Final report for ITS Center project: Hampton Roads ATIS

UVA Center for Transportation Studies

A Research Project Report

For the Virginia Department of Transportation and

the National ITS Implementation Research Center

A U.S. DOT University Transportation Center

HRATIS First Year Evaluation Report

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HRATIS FIRST YEAR EVALUATION REPORT

Baseline Data and Preliminary Impacts

September 2000 - August 2001

INTRODUCTION

In accordance with the guidelines of FHWA and Transportation Equity Act for the 21st Century, TEA-21, each ITS project is required to undertake a self-evaluation (1,2). This document describes the first year, or baseline evaluation for the Hampton Roads Advanced Traveler Information System (HRATIS), an ITS integration project.

BACKGROUND

The Hampton Roads region is one of the most diverse and expanding regions of the country. One of the most important characteristics of the region is tourism. It is also home to one of the busiest ports in the country, leading to a heavy freight import/export. The area also houses one of the largest naval bases in the world.

The ITS integration project, the Hampton Roads Advanced Traveler Information System (HRATIS), is a public-private partnership. The service collects information from multiple sources, fuses the data elements, and distributes the information through various media. The system will keep local residents informed of immediate traffic problems, will serve as a route decision-making support tool for over-the-road carriers and military transporters, and will give tourists visiting the area a tool to make their trip less stressful and hopefully accident free (3).

System Description

The Hampton Roads ATIS project collects, processes and disseminates traffic and related information to the public for improving the overall system performance. A system information flow diagram is shown in Figure 1, which illustrates the various system components such as the information sources and the dissemination modes. The various information sources include the direct information sources like the loop detectors, Transportation Management System (TMS) Cameras, Bridge Tunnel sensors, 911 calls, and other secondary information sources such as the Transportation Emergency Operation Center (TEOC), Freeway Incident Response Team (FIRT), Virginia Operational Information System (VOIS), Virginia State Police (VSP) Radio and the State Police Incident Database. The two private sources of information - US Wireless, and Metro/ Etak - are in the negotiation stages. The main form of information dissemination is planned as congestion maps on the Internet and through TV/Cable Television. Highway Advisory Radio and Highway Advisory Telephone will relay text-based information in the audio format.

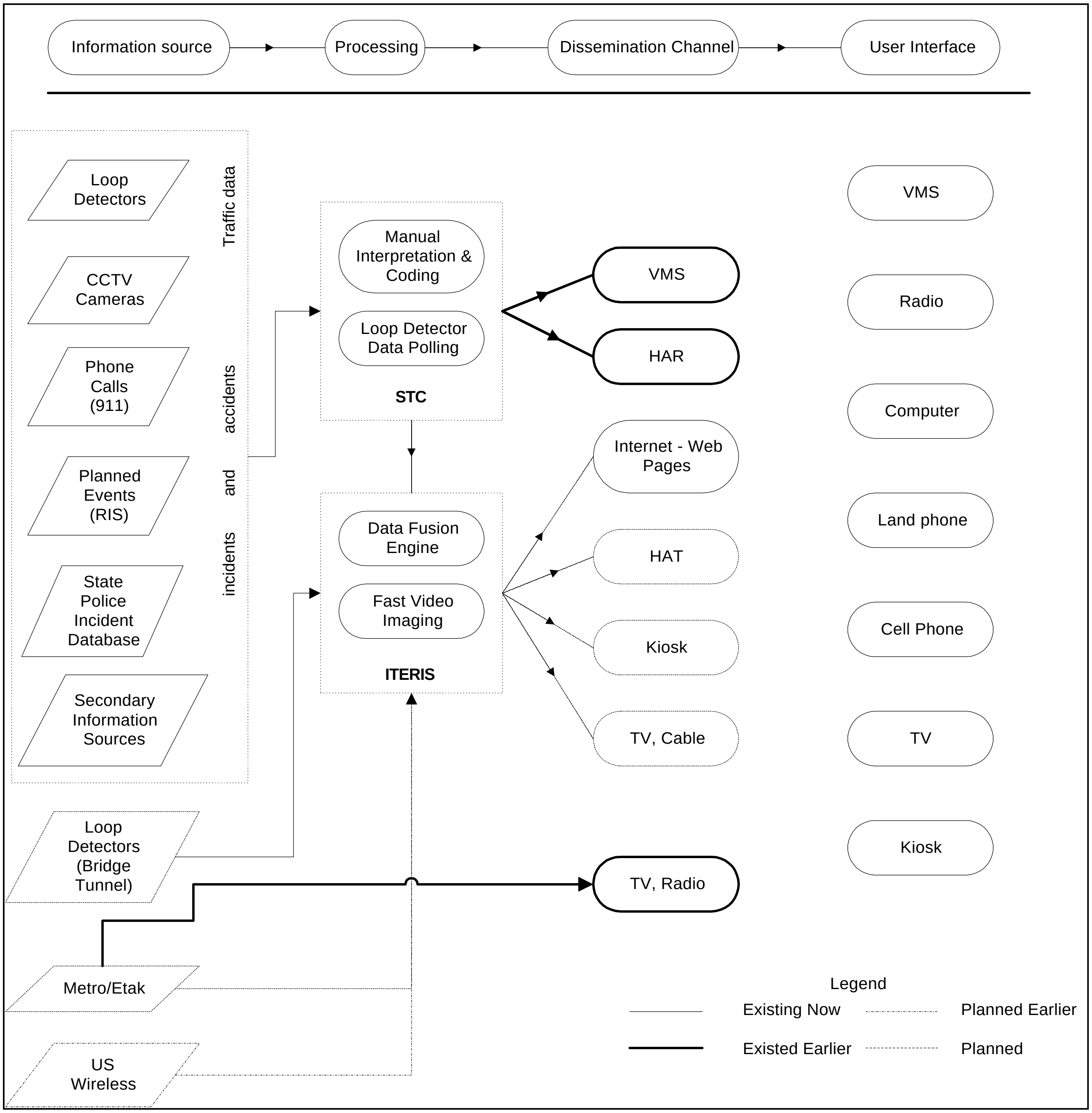

Figure 1. System Description and Information Flow Diagram

Figure 2 gives an understanding of the higher-level interconnection among subsystems and terminators, all of which are named and depicted in the regional context. The Interconnect diagram was obtained by using the Turbo Architecture tool (4). Each node represents a subsystem or a terminator, and the party responsible for that entity. Figure 3 describes the physical architecture consisting of both existing and planned subsystems, and communication infrastructure for HRATIS with respect to the terms described in the National ITS Architecture.

As can be seen in Figure 1, some data is obtained by ITERIS directly, and some through the Smart Traffic Center (STC). The format of a typical traffic data file, based on the loop detector data, obtained by ITERIS from the STC is in an open format and is described later. The system consists of loop detectors across all the lanes at different locations. Each of these cross-sections, with detectors in each lane is called a station. Depending on the number of lanes and the nature of the loop detectors (single or double), the number of detectors that connect to a station varies, and some stations connect with up to 12 detectors.

