Southern California Priority Corridor
Showcase Program Evaluation

Modeshift Evaluation Report

FINAL

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Abbreviations & Acronyms

ATIS	Advanced Traveler Information System
ATMS	Advanced Transportation Management System
AVL	Automatic Vehicle Location
Caltrans	California Department of Transportation
CCTV	Closed-circuit Television surveillance camera
CM	Configuration Management
CMP	Configuration Management Plan
CMS	Changeable Message Sign
CORBA	Common Object Request Broker Architecture
COTS	Commercial Off-the-Shelf
CTC	California Transportation Commission
CVO	Commercial Vehicle Operations
CW	Corridor-wide
CWATIS	Corridor-wide Advanced Traveler Information System Project
CWATMS	Corridor-wide Advanced Transportation Management System Project
CWCVO	Corridor-wide Commercial Vehicle Operations Project
CWSIP	Corridor-wide Systems Integration Project
CWSPP	Corridor-wide Strategic Planning Project
DOIT	Department of Information Technology
EAP	Evaluation Activity Plan
EP	Evaluation Plan
FHWA	Federal Highway Administration
FSR	Feasibility Study Report
FTA	Federal Transit Administration
FTE	Full-Time Equivalent (one full-time employee)
GPRA	Government Performance and Results Act
GUI	Graphical User Interface
HP	Hewlett-Packard
HQIT	Headquarters - Information Technology (division of Caltrans)
IDL	Interface Definition Language
IPR	Intellectual Property Rights
ITS	Intelligent Transportation Systems
ISSC	Information Systems Service Center (division of Caltrans)
ISTEA	Intermodal Surface Transportation Efficiency Act (of 1991)
LACDPW	Los Angeles County Department of Public Works
LACMTA	Los Angeles County Metropolitan Transportation Authority
LADOT	City of Los Angeles Department of Transportation
LAN	Local Area Network
MOU	Memorandum of Understanding
MPO	Metropolitan Planning Organization
MTBF	Mean Time Between Failure
NDA	Non-Disclosure Agreement
NET	National Engineering Technology Corporation

NTCIP	National Transportation Communications for ITS Protocol
NTR	Division of New Technology & Research (division of Caltrans)
OCTA	Orange County Transportation Authority
O&M	Operations and Maintenance
OS	Operating system (such as Windows™, Unix, Linux, et. al.)
PC	Personal Computer (Windows™-based)
RCTC	Riverside County Transportation Commission
RFP	Request for Proposals
RTP	Regional Transportation Plan
RTPA	Regional Transportation Planning Agency
RWS	Remote Workstation
SANBAG	San Bernardino Association of Governments
SANDAG	San Diego Association of Governments
SCAG	Southern California Association of Governments
SCAQMD	South Coast Air Quality Management District
SCPCSC	Southern California Priority Corridor Steering Committee
SIP	Systems Integration Plan
TEA-21	Transportation Equity Act for the 21st Century
TMC	Transportation Management Center
USDOT	United States Department of Transportation
VDS	Vehicle Detector Station
VOS	Volume/Occupancy/Speed
VCTC	Ventura County Transportation Commission
WAN	Wide Area Network

Executive Summary

Background

As required by federal law, all Intelligent Transportation System (ITS) projects that receive federal funding must undergo an evaluation to help assess the costs and benefits of ITS. This document is one of 23 reports produced as part of the Southern California ITS Priority Corridor Showcase Program Evaluation to help planners and decision-makers at the federal, state and local levels make better-informed decisions regarding future ITS deployments. This report presents the experiences, costs, and lessons learned from Southern California's Modeshift project.

In 1993, the U.S. Department of Transportation designated Southern California as one of four Priority Corridors in which ITS could have particular benefit. Southern California suffers from extreme traffic congestion, limited room for expanding transportation facilities, and above-average air pollution levels. The Southern California Priority Corridor is one of the most populated, traveled, and visited regions in the country, and consists of four adjoining regions:

- Los Angeles/Ventura Counties
- Orange County
- San Diego County
- Inland Empire (San Bernardino and Riverside Counties).

The ITS Showcase Program is one of several programs that have been implemented in Southern California's Priority Corridor to help aid mobility and mitigate traffic congestion and its associated environmental impacts. The Showcase Program consists of 17 ITS projects that collectively form a corridor-wide intermodal transportation management and information network between Los Angeles, Orange County, San Diego, and the Inland Empire. Each Showcase project deploys a piece of this corridor-wide ITS network, including regional Advanced Traveler Information Systems (ATIS), regional Advanced Transportation Management Systems (ATMS), and regional and interregional communications infrastructure. Eleven of the projects are regional in nature, while the remaining six are corridor-wide.

The Integrated Mode-shift Management System (Modeshift) is a multi-faceted traveler information service. Modeshift provides travelers – whether commuters, tourists or truckers – with the tools to make informed travel choice decisions by providing real-time travel time estimates between any two locations for vehicular and transit modes. By having access to up-to-the-minute traffic conditions, travelers can adjust travel routes, modify departure times and compare the generalized cost of alternative modes. On a large scale, such behavioral adjustments would offer safety and efficiency benefits to the operation of the transportation system. Although the system is primarily envisioned as a pre-trip planning tool, there are several mobile-Internet products on the market that could

enable Modeshift to be an *en route* traveler information service as well. Modeshift is available on-line at www.modeshift.net.

Evaluation Findings, Conclusions, and Recommendations

Modeshift brings the Los Angeles metropolitan region another critical element towards the achievement of an integrated ITS. Modeshift provides accurate, real-time traveler information for a major subregion of Los Angeles County, with comprehensive itinerary functionality for vehicular and transit trips. Modeshift provides the following specific information to the end user:

- Real-time traffic conditions for freeways and arterials
- Real-time event information for freeways and arterials
- Transit schedules and fare information for rail and bus
- Access to other travel-related data, such as paratransit service

The goal of Modeshift was to provide detailed trip itinerary information for multiple transportation modes, allowing the traveler to make more informed travel choices. Travelers can compare estimated travel times for both auto- and transit-based trips and then select the most attractive alternative. This level of functionality in on-line traveler information services is unique and unprecedented.

The Modeshift system complements other Showcase-funded advanced traveler information systems by offering a trip itinerary planning component based on real-time traffic information. The ability to provide trip itinerary information based on real-time traffic conditions makes Modeshift qualitatively different from other trip itinerary packages in the marketplace, which typically consist of non-dynamic functionality. Perhaps the biggest side benefit of the Modeshift is the successful conversion of data from disparate host management systems into a common Showcase data communications format in accordance with all functional requirements.

Through a "legacy bridge," Advanced Traveler Management System (ATMS) data such as incident details, construction activity, planned lane closures, real-time congestion data, Closed Circuit Television (CCTV) status, and CMS sign status are extracted from the ATMS traffic and events database tables and placed on the the regional network as "Showcase-Managed Objects." This is a significant accomplishment because transparent data exchange between Caltrans D7 ATMS and LADOT's traffic management system is now possible, and is incorporated into the Santa Monica Smart Corridor. The content and format of this data is standardized according to an Interface Definition Language (IDL) that defines Showcase data objects. Modeshift is the third system to be fully compliant with the corridor's Showcase Architecture, and it is among the first Showcase projects to successfully integrate control and dispatch centers with the interregional Showcase Network.

The fixed-price Modeshift contract initially specified an 18-month period of performance, however the period of performance was extended well beyond the originally anticipated project schedule. Modeshift's software implementation, integration and testing took over 36 months to complete, due largely to the amount of interagency coordination, consensus building and system planning required.

Despite several substantial postponements of key milestones, the extended period of performance did not materially result in a final project budget that exceeded the initial cost estimate. Future ITS projects might benefit from a phased or task order-oriented approach that would permit a re-evaluation of the project's progress and costs after each systems engineering step. This approach would aid in estimating project cost and duration, and would relieve some of the financial risk imposed on contractors by fixed-price agreements. It should be noted that the software vendor has worked closely with Caltrans to disclose unanticipated development issues, and taken on an active role in shepherding the project through the process.

In four months of observed system operation, there has been no evidence of any major system failures. Training on system operation and maintenance was provided to agency staff during the final phase of the project.

Although the Modeshift system was successfully completed and tested, an analysis of Modeshift's transportation system impacts has not been performed, pending the establishment of a clearly defined business model. The Modeshift deployment area, which covers approximately one-quarter of the total area of Los Angeles County, consists of several major transit services, including Metro Bus, Metro Rail (Red and Blue Lines), Metrolink, Montebello Transit, Foothill Transit and LADOT. While the amount of transit service available within the initial deployment area is extensive, the deployment area covers a significant but small portion of the travel market in the metropolitan Los Angeles area.

Perhaps the biggest challenge facing Modeshift is establishing a permanent home where it will receive the level of funding support necessary to keep it available to the end user via standard web browsers. At this stage, no funds have been set aside for ongoing operations, maintenance and marketing of Modeshift beyond the demonstration project phase. As a result, public awareness of Modeshift remains limited, especially in the face of more comprehensive marketing campaigns for advanced traveler information services supported through ad-supported public-private partnerships.

It is recommended that Caltrans draft a Modeshift business plan that identifies the role of Modeshift in integrating Showcase applications currently being supported by local TMCs, and highlights the benefits of continued regional integration to local and regional agencies. In order to establish a sustainable cost-sharing memorandum of understanding (MOU), the benefits of the next phases of the Modeshift project should be clearly articulated, so that a case for participation can be made within each member agency.

1 Introduction

1.1 Purpose and Scope of this Report

As required by federal law[1], all Intelligent Transportation System (ITS) projects that receive federal funding must undergo an evaluation to help assess the costs and benefits of ITS. The information provided in this report is intended to help planners and decision-makers at the federal, state and local levels make better-informed decisions regarding future ITS deployments based on the experiences of Southern California's Modeshift project.

