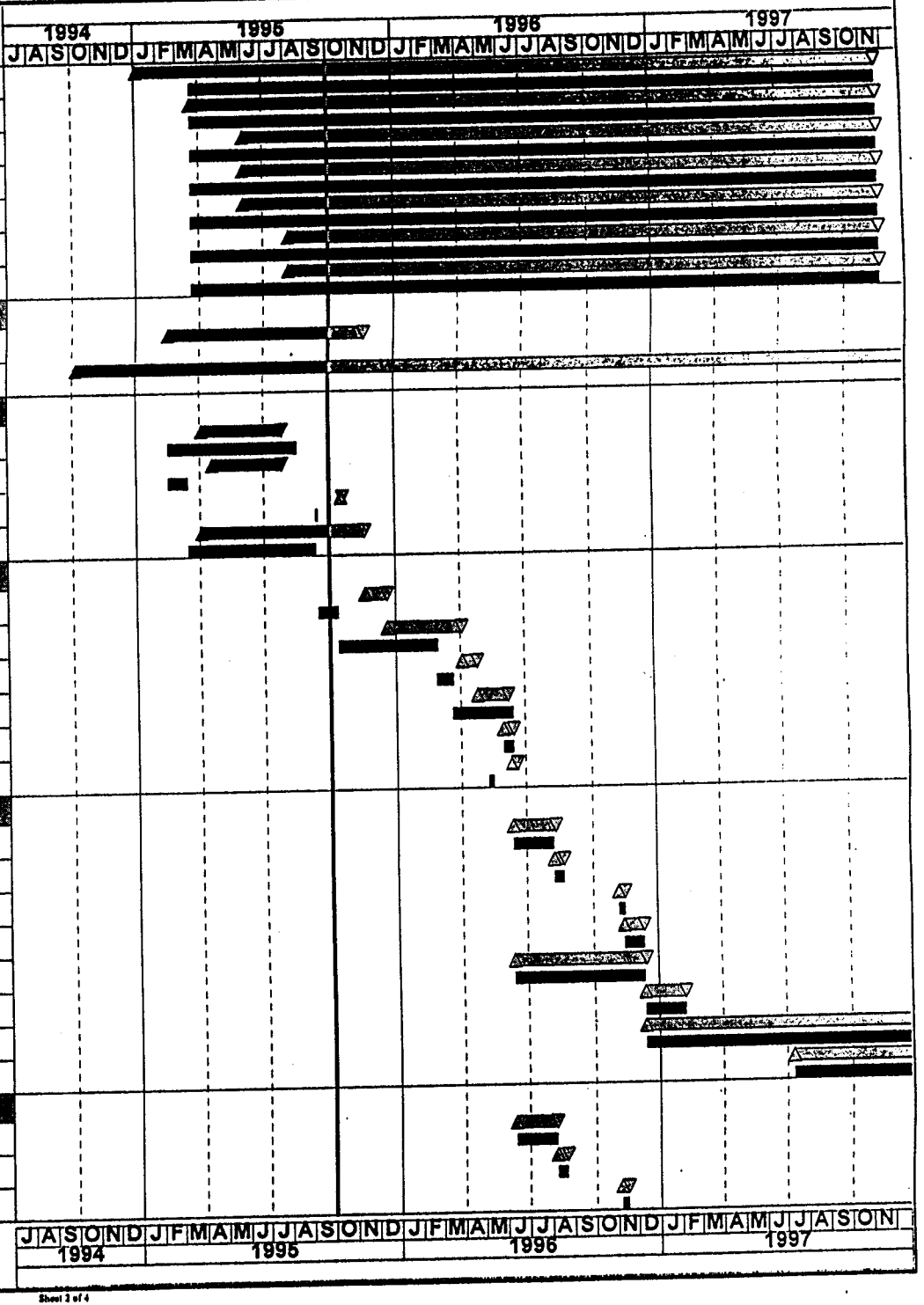
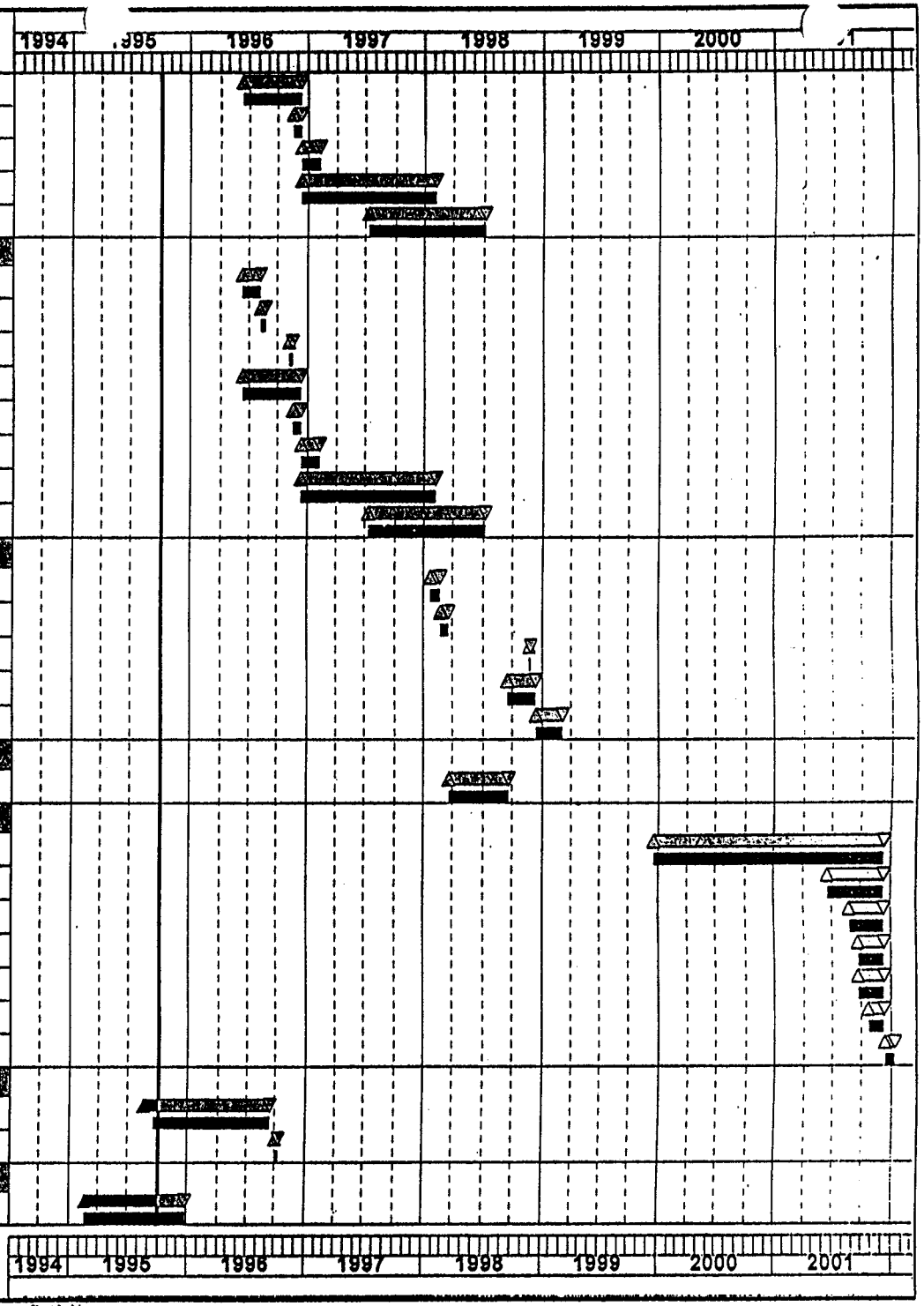
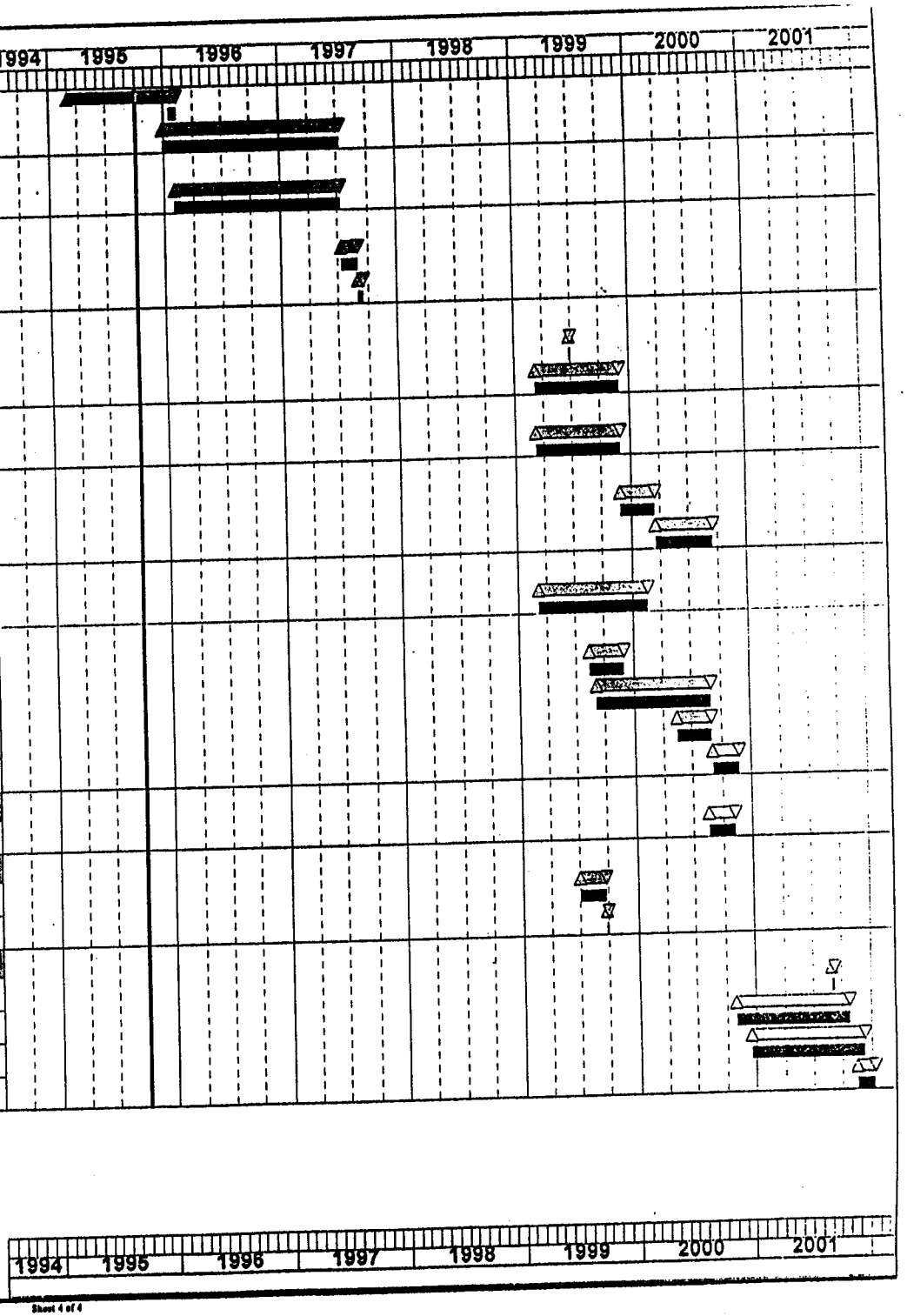
WBS	Activity Description	Start	Finish
.	Acquire Networking Infrastructure	01/03/95A	11/21/97
.	Acquire Computing Assets (H/W & S/W)	03/20/95A	11/21/97
.	Acquire/Develop Technical Analysis Tools	06/01/95A	11/21/97
.	Acquire Comp Aided S/W Eng. Tools	06/01/95A	11/21/97
.	Acquire Cost Analysis Tools	06/01/95A	11/21/97
.	Acquire/Develop Simulation Tools	08/04/95A	11/21/97
.	Acquire/Develop Other Tools...	08/04/95A	11/21/97
B6	Societal and Institutional Analysis		
.	SOW Plan and Budget	02/15/95A	11/20/95
.	Perform Societal and Institutional Analysis	10/07/94A	03/19/99
C1	Develop Initial Suite of Concepts & WS#2		
.	Solicit Concepts Nationally	04/03/95A	07/26/95A
.	Identify Candidate Concepts	04/17/95A	07/25/95A
.	Conduct WS#2 - Concept Definition Rev	10/18/95*	10/20/95
.	Reduce to Basic Concept Families	04/03/95A	11/20/95
C2	Downselect Sys Config & WS#3		
.	Review System Requirements	11/21/95*	12/20/95
.	Analyze & Eval Surviving Concepts	12/21/95*	04/02/96
.	Review Sys. Requirements	04/03/96	04/24/96
.	Prep Sys Description Doc for Each Concept	04/25/96*	06/05/96
.	Document Decision Process	05/30/96*	06/13/96
.	Conduct WS#3 - Concept Evaluation Rev	06/12/96*	06/19/96
C3A	Dev, Build & Test Candidate A		
.	Outreach to Stakeholders & Recieve Feedback	06/13/96*	08/09/96
.	Refine Designs in Response to Outreach Efforts	08/08/96*	08/22/96
.	Conduct WS#4 - Concept Des Rev	11/07/96*	11/14/96
.	Select Comp, Subsys & Combination for Build/Test	11/14/96*	12/12/96
.	Develop 3 Candidate Systems Dsn	06/13/96*	12/13/96
.	Prepare Estimated Deployment Timeline	12/12/96*	02/06/97
.	Build Critical Portions of the 3 Sys Concepts	12/12/96*	02/05/98
.	Test Critical Portions of the 3 Sys Concepts	07/10/97*	07/09/98
C3B	Dev, Build & Test Candidate B		
.	Outreach to Stakeholders & Recieve Feedback	06/13/96*	08/08/96
.	Refine Designs in Response to Outreach Efforts	08/08/96*	08/22/96
.	Conduct WS#4 - Concept Des Rev	11/07/96*	11/14/96