System Operation

The system operation mainly consists of obtaining information from the sources indicated and fusing them, eliminating any duplicity and checking for unreliable data, and finally disseminating information to the information providers, who then provide the information to travelers.

The data fusion engine developed by ITERIS Inc., unifies the same event received from different sources, forwards video images on a still frame basis with a refresh rate of 1 frame every 10 seconds, and allows each distribution channel to “subscribe” to the fusion engine to receive information according to the needs of the distribution channel. Internet protocol will be used for information transfer to the private partners, who supply the information to the travelers. The private partners will distribute traveler information through a combination of different media outlets including Internet, cable television, commercial radio, kiosks, highway advisory telephone, broadcast television, and personal digital assistants.

System Benefits

The anticipated benefits and services of the system to be derived by VDOT through ITERIS, as described in the original project document (3) are

- A real time congestion map for traffic management and traffic operations that includes sensor data for surface streets and freeway sections not yet covered by VDOT sensors;
- An automated telephone call-in system to disseminate information to the traveling public;
- 4 years of operations support to the telephone system where ITERIS provides data supporting the dissemination of traveler information via the telephone system;
- an NTCIP compliant interface to the Roadway Information System so that the RIS can be incorporated into the RMMS rather than be discarded as an interim solution;
- $1 million revenue in cable television advertising.