This document is one of 23 reports produced as part of the Southern California ITS Priority Corridor Showcase Program Evaluation, and covers only the events and findings resulting from the Modeshift evaluation. The complete set of findings from the Showcase Program Evaluation are found in the following collection of documents:

Document Type/Title	Date	Document Number
17 Individual Project Evaluation Reports		
Corridor-wide ATIS Project Report	7/16/2003	65A0030/0033
Corridor-wide ATMS Project Report	TBD	65A0030/0049
Corridor-wide CVO Project Report	TBD	65A0030/0051
Corridor-wide Rideshare Project Report	TBD	65A0030/0048
Corridor-wide Strategic Planning Project Report	10/29/2002	65A0030/0028
Fontana-Ontario ATMIS Project Report	TBD	65A0030/0047
IMAJINE Project Report	3/17/2003	65A0030/0029
IMTMC Project Report	TBD	
InterCAD Project Report	4/2/2003	65A0030/0030
Kernel Project Report	5/30/2003	65A0030/0031
LA ATIS Project Report	3/15/2004	65A0030/0038
Mission Valley ATMIS Project Report	TBD	65A0030/0050
Modeshift Project Report	**10/28/2004**	**65A0030/0052**
OCMDI Project Report	2/20/2004	65A0030/0040
Traffic Signal Integration Project Report	TBD	
Transit Mgt System Project Report	TBD	
TravelTIP Project Report	6/3/2003	65A0030/0036
5 Cross-Cutting Evaluation Reports		
System Performance Cross-Cutting Report	TBD	
Costs Cross-Cutting Report	TBD	
Institutional Issues Cross-Cutting Report	TBD	
Information Management Cross-Cutting Report	TBD	
Transportation System Impacts Cross-Cutting Report	TBD	
Final Summary Evaluation Report		
Showcase Program Evaluation Summary Report	TBD	

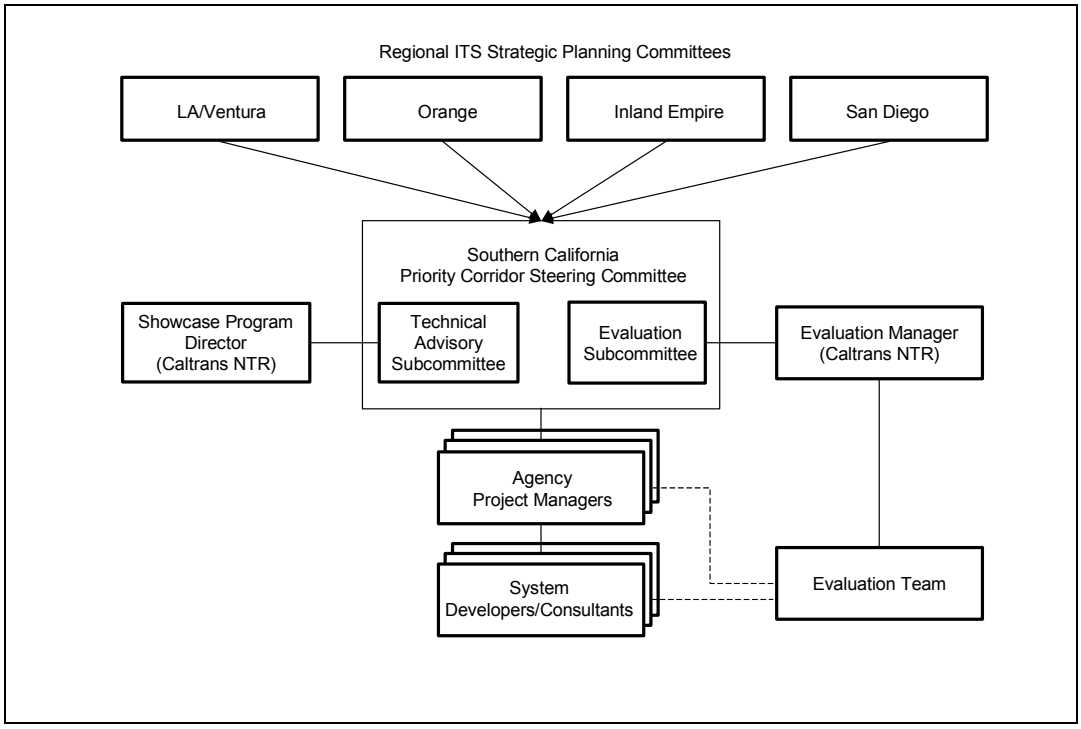
"TBD" indicates a future deliverable that is not yet available.

1.2 Evaluation Design and Approach

The findings outlined in this report are based on over four years of direct observations at project meetings, reviews of released project documents and agency memos, as well as formal and informal interviews and discussions with project partners.

The evaluation is responsive to the needs and suggestions of the Priority Corridor's Evaluation Subcommittee, which reports to the Priority Corridor's Steering Committee. As shown in Exhibit 1, both committees are comprised of stakeholders from the federal, state, and local levels.

Exhibit 1 – Management Structure and Organization of the Showcase Program



The Steering Committee's member agencies include:

- California Highway Patrol (CHP)
- Caltrans, Division of Traffic Operations (headquarters)*
- Caltrans, District 7*
- Caltrans, District 8*
- Caltrans, District 11*
- Caltrans, District 12
- City of Irvine*
- City of Los Angeles Department of Transportation (LADOT)
- City of San Diego
- Federal Highway Administration (FHWA)*
- Federal Transit Administration (FTA)
- Los Angeles County Metropolitan Transportation Authority (MTA)

- Orange County Transportation Authority (OCTA)
- Riverside County Transportation Commission (RCTC)
- San Bernardino Association of Governments (SANBAG)
- San Diego Association of Governments (SANDAG)
- South Coast Air Quality Management District (SCAQMD)
- Southern California Association of Governments (SCAG).

* Indicates an Evaluation Subcommittee member

The Showcase Program's Evaluation Design is based on a set of evaluation Goals and supporting Objectives and Measures that were developed by the Evaluation Team in partnership with federal, state and local stakeholders, and documented in the "Showcase Program Evaluation Approach" in 1998. Each individual Showcase project is evaluated based on an applicable subset of these Goals, Objectives, and Measures in order to help ensure that summary evaluation results can be aggregated from across the multiple Showcase project evaluations. The Showcase Program's five evaluation Goals include:

- Evaluate System Performance
- Evaluate Costs
- Evaluate Institutional Issues and Impacts
- Evaluate the Use and Management of Transportation/Traveler Information
- Evaluate Transportation System Impacts.

As Modeshift evolved, project-specific refinements to the evaluation design were documented in a high-level Evaluation Plan (EP) and a detailed Evaluation Activity Plan (EAP). In general, the EP describes the project and/or system under evaluation, and lays the foundation for further evaluation activities by developing consensus among the Evaluation Subcommittee and project partners as to which of Showcase's evaluation Goals, Objectives, and Measures best apply to the project.

As the project matured, and after the EP had been approved, an EAP was developed to plan, schedule, and describe specific activities (e.g., interviews, surveys) and provide step-by-step procedures for conducting the evaluation. Data collection began after both plans had been reviewed and subsequently approved by the Evaluation Subcommittee and the project's partners.

1.3 Organization of this Report

The Modeshift Evaluation Report provides a background description of the Southern California Priority Corridor and the transportation challenges facing Los Angeles County. This is followed by descriptions of the Showcase Program and the Modeshift project, including a detailed

technical description. The evaluation itself is subdivided and ordered into the five topic areas described below:

System Performance — provides important benchmark information regarding system availability, reliability, scalability and compatibility. The evaluation quantifies those items and could be used to identify needed improvements and help develop specifications for future systems.

Cost — provides important benchmark information regarding funding sources, software licensing, development costs, costs to re-deploy elsewhere or expand the system, and operations and maintenance (O&M) costs. This report includes an estimate of how much it might cost to re-deploy ATIS "from scratch" elsewhere in the State, and also looks at the incremental costs for integrating additional partner agencies and/or traveler information kiosks into the existing system.

Institutional Impacts — provides important information regarding the administrative, procedural and legal impacts resulting from the deployment of Modeshift. Such impacts include changes in operator workloads, responsibilities and job turnover rates, as well as changes and limitations of agency-wide policies, procedures and guidelines.

Transportation & Traveler Information Management — provides important benchmark information on system usage and user acceptance (by both agency operators and the general public). This report provides both quantitative and qualitative findings on those items and can be used to identify user demand, needed improvements and potential areas of future growth.

Transportation System Impacts — provides important information regarding Modeshift's impacts on transit usage, traffic congestion, air quality, and traffic safety.

The report concludes with a summary, final remarks and recommendations for next steps.

1.4 Privacy Considerations

Some of the information acquired in the interview and discussion process could be considered sensitive and has been characterized in this report without attribution. The Evaluation Team has taken precautions to safeguard responses and maintain their confidentiality. Wherever possible, interview responses have been aggregated during analysis such that individual responses have become part of a larger aggregate response. The names of individuals and directly attributable quotes have not been used in this document unless the person has reviewed and expressly consented to its use.

1.5 Constraints & Assumptions

The Modeshift evaluation is subject to the following constraints and assumptions:

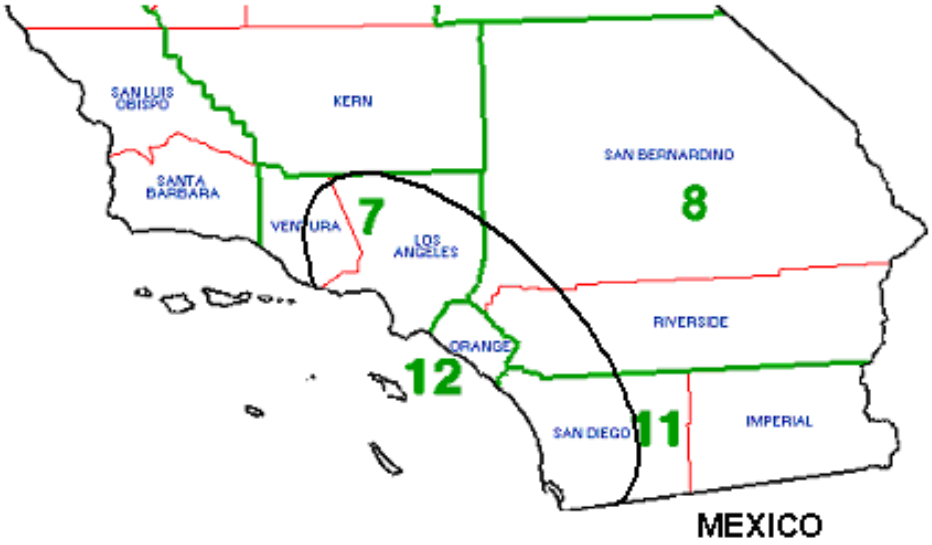
- The amount of time between completion of the Modeshift project and the end of the Evaluation contract was not sufficient for thoroughly evaluating the impacts of the system on travel behavior, traffic congestion and air quality.

1.6 Project Background

1.6.1 The Southern California Priority Corridor

In 1993, the U.S. Department of Transportation designated Southern California as one of four Priority Corridors in which Intelligent Transportation Systems (ITS) could have particular benefit. Southern California suffers from extreme traffic congestion, limited room for expanding transportation facilities, and above-average air pollution levels. The Southern California Priority Corridor, illustrated in Exhibit 2, is one of the most populated, traveled, and visited regions in the country.

Exhibit 2 – The Southern California Priority Corridor and Vicinity



The Southern California Priority Corridor consists of four distinct regions that correspond with the four Southern California Caltrans districts:

- Los Angeles/Ventura (Caltrans District 7)
- Orange County (Caltrans District 12)
- San Diego County (Caltrans District 11)
- Inland Empire (Caltrans District 8).

Roughly two-thirds of the state's population – about 20 million people – resides in or around the Southern California Priority Corridor.

Exhibit 3 – Population and Number of Registered Vehicles by County

County	Population[2] (as of 7/1/2001)	Registered Vehicles[3]* (as of 12/31/2000)	Caltrans District
Los Angeles	9.7 million	6.2 million	7
Orange	2.9 million	2.1 million	12
San Diego	2.9 million	2.1 million	11
San Bernardino	1.8 million	1.1 million	8
Riverside	1.6 million	1.1 million	8
Ventura	0.8 million	0.6 million	7
Imperial	0.15 million	0.1 million	11
Total	**19.85 million**	**12.7 million**	

*Includes autos, trucks, and motorcycles. Trailers not included.