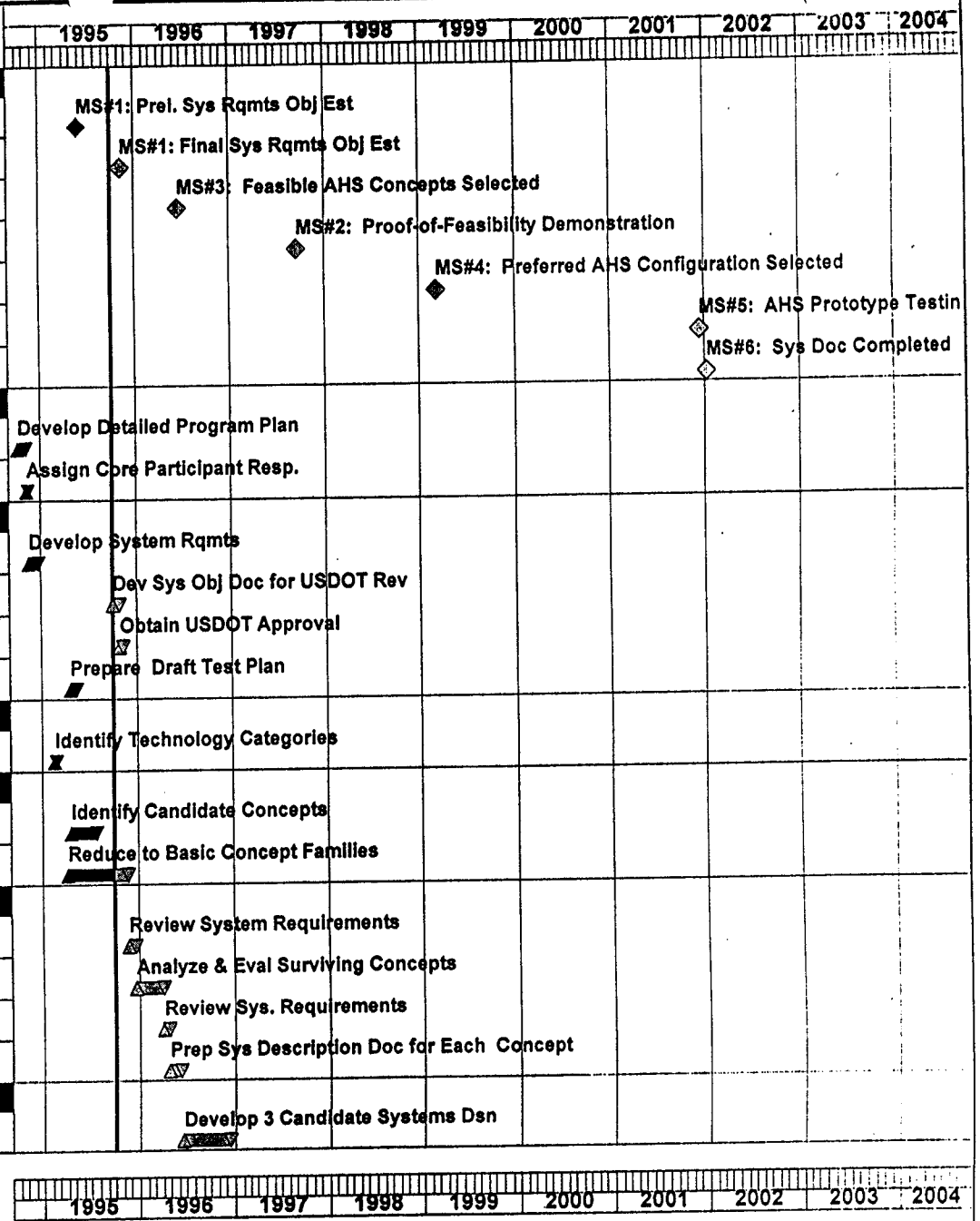
WBS	Activity Description	Start	Finish
.	Develop 3 Candidate Systems Dsn	06/13/96*	12/12/96
.	Select Comp, Subsys & Combination for Build & Te	11/14/96*	12/12/96
.	Prepare Estimated Deployment Timeline	12/12/96*	02/06/97
.	Build Critical Portions of the 3 Sys Concepts	12/12/96*	02/05/98
.	Test Critical Portions of the 3 Sys Concepts	07/10/97*	07/09/98
C3C	Dev, Build & Test Candidate C		
.	Outreach to Stakeholders & Recieve Feedback	06/13/96*	08/08/96
.	Refine Designs in Response to Outreach Efforts	08/08/96*	08/22/96
.	Conduct WS#4 - Concept Des Rev	11/07/96*	11/14/96
.	Develop 3 Candidate Systems Dsn	06/13/96*	12/12/96
.	Select Comp, Subsys & Combination for Build & Te	11/14/96*	12/12/96
.	Prepare Estimated Deployment Timeline	12/12/96*	02/06/97
.	Build Critical Portions of the 3 Sys Concepts	12/12/96*	02/05/98
.	Test Critical Portions of the 3 Sys Concepts	07/10/97*	07/09/98
C4A	Rev Sys Rqmts/MOEs for Consistency, Compl		
.	Rev Sys Rqmts & MOEs for Consistency, Completene	01/22/98*	02/19/98
.	Perform Spec Compliance Chks	02/19/98*	03/19/98
.	Conduct Workshop #5 - CS Rev	11/20/98*	11/26/98
.	Compare Concepts	09/17/98*	12/10/98
.	Select or Synthesize Configuration	12/11/98*	03/04/99
C4C	Perform Evaluation Studies		
.	Perform Evaluation Studies	03/20/98*	09/17/98
C5	Develop Syst & Supporting Doc		
.	Maintain System Specifications	12/16/99*	12/13/01
.	Dev Prel. Plan for Operational Tests & Eval.	06/15/01*	12/13/01
.	Estimate Future Costs & Benefits	08/24/01*	12/13/01
.	Identify Standards & Prel. Guidelines	09/21/01*	12/13/01
.	Prepare Evaluation Roadmap	09/21/01*	12/13/01
.	Update Sys Top-Level Dsn Doc	10/19/01*	12/13/01
.	Prepare Final Report	12/14/01*	01/10/02
D1A	Pln Prep & Conduct '96 Exhbts & Demos		
.	Plan & Prepare Exhibits & Demos	08/15/95A	09/13/96
.	Conduct Exhibits & Demos	10/01/96*	10/07/96
D2A	Identify '97 Demo Content & Prep Plan		
.	Identify '97 Demo Content	02/15/95A	12/26/96