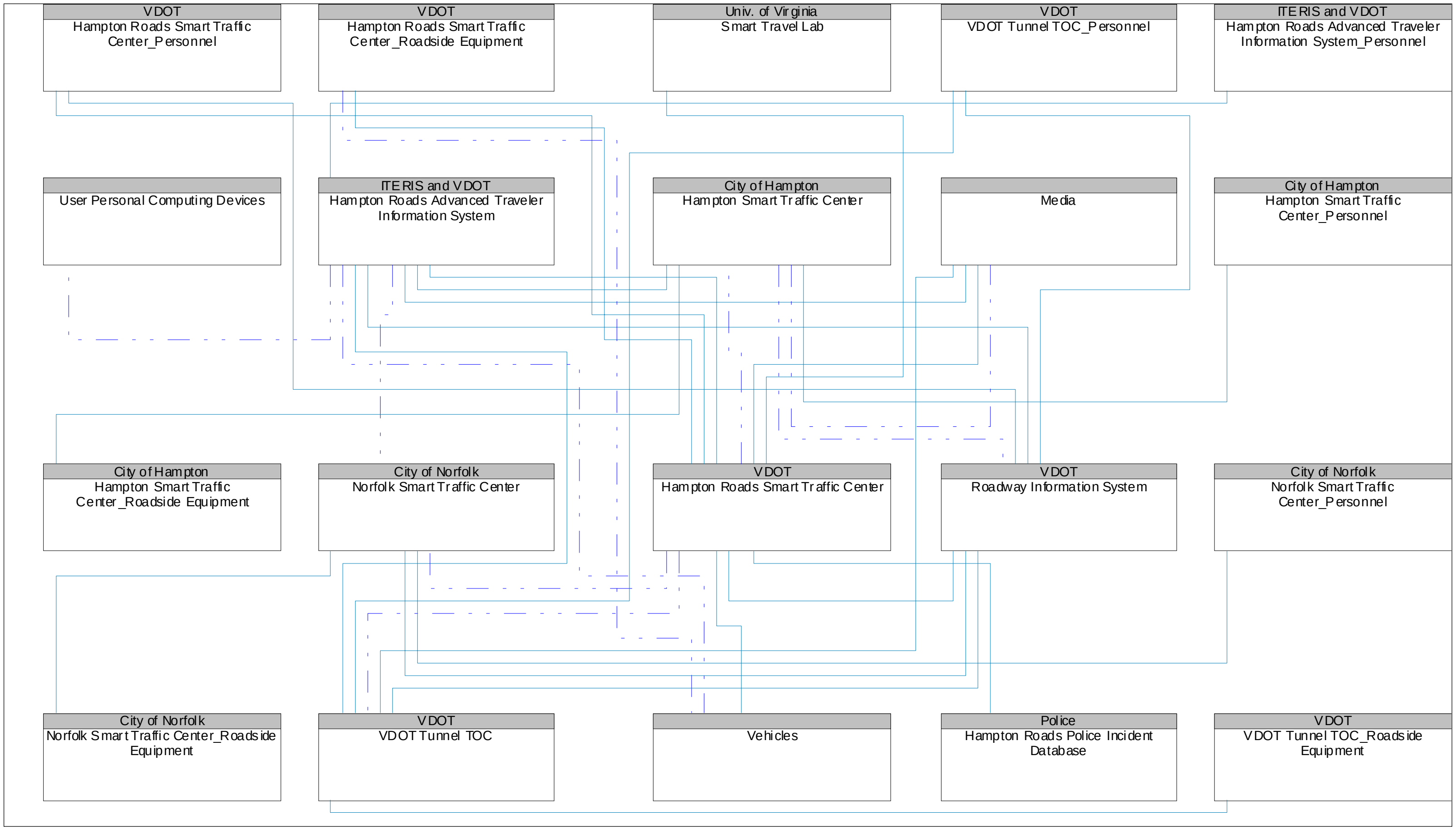

Figure 2. Connectivity Diagram

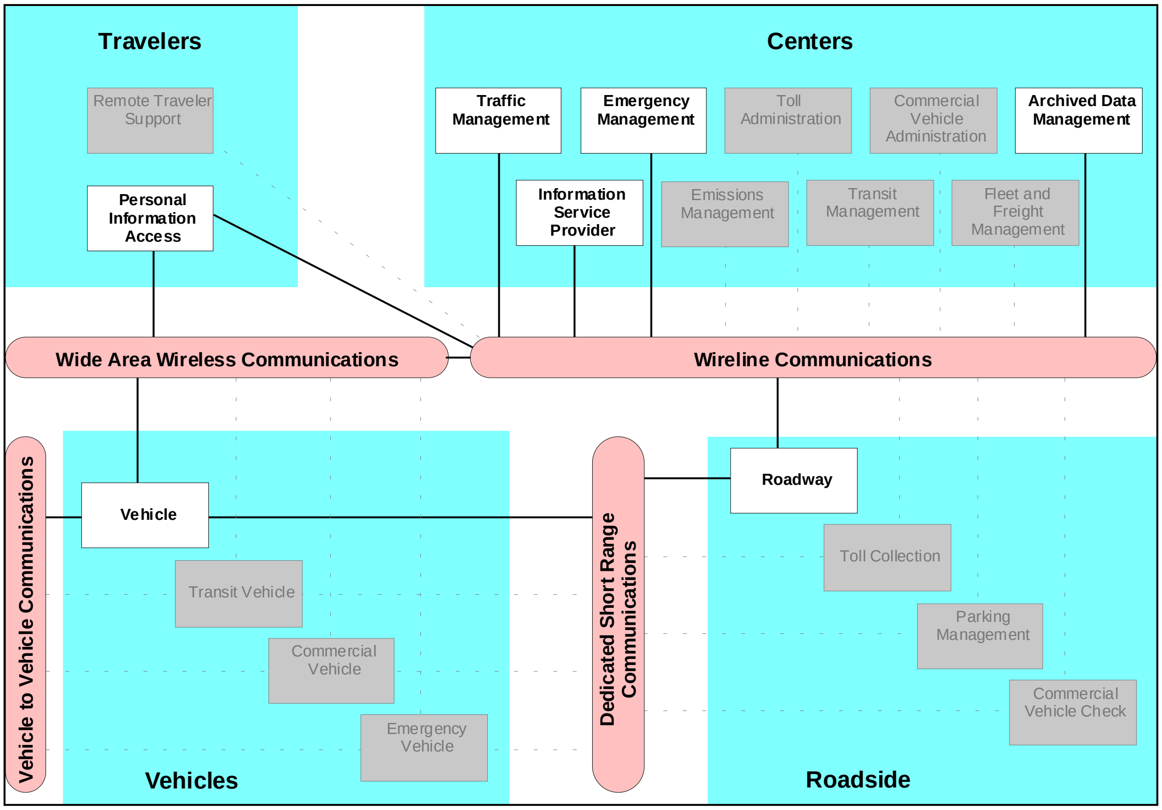

Figure 3. Physical Architecture: Subsystems and Communication

EVALUATION PLAN

An Evaluation Plan was designed at the onset of the project, describing the Goal Areas to be studied for the self evaluation study, and the detailed Measures of Effectiveness (MOEs) to be addressed within these goal areas. The goals and MOEs, decided upon by the evaluation committee, to be investigated for this study are detailed below.

Goal Areas

The COMPARE plan (COngestion Mitigation Plan, A Regional Effort)(3) had set the following goals to be monitored for the ITS evaluation project

- Safety
- Mobility
- Customer Satisfaction and
- Environment

Along with these goals, the following additional goals from the *Evaluation Guidelines* (1) are proposed for this evaluation.

- Lessons learned in institutional issues
- Technical lessons learned
- Lessons learned in innovative financing
- Cost benefit analysis

The set of specific measures for these goals and related data sources to be used in the evaluation were selected with the guidance of the evaluation team and are summarized in Table 1.

Null Hypotheses

A set of null hypotheses that define the impacts of an ATIS project using before and after data is proposed as follows.

1. Safety: With the use of ATIS, secondary accidents will be reduced. Users make informed choices and it is assumed that travelers will tend to avoid more dangerous situations.
2. Safety: With the use of ATIS, accidents in Work zones will be reduced. Users are supplied with information regarding work zones and are expected to drive more cautiously or change routes or times of travel.
3. Mobility: Travel time variability will reduce during peaks. Users with better knowledge are likely to optimize their travel times and hence result in the optimization of the travel time of the system. The actual values to be compared have to be normalized for varying factors like AADT.
4. Mobility: With the use of ATIS, travel time variability during accidents will be reduced. This hypothesis follows the same reasoning mentioned above.

5. Customer Satisfaction: With the implementation and operation of the ATIS system, customer satisfaction is expected to increase. Users like to know information before hand to reduce anxiety and be sure their trip expectations will be met.

The actual factors used to test the hypotheses need to be normalized to account for external influences such as increased AADT, increase in the coverage area of ATIS service provision, increase in lane miles due to construction activities, time of day of the occurrence of incidents, duration of incident, weather, etc.

Table 1. HRATIS Evaluation Measures

	YR 1 (Historic data)		**YR 2** (2nd year data)	
GOAL AREAS	**MOE**	**Data Source**	**MOE**	**Data Source**
Safety	Crashes	STL, STC	Crashes	STL, STC
Mobility	Survey	CB&A	Survey	TBD
For selected routes	Travel time	HRPDC	Travel time	HRPDC, STL, STC
			Travel speed	HRPDC, STL
	Travel time, speed, etc.	PARAMICS* (simulation)	Travel time, speed, etc	PARAMICS* (simulation)
Customer Satisfaction	*Use of Disseminated travel information*		Impact of new information	Survey
	Survey Analysis	CB&A	Survey Analysis	TBD
	Market Penetration			
	No. calls-911, #77	Agencies	No. calls-911, 511, #77	Agencies
			No. page views	Webmaster
Environment	System data, IDAS	HRPDC, UVA*	System data, IDAS	HRPDC, UVA*
Lessons Learned	Technical	UVA, Partners	Technical	UVA, Partners
	Institutional	UVA, Partners	Institutional	UVA, Partners
	Financial	UVA, Partners	Financial	UVA, Partners
Cost/Benefit Analysis	General Project Costs	ITERIS, VDOT	General Project Costs	ITERIS, VDOT
			Benefits	ITERIS, VDOT

*** to be conducted in Year 2.**

Data Collection Strategies

The following data collection strategies are utilized for obtaining information related to the defined goals. The first stage evaluation was accomplished using the following four strategies.

1. Traffic, Incident/Crash, and Information Technology measures

The first is the information that has been collected or will be collected as a part of the system operations. Data of this type include traffic and incident data under various conditions. Some of these data are available in the Smart Travel Laboratory at the University of Virginia through the direct link from the VDOT's Hampton Roads Smart Traffic Center. Additional data will be obtained from the project partners.

2. Simulation measures

System performance data that are not readily available to the evaluation team will be obtained from simulation models. These include total travel time, emissions, impact of diversion, capacity reduction, etc. ITS Deployment Analysis System (IDAS) will be used mainly to analyze the before and after ITS deployment scenarios. A stochastic and microscopic simulation model, Paramics, is proposed for later consideration, depending on the resources available. The performance measures of Paramics will be compared to those of IDAS, a deterministic and macroscopic based ITS evaluation tool. One of the challenges is the calibration of any simulation model used, which requires good quality data. In this project, the real-time traffic data from Hampton Roads STC along with the field data to be collected during before and after deployment periods will be used for simulation model calibration. The simulation model output will also be used for the cost/benefit analysis.

3. User survey data

The third type of data will be obtained from surveys and interviews. Data related to customer satisfaction and mobility generally falls into this category. For this data, sub-contractors or in-house resources, if available, will be used to design and conduct the surveys.

4. Lessons learned, financial data, system architecture and standards

Finally comes the information that will be documented by the system developers and operators. These include data for reporting on the lessons learned in technical, institutional and innovative financing areas and appropriate cost data, and factors associated with the system architecture and standards. This information will be supplemented by on-site interviews with stakeholders, VDOT and ITERIS, conducted by the evaluation team

This citation of data collection categories aids in the specification of information gathering and analysis tasks, and responsibilities for this ITS deployment self-evaluation. The remainder of this report addresses the development of baseline measures for the stated goal areas that include safety, mobility, customer satisfaction, environmental impact, institutional, technical and financing lessons learned and costs and benefits.