1.6.2 The Southern California Priority Corridor's ITS Showcase Program

The ITS Showcase Program is one of several programs that have been implemented in Southern California's Priority Corridor to help aid mobility and mitigate traffic congestion and its associated environmental impacts.

The Southern California ITS Showcase Program consists of 17 individual ITS projects that collectively form a corridor-wide intermodal transportation management and information network between Los Angeles, Orange County, San Diego, and the Inland Empire. Eleven of the projects are regional in nature, while the remaining six are corridor-wide in scope. Los Angeles County's Modeshift project is one of the eleven regional projects.

The 17 Showcase projects are listed by region in Exhibit 4. Eight of the projects, including Modeshift, were fast-tracked and designated "Early Start" projects because of their importance as base infrastructure and potential to act as role models for the rest of the Showcase Program.

Exhibit 4 – The 17 Showcase Projects and their Status as of August 2004

Project	RFP Issued	Contractor Selected	Contract Executed	Project Underway	Project Complete
Corridor-wide					
Scoping & High Level Design (Kernel)*	✓	✓	✓	✓	✓
Strategic Planning/Systems Integration	✓	✓	✓	✓	✓
CVO🗎					
ATIS	✓	✓	✓	✓	✓
ATMS🗎					
Rideshare	✓	✓	✓	✓	✓
Los Angeles Region					
IMAJINE*	✓	✓	✓	✓	✓
Modeshift*	✓	✓	✓	✓	✓
LA ATIS	✓	✓	✓	✓	✓
Inland Empire Region					
Fontana-Ontario ATMIS	✓	✓	✓	✓	✓
Orange County Region					
TravelTIP*	✓	✓	✓	✓	✓
OCMDI	✓	✓	✓	✓	✓
San Diego Region					
InterCAD*	✓	✓	✓	✓	✓
Mission Valley ATMIS*	✓	✓	✓	✓	✓
IMTMS/C (ATMSi)*	✓	✓	✓	✓	
Traffic Signal Integration (RAMS)	✓	✓	✓	✓	
Transit Management System*	✓	✓	✓	✓	

* Indicates an "Early Start" project.
🗎 CWCVO and CWATMS do not yet have approved workplans.

2 Project/System Technical Description

Modeshift is an advanced trip planning system that provides the general public with real-time travel itinerary information in Los Angeles County, with an emphasis on providing trip itinerary information for vehicular and transit modes. The system enables end users to have real-time access to Advanced Traveler Management System (ATMS) data such as real-time congestion data (volumes, occupancies or estimated speed), incident details, construction activity and resulting lane closures, CCTV status, and CMS sign status. The content and format of this data is standardized according to an Interface Definition Language (IDL) that defines the Showcase data object.

Different projects within the Showcase umbrella are responsible for developing their own domain-specific IDLs. In the example cited above, the ATMS seed and IDL were developed in parallel with the Caltrans Modeshift project. The end result of this process is a consistent data format going into a public sector data collection point.

The primary market for Modeshift is the traveling public. While it is anticipated that public agencies, particularly cities that operate Transportation Management Centers (TMCs), can benefit by having access to real-time trip itinerary information, the intended end users include the traveling public making trips using both commercial and non-commercial vehicles. The data items furnished by Modeshift partners are summarized in Exhibit 5.

Exhibit 5 – Summary of Modeshift Partners, Data Availability and Dissemination Devices Used in the Los Angeles Region

Agency	Data Available	Dissemination Devices in Use	Existing Inter-ties
Caltrans	Static Data – Planned Lane Closure Information Route/Information Day/Time Start/End Time Start/end Points Dynamic Data Raw Detector Data Volume, Occupancy, Speed Average Values for Each Detector Station – Volume, Occupancy, Speed CMS Status/Message CCTV Image Incident Data – Location, Time, Type, Duration, Blockage	Web – www.dot.ca.gov/dist7 HAR CMS Kiosks Cable TV BCST Media Auto Faxing	City of Los Angeles City of Pasadena
The Partnership	Transit Schedules for all transit operators in Los Angeles and Ventura Counties Location of Park & Ride Lots Ridesharing information (participant name, route, schedule) Trip planner	Web – www.scag.ca.gov/transit Phone – 1-800-COMMUTE TranStar	LACMTA

Modeshift's partner agencies represent a diverse cross-section in terms of ITS experience and the amount of ITS infrastructure they had in place prior to Modeshift. Caltrans District 7 has been active in ITS for many years and had various legacy ITS systems in place.

Project Design Concept

Each of four Congressionally-designated Priority Corridors received federal funds to develop strategic plans for the deployment of Intelligent Transportation Systems (ITS) technologies that fit into a 'national' architecture intended to integrate systems and allow for seamless exchange of information. Several partners – the California Department of Transportation (Caltrans), California Highway Patrol (CHP), City of Los Angeles Department of Transportation (LADOT), Los Angeles County Bus Operators Subcommittee (BOS), Los Angeles County Department of Public Works (LACDPW), Los Angeles County Metropolitan Transportation Authority (MTA), Southern California Air Quality Management District (SCAQMD), Southern California Association of Governments (SCAG), and Ventura County Transportation Commission (VCTC) – worked in partnership to develop an ITS Strategic Deployment Plan for the Los Angeles and Ventura Counties region.

In addition to articulating a vision statement and performing a comprehensive Needs Assessment, the Plan prioritized Users Services and Market Packages as defined by the National ITS Architecture. Advanced Traveler Information Systems (ATIS) were identified as a major market package. It is funded and envisioned as a "design once and deploy many" system and leverages investments already made in the Orange County traveler information system "TravelTIP" and other Showcase-compliant projects. The design of Modeshift reuses many of the TravelTIP design elements, pursuant to specific business parameters unique to the Modeshift Business Plan.

There are many transportation management systems throughout the Los Angeles metropolitan region. While each has a varying degree of automation, most can provide interface support to the Modeshift system and data pertinent to a travel information dissemination system. The software vendor was tasked to design a system architecture for Modeshift that included the Caltrans District 7 ATMS as an external subsystem and was open enough to accommodate a range of design solutions. Much of the final architectural design alternatives are presented in detail in the "Final Modeshift Integration System Architecture" document prepared by National Engineering Technology (NET) Corporation and submitted to Caltrans District 7 in September 2000.

Final Design of Architecture for Modeshift

The architecture design of the Modeshift system emerged from a comprehensive analysis of alternatives for transit data source, performance, communications, security, transit trip planning, and non-transit trip planning elements. Each architectural element was evaluated against criteria such as upgradeability, cost and system compatibility. The following is a description of the alternative selected for each architectural element:

- Transit Data Source – Because TranStar is an existing integrated transit data source that has a programmatic interface with several agencies, TranStar was chosen as the transit data source for Modeshift. TranStar contains all route and schedule data for the transit agencies in the Modeshift deployment area. It also provides a well-maintained programmatic interface with a single functional communications connection, which lowered bridge software development costs.

- Performance – Considering issues of vendor support, scalability, processing power, upgradeability, size, cost and compatibility, the Modeshift developer recommended the acquisition of a New Web Server (HP N-4000) instead of utilizing the existing Web Server, which would have had less processing power. The new Web Server is scalable in terms of throughput, RAM, Hard Disk memory and internal/external device options.

- Communications – The Modeshift developer chose to connect Modeshift to an integrated Transit Data Source, which had the advantage of requiring only one communication link to exchange Transit data and piggy-backing onto an existing trip planning function. This option would have been the least expensive, requiring only a dedicated 56Kbps lease line.

- System Security – The option chosen was simply to modify the existing Caltrans District 7 Firewall Server, which is a Pentium PC with 6-8 usable ports, with 3 currently in use with an Ethernet Card. Because the Caltrans TMC would required only a small bandwidth over the next several years, modifying the Caltrans District 7 Firewall Server was sufficient to satisfy bandwidth requirements.

- Transit Trip Planning Implementation – The Transit Trip planning function chosen was TranStar, which has a programmatic interface component, dial up, leased line and frame relay access available offering full functionality access for Modeshift.

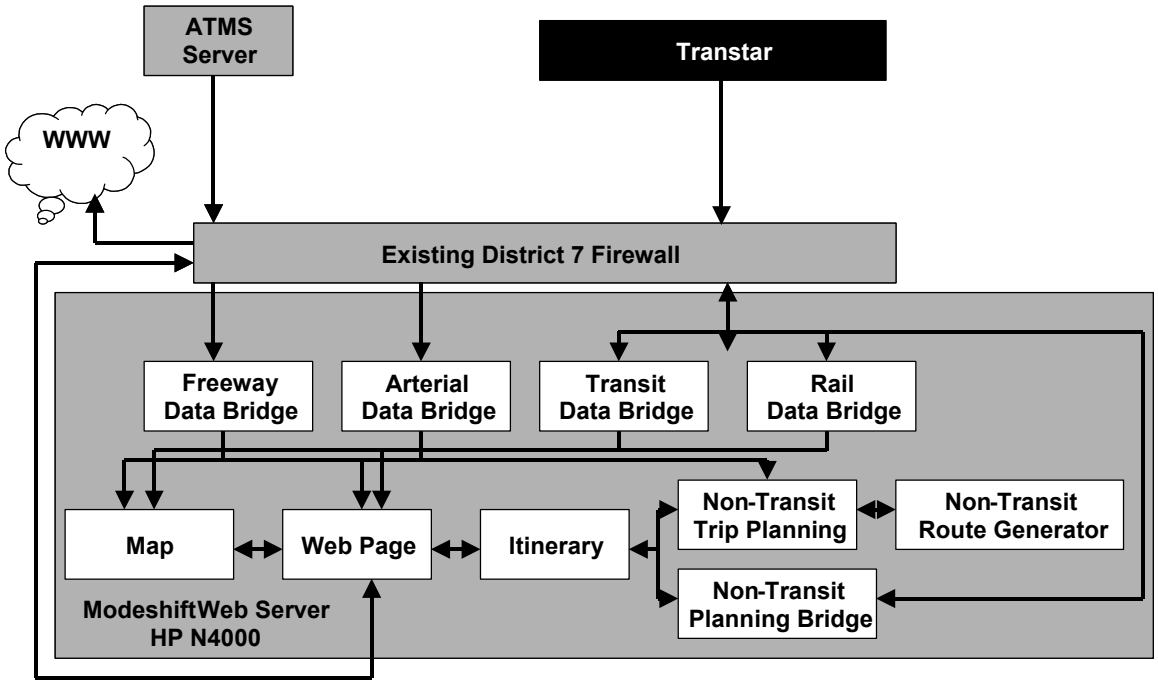
- Non-Transit Trip Planning Implementation – The Non-Transit Trip Planning Implementation function is Environmental Systems Research Incorporated (ESRI), with utilization of Net Engine software and Arc IMS and a separate map database via NavTech.