WBS	Activity Description	Start	Finish
.	Ident Required Test Facil & Infrastr	03/01/95A	02/12/96
.	Prepare Demo Plan	12/26/95*	07/07/97
D2D	Develop The Demo Systems		
.	Develop the Demo Systems	01/30/96*	07/07/97
D2E	Prepare & Execute The Demo(s)		
.	Prepare & Execute The Demo(s)	07/08/97*	09/01/97
.	Document Results & Feedback	09/02/97*	09/15/97
E1A	Perform Detailed Sys Dsn & WS#6		
.	Conduct WS #6 - AHS Preliminary Des Rev	08/25/99*	07/01/99
.	Perform Detailed Sys Dsn	03/05/99*	12/02/99
E1B	Develop Control System Algorithms		
.	Develop Control System Algorithms	03/05/99*	12/02/99
E2A	Prepare Roadway Enhancement Procurement		
.	Prepare Roadway Enhancement Procurement	11/25/99*	03/15/00
.	Enhance Roadway & Embed Instrumentation	03/16/00*	09/13/00
E2C	Build Software Components		
.	Build Software Components	03/05/99*	02/17/00
E2D	Procure Components for 25 Vehicles		
.	Procure Components for 25 Vehicles	08/13/99*	12/02/99
.	Build First Vehicle Prototype Hardware	09/03/99*	08/31/00
.	Perform Unit/Module Testing of Components for Ve	05/12/00*	08/31/00
.	Integrate Vehicle Systems for vehicles 2-25	09/01/00*	11/23/00
E2H	Integrate Vehicles with Infrastructure		
.	Integrate Vehicles with Infrastr	08/17/00*	11/08/00
E3A	Prepare Test Plans & WS#7		
.	Prepare Test Plans	07/02/99*	09/23/99
.	Conduct Workshop #7 - Test Plan Review	09/24/99*	09/30/99
E3C	Conduct Testing & WS#8		
.	Conduct WS#5 - Test Results	08/31/01*	09/06/01
.	Conduct Testing	10/27/00*	10/25/01
.	Reduce & Analyze Test Results	12/15/00*	12/13/01
.	Prepare Summary Doc	11/16/01*	01/10/02



OC	Activity description	Start	Finish
Milestones			
.	MS#1: Prel. Sys Rqmts Obj Est		05/24/95A
.	MS#1: Final Sys Rqmts Obj Est		11/09/95*
.	MS#3: Feasible AHS Concepts Selected		06/13/96*
.	MS#2: Proof-of-Feasibility Demonstration		09/15/97*
.	MS#4: Preferred AHS Configuration Selected		03/04/99*
.	MS#5: AHS Prototype Testing Completed		12/13/01*
.	MS#6: Sys Doc Completed		01/10/02*
A4. Site Program Management & Program Baseline			
.	Develop Detailed Program Plan	10/07/94A	11/03/94A
.	Assign Core Participant Resp.	11/04/94A	11/10/94A
B1A. Develop System Rqmts & WS#1			
.	Develop System Rqmts	11/14/94A	12/23/94A
.	Dev Sys Obj Doc for USDOT Rev	10/02/95*	10/25/95
.	Obtain USDOT Approval	10/26/95*	11/08/95
.	Prepare Draft Test Plan	04/14/95A	05/11/95A
B2. Assess Enabling Tech			
.	Identify Technology Categories	02/16/95A	02/23/95A
C1. Develop Initial Suite of Concepts & WS#2			
.	Identify Candidate Concepts	04/17/95A	07/25/95A
.	Reduce to Basic Concept Families	04/03/95A	11/20/95
C2. Downselect Sys Config & WS#3			
.	Review System Requirements	11/21/95*	12/20/95
.	Analyze & Eval Surviving Concepts	12/21/95*	04/02/96
.	Review Sys. Requirements	04/03/96	04/24/96
.	Prep Sys Description Doc for Each Concept	04/25/96*	06/05/96
C3A. Dev, Build,& Test Candidate A			
.	Develop 3 Candidate Systems Dsn	06/13/96*	12/13/96