BASELINE AND PERFORMANCE DATA AND ANALYSIS (YEAR 1)

Baseline data is necessary to show impacts of ITS deployments for future evaluations. This section of the report deals entirely with the baseline data for the HRATIS project, and the various measures of effectiveness described in the Evaluation Plan. Data is tabulated for each evaluation measure, and categorized based on the goal area. Wherever possible, data for the year 2000 has been obtained as baseline information. A survey was administered in February/March of 2001. Travel time runs using GPS equipped vehicles were carried out in the summer of 2001.

SAFETY

The first primary goal area addressed is safety. Reduction in the total number of crashes, fatalities, secondary accidents and severity of accidents are typical measures that apply here. Other than severe weather advisory information, an ATIS does not play a significant role in the severity of the accidents. On the other hand, it is expected that secondary accidents and the accidents in work zones will lessen, by providing information to the users, assuming that they will be more aware of the situation and exercise caution.

Most of the information required for this goal area is obtained from the Hampton Roads Smart Traffic Center. The HRATIS project maintains a log of all the accidents and incidents obtained from the Incident Management System, observation of CCTV images, and information obtained from other sources like Transportation Emergency Operations Center (TEOC) and 911 services. This database is also archived at the Smart Travel Laboratory at the University of Virginia. The Measures of Effectiveness (MOEs) studied under this goal area are

1. Reduction in the total number of accidents
2. Reduction in the number of secondary accidents
3. Studying the trends in variation in the source of accident information

Table 2 presents the total number of accidents, categorized for each section of freeway, obtained from the Smart Travel Laboratory. Secondary accidents are not reported separately in the database system. Hence assumptions need to be made to separate them from the primary accidents. For the purpose of this study, secondary accidents are defined as the accidents that occur in the same location of the primary accident or the immediate upstream location, and the same direction of highway, within the time of clearance of the primary accident. Locations are sections of highways that span 1 to 3 miles, and defined by the HRSTC for the purpose of accident location determination. This data is also presented in Table 2.

As further phases of the system are deployed, and the effectiveness of the system improves, it is expected that more calls from users will be obtained at the Smart Traffic Center through cellular phones. Also, the calls are expected to reduce due to timely dissemination of information through different channels like Highway Advisory Radio

(HAR), Highway Advisory Telephone (HAT), and Variable Message Signs (VMS). With improved efficiency of the Incident Management System, the STC is likely to identify incidents at a faster pace from the loop detector data and other sources. Therefore, to measure the performance of the system, the source of the accident information is studied and provided in Table 3.

Table 2. Accidents categorized by freeway sections

Interstate	Direction	Segment length (Miles)	Total Accidents	Secondary accidents in the section	
				Number	% of total
I-64	East Bound	11.4	797	14	1.76
I-64	West Bound		711	18	2.53
I-264	East Bound	6.0	399	12	3.01
I-264	West Bound		359	9	2.51
I-564	East Bound	1.8	24	0	0.00
I-564	West Bound		48	2	4.17
Total		**19.2**	**2338**	**55**	**2.35 %**

Table 3. Accidents categorized by Source of detection

Source	Total number of accidents detected	% of total accidents
FIRT	1370	58.6
Phone Call	70	3.0
TMS Camera	298	12.7
VOIS	1	0.0
VSP Radio	579	24.8
Other	20	0.9
Grand Total	**2338**	**100**

MOBILITY

Performance measures for this goal area are the savings in travel time and enhancement in travel time reliability. The trends in the variation of average travel times and travel time variability during AM peak, PM peak and off-peak periods have been selected by the evaluation committee as primary measures. However, the availability and accuracy of loop detector data for the year 2000 has been found to be inadequate for these purposes. The non-availability of good quality loop detector data for the base year led to collection of travel times based on runs made by GPS equipped vehicles. The Hampton Roads Planning District Commission undertook these runs and provided the data. This data is condensed in Table 4 and will be used as baseline data. The routes depicting the locations are presented in Figure 4. All the GPS travel time data have been filtered, for any incidents and weekend effects. Hence these values correspond to travel times and speeds during normal conditions for the given times of the day. This data will be compared with data to be collected in future.

Travel time variability during incidents is the second performance measure considered in this goal area. The extent to which acceptable loop detector data is not available precludes use of statistical methods at this time. Future analyses will be based on the availability of data as to whether to perform statistical or qualitative analyses.

Further analysis conducted with the speed data archived in the Smart Travel Lab (STL), for the same periods of time as in the GPS trial runs, is presented in Table 5. The loop detector data for speeds have been screened using quality filters developed in the STL. Data from all the interstates other than I-664 are available at the Smart Traffic Center. The travel time for I-564 route is quite small for any comparisons or tests to be conducted. Hence the speed data for I-64 and I-264 from GPS studies and Loop detector data have been compared in Table 5. It can be seen that the loop detectors overestimate speed values compared to the actual GPS trial runs.

Table 4. Travel Times From GPS Runs

Route	Time of day	From	To	Avg. Travel Time	Std Dev. of Travel Time
I-564	AM Peak	I-64	Admiral Taussig Blvd	0:05:05	0:00:27
	Off-Peak			0:05:29	0:00:09
	PM Peak			0:07:14	0:03:14
	AM Peak	Admiral Taussig Blvd	I-64	0:05:03	0:00:13
	Off-Peak			0:05:26	0:01:00
	PM Peak			0:06:01	0:00:51
I-64	AM Peak	Mercury Blvd	Battlefield Blvd	0:30:04	0:01:20
	Off-Peak			0:29:40	0:01:16
	PM Peak			0:30:55	0:03:17
	AM Peak	Battlefield Blvd	Mercury Blvd	0:30:04	0:00:26
	Off-Peak			0:33:14	0:05:59
	PM Peak			0:33:08	0:04:20
I-264	AM Peak	I-464	Parks Ave	0:21:05	0:00:16
	Off-Peak			0:20:08	0:00:39
	PM Peak			0:20:46	0:00:50
	AM Peak	Parks Ave	I-464	0:20:33	0:01:22
	AM Peak			0:19:51	0:00:56
	Off-Peak			0:20:17	0:00:54
I-664	PM Peak	College Dr	I-64	0:16:08	0:04:12
	AM Peak			0:15:57	0:01:29
	Off-Peak			0:18:23	0:02:58
	PM Peak	I-64	College Dr	0:13:40	0:00:39
	AM Peak			0:14:18	0:00:45
	AM Peak			0:13:58	0:00:25