Functional Architecture of Modeshift

Exhibit 6 illustrates the Modeshift architecture, which consists of Software Configuration Items (SCIs), Hardware Configuration Items (HCIs) and supporting subsystems. The Modeshift software architecture follows an object-oriented paradigm, utilizing distributed object technology for system design and implementation.[4] The software configuration items consist of:

- Freeway Data Bridge – this software conversion process translates information from the Caltrans ATMS system into a usable format for Modeshift. Shared data includes Vehicle Detector Stations (VDS), Event information, and Changeable Message Signs (CMS) information.

Exhibit 6 – Modeshift Functional Architecture



- Arterial Data Bridge – this software conversion process translates information from the external City/County TMC legacy system, allowing data to be shared regarding Vehicle Detector Stations (VDS), Event information and Changeable Message Sign (CMS) information.

- Transit Data Bridge – the Modeshift Web Server obtains route, schedule, fare, special accommodation, stop and status information from TranStar.

- Rail Data Bridge – because the Transit Data Bridge obtains rail route, schedule, fare, special accommodation, stop and status information from TranStar, no rail data is actively obtained by the Modeshift Web Server via this bridge.

- Map – this module provides a geographic-based graphical user interface (GUI) that displays a map of the Modeshift deployment area within the larger Los Angeles/Ventura region. The Modeshift deployment area is shown in a bounded area on the map.

- Web Page – this process translates information from the various data bridges, the Map Display, the Itinerary process, and the Trip Planning processes to the World Wide Web.

- Itinerary – this process provides an interface from the Web Page to the trip planning processes. It receives query information from the Web Page and transfers the information to the non-transit trip planning or the transit trip planning process. Once the query and default information is sent to the appropriate trip planning itinerary process, recommended routes are generated and provided through the Itinerary process.

- Non-Transit Trip Planning – this process receives real-time traffic conditions on freeways, HOVs and arterials from the Freeway and Arterial data bridges. Traffic condition information includes speed (VDS) and event information. If real-time VDS data from either the freeway or arterials is unavailable, the process will use posted speed in its non-transit route generation. This information and the itinerary process information are used to generate a recommended non-transit based route.

- Transit Trip Planning – the transit planning process receives information from the Transit Data bridge. Using the information form the Itinerary process and the transit information, this process generates a recommended transit-based route.

The external subsystems, which provide Modeshift with required data and disseminate the data to end users, are the ATMS Server, , and Transit Data Source. Based on the functional requirements,. Modeshift translates the data and disseminates information for users via the World Wide Web. All subsystems will interface with Modeshift systems through the Caltrans District 7 Fire Wall Server. The subsystems include:

- ATMS Server – the ATMS Server, which resides in Caltrans District 7, interfaces with the Freeway Data Bridge and supplies real-time information on confirmed incidents, planned lane closures, active CMS messages, and real-time speeds and location data for mainline and HOV lanes.

- Transit Data Source – this source provides both bus and rail data to Modeshift.

- Transit Trip Planning Process – this process for Trip Planning receives information from the transit bridges. Included in the transit process information is the current schedules, current stops, current transit status, fares, holiday schedules, and special accommodation information.

- World Wide Web – WWW disseminates the information gathered from all other subsystems to travelers.

The source for the transit data was TranStar, a web-based trip itinerary and trip-scheduling program that contains all route and schedule data for the transit agencies in the Modeshift deployment area. TranStar provides a single agency interface that met the requirements of the project.

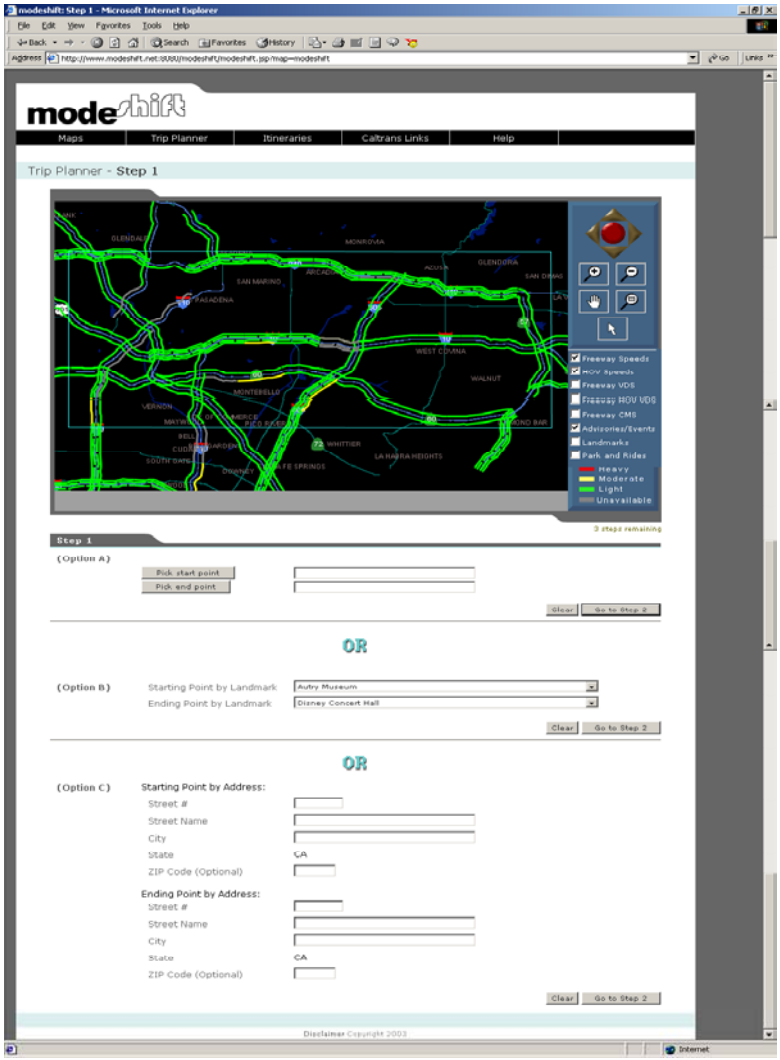
The Modeshift functional architecture is object-oriented, utilizing distributed object technology for system design and implementation. The freeway data bridge converts information from the Caltrans Advanced Traveler Management System (ATMS) into a usable form for Modeshift. Shared data includes Vehicle Detector Station (VDS), Event information, and Changeable Message Sign (CMS) information.

The Modeshift web server also receives route, schedule, fare, special accommodation, stop and status information from a variety of external transit agency systems for both fixed route bus and rail services. The map module provides a geographic-based graphic user interface (GUI) that displays a Los Angeles/Ventura region base map. Freeway and arterial roadway traffic conditions, traffic events and active CMSs are displayed on the map.

The web page process provides information from the various data bridges, the Map Display, the Itinerary process, and the Trip Planning process to the World Wide Web (www). The itinerary query form is available on-line at www.modeshift.net. After the recommended itinerary route information is received from the Itinerary process, the Web Page displays a textual description of the route and provides an option to view the recommended transit route, which includes the following information:

- Specific origin and destination sites
- Specific transit carrier name
- Recommended route number
- Boarding time based upon the specified start date and time
- Next available boarding time
- Fare information for the total trip
- Fare information for each travel segment
- Any transfer information

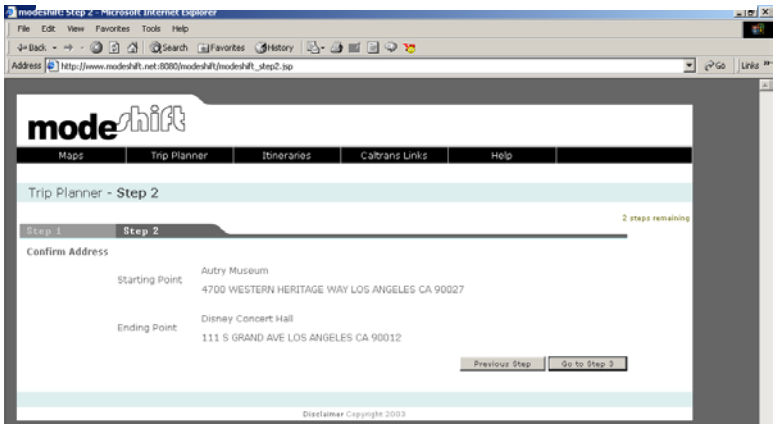
Exhibit 7 – Step 1 of Modeshift



- Walking directions to the selected origin point
- Estimated travel time for the entire trip
- Estimated time of arrival at the destination site
- Any delay indication (if the carrier provides)
- Any contact information for the specific carrier
- Carrier web site link (if available).

On Step 1 of the trip planner, Modeshift displays a real-time map of the deployment area, which gives the user the option to display any combination of the following information: freeway speeds, HOV speeds, freeway VDS, freeway HOV VDS, freeway CMS, advisories/events, landmarks and/or Park & Rides. The map gives the user real-time traffic conditions prior to performing trip planning activities. Below the map, the user is given the choice of three trip planning options:

Exhibit 8 – Step 2 of Modeshift

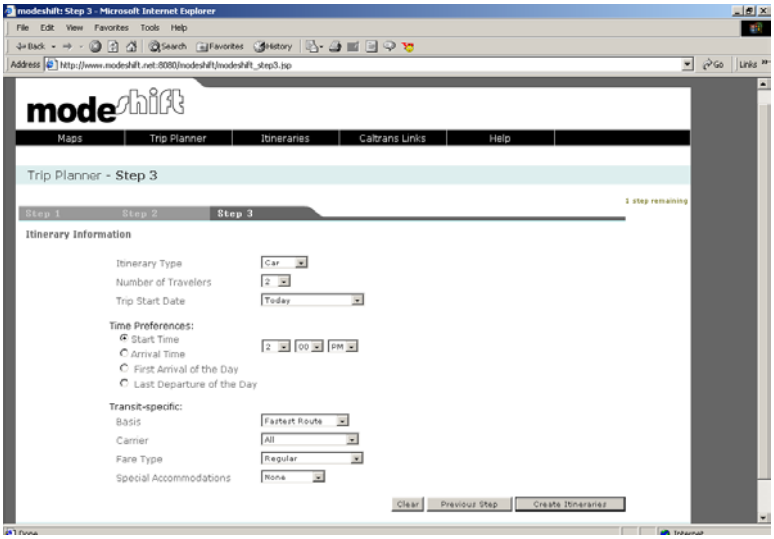


- Pick Start Point/End Point
- Starting Point By Landmark/Ending Point By Landmark
- Starting Point By Address/Ending Point By Address.

After the user inputs starting point and end point locations and clicks the "Go to Step 2" button, Modeshift displays a confirmation page, which confirms that the starting and ending point information is correct.

The user then clicks on the "Go to Step 3" button. On the display page for Step 3, the user is asked to specify mode choice. For automobile trips, the user is required to designate number of travelers, trip start date and trip start.

Exhibit 9 – Step 3 of Modeshift



For transit trips, the user is required to specify some additional information: basis, carrier, fare type and special accommodations.

Step 3 is completed after all of the appropriate trip planning information is entered and the user clicks the "create itinerary" button.