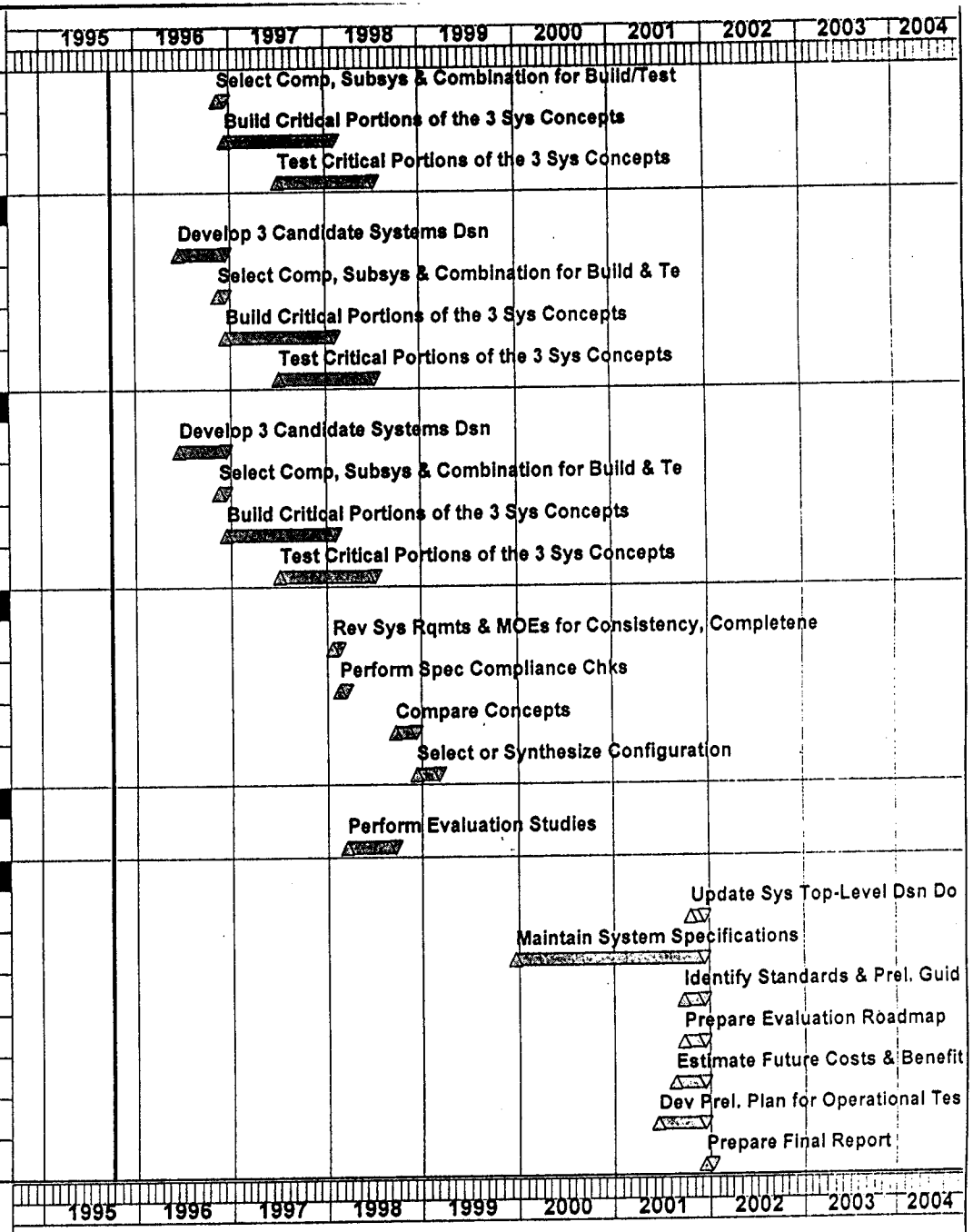
Project Start	10/01/94
Project Finish	01/10/02
Data Date	10/01/95
Plot Date	11/08/95

Early Bar
Progress Bar

AHSD

National AHS Consortium
Critical Path Schedule
Update as of 10/01/95

OC	Activity description	Start	Finish
.	Select Comp, Subsys & Combination for Build/Test	11/14/96*	12/12/96
.	Build Critical Portions of the 3 Sys Concepts	12/12/96*	02/05/98
.	Test Critical Portions of the 3 Sys Concepts	07/10/97*	07/09/98
C3B.	**Dev, Build,& Test Candidate B**		
.	Develop 3 Candidate Systems Dsn	06/13/96*	12/12/96
.	Select Comp, Subsys & Combination for Build & Te	11/14/96*	12/12/96
.	Build Critical Portions of the 3 Sys Concepts	12/12/96*	02/05/98
.	Test Critical Portions of the 3 Sys Concepts	07/10/97*	07/09/98
C3C.	**Dev, Build,& Test Candidate C**		
.	Develop 3 Candidate Systems Dsn	06/13/96*	12/12/96
.	Select Comp, Subsys & Combination for Build & Te	11/14/96*	12/12/96
.	Build Critical Portions of the 3 Sys Concepts	12/12/96*	02/05/98
.	Test Critical Portions of the 3 Sys Concepts	07/10/97*	07/09/98
C4A.	**Rev Sys Rqmts/ MOEs for Consistency, Compl**		
.	Rev Sys Rqmts & MOEs for Consistency, Completene	01/22/98*	02/19/98
.	Perform Spec Compliance Chks	02/19/98*	03/19/98
.	Compare Concepts	09/17/98*	12/10/98
.	Select or Synthesize Configuration	12/11/98*	03/04/99
C4C.	**Perform Evaluation Studies**		
.	Perform Evaluation Studies	03/20/98*	09/17/98
C5.	**Develop Sys & Supporting Doc**		
.	Update Sys Top-Level Dsn Doc	10/19/01*	12/13/01
.	Maintain System Specifications	12/16/99*	12/13/01
.	Identify Standards & Prel. Guidelines	09/21/01*	12/13/01
.	Prepare Evaluation Roadmap	09/21/01*	12/13/01
.	Estimate Future Costs & Benefits	08/24/01*	12/13/01
.	Dev Prel. Plan for Operational Tests & Eval.	06/15/01*	12/13/01
.	Prepare Final Report	12/14/01*	01/10/02