Table 5. Speed Comparison From GPS Runs and Loop Data

Route	Time of day	From	To	Speeds from GPS trial runs			Speeds from Loop detector data		
				Average	Std Dev.	Median	Average	Std Dev.	Median
I-64	AM Peak	Mercury Blvd	Battlefield Blvd	58.15	5.01	59.23	62.40	3.00	63.19
	Off-Peak			58.06	5.06	59.52	60.46	5.12	62.11
	PM Peak			56.05	8.08	58.69	57.55	7.70	60.81
	AM Peak	Battlefield Blvd	Mercury Blvd	56.83	6.07	58.51	58.19	5.93	58.71
	Off-Peak			58.93	3.18	59.32	58.07	7.33	60.17
	PM Peak			58.00	4.44	58.93	56.49	11.87	60.59
I-264	AM Peak	I-464	Parks Ave	54.32	12.17	59.25	56.63	11.96	60.33
	Off-Peak			56.53	7.48	58.72	59.60	6.47	62.41
	PM Peak			56.59	5.97	58.57	57.85	7.53	59.57
	AM Peak	Parks Ave	I-464	54.40	8.02	56.90	No detector data available		
	Off-Peak			55.97	9.29	59.10			
	PM Peak			56.39	9.94	60.54			

Figure 4. Routes of travel time runs by GPS equipped vehicle

CUSTOMER SATISFACTION

A telephone survey was performed to obtain baseline information on customer satisfaction regarding travel information in the Hampton Roads area while the HRATIS was being implemented. Specific data collected are:

- Trip characteristics of population
- Sources of travel/traffic information used
- Internet use to obtain travel/traffic information
- Changes in behavior based on exposure to travel/traffic information

Follow-up surveys will be conducted in the years 2002 and 2004 and compared to data collected in this baseline survey to measure the effectiveness of the Advanced Traveler Information System. CB&A Research was contracted to do this task. The following summarizes the procedure and findings of the survey.

Sampling Plan

The study was conducted as a computer assisted telephone interview (CATI) among households in the Hampton Roads Planning Area, comprising 16 cities and counties. These were combined into five groups as shown in Figure 5, and described in Table 6. The only screening requirement was that respondents were age 18 or older and lived in the study area. The CB&A Research in-house interviewing staff completed a total of 484 CATI interviews with adults residing in the Hampton Roads Area (one adult per household).

A random-digit dialing (RDD) sample frame was used as the basis for the survey sample. This design is commonly used, and has been shown to have little bias in the travel characteristics that result. All telephone numbers in the study area make up a pool of numbers from which both listed and unlisted numbers are randomly drawn.

To be statistically valid at the 95 percent confidence level with a margin of error of plus or minus 10 percent at the grouped county level, the survey required 96 completed surveys per county group. Therefore, a total of 484 surveys were completed resulting in statistically valid results (for the total sample) at the 95 percent confidence level with a margin of error of plus or minus 4.5 percent. The sampling plan for this study is shown in Table 6.