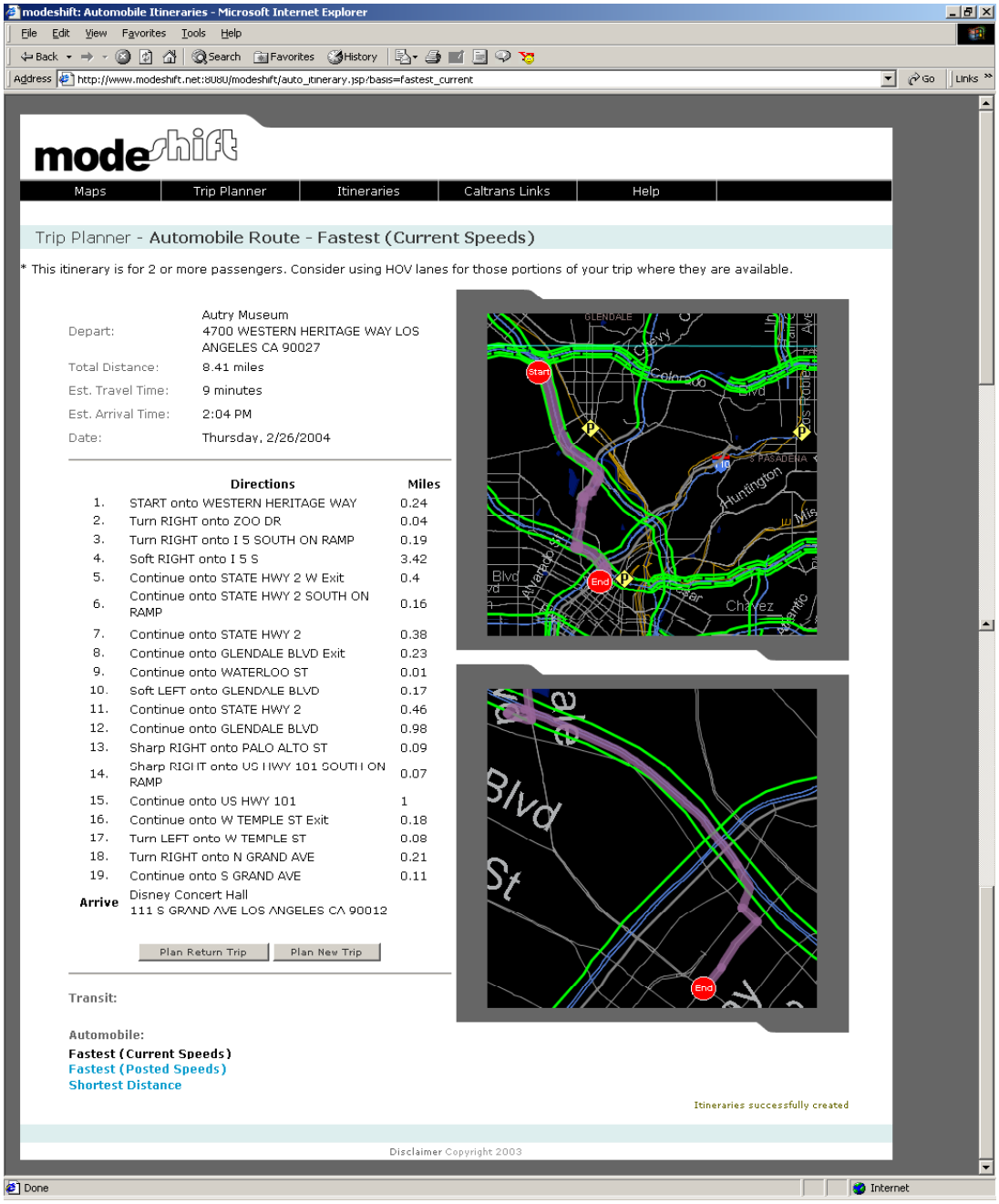
In the demonstration shown here, the user has selected an automobile trip between the Autry Museum and Disney Concert Hall using

Option B in Step 1. In Step 3, the user has selected a car trip with two travelers for the same day. A start time of 2:00pm was designated.

Exhibit 10 on the following page shows complete trip itinerary page. It displays a map showing real-time traffic conditions in the vicinity of the recommended route between the designated starting and ending points. To the left of the map, Modeshift provides a textual description of driving directions, similar in look-and-feel to trip itinerary planners such as Mapquest and Yahoo driving directions.

It is worth pointing out that auto-trip planning feature has an HOV function, which enables Modeshift to identify fastest route on HOV lanes for eligible HOV trips. At the bottom of the page, the user has the option to plan a return trip or plan a new trip.

Exhibit 10 – Modeshift Sample



3 System Performance Evaluation

3.1 The Project/System Development Process and Timeline

Modeshift's development followed a systems engineering process, but took much longer than originally anticipated.

Modeshift is the culmination of roughly four years of design, software development and implementation efforts. The Modeshift project was initiated in March 1999, with an original project completion date of November 2001. The Modeshift project was completed in February 2004. There were several factors that contributed to the delay in the completion of the project:

- Changes in State Procurement Policy — During the Modeshift project, the state of California overhauled the policies and procurement governing procurement of services. Modeshift was unable to procure equipment and software until the new policies and procedures were finalized. *(Schedule impact: 12 months)*

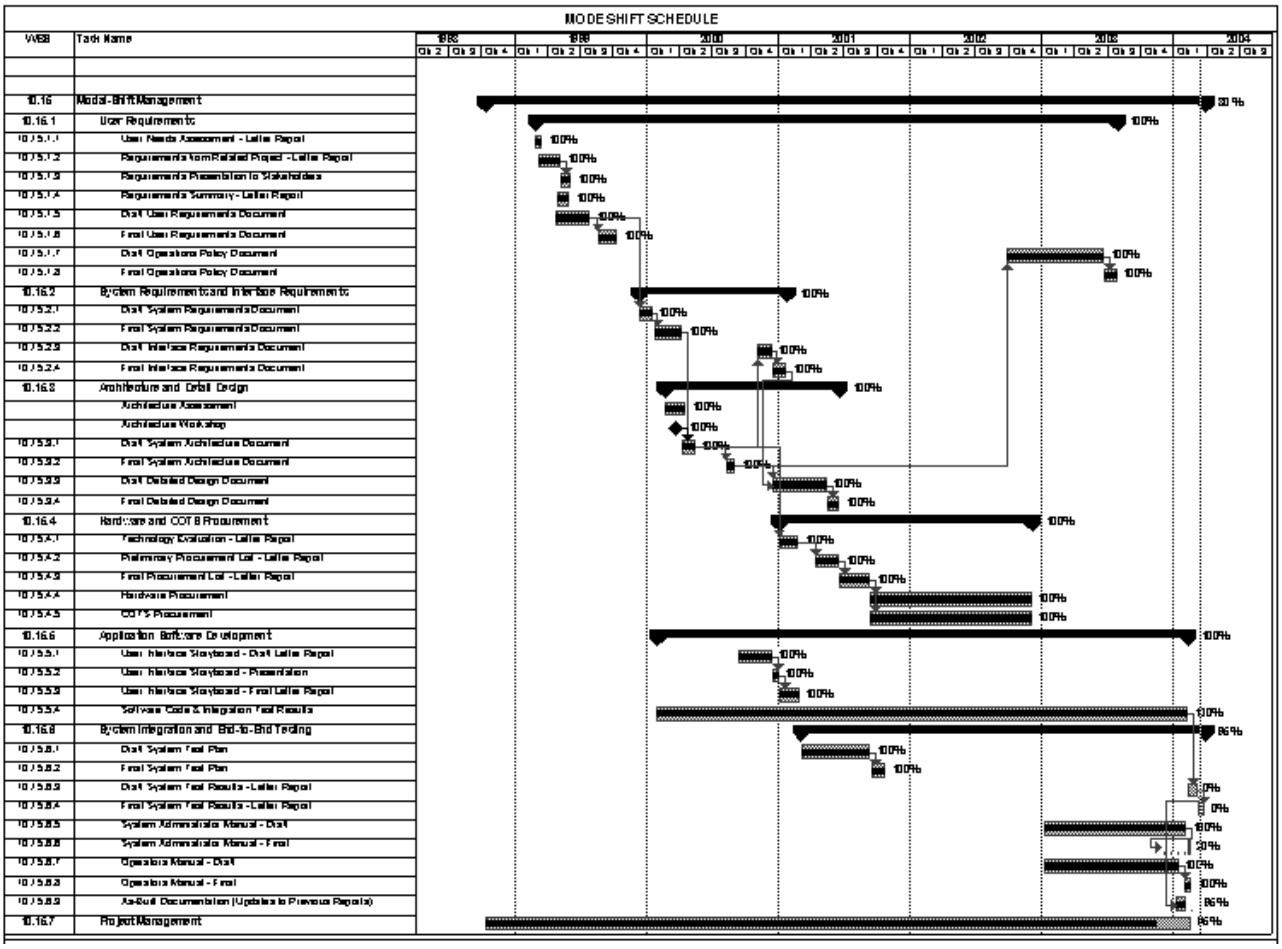
- Software Development – During the software and integration phase, there were several delays in developing the TranStar interface component. The delays were related to SCAG resource availability, equipment relocation, TranStar system down time, and other integration challenges. *(Schedule impact: 5 months)*

- State Budget Delays – Due to state budgetary problems related to the accounting and prioritization of available funding for ongoing projects statewide, projects like the LARTMC System Integration and Cutover project (of which Modeshift is a task) were suspended until year-to-year funding to complete the project was identified and prioritized. When the Modeshift resumed, it took approximately three months to reallocate resources back to the project. *(Schedule impact: 12 months)*

Modeshift is primarily a software development and systems integration project, and utilized the traditional systems engineering approach as evidenced by the following project milestones and deliverables displayed in Exhibit 11.

The Modeshift contract initially specified an 18-month period of performance, but as the dates on the milestones reveal, the time required to plan, design and reach consensus on Intelligent Transportation Systems was much longer. The timeline below shows that although software implementation, integration and testing was accomplished in slightly less than 18 months, the coordination, consensus building and system planning that preceded these activities required nearly three years of effort. This additional time required the contract to be amended several times to extend its period of performance.

Exhibit 11 – Modeshift Project Schedule



The two documents requiring the most effort were the User Requirements and Systems Requirements documents. Each of these documents required several months of consensus building, preparation, review, discussion, and revision to complete. In the absence of a less "process-driven" (and more "product-driven") approach, future ITS projects might benefit from initiatives that make review and finalization of such documents more time-efficient. Such initiatives might include:

1. Approaching the system development in "baby steps." Only include the most critical system requirements in the Requirements document, and leave less critical "wish list" items to future builds of the system. This is sometimes referred to as the incremental waterfall approach to new technology implementation. It requires that one build a little, test and apply the technology, and then enhance it as user familiarity and needs evolve.

2. Developing and using formal document review procedures that define the manner and format in which comments/issues will be received, processed, and resolved. For

example, the Modeshift project utilized a comment disposition matrix for each document deliverable in order to track and disposition all comments.