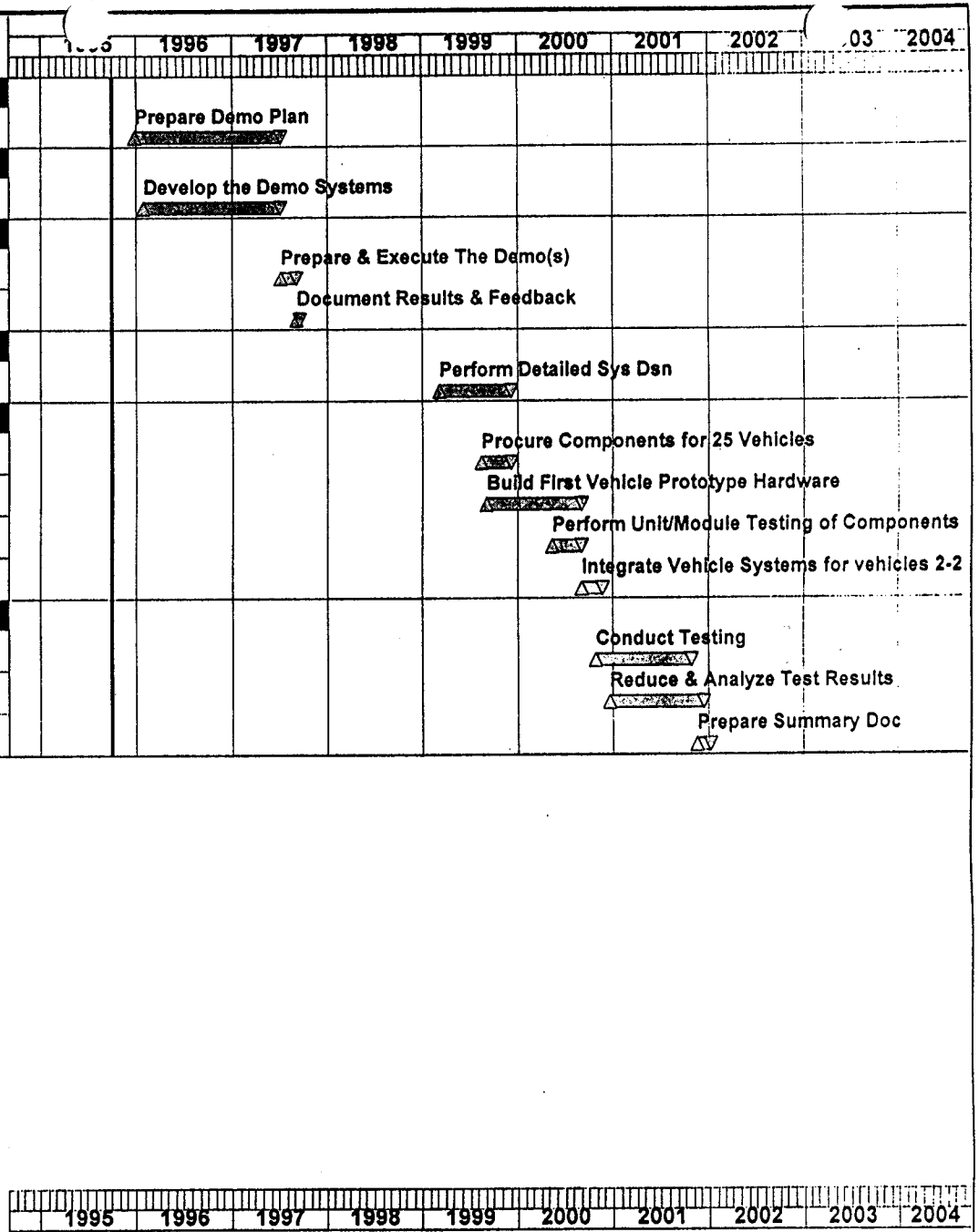
Project Start	10/01/94
Project Finish	01/10/02
Data Date	10/01/95
Plot Date	11/08/95

Early Bar
Progress Bar

AHSD

National AHS Consortium
Critical Path Schedule
Update as of 10/01/95

OC	Activity description	Start	Finish
D2A. Identify '97 Demo Content & Prep Plan			
.	Prepare Demo Plan	12/26/95*	07/07/97
D2D. Develop The Demo Systems			
.	Develop the Demo Systems	01/30/96*	07/07/97
D2E. Prepare & Execute The Demo(s)			
.	Prepare & Execute The Demo(s)	07/08/97*	09/01/97
.	Document Results & Feedback	09/02/97*	09/15/97
E1A. Perform Detailed Sys Dsn & WS#6			
.	Perform Detailed Sys Dsn	03/05/99*	12/02/99
E2D. Procure Components for 25 Vehicles			
.	Procure Components for 25 Vehicles	08/13/99*	12/02/99
.	Build First Vehicle Prototype Hardware	09/03/99*	08/31/00
.	Perform Unit/Module Testing of Components for Ve	05/12/00*	08/31/00
.	Integrate Vehicle Systems for vehicles 2-25	09/01/00*	11/23/00
E3C. Conduct Testing & WS#8			
.	Conduct Testing	10/27/00*	10/25/01
.	Reduce & Analyze Test Results	12/15/00*	12/13/01
.	Prepare Summary Doc	11/16/01*	01/10/02



Project Start	10/01/94
Project Finish	01/10/02
Data Date	10/01/95
Plot Date	11/08/95

Early Bar
Progress Bar

AHSD

Sheet 3 of 3

National AHS Consortium
Critical Path Schedule
Update as of 10/01/95

7.0 NATIONAL AUTOMATED HIGHWAY SYSTEM CONSORTIUM (NAHSC) PROGRAM MANAGEMENT

The Program Plan reflects the unique nature of the Automated Highway System (AHS) Program as a cooperative agreement among highly diverse participants with different organizational cultures, goals and motivations. The National Automated Highway System Consortium (NAHSC) governance has been designed to balance the influence of the participants, providing all with a voice in the decision making at all levels, and including provisions for conflict minimization and resolution. A Policy Steering Board provides the means for participation and buy-in at the highest levels within each Core participant's organization, including United States Department of Transportation (USDOT). A Program Management Oversight Committee provides the means for many diverse stakeholder organizations to influence the direction and outcome of the AHS Program and to achieve a national consensus. The Program Manager's Council consist of the AHS project managers from each Core Participant and the Program Manager and is organizationally represented as part of the Program Office. The Program Manager's Council assists the Program Manager to plan and execute the overall AHS Program while managing the day-to-day activities of the program for their individual organizations. The Program Managers' Council will be addressed in more detail as part of the Program Office.

The NAHSC, including the USDOT, will carry out the Systems Definition Phase of what ultimately will be deployed as the next major performance upgrade of the nation's vehicle-highway system. The Consortium will involve a wide range of interests in data gathering, analysis and decision-making that will take place throughout the life of the AHS program. To achieve this, the Consortium is organized to balance the needs of planning, managing and executing a challenging technical project with the need to involve the broadest possible range of stakeholders and interested parties. The structure of the Consortium is shown in Figure 7-1 Management Structure of the AHS Program.