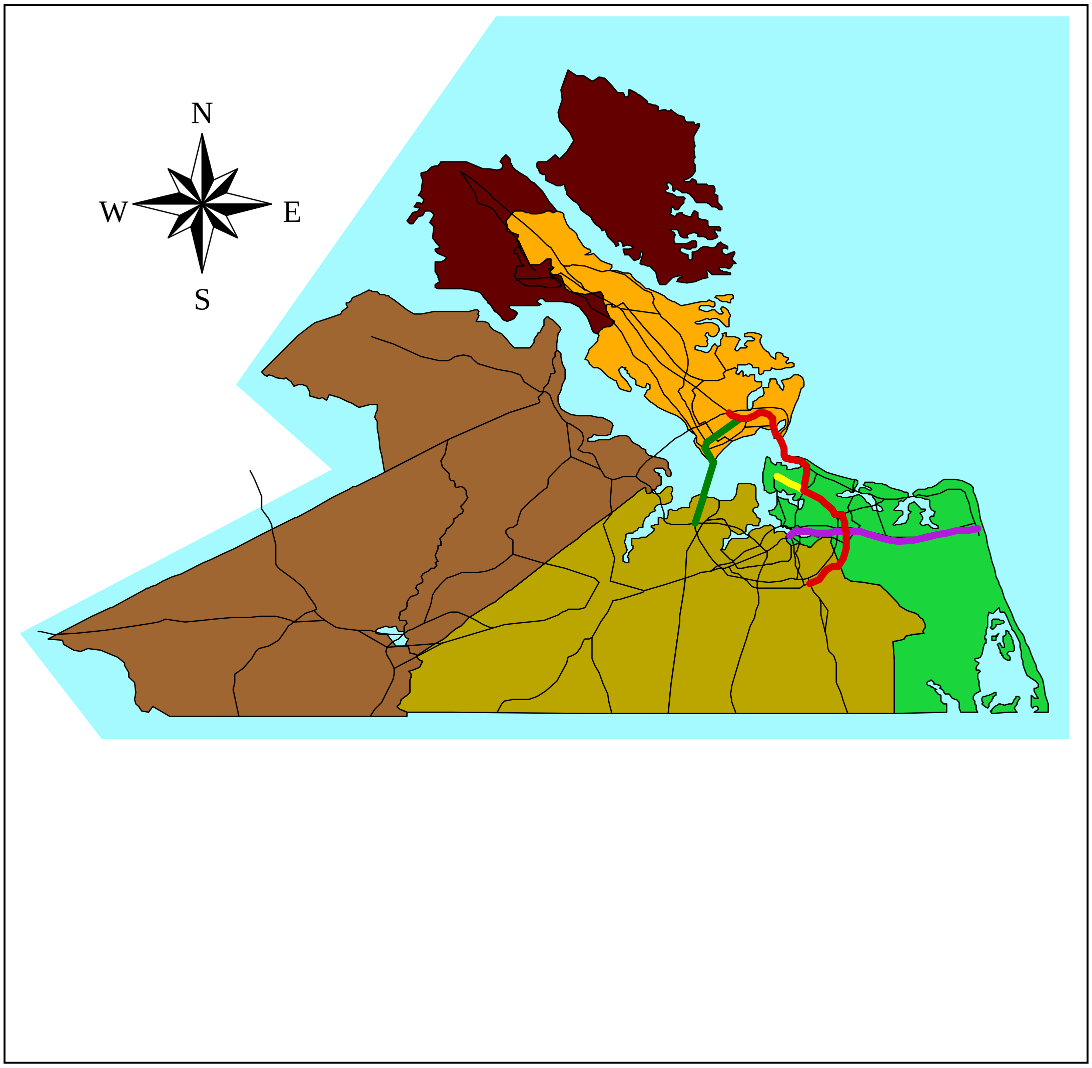

Figure 5. Cluster groups for the survey

Table 6. Hampton Roads Transportation Telephone Survey Sampling Plan

Strata		Population Age 18+	Percent of Total Population Age 18+	Total Population	Percent of Total Population	Percent of Population Within Subgroup	Sample Size
Group # 1	Franklin	6,598	1%	9,043	1%	14%	14
	Isle of Wight Co.	21,629	2%	29,404	2%	47%	45
	Southampton Co.	13,837	1%	17,883	1%	28%	27
	Surry County	4,799	0%	6,502	0%	10%	10
	Combined	**46,863**	**4%**	**62,832**	**4%**	**100%**	**96**
Group # 2	Chesapeake	145,488	13%	205,122	13%	56%	54
	Portsmouth	72,464	6%	98,677	6%	27%	26
	Suffolk	46,429	4%	63,780	4%	17%	16
	Combined	**264,381**	**23%**	**367,579**	**23%**	**100%**	**96**
Group # 3	Norfolk	170,472	15%	224,413	14%	34%	33
	Virginia Beach	315,070	27%	440,663	28%	66%	63
	Combined	**485,542**	**42%**	**665,076**	**42%**	**100%**	**96**
Group # 4	Hampton	104,215	9%	139,853	9%	36%	35
	Newport News	127,475	11%	176,677	11%	45%	43
	Poquoson	8,426	1%	11,568	1%	3%	3
	York County	42,952	4%	60,277	4%	16%	15
	Combined	**283,068**	**25%**	**388,375**	**25%**	**100%**	**96**
Group # 5	Gloucester County	25,914	2%	35,569	2%	39%	37
	James City County	33,992	3%	44,788	3%	49%	47
	Williamsburg	10,713	1%	11,894	1%	13%	12
	Combined	**70,619**	**6%**	**92,251**	**6%**	**100%**	**96**
	Total	**1,150,473**	**100%**	**1,576,113**	**100%**		**480**

Details on the survey design and results, and the survey form can be found in "Hampton Roads Transportation Baseline telephone Survey Report", CB&A Research, Winston-Salem, NC, March, 2001. A summary of the key results that are related to the HRATIS evaluation is reported below.

Work Related Travel Information - Availability of Multiple Routes to Get to Work

- The majority of respondents (77%) say there is more than one route available to get to work.

- For most (87%), that alternate route adds time to their commute. Of those who say the alternate routes takes more time, 69% say the alternate route takes between 0 to 10 minutes more.

- Only 13% say that their alternate route takes less time. Of those who say the alternate routes takes less time, 64% say the alternate route takes between 0 to 5 minutes less.

Sources Used to Obtain of Traffic Information

- Across the total sample, use of the radio (58%) and television (66%) to obtain traffic information is high and use of the Internet is low (15%).

Use of the Radio for Traffic Information

- Among those who use the radio to obtain traffic information …

  – 64% use the radio to obtain traffic information before leaving for work;

  – 72% use the radio before leaving for trips other than work;

  – 87% use the radio during trips to work; and

  – 74% use the radio during trips other than work.

Use of the Television for Traffic Information

- Among those who use the television to obtain traffic information 78% use the television to obtain traffic information before leaving for work and 82% use the television before leaving for trips other than work.

Use of the Internet for Traffic Information

- The majority of respondents (70%) have access to a computer and the Internet.

- Among those who have access to the Internet, only 15% say they use the Internet to obtain traffic information.

- Respondents who use the Internet to obtain traffic information use it most often before leaving for trips other than work (74%). About three out of ten respondents use the Internet before leaving for work (28%) and before leaving from work (30%).

Other Sources of Traffic Information

- When asked what other sources respondents use to get traffic reports, only 16% say they use other sources. Word of mouth is mentioned most often as another source of traffic information (7%).

Effects of Traffic Reports on Travel Behavior

- Traffic reports are most likely to change respondents usual route (66%) and departure time (60%).

- Traffic reports have a moderate effect on changing respondents' decisions to travel. About four in ten (40%) respondents say traffic reports cause them to change their decision to travel (35% sometimes, 5% often).

- Traffic reports are least likely to change respondents means of travel (13%) and their destination (25%).

Benefits of Traffic Reports

- The greatest benefits received from traffic reports are 'avoided traffic problems' (77%) and 'saved time' (70%).

- About half of respondents (56%) say traffic reports reduced their anxiety or frustration.

- Only 35% of respondents say traffic reports saved them money.

Accuracy of Traffic Reports

- Over half (55%) of respondents say traffic reports are often accurate in terms of content and timeliness; 37% say they are sometimes accurate; and only 8% say they are never accurate.

Methods for Improving Travel Information Services

- When asked how travel information services could be improved in the Hampton Roads Area, respondents most often mention methods related to communication (22%) followed by roadway improvements (9%).

- Specific communication concerns included more frequent broadcasts (9%) and quicker/more timely reporting of traffic conditions (8%).

A summary of the customer satisfaction from the results of the survey is provided in Table 7 below.

Table 7. Customer Satisfaction Summary

Issues	Results from Survey

Availability of Multiple Routes to Get to Work	▪ 77% of respondents have choice.
	  ▪ For 87% of these, alternative route adds to commuting time. For 69% of these, alternative route takes 0-10 minutes more
	  ▪ 64% of the remaining respondents' alternative route takes 0-5 minutes less than normal route.

Sources Used to Obtain of Traffic Information	▪ 58% use Radio for traffic information
	  ▪ 64% of these use radio before leaving for work
	  ▪ 72% use radio before leaving for trips other than work
	  ▪ 87% use radio during travel to work
	  ▪ 74% use the radio during trips other than to work
	▪ 66% use TV for traffic information
	  ▪ 78% of these obtain information before leaving for work
	  ▪ 82% use TV before leaving for trips other than work
	▪ 15% use Internet for traffic information
	  ▪ 28% of these use Internet before leaving for work
	  ▪ 30% use Internet before leaving from work
	  ▪ 74% use Internet before leaving for trips other than work

Effects of Traffic Reports on Travel Behavior	▪ 66% of respondents say they change route based on reports ▪ 60% change their departure time ▪ 40% change their decision to travel based on the reports ▪ Only 13% change their means of travel ▪ 25% change their destination
Benefits of Traffic Reports	▪ 77% of respondents perceive avoidance of traffic problems ▪ 70% perceive savings in time ▪ 56% perceive reduction in anxiety and frustration ▪ 35% perceive savings in money
Accuracy of Traffic Reports	▪ 55% of respondents feel reports are often accurate in content and timeliness ▪ 37% say the reports are sometimes accurate ▪ 8% feel the reports are never accurate
Methods for Improving Travel Information Services	▪ 22% of the respondents are concerned with communication ▪ 9% are concerned with frequent broadcasts ▪ 8% are concerned with timeliness of the reports ▪ 9% are concerned with roadway improvements

ENVIRONMENTAL AND COST/BENEFIT ANALYSIS - IDAS

The ITS Deployment Analysis System (IDAS) is "an ITS sketch-planning analysis tool" that calculates relative costs and benefits of ITS deployments. IDAS incorporates a cost module, a benefit module, and an internal travel demand model to generate cost/benefit comparisons for alternative ITS deployments. IDAS provides three resources: default ITS component settings, the IDAS equipment database spreadsheet, and the ITS library. IDAS can estimate travel time, system throughput, emissions, accidents, and travel time reliability (5).