3. Strictly limiting the amount of time to read and review a document to 2-3 weeks for each review cycle, and gaining commitment from participants to maintain the schedule.

4. Making formal oral presentations of major documents to stakeholders in order to gather direct feedback and address stakeholder concerns.

5. Dictate drafts of major documents onto tape or CD and circulate them as "books-on-tape" so that they are more convenient to carry and review while traveling, commuting, etc.

3.2 System reliability, availability, compatibility, and scalability

3.2.1 System Reliability and Availability

The Modeshift system is functionally operational, and is available indefinitely through a public access website (www.modeshift.net)

In identifying transit data sources, one of the main considerations was evaluating the trade-off between developing multiple agency interfaces (and associated software integration costs) and the risks associated with relying on a single system interface for all transit data. Ultimately, TranStar was selected because it is an existing integrated transit data source with built-in programmatic interfaces with several transit agencies. More importantly, it offered a single functional communications connection.

In the system's roughly four months of operation, there has been no evidence of any system failures. However, it should be noted that the Modeshift system is susceptible to down-time when the TranStar system is down or undergoing temporary maintenance. Over the evaluation period, there have been no instances in which Modeshift has been down due to problems with the TranStar system.

3.2.2 Compatibility

There was no evidence of any system incompatibilities.

Compatibility is the ability of two or more systems or components to perform their required functions while sharing the same hardware or software environment. Because a new HP Enterprise Server Solution was acquired to support Modeshift software functions, there are no incompatibilities that impact ability of the system to perform basic functions. Vendor support for the HP Enterprise Server is available for six years. There have not been any system failures

or anomalies experienced during the four months of this study that would indicate an incompatibility with the existing software/hardware environment.

3.2.3 Scalability

As a distributed, object-oriented system, Modeshift is scalable to accommodate several additional centers.

Scalability describes the extent to which system usage can grow without sacrificing system performance or requiring architectural or technology changes. In this study, system usage is defined in terms of data (object) throughput and is measured in units of megabytes per second (MB/sec). System usage could increase due to an increased utilization of existing workstations or because of the addition of new centers and workstations onto the Modeshift system. The factors that influence the system's scalability include:

- Hardware capability
- Software design.

The Modeshift system uses a new HP 9000 L3000 Enterprise Server Solution, which exceeds the performance criteria for processing speed and scalability. The HP Enterprise Server is configured with two 550 Mhz processors, 2GB DRAM and two 36 GB hard disks housed in one standard-sized rack. Vendor support for the HP platform is available for six years. In terms of throughput, RAM, Hard Disk memory, and internal/external device options, the HP 9000 L3000 Enterprise Server meets and exceeds scalability requirements.

Software design also effects scalability. The more modular the software is, the easier it is to modify without making major design or architectural changes. Modeshift's object-oriented software design is modular and utilizes Showcase's standardized, non-proprietary objects. Modeshift resulted in the deployment of a workstation at the Caltrans District 7 TMC. Adding centers to the Modeshift network should not require a change to the system architecture. Furthermore, since Modeshift is a distributed system in which each workstation processes its own workload, adding centers to the network should not significantly impact the system's performance. If additional capabilities are needed, there is sufficient capacity remaining to reach maximum rack utilization on the HP Enterprise Server.

3.3 Impact of Showcase Integration on Project Deployment and System Performance

Modeshift is one of 17 projects that make up the Showcase Program and Network. As such, many interdependencies developed between the projects as plans were made for eventual regional and corridor-wide integration. This section describes how these interdependencies impacted Modeshift and other Showcase projects.

3.3.1 Impact of Modeshift on other Showcase Projects

Although Modeshift did not integrate to the Showcase Network, the data bridges created as part of the "Intertie Server" are CORBA standard objects consistent with the Showcase protocol.

As the second Showcase project to involve a multimodal, interjurisdictional exchange of data, Modeshift has contributed to the state-of-the-art in the development of object definitions and interface standards for traveler information systems within the Southern California Priority Corridor. These standards provide a common understanding of the representation and interaction of transit elements (e.g. buses, drivers, routes) in CORBA-based object-oriented software. When employed in subsequent transit-related ITS projects in Southern California, these standards will aid system integration, help ensure system interoperability, and support the Showcase Program's goal of "design once, deploy many times," which seeks to achieve cost efficiency through modular system design and software reuse. In the future, it is anticipated that the Intertie Server will enable transparent data exchange of District 7 ATMS freeway data and Santa Monica Smart Corridor arterial data between Caltrans District 7 and LADOT's ATSAC system. This capability is consistent with point-to-point distributed regional Showcase architecture.

3.3.2 Impact of other Showcase Projects on Modeshift

Delays with the development of the Showcase Network impacted Modeshift's architectural design.

The four regional Kernels comprise the centerpiece of the Showcase Architecture. The Kernels authenticate (identify and approve) agency centers that wish to log on to the Showcase Network, as well as provide additional common services such as location translation, "yellow pages," publish & subscribe, and query. Regional systems that wish to exchange information across the interregional Showcase Network must contain software to communicate and interface with the Kernels.

The Kernels were developed in parallel with other Early Start projects such as IMAJINE, TravelTIP, and Modeshift. This situation of concurrent development provided an opportunity for constructive feedback and consensus building between the projects, but also slowed development as design details were shared and consensus was built.

In evaluating the various communications options for connecting with external agencies for transit and arterial data, the vendor excluded from consideration agencies that did not have a system interface available at the start of Modeshift system design. This was done to minimize the risk that external communications issues would adversely impact the Modeshift interface.

The vendor considered three communications options: (1) point-to-point connectivity among transit agencies, (2) connectivity to the Showcase Network, and (3) single source connectivity. Point-to-point connectivity would have required multiple communications links to support

connectivity, which translates to higher installation, operations and maintenance costs. This option was ruled out. The advantage of connection to the Showcase Network is that only one communication link for data exchange would be required, assuming transit agencies and TMCs would also eventually connect to the Showcase Network. The drawback of the Showcase Network option, however, was that there was some risk that it would not be available by the completion of the Modeshift project. Moreover, there was concern about whether transit agencies would connect to the Showcase Network. Even if they did, the cost and effort required to develop a software bridge for each agency's legacy system to facilitate data exchange would be significant.

The vendor eventually recommended connecting to an existing integrated transit data source, TranStar, which required only one communication link to facilitate data exchange. A 56 Kbps leased line was available and determined to be the least costly communications alternative.

4 Cost Evaluation

The cost evaluation draws information from documented costs and personal interviews. Budget information was taken directly from the project's contracts and amendments, while operations and maintenance costs were obtained from discussions with agency personnel. Informal interviews were conducted to verify information and fill in any "holes" that were discovered during analysis.

4.1 Constraints & Assumptions

One consideration for the Cost Evaluation includes:

- Operations and maintenance (O&M) costs have been estimated based on available information. The actual costs may vary.

4.2 Project Budget & Estimated Development Costs

This section addresses the project's contracted tasks and budget, as well as its role in supporting the Showcase Program's "design once, deploy many times" philosophy.

4.2.1 Project Budget

Modeshift was funded under a cost-reimbursable contract.

$1,319,706 was spent on the Modeshift project. Of that amount, $332,719 represented software products and hardware equipment. Exhibit 12 lists the project's seven major tasks and the budget associated with each one, as agreed to in the initial contract and subsequent contract amendments. More detail regarding each task is provided below.

Exhibit 12 – Modeshift Project Budget per Task[5]

Task/Cost Item	Final Budget	Final %
Task 1 – User Requirements	$127,382	9.7
Task 2 – System Requirements and Interface Requirements	$95,276	7.2
Task 3 – Architecture and Design Detail	$178,108	13.5
Task 4 – Hardware and COTS Procurement	$97,312	7.4
Task 5 – Application Software Development	$347,140	26.3
Task 6 – System Integration and End-to-End Testing	$319,956	24.2
Task 7 – Project Management	$154,532	11.7
Total	**$1,319,706**	

Exhibit 12 shows that the greatest single cost of Modeshift consisted of Task 5 – Application Software Development, which represented about 26.3% of the total project costs. The next largest project cost was Task 6 – System Integration and End-to-End Testing, which comprised 24.3% of total project costs. The Modeshift project uses a development server, Intertie server, Web Server and Geocoder server, with one monitor for each. The estimated total cost for the hardware equipment is $221,694. The remainder (and majority) of the equipment cost was for software used for the non-transit trip planning function, the transit trip planning function and development of the data bridges.

The high-level system consists of the following hardware:

Exhibit 13 – Modeshift System Hardware Items

Hardware Items	Quantity	Unit Cost❶	Total Cost
HP 9000 L3000 Enterprise Server Solution	1	$92,440	$ 92,440
HP 9000 L3000 Enterprise Server Solution	1	$87,599	$ 87,599
HP Workstation J6700	1	$35,463	$ 36,463
HP Workstation x2000	1	$5,192	$ 5,192
TOTAL			$221,694

❶ Cost at time of purchase in 2002.

Based on this information, hardware costs for the Modeshift project totaled an estimated $221,694.

Exhibit 14 – Modeshift System Software Items

Software Items	Quantity	Unit Cost❶	Total Cost
NetEngine for Unix 1.1	12	$1,250.75	$15,009
ArcView	1	$2,200	$2,200
GDT Matchmaker SDK Pro (2 licenses)	2	$3,500	$7,000
GDT Dynamap/Transportation (2 licenses)	2	$8,750	$8,750
Iona Orbix: CORBA ORB			
Orbix 3.3 Developers (JAVA) Kit (Solaris 7/8/NT 4.0/2000/HPUX 11)	2	$4,500	$8,550
Orbix 3.3 Standard (JAVA) Support (Solaris 7/8/NT 4.0/2000/HPUX 11)	2	$800	$1,600
Orbix 3.3 Developers (C++) Kit (HPUX 11)	1	$7,500	$7,125
Orbix 3.3 Standard (C++) Support (HPUX 11)	1	$1,274	$1,274
Orbix 3.3 C++ Runtime (HPUX 11)	1	$20,000	$19,000
Orbix 3.3 C++ Standard Runtime Support (HPUX 11)	1	$3,400	$3,400
SmartSockets Rtserver bundle, v5.0 (runtime) for HPUX 11, with 1 Rtserver and 25 Rtclient connections, includes C, C++, JAVA and ActiveX libraries	1		$24,000
ILOG Jviews	1	$6,500	$6,500

Microsoft Visual C++	1	$109	$109
Adobe Photoshop	1	$609	$609
Corel Photo Paint	1	$549	$549
Macromedia Dreamweaver	1	$300	$300
WebGain Visual Café 4.5 Expert Ed	1	$900	$900
TOTAL			$112,025

❶ Cost at time of purchase in 2002.

Based on this information, software costs for the Modeshift project totaled an estimated $112,025.

4.2.2 Design Once, Deploy Many Times

Modeshift supports the "design once, deploy many times" philosophy through the use of the Showcase Program's high-level Kernel-Seed architecture, object-oriented technology, and standardized objects and interfaces.