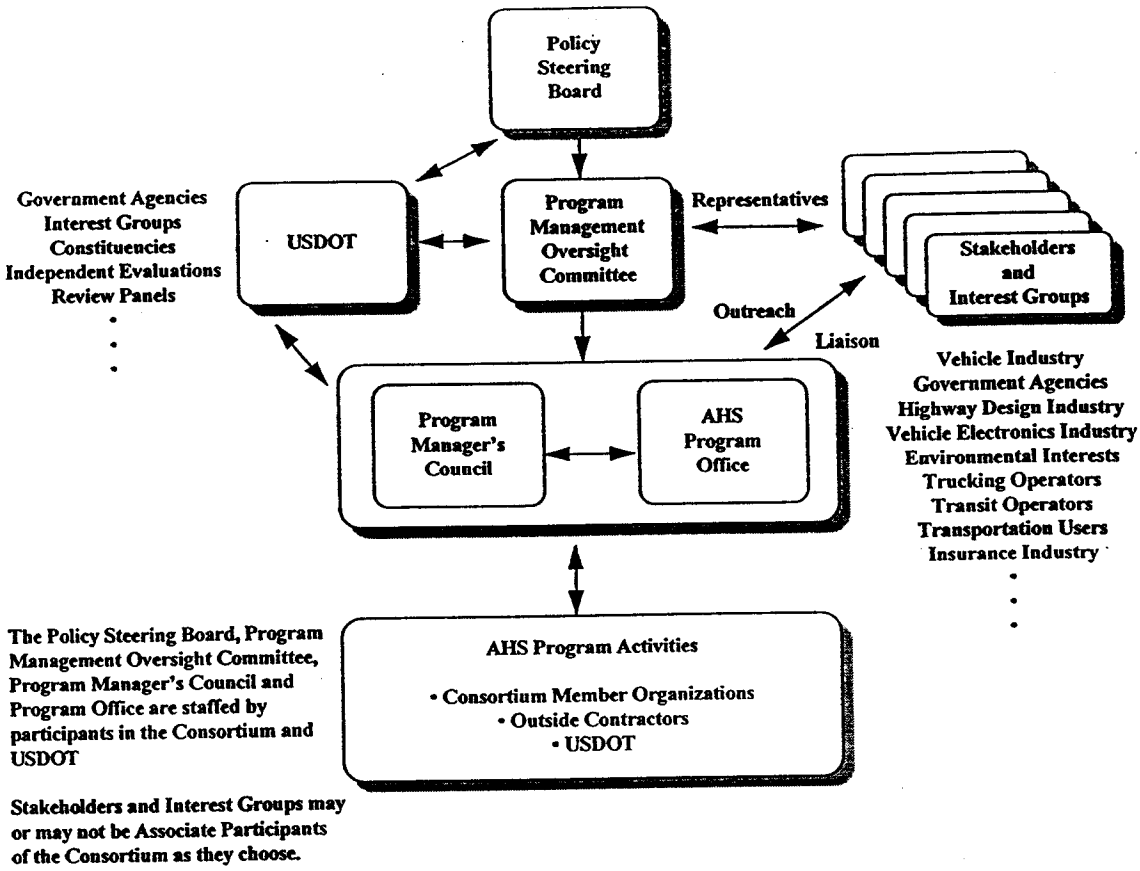


Figure 7-1 Management Structure of the AHS Program

7.1 NAHSC Program Office Roles and Responsibilities

This section describes the National Automated Highway System Consortium (NAHSC) Program Office structure and organization to perform the program management. Figure 7.1-1 below depicts the program office organization.

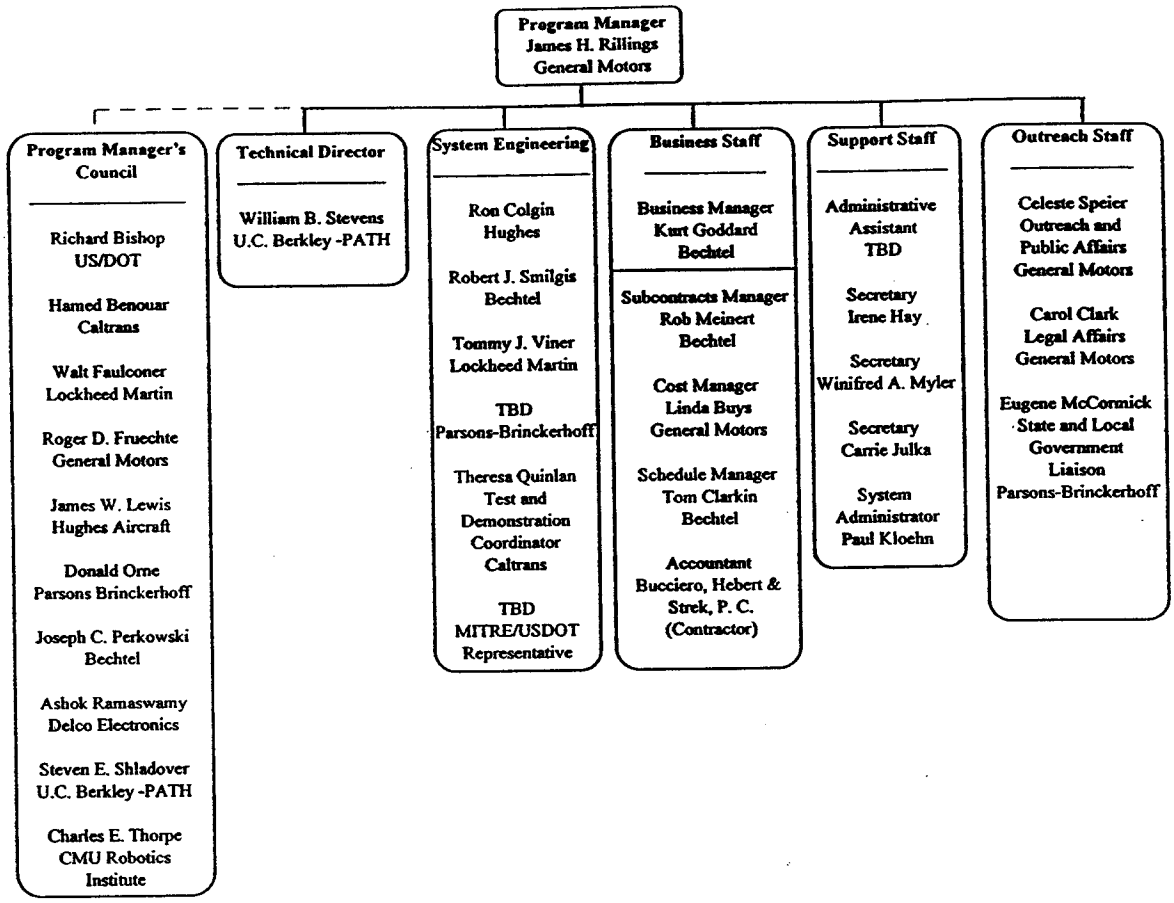


Figure 7.1-1 NAHSC Program Office Organization

7.1.1 Program Manager

The AHS Program organizational structure provides the Program Manager with visibility into, authority over, and ultimate responsibility for the major functional areas within the National Automated Highway System Consortium (NAHSC) Program Office. The NAHSC Program Manager (PM) is responsible for the successful completion of the AHS program. The Program Manager:

- Manages and directs the overall operation of the NAHSC according to the terms of the Collaborative Agreement.
- Manages and directs the AHS Program according to the terms of the Cooperative Agreement with USDOT.
- Organizes and directs the operations of the Program Manager's Council and serve as permanent Chair.
- Exercises overall responsibility for successful planning and execution of the AHS Program, achieving the technical objectives, meeting the program schedule and controlling the program budget.

7.1.2 Program Manager's Council

The Program Manager's Council (PMC) consists of the NAHSC Program Manager and the site program manager from each of the ten (10) consortium member organizations. Those organizations are Bechtel, California Department of Transportation (Caltrans), Carnegie Mellon University Robotics Institute, Delco Electronics, General Motors, Hughes Aircraft Company, Lockheed Martin, Parsons Brinckerhoff, the University of California - Partners for Advanced Transit and Highways (PATH), and U.S. Department of Transportation. Each site Program Manager manages the work of his or her organization's team and as part of the Program Manager's Council participates in planning, directing and executing the AHS program. Each site program manager:

- Collaborates with the NAHSC Program manager to plan and execute the AHS Program.
- Serves as member of the Program Manager's Council.
- Manages and directs the AHS Program activities of his/her Core Participant according to the terms of the NAHSC program plan, the Collaborative Agreement and the Cooperative Agreement with USDOT.
- Exercises overall responsibility for his/her Core Participant's role in the successful planning and execution of the AHS Program, achieving the technical objectives, meeting the program schedule and controlling the program budget.
- Submits monthly cost and schedule performance reports to the Business Manager in the prescribed format.

7.1.3 Technical Director

The Technical Director provides technical direction to the Systems Engineering organization and is the focal point for the System Engineering Process. The Technical Director is responsible for providing a planned and systematic process to ensure that products and activities conform to established technical and management requirements. The Technical Director independently confirms compliance with products and processes to applicable policies, procedures, guidelines, standards, and requirements. The Technical Director is responsible for leading the identification, assessment, and development or acquisition of the technologies necessary to the development of the AHS specifications and prototype. These include technologies for the vehicle, infrastructure, communications, modeling and simulation. The Technical Director independently confirms compliance of products and processes to applicable policies, procedures, guidelines, standards, and requirements. The Technical Director is responsible for the timely assessment, development and acquisition of enabling technologies to meet the goals of the program. Specifically, the Technical Director:

- Leads the program Systems Engineering efforts
- Provides technical oversight for the AHS Program.
- Leads the assessment of critical enabling technologies.

- Provides recommendations to the program manager and the PMC on which technologies should be acquired and/or developed for the AHS Program and what resources should be devoted to each.
- Assists the task leader(s) plan, budget, execute and report acquisition and development of technologies.
- Monitors the entire portfolio of AHS technology development projects to ensure a proper balance.
- Provides technical review and oversight of the acquisition and development of technologies for AHS, making regular reports and recommendations to the program manager and the PMC.
- Coordinates the acquisition and development of technologies to ensure proper interfacing, synergy and mutual support.