The evaluation team acquired a planning level road network in MINUTP (6) format and O/D tables for years 1990 and 2021 from HRPDC. Since the input formats of IDAS and MINUTP are different, the network and O/D tables need to be reformatted. Furthermore, the network and O/D table must be updated to year 2000 to be compatible with the base year in this study. The year 2000 O/D table was interpolated from the existing 1990 and 2021 O/D tables. Both the road network and O/D table from MINUTP have been successfully converted into the IDAS program. The existing base condition (i.e., current detection systems, VMS, etc.) was coded for the base year 2000, while an alternative ATIS scenario is being coded as it is scheduled in the proposed ATIS deployment. The ATIS components including HAR, VMS, Internet, TV broadcasting, and others are being added into IDAS and a preliminary testing will be conducted. Sensitivity analysis of different user compliance rates on provided ATIS information will also be conducted. If applicable, more detailed system performance measures including travel time, emissions, accidents, and travel time reliability will be collected and compared with field data.

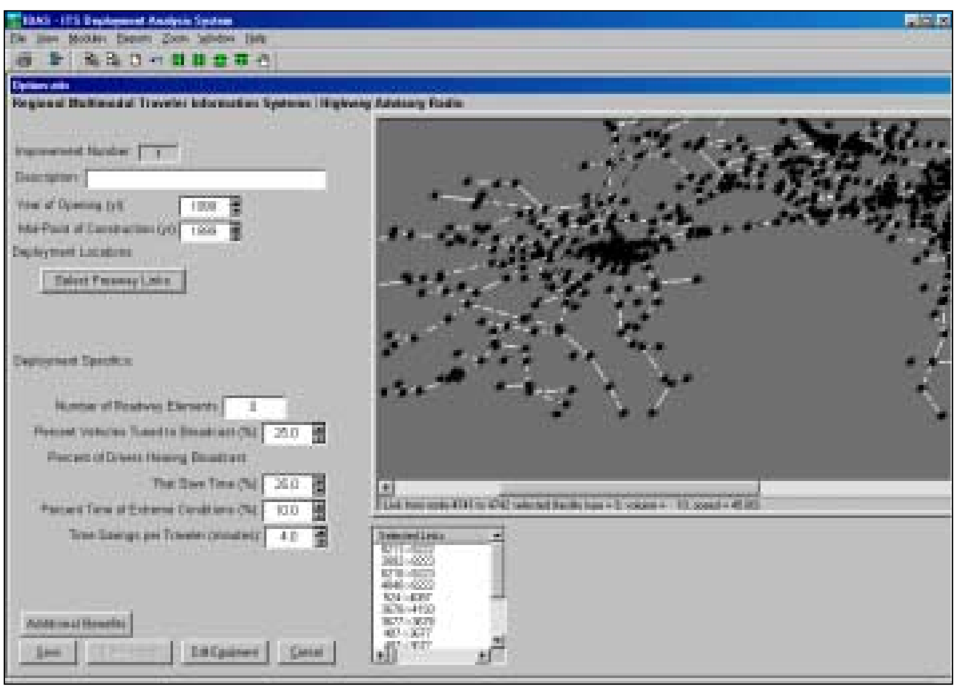

Figure 6. Screenshot from IDAS

The application of IDAS to evaluate environmental and energy issues is in progress. The entire road network and the OD flows for 1990 have been input into IDAS, as shown in Figure 6, and tested for workability. The Hampton Roads network and flows will be updated for the year 2000 conditions. Coding the network for deployments related to the ATIS, identified as Regional Multimodal Traveler Information Services in IDAS, is also in progress.

COST/BENEFIT ANALYSIS

The general cost information for the project from January 2000 to August 2001 is summarized in Table 8. It reflects the costs that ITERIS and its partners incurred for the listed categories. It is noted that the R&D costs were incurred prior to the signing of the contract, January 2000 through September 6, 2000. The operation and maintenance of the system started in March 2001. At this stage, benefits cannot be incorporated into the analysis.

Table 8. Cost Data

Category	Costs Incurred ($)
• Research and Development*	467,550
▪ Program Development: Engineering Design, Implementation, and Testing	392,804
• Program Management: Overall project management, Meetings, and Contracts (both with VDOT and potential private partners)	64,054
▪ Operation and Maintenance: System Monitoring, Data Quality, and System Operation	73,740
Total Cost	998,148

* Incurred between January 2000 and September 6, 2000.

LESSONS LEARNED

INTRODUCTION

As part of the HRATIS evaluation, a lessons learned report on technical and institutional issues encountered during ITS deployments, and a discussion of the lessons learned in employing innovative financing or procurement and/or public-private partnering techniques is required. This task was accomplished by asking the project partners questions that were previously reviewed by the evaluation committee. The various questions addressed are categorized under each of the issues – Technical, Institutional and Financial.

TECHNICAL ISSUES

The data flow structure in Figure 1 has been modified to incorporate the existing, and the future components and flows. It also describes the different channels of information gathering and dissemination, and the agencies currently pursued by ITERIS towards this purpose.

- Were there any technical problems encountered with any of the components identified above, either during the installation phase or with subsequent O&M?

During the installation phase of ATIS, space in the Smart Traffic Center to house various new equipment/servers for video transfer to ITERIS was in short supply, causing existing equipment to be moved. After installation, electric spikes posed problems. In one case, ITERIS lost an Uninterrupted Power Supply (UPS) because of occurrence of continuous spikes. The HVAC (Heating, Ventilation and Air Conditioning) system at the TMC may have played a part in the problems with the equipment.

- Were there any data quality issues encountered in this project? Are the equipment/data used currently validated?

CCTV failures and/or loop detector failures affect the quality of data. The Phase I loop detectors were installed prior to HRATIS deployment, but in Phases II and Phase III projects, the Smart Traffic Center (STC) is planning to install non-intrusive detectors such as acoustic and/or RTMS radar detectors. However, communication failure has not been a serious problem for long continuous periods. The filtering part of the algorithm takes care of the effect of poor data quality, and screens out invalid data.

Loop detectors have not been validated since installation, which is important for establishing confidence in using the values provided by the detectors. There is no mention of any study related to validating the detector data.

- Why were 2-minute intervals chosen for loop detector data (quite large compared to other traffic management centers)?

This characteristic of the system was not chosen for the HRATIS. It was established earlier for the STC. The data transfer rate of the interface designed in the hardware and the software for polling the system was built originally at 1200 baud. This system was a state of the art technology when it was built. Hence, the polling cycle takes 2 minutes to poll all of the stations in the system. The new system planned for the next phase will be much faster than this, and, hence, will be able to provide traffic data at a much lesser level of aggregation.