"Design Once, Deploy Many Times" is the Priority Corridor's philosophy for achieving cost efficiency through a modular system design, software re-use, and "economy of scale." In general, Modeshift supports the "design once, deploy many times" philosophy through the use of the Showcase Program's high-level Kernel-Seed architecture, object-oriented technology, and standardized objects and interfaces (CORBA IDL).

4.3 Estimated Operations & Maintenance Costs

Modeshift's estimated annual O&M cost is roughly $25,000.

4.3.1 Operations

The operations cost for Modeshift has been broken down into three contributing components: labor costs, utility costs, and office space costs. Each of these cost components applies in a varying degree to each project participant. Because Caltrans and other sponsoring agencies have not yet established a detailed business framework for covering ongoing operations and maintenance costs, there has not been any analysis performed regarding the revenue potential to pay operate and maintain the server and pay for ongoing communications costs in a public/private framework.

4.3.1.1 Labor

The Modeshift system provides a system administrator interface for general system administrative purposes, including monitoring usage, bandwidth, and system performance statistics. The labor cost for periodically checking system performance is estimated to be negligible.

4.3.1.2 Utilities

The utility costs that are most attributable to the Modeshift system are electricity (for powering the Intertie and Web servers) and telecommunications (for interagency communications). Because Modeshift is bundled into Caltrans District 7 overhead costs, utility costs attributable to Modeshift can only be estimated at this time. Exhibit 15 estimates the annual electricity cost impact that could be produced by Modeshift hardware. These estimates are based on the following assumptions:

- An average electricity rate of $0.18 per kW-hour (the actual rate varies seasonally)
- PCs and workstations operate 8 hours per day, 48 weeks per year
- Monitors draw 135W for 8 hours each day, draw 15W in "sleep" mode overnight, and operate 48 weeks per year.

Exhibit 15 – Estimated Marginal Annual Electricity Costs for Modeshift

Hardware Item	Model	Power Draw	Power Cost	Est. Annual Cost
Intertie Server	HP 9000 L3000 Enterprise Server Solution	250W	$0.18/kW-hr	**$86**
Web Server	HP Workstation J6700	250W	$0.18/kW-hr	**$86**
Geocoder Server	HP Workstation x2000	250W	$0.18/kW-hr	**$86**
4 Monitors	Various	15W-135W ea.	$0.18/kW-hr	**$183**
				$441

Actual communications costs will vary depending on whether the agencies leave workstations on continuously, shut down their hours of operations based on a fixed schedule, or operate them on special occasions only.

Exhibit 16 – Monthly and Annual Communications Costs

Description	One-time Installation Fee	Est. Ongoing Monthly Cost	Est. Ongoing Annual Cost
56 Kbps Leased Line	-0-	$2,000	**$24,000**
			$24,000

4.3.1.3 Office Space

All partner agencies reported that there was no additional financial cost for the space occupied by Modeshift equipment because there is no specific accounting down to the project or system level.

4.3.2 Maintenance

At this time, Modeshift system maintenance costs are not known. For the first six months after project deployment, Caltrans District 7 will support the operations and maintenance out of its ITS budget. Because Caltrans does not have a policy for ongoing support of advanced traveler information systems, it is anticipated that Modeshift will be sold to an outside vendor.

5 Institutional Impacts Evaluation

5.1 Impacts to Operations and Maintenance Procedures and Policies

Caltrans District 7 TMC hosts and operates the Modeshift system, with no funding commitment from external partners for ongoing operations and maintenance costs.

Currently, Caltrans does not have an official policy regarding the ongoing support of Advanced Traveler Information Systems that provide benefits to agencies external to Caltrans. After system acceptance and prior to the expiration of NET's O&M period, Caltrans must develop a long-term funding plan to support Modeshift. The Caltrans District 7 TMC was selected to host it because of its familiarity with similar technologies and the availability of greater communications bandwidth.

Caltrans District 7 hosts (provides space, electricity and network connection for) the Modeshift hardware (application server, web server) and solely provides maintenance support (re-booting hardware, if necessary).

5.2 Impacts to Staffing/Skill Levels and Training

Modeshift has had no impact to staffing or required skill levels.

Users with general computer skills can operate a Modeshift workstation. The workstations have an intuitive Windows™-like user interface, and NET provided training and demonstrations to familiarize the project partners with the system's full range of capabilities.

Operator and System Administrator training was provided, but continued support for Modeshift is subject to budget conditions.

5.3 Impacts to the Competitive Environment

Modeshift's system design is well documented and consistent with Showcase-defined data conversion processes.

Although Modeshift is not integrated with the Showcase Network (i.e., the Kernel), Modeshift involved the development of object definitions and interface standards consistent with Showcase's standard IDL. Because Modeshift uses standard IDL, the effort required for someone other than the system developer to modify the system is minimized.

5.4 Impacts to Local Planning Processes, Policy Development, and the Mainstreaming of ITS

Modeshift helped create both a physical and institutional foundation for further ITS development in Los Angeles County.

Physically, one of the biggest accomplishments of the Showcase Program is its development of system interface standards for Southern California. Similar to the national effort on NTCIP, adoption of these standards will help promote interoperable systems that enable greater information sharing, improved agency coordination, and reduced costs over time.
Perhaps more importantly, Modeshift contributes one building block of an institutional foundation that helps to mainstream ITS in the region. Through the Modeshift experience, regional partners have identified several critical institutional issues and established some direction for the region's future ITS projects. Some of these critical issues include, but are not necessarily limited to:

- System and information security – The system developer, in close coordination with Caltrans District 7, chose to modify the existing Caltrans District 7 Firewall instead of procure a separate Modeshift firewall server. The primary rationale for modifying the existing Caltrans District 7 Firewall was that there appeared to satisfactory bandwidth requirements and the desired security function could be met at lower cost.

- System reliability – As the project sponsor, Caltrans District 7 tracks system reliability through the www.modeshift.net/stats/ utility, which tracks visits, pages, bandwidth and other system statistics. The system administrator also can retrieved information on the total number of hours Modeshift is down based on problems with Caltrans ATMS, TranStar or other supporting systems.

- Policies regarding control of field equipment such as CCTVs and CMSs – Modeshift's Freeway Data Bridge converts information from Vehicle Detector Stations (VDSs) and Changeable Message Signs (CMSs) posted to the Caltrans ATMS system. At this stage, Caltrans retains exclusive control of all field equipment, and data is retrieved through the Data Bridge conversion process.

- Software ownership and the treatment of intellectual property rights – The issue of long-term software ownership has not been fully investigated by project sponsors beyond the demonstration phase of the Modeshift project. The treatment of intellectual property rights is among several that should be addressed in a Modeshift business plan.

- Delegation of operations and maintenance responsibilities (including funding). – Long-term responsibility for overall operations and maintenance issues have not settled beyond the initial demonstration phase. The issue of long-term operations, maintenance and project cost sharing is among several that should be addressed in a Modeshift business plan.

These precedents should help clear the way for future ITS advancements in Los Angeles County.

6 Traveler and Transportation Information Management Evaluation

6.1 Extent of Regional and Interregional Transportation and Traveler Information Integration Between Agencies

6.1.1 Modeshift System Impact on Data Flows

Modeshift is recognized for its goals of integrating transportation management systems in Los Angeles County. Modeshift helps lay the foundation for the expanded exchange and use of transportation data among the regional partners.

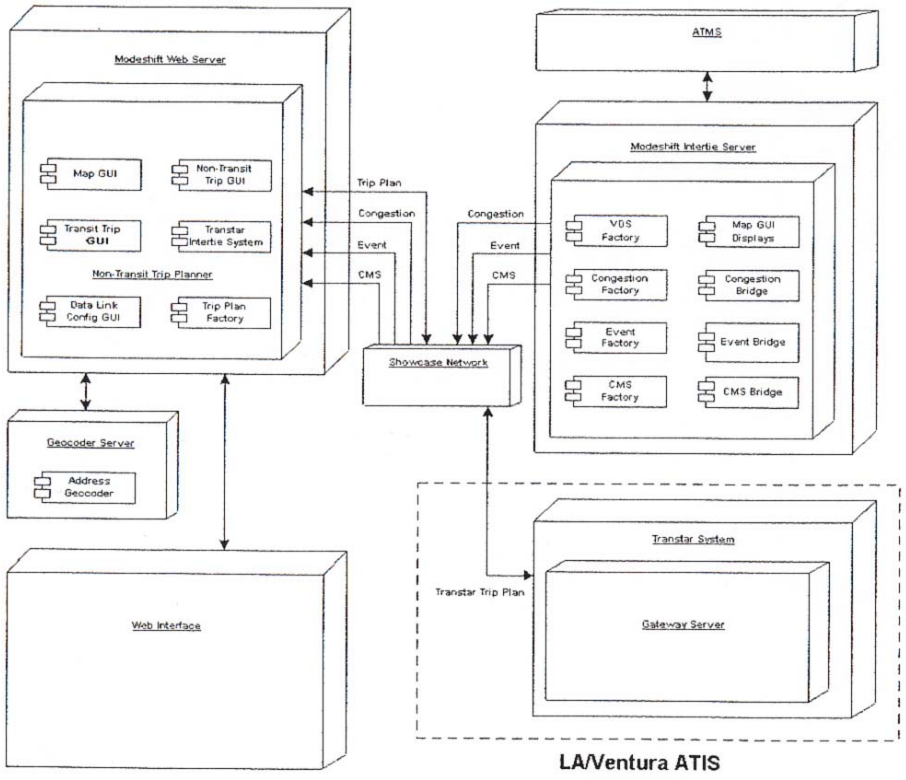
The Modeshift software architecture follows an object-oriented paradigm, utilizing distributed object technology for system design and implementation. Software conversion processes were developed for each data object to translate information into a usable format. The data to be shared includes freeway, arterial and transit (bus and rail). All data are converted to CORBA standard objects that other systems can easily call via standard Showcase protocol.

Modeshift's architectural design is depicted in Exhibit 17 (see definition of 'architecture flow' in the National ITS Architecture). The system interfaces with the Transtar System and the Caltrans District 7 ATMS system. The software system components and the deployment hosts consist of:

- **Modeshift Web Server** – hosts an Apache/Tomcat web server running Java software to interact with public end user, generating maps and travel itineraries as needed.
- **Modeshift Intertie Server** – provides connection to D7 ATMS system and hosts factories and bridges (i.e., seed) for this connection.
- **GeoCoder Server** – performs address geocoding for all Trip Planning functions; geocoding software from Geographic Data Technologies (GDT) requires Microsoft NT.
- **Web Interface** – enables the public the entry point to perform trip planning using traffic and transportation information that allows travelers to make informed decisions about which routes to travel. The Web Page provides the public with trip planning itinerary information. The traffic and transit information will be gathered from other Modeshift external subsystems. The Web Page will display the textual and graphical itinerary descriptions of the route information.
- **TranStar System** – SCAG Transtar system is an automated transit trip planning system that provides detailed transit trip itinerary information to the public. Information provided by Transtar enables travelers to make informed decisions about their travel. Transit itinerary data will be provided to the Modeshift project for transit itinerary planning.