7.1.4 System Engineering

NAHSC's Systems Engineering is responsible for planning controlling and supporting system design, hardware engineering, requirements analysis, technical performance measurement, system integration and validation efforts. Systems Engineering is a technical engineering element of the NAHSC.

NAHSC has organized systems engineering into disciplines staffed by specialists that will perform requirements development and analysis, and carry the requirements allocation documents and databases forward. As the system goes through requirements analysis and definition, domain experts and system engineers will work together to ensure that system requirements are developed, allocated to subsystems, traced to System Specification, implemented into prototype hardware and software, and ultimately validated. The design activity is supported through the use of system performance prediction models, to provide design predictions, and evaluations of possible design solutions. Systems Engineering has primary responsibility for the definition and documentation of the system through the subsystem level. At the subsystem level, SE ensures that the system integrity is maintained and that all system/subsystem requirements are traceable to the lowest levels.

For details on the AHS System Engineering process refer to the AHS System Engineering Plan (SEP).

Although the Test and Demonstration Coordinator is included in the System Engineering group of the program office, there are some unique responsibilities identified for that position. The Test and Demonstration Coordinator:

- Leads the planning and execution of major NAHSC exhibits and demonstrations including:
  - the 1996 ITS world Congress Exhibit
  - the 1997 Proof of Feasibility Demonstration
  - the Prototype AHS System Demonstration in 2001
  - exhibits and demonstrations at various conferences
- Leads evaluation and selection of test and demonstration sites.
- Leads the planning and execution of evaluation testing for the AHS Prototype System.
- Supports task leaders in the planning and execution of major engineering tests.
- Coordinates preparation and delivery of test reports.
- Designates and supervises a test safety officer for each major test and demonstration.
- Ensures all tests and demonstrations comply with the NAHSC Safety Policy and the NAHSC Use of Humans as Research Subjects Policy.
- Serves as permanent Secretary of the NAHSC Human Research Committee.

7.1.5 Business Management

The Business Management and Support Staffs accomplish work to support the technical development teams. The Business Management staff is headed by a Business Manager and consists of Agreement and Contracts Manager, Cost Manager, Schedule Manager, and a contracted Accounting firm. The Business Management and Support Staffs are responsible for planning, personnel, material, finance and property management, and administrative services.

7.1.5.1 Business Manager

The Business Manager has the following responsibilities:

- Supports program manager in planning and managing the program
- Exercises oversight and control of NAHSC business issues including:
  - Cost
  - Cost Share
  - Schedule
  - Contracts
  - Program Planning
- Reviews and submits NAHSC annual budgets to USDOT.
- Reviews and submits NAHSC quarterly budget reports to USDOT.
- Provides liaison to the USDOT Agreement Officer and Agreement Administrator.
- Supports the PMC, the PMOC, the PSB and the business staffs of the Core Participants on NAHSC business issues.
- Participates in outreach.

7.1.5.2 Agreements and Contracts Manager

Responsibilities of the Agreements and Contracts Manager are:

- Assists Core Participants in preparing, soliciting, evaluating and awarding contracts and obtaining USDOT approval as required.
- Prepares and submits NAHSC Standard Form (SF) 294/295 small business utilization reports to USDOT.
- Tracks and facilitates the Consortium's progress towards its goals for contracting to small business, small disadvantaged business and historically black colleges and universities.
- Performs outreach to disadvantaged business enterprises and historically black colleges and universities.
- Serves as administrative liaison to Associate and Outreach Participants.
- Administers the NAHSC-USDOT Cooperative Agreement.
- Serves as the interface to the NAHSC legal counsel on business matters.
- Coordinates purchasing and contracting for Program Office needs.

7.1.5.3 Cost Manager

The NAHSC Program Office Cost Manager:

- Prepares the following financial documents for the program:
  - NAHSC annual budget for USDOT 1411, 424A and 424B forms.
  - NAHSC quarterly budget reports for USDOT SF269 and SF272 forms.
  - Work authorization forms.
  - Requests for advanced funds using USDOT SF270 form.
  - Cost performance report summaries.
- Assists Task Leaders to monitor cost on major tasks.
- Assists Site Program Managers to prepare their monthly and annual budget reports.
- Performs monthly budget analysis.
- Reviews all NAHSC financial plans and changes.
- Directs and reviews work of NAHSC accountant.
- Manages cash-flow for the NAHSC.

7.1.5.4 Planning and Scheduling Manager

The NAHSC Program Office Planning and Scheduling Manager:

- Assists task leaders in planning and scheduling.
- Builds and maintains program schedule and task schedules using the Primavera P3® Scheduling Tool.
- Performs monthly updates to schedule, checking for inconsistencies and delays.
- Recommends actions to reduce impact of schedule delays.
- Supports Business Manager in preparation of budget forecast and budget analyses.
- Works with Cost Manager to determine trends and variances in cost and schedule.

- Analyzes cost and schedule impacts of forecast work (cost and schedule) over actual work performed using Primavera Parade® software.
- Uses software tools (above) to perform analysis of Federal Share budget variances to future budgets and schedules.

7.1.6 Outreach Staff

The Outreach staff is concerned primarily with issues involving interested parties other than Core Participants. They address these issues with the outside parties and coordinate all involvement by the Core Participants. The responsibilities of the Outreach Staff include outreach and public affairs, legal affairs, state and local government liaison and policy coordination.

7.1.6.1 Outreach and Public Affairs Manager

The NAHSC Program Office Outreach and Public Affairs Manager:

- Develops and integrates a public relations/public affairs plan as part of the overall outreach plan.
- Develops a "NAHSC Key Message" plan in coordination with the Societal and Institutional Issues Team, the PMC, PMOC and PSB.
- Plans, budgets and executes public information communications, targeting the public and the media, including:
  - NAHSC Newsletter "AHS Updates"
  - Brochures and Press Kits
  - News releases
  - Press conferences
  - Videos
  - Interviews
  - Exhibits
- Coordinates dissemination of information to the public with the public affairs offices of the NAHSC Core Participants, including USDOT.
- Organizes and schedules public forums.
- Supports the outreach team and task leader as required.

7.1.6.2 Legal Affairs Representative

The NAHSC Program Office Legal Affairs Representative:

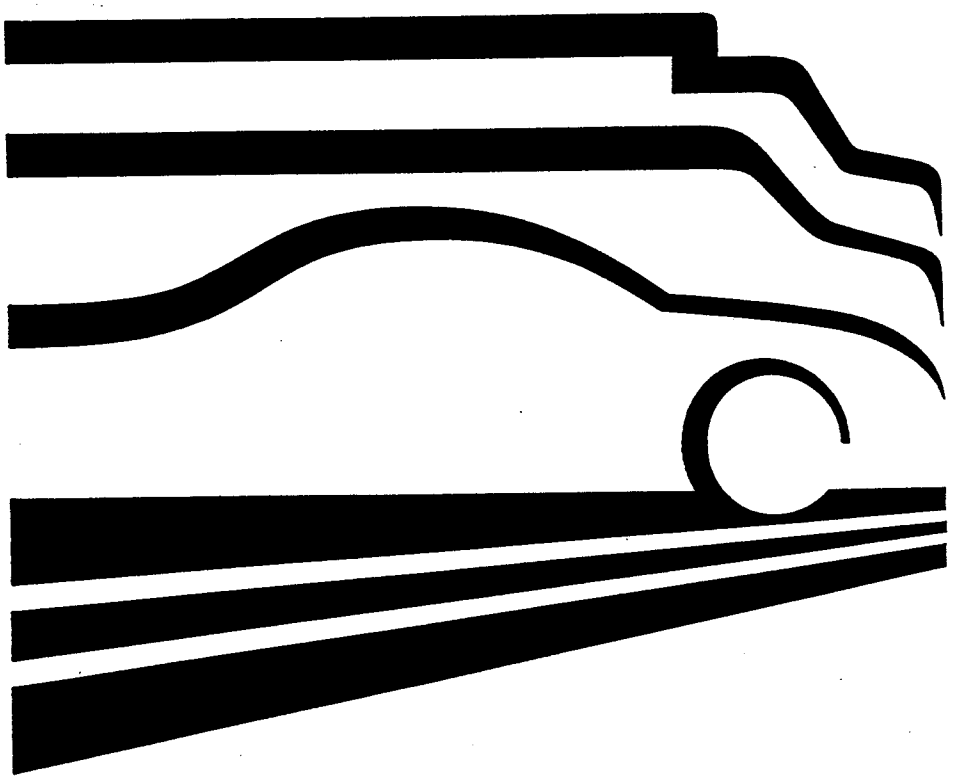
- Develops and maintains Collaborative Agreement.
- Provides the legal advice relative to the Cooperative Agreement with USDOT.
- Advises the NAHSC on legal issues relating to the business of the Consortium.
- Handles Freedom Of Information Act requests.
- Addresses legal issues associated with test and demonstration activities.
- Develop approaches for dealing with legal issues relating to deployment of AHS.