- **ATMS** – Caltrans District 7 ATMS system is designed to assist in collection and dissemination of traffic information in order to effectively manage the existing Caltrans District 7 transportation system. Through rapid detection of, and response to, and removal of incidents on the freeway, the D7 ATMS helps to reduce traffic congestion and increase safety.

Exhibit 17 – Modeshift Functional Architecture



6.1.2 Impact on Traffic Operations and Communications

At this time, no analysis of the impact of Modeshift on traffic operations and communications was performed. The issue of how Modeshift impacts traffic operations and communications should be explored in greater detail after Caltrans has developed a formal policy regarding its support for regional advanced traveler information systems and has fully transitioned Modeshift to a long-term ownership arrangement.

6.2 Utilization of Regional and Interregional Transportation and Traveler Information by Public Agencies

Modeshift partner agencies report that they do not utilize the system at this time.

The Modeshift project is the first step of a multi-stage effort. At this time, Modeshift is fully operational and performs trip planning functions for the deployment area defined in the user requirements. In the future, Modeshift has the capability to integrate LADOT traffic management data in addition to data from the LADOT's Santa Monica Smart Corridor project, allowing the user to access local traffic conditions. Likewise, Modeshift enables the communication of freeway incident data from Caltrans District 7 to LADOT through the District 7's Intertie Server.

Several partner agencies were contacted to determine the performance and utilization of Modeshift. Of the five partner agencies that were interviewed, two were aware of the Modeshift project, and three had never heard of Modeshift prior to the interview.

6.3 Extent to which Comprehensive and Seamless Traveler Information is being Disseminated to – and Used by – the Traveling Public

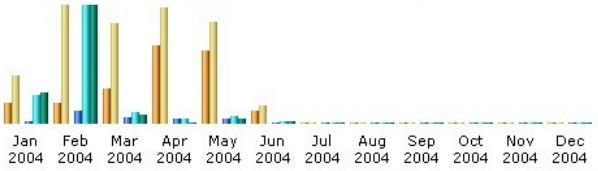
6.3.1 Modeshift Website

The Modeshift website received an average of 653 hits per month, which is not enough market penetration to significantly impact traffic conditions.

Data on the public's use of the Modeshift website is available for the system's four months of operation immediately following completion of acceptance testing in February 2004, as shown in Exhibit 18. The usage data is drawn from automatically collected server statistics and is based on the number of web pages requested. These statistics provide both the number of unique users or the number of distinct user sessions. Modeshift's traffic map refreshes automatically approximately every 60 seconds, and each refreshed page is counted as a new page request or "hit." In the month of March 2004, for example, Modeshift received 260 hits and had 32 unique visitors.

Exhibit 18 – Modeshift Website Usage, by Month

First visit	Summary			Last visit
01 Jun 2004 - 10:27	**Month Jun 2004**			02 Jun 2004 - 13:54
Unique visitors	Number of visits	Pages	Hits	Bandwidth
11	**16** (1.45 visits/visitor)	**24** (1.5 pages/visit)	**52** (3.25 hits/visit)	**75.22 KB** (4.7 KB/visit)



Month	Unique visitors	Number of visits	Pages	Hits	Bandwidth
Jan 2004	18	43	59	649	1.04 MB
Feb 2004	19	107	282	2674	4.04 MB
Mar 2004	32	91	141	260	287.09 KB
Apr 2004	71	105	117	117	21.25 KB
May 2004	66	92	103	168	172.92 KB
Jun 2004	11	16	24	52	75.22 KB
Total	217	454	726	3920	5.62 MB

The average hits-per-month to Modeshift's traffic page was 653 between January and June 2004. The low usage reflects the fact that most of the visits are from individuals who were affiliated the Modeshift project, and who repeated visited Modeshift during the pre-acceptance and post-acceptance phase to assess functionality. In the month of May 2004, Modeshift averaged only 2.86 unique visits per day.

7 Transportation System Impacts Evaluation

This chapter describes the impacts of the Modeshift system on the transportation network in Los Angeles County. Since Modeshift is only the first step of a multi-stage program, and much of the functionality is currently idle, a detailed impacts analysis was not warranted. The following sections describe the current status of the Modeshift system.

7.1 Impacts to Modeshifting and Intermodalism

An empirical analysis of the impact that Modeshift may have on modeshifting or intermodalism could not be detected at this time, due to the limited public exposure to Modeshift. After the conclusion of the 6-month demonstration phase, it is possible that Modeshift will be made available to the public via a link on the sponsor's website. An analysis of the impacts of modeshifting and intermodalism can be performed if and when the sponsor develops a survey of Modeshift users. It is recommended that the agency that sponsors Modeshift support a survey that requires new registered subscribers to complete a travel behavior survey as a condition of registration. The purpose of the survey should be to yield information about how often users rely on the website, what types of information are retrieved, how information impacts departures times and mode choice.

7.2 Impacts to Traffic Safety and Accident Reduction

Given its limited usage, Modeshift does not have any detectable impact on traffic safety or accident reduction. The system is designed to display traffic advisory information reported by the California Highway Patrol (CHP) to enable motorists to modify routing and departure time decisions in order to avoid delays resulting from non-recurring incidents that cause an unplanned lane closure. Once Modeshift has achieved greater market penetration, an analysis of the impacts of providing traffic advisory information on travel behavior should be performed through a quantitative survey research.

7.3 Impacts to Traffic Congestion

Modeshift's impact on traffic congestion cannot be detected at this time, due to the small geographic size of the initial deployment area and limited public exposure to the Modeshift system.

7.4 Impacts to Environmental Effects of Traffic

At this time, an empirical analysis to detect the impacts of Modeshift on air quality and the environment was not performed. It is recommended that the agency that sponsors Modeshift support a survey that requires new users to complete a travel behavior survey as a condition of

registration. The purpose of the survey should be to yield information about how often users rely on the website, what types of information are retrieved, how information impacts departures times and mode choice. Information about how travel behavior adapts can be a useful tool for estimating changes in VMT resulting from better trip itinerary information, which will allow for a better understanding of environmental impacts.

7.5 Impacts on Transit Operations

At this time, an analysis of impact of Modeshift on transit operations was not performed, due to the small geographic size of the initial deployment area and limited public exposure to the Modeshift system.

Conclusions and Recommendations

This evaluation finds that Modeshift is a Showcase project that demonstrates the benefits of regional integration in delivering a qualitatively unique on-line trip itinerary system. On-line trip planning services like Mapquest have been available in the on-line marketplace for years. However, these are non-dynamic trip planners that cannot provide route information based on real-time traffic conditions. Furthermore, they do not offer itinerary information for transit-based trips. Modeshift is the first on-line product that enables the user to plan trips for both automobile and transit based on real-time traffic conditions.

The other major accomplishment achieved through Modeshift is the establishment of data exchange standards and an open architecture, which will enable Modeshift to integrate local traffic data from LADOT's traffic management system and future ITS projects like the Santa Monica "Smart Corridor." One of the challenges facing long-term deployment of ITS projects is developing a sustainable funding and maintenance program that distributes costs, risks and benefits equally among all partner agencies.

Currently, Caltrans does not have a formal policy for supporting non-revenue ITS projects beyond funding available for project development and initial deployment. Unless Caltrans Headquarters develops a policy that links ongoing operational and maintenance support to an MOU with an external partnership, Modeshift may become idle until such time that the package is sold to an external agency or dedicated funding is secured.

There are several findings presented here:

1. The transit trip planning capabilities of Modeshift are only as good as TranStar, which has some trip planning algorithms that result in illogical transit planning suggestions. One of the advantages of relying on TranStar for transit trip functionality is that Modeshift does not have to "reinvent the wheel" at high cost. The disadvantage is that Modeshift suffers some trip planning quirks inherent to TranStar's logic. Another issue that may arise is that Modeshift's functionality is predicated on TranStar's availability.

2. Modeshift's display map is capable of providing a broad array of valuable traveler information, the most interesting of which is CHP advisory data, landmark data and Park & Ride location data. The ability to display the location of Park & Ride lots throughout Los Angeles County is valuable, insofar as it provides the user with information about constructing multimodal trips to areas with limited or expensive parking such as downtown Los Angeles.

3. At present, Modeshift allows the user to select trip origins and destinations by clicking on Landmark icons. It is recommended that Caltrans change icons that represent Park & Ride lots to symbols that denote a landmark. This will allow users to use the point-and-click functionality of the GUI to plan trips to and from Park & Ride locations. This is particularly valuable in planning multimodal trips to areas like downtown Los Angeles, where parking costs tend to make transit more appealing.

4. The current size of the Modeshift deployment area is approximately 45 square miles, covering a broad area encompassing the eastern edge of Koreatown, Silverlake, downtown Los Angeles and communities throughout the western San Gabriel Valley. The next phase of the project should be to expand the geographic size of the deployment area. This will result in a manifold increase in the utility of the system, which will serve a wider network of potential trip origins and destinations.

5. It is recommended that Caltrans draft a Modeshift business plan that identifies the role of Modeshift in integrating Showcase applications currently being supported by local TMCs, and highlights the benefits of continued regional integration to local and regional agencies. The development of a business plan is critical in transitioning the project from a proof-of-concept demonstration to a public access web tool that can build and sustain a market niche among Los Angeles area travelers. The business plan should include usage estimates as a basis for determining future communication options, and the cost liability associated with these options. In addition, the business plan should identify an online survey mechanism for capturing how Modeshift is used, how tripmaking adjusts to real-time information, and whether the availability of real-time information induces shifts from automobile to transit. This feedback element is critical in ensuring that Modeshift is responsive to real on-line traveler preferences. In order to establish a sustainable cost-sharing memorandum of understanding (MOU), the benefits of the next phases of the Modeshift project should be clearly articulated, so that a case for participation can be made within each member agency.

6. Modeshift requires the user to select either a ‘car’ or ‘transit’ mode in Step 3 of the trip planning function. This determines which type of itinerary the user will be presented first. If the user selects a ‘car’ trip, Modeshift provides turn-by-turn driving directions and distances. The ‘transit’ trip itinerary with routes and fares will only be displayed if the user clicks on the Transit Itinerary link. A possible improvement might be to automatically display both ‘car’ and ‘transit’ itineraries on the same page, or provide some catchy statement to lure the user to view the transit information. As it is now, the transit information may often go unnoticed and unused.

Endnotes/References

[1] ISTEA requires that "operational tests utilizing federal funds have a written evaluation of the Intelligent Vehicle Highway Systems technologies investigated and the results of the investigation." Although Showcase is not officially an operational test, it deploys and demonstrates ITS services, functions, and technologies under "real world" conditions, similar to an operational test.

[2] California Statistical Abstract, Table B-4. California Department of Finance, Sacramento, CA. October 2001.

[3] California Statistical Abstract, Table J-4. California Department of Finance, Sacramento, CA. October 2001.

[4] Modeshift Integration System Architecture, Final. National Engineering Technology Corporation, September 2000

[5] The total project budget numbers are accurate and come from the project contract (LACMTA PS-4340-0143) and its amendments. Individual task budgets were estimated based on approximations provided by NET.