7.1.6.3 Government Liaison

The NAHSC Program Office Government Liaison:

- Encourages participation by government stakeholders at the Federal, State, regional and local levels
- Conveys government issues and concerns to the NAHSC and coordinates responses to them.
- Presents to government entities the policies, goals and technical solutions of the NAHSC
- Consults with Federal Administration and Congressional officials to determine policy direction.
- Briefs PMC, PMOC and PSB on national policy issues and implications for the NAHSC.
- Ensures NAHSC activities are in harmony with USDOT and Congressional policies
- Provides advice on societal and institutional issues.
- Participates in outreach to decision-makers in the Federal government and elsewhere.

SECTION B



National Automated Highway System Consortium

MILESTONE ONE

NAHSC Milestone #1

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Preface

The AHS System Objectives and Characteristics document was created as a stand-alone document to define performance objectives, and to identify design objectives, measures of effectiveness (MOE) and measures of performance (MOP). This is an NAHSC working document. It has gone through several outreach reviews and three formal review iterations with the stakeholder community in Workshop #1, System Requirements Review #1 and Workshop #2. A summary of the stakeholders involved in the review and comment to the System Objectives and Characteristics Document are shown below. The System Objectives and Characteristics Document will continue to evolve as the program progresses, but now forms a solid baseline and is under formal change control.

Reviewing Organization	WS#1	SRR#1	WS#2	Outreach
3M			Yes	
AAA of Southern California			Yes	
AARP				Yes
Aberdeen Test Center			Yes	
AEG Transportation Systems, Inc.	Yes		Yes	
AFDTC/DRX	Yes			
Aisin Seiki Co., Ltd		Yes		
American GNC Corp.			Yes	
American Trucking Association				Yes
Analogy, Inc.	Yes			
ANSTEC, Inc.	Yes			
Argonne National Laboratory		Yes		
Artificial Intelligence Laboratory	Yes			
Artistic Analytical Methods	Yes			
ATA Foundation	Yes			
Battelle		Yes		
Bell Associates, Inc.	Yes			
Brar, Inc.	Yes			
BRW, Inc.	Yes	Yes		
California Highway Patrol			Yes	
California Institute of Technology	Yes			
California State University - Long Beach	Yes			
Calspan		Yes		
Casde Corp.	Yes			
CCG Associates, Inc.	Yes			
Center for Transportation Research			Yes	

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Reviewing Organization	WS#1	SRR#1	WS#2	Outreach
Cherokee County Engineer, Cherokee, Iowa				Yes
Colorado Department of Transportation			Yes	
Colorado Regional Transportation District				Yes
COMARCO, Inc.	Yes			
Commonwealth of Virginia DOT	Yes			
Contract Compliance		Yes		
Creative Transit Alternatives		Yes		
CTA International			Yes	
Cybernet Systems Corp.	Yes			
Damiler Benz - Washington	Yes			
Daniel Consultants, Inc.		Yes		
Data Communications Corp.	Yes			
David Sarnoff Research Center	Yes			
Digital Systems	Yes			
Digital Systems			Yes	
DMJM	Yes			
DTS, Inc.	Yes			
Dunn Engineering		Yes		
E-Systems			Yes	
Ecole des Mines de Paris			Yes	
Ellen Williams and Associates			Yes	
Environmental Research	Yes			
Freightliner Corp.	Yes			
Fris Zero Visibility			Yes	
FTS Consulting, Inc.	Yes			
GWU National Crash Analysis Center	Yes			
Haugen Associates			Yes	
Hewlett Packard			Yes	
Hickling Lewis Brod, Inc	Yes			
Honda Motor Co., Ltd.			Yes	
Honda R&D North America	Yes			
Honeywell		Yes		
Houston Metro		Yes		
HR Ross Industries, Inc.			Yes	
I-95 Corridor Coalition			Yes	
Idaho National Engineering Laboratory		Yes		
Idaho State Police (Motor Carrier Safety)				Yes

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Reviewing Organization	WS#1	SRR#1	WS#2	Outreach
Idaho Transportation Department				Yes
IMC, Inc.			Yes	
IMRA America	Yes	Yes		
INRETS			Yes	
INRIA			Yes	
ITS America	Yes			
ITS Consortium	Yes			
Jet Propulsion Laboratories			Yes	
Kan Chen, Technologies, Inc.	Yes			
KKW Trucking Inc.			Yes	
LACMTA			Yes	
LS Gallegos and Associates, Inc.			Yes	
Martin Enterprises and Associates			Yes	
Maryland DOT	Yes			
Massachusetts Institute of Technology			Yes	
Mechanical Engineering Laboratory			Yes	
METRO			Yes	
Michigan DOT		Yes		
Michigan Technology University	Yes			
Ministry of Transportation and Public Works			Yes	
Minnesota Department of Transportation				Yes
Montana DOT (Transportation Planning Division)				Yes
National Institute of Standards and Technology		Yes		
Navigation Technologies			Yes	
New Jersey Highway Authority	Yes			
Nissan Research and Development	Yes			
NJIT, Institute for Transportation	Yes			
Northrop Grumman	Yes			
Oakland University		Yes		
Ohio State University	Yes	Yes		
Oregon Department of State Police (E911)				Yes
Pennsylvania Turnpike Commission	Yes	Yes		
PEPCO			Yes	
Project California			Yes	
QST Electronics Inc.			Yes	
Queen's University	Yes			
Raytheon Co.	Yes			

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Reviewing Organization	WS#1	SRR#1	WS#2	Outreach
Red Zone Intelligent Vehicle	Yes	Yes		
Richardson Association, Inc.	Yes			
Robot Technology, Inc.		Yes		
Rockwell International			Yes	
Roper and Associates			Yes	
SAE	Yes			
San Diego RTTA			Yes	
SANDAG			Yes	
Sandia National Laboratories	Yes			
SCAG			Yes	
SCAQMD			Yes	
Science Apple International Corp.			Yes	
Shell Oil Products Co.	Yes			
Ski International	Yes			
SRI International		Yes		
Stanford Telecom	Yes			
State University of New York at Stony Brook		Yes		
Sumitomo Electric USA, Inc.	Yes		Yes	
TASC, Systems Sciences Division	Yes			
TEC Engineering, Inc.	Yes			
Techno Transfer	Yes			
The Nettleship Group			Yes	
The Pennsylvania State University	Yes			
The Scientex Corp.	Yes			
The University of Michigan	Yes			
Thermacore, Inc.	Yes			
Tigris Technologies, Inc.			Yes	
Toyota Motor Corp.	Yes	Yes		
Toyota Technical center	Yes	Yes		
Transportation Research Center	Yes			
TRC				Yes
Trucking Movers Corporation				Yes
University of Iowa, Center for CAD	Yes			
University of Massachusetts	Yes			
University of Minnesota	Yes		Yes	
Utah Department of Transportation				Yes
Vanasse Hangen Brustolin, Inc.	Yes			

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Reviewing Organization	WS#1	SRR#1	WS#2	Outreach
Virginia Tech		Yes		
Volpe Center, DOT	Yes			
Walcoff and Associates	Yes			
Wilbur Smith Associates		Yes		
Williams Technologies			Yes	
Wisconsin State Patrol				Yes
Zapata Engineering		Yes		