The existing system has been built and maintained to sustain the incident management system. The accuracy and level of detail is therefore sufficient for that purpose most of the time. The level of accuracy of data for ATIS systems needs to be determined and bench marked for future purposes. ITERIS will provide a minimum threshold limit for the level of accuracy and quality of data needed.

- Were there any problems regarding the data format – either for collection / fusion / archiving / dissemination purposes?

All the data formats used in the entire process are open. No serious problems have been encountered with either the data or the maps. ITERIS obtains data from the STC in an open format. The file is in text format, delimited by a special character ("|"). The text file contains a total of 7 used fields as described in Table 9 below. ITERIS archives this data in this text format. After processing and analyzing the data, the processed data is also in open format based on NavTech Link Ids. The congestion map data is derived from this base data. ITERIS also archives this final file in a compressed format.

Table 9. Fields in The Text Files Transferred from HRSTC to ITERIS

Field Number	Description
1	Station Number
2	Road Description (the number after the dash is the cabinet number)
3	Volume (# of cars)
4	Occupancy (%)
5	Speed
6	Number of Lanes
7	Lanes with Data

For the underlying map processing, the data format is NavTech maps. The algorithm in the Data Fusion Engine, consisting of multiple proprietary algorithms, analyzes data in the same format. The final image map is in JPEG graphic format. There have not been any problems regarding the use of these maps for processing as well as the final output.

- How useful / difficult was the use of standards and protocols – any concerned issues?

Standards: Interfacing the RIS (Roadway Information System) to the HRATIS was problematic because of immature data exchange standards. DATEX-ASN, one of the NTCIP C2C protocol standards, was initially planned to be provided between the RIS and the HRATIS. At the time of the proposal, ITERIS had a Beta version of a DATEX Toolkit product at version 8 of the standard. This standard is specifically an NTCIP Center-to-Center (C2C) DATEX-ASN draft ITS standard (NTCIP 2304: Application Profile for DATEX-ASN). Unfortunately, the draft base standard (ISO DATEX documents 14827, parts 1 and 2) has over 100 international comments against it at this time. This situation creates uncertainty regarding the future direction of DATEX-ASN and reflects in part some of ITERIS' difficulties with earlier versions of the standard. The primary reason for including DATEX-ASN in the proposal was the future interface of Regional Multi-modal Management System (RMMS) with HRATIS. It was envisioned that the creation of a DATEX-ASN protocol interface between the Roadway Information System (RIS) and the Hampton Roads ATIS would allow the future RMMS to easily interface with both the systems in a standardized manner. This capability will still exist, but without utilizing DATEX-ASN. ITERIS will provide the simple interface details for exchanging data between the RIS and HRATIS, to VDOT. In effect, the same open (i.e. non-proprietary) interface can be used by the RMMS later.

Besides the DATEX-ASN protocol standard, the message sets and data dictionaries are still not mature. For data transfer to message sets, ATIS standards did not seem to fit best. Instead, Incident Management standards were found to provide the best fit. Therefore the data content for ATIS had to be changed to fit those standards.

<u>Protocols</u>: DATEX and CORBA are the NTCIP protocols existing currently for use in Center-to-Center data exchange. CORBA is more suited for enterprise wide data distribution and hence DATEX was considered for use in the beginning. Since DATEX is also found to be complicated, data exchange is currently carried out in an open format. DATEX V.8 is what ITERIS used in the beginning, during development of the Data Fusion Engine. The current version of DATEX, V.19, has generated many comments internationally. Using DATEX is perceived to be of high risk.

Overall, it is considered inappropriate to use ITS standards in the HRATIS at this point. The practicability / operational feasibility of the standards and protocols suggested for ATIS systems seems to be very sparse. There is high risk in implementing a developing suite of standards now, as they are not finalized. As they mature, the risk will decrease. It is easier to retrofit a mature standard than to build to fit a developing standard. It also proves impractical in terms of the cost.

INSTITUTIONAL ISSUES

- Were there issues of concern in the public-private partnerships? Regarding:
  - Agreements/contracts
  - Coordination (inter agency as well as intra agency)
  - Legal impediments
  - Schedule management and adherence
  - Intellectual Property / Royalty / Patents Issues

The chronology of important events in the HRATIS public-private partnership project is

June 18, 1999	-	Proposals due
August 5, 1999	-	Presentation by ITERIS
January 2000	-	Contract awarded
March 2000	-	Added to TIP
April/May 2000	-	Concept of operations done by ITERIS; Initiated developments
September 6, 2000	-	Contract signed

Throughout this process, ITERIS was taking risks. This gap between various events was perceived by both sides to be very long. None of the private partners of ITERIS wanted to sign contracts until VDOT signed theirs with ITERIS. Even before the public-private partnership agreement was signed, ITERIS started development work on the Data Fusion Engine. ITERIS feels that they would have signed contracts with COX and US Wireless Corporation (USWC) if not for the delay of the contract with VDOT.

E-911 was the main plan of USWC originally and not traffic data. At the beginning, USWC agreed to provide point data to ITERIS. After ITERIS signed the contract with VDOT, USWC approached ITERIS concerning the accuracy/quality of data needed for ATIS purposes. They also changed from giving point data to link data, along the way. Even though about fifteen iterations of agreements with USWC had taken place, a contract was never finalized and signed. Subsequently, on August 29, 2001, USWC declared chapter 11 bankruptcy. While not precluding future USWC involvement with the HRATIS project, this will certainly decrease the possibility of their involvement.

Cox IM wanted the system to be at least partially operational by Memorial Day 2000. The contract scenario between ITERIS and Cox IM changed from local to national level partnership, but finally fell through due to deteriorating market finance conditions.

There were multiple iterations of contracts between ITERIS and VDOT, as well as ITERIS and their other potential private partners. Some of the reasons for the delay were

- ITS projects are looked at as different from the other traditional projects.
- Procurement for an ITS project is not like procuring asphalt and concrete. Changes in technologies, part played by market forces, finances etc. need to be considered. Procurement needed to figure out how to word the contract, as there was no real precedent. There were no specifications, which left it to the responders to state what they were to do and at what cost. The options were quite open.
- DOTs and States need to be aware that ATIS projects do not deliver any particular physical product, but it is a service to the customers.
- Numerous internal iterations within and between VDOT and FHWA occurred due to the different nature of ITS projects when compared to traditional construction contracts. Federal Aid regulations are not readily available for cases where no tangible product is delivered.
- Funding was not available until the contract was signed. In addition, funds from three different sources had to be used by VDOT: an Earmark, CMAQ funds, and state funds. This made it necessary to write the contract in phases,

with goals tied to expenditures. Deliverables were difficult to identify, making it a service contract.

There was also a concern of legal problems like patents on both the sides. A patent holder notified VDOT that VDOT/ITERIS could be in violation of a patent. The investigation into potential patent infringement took a lot of time of VDOT, ITERIS and ITSA. Writing an infringement liability section for the contract was also found to be particularly difficult. With the assistance of the Office of the Virginia Attorney General, some existing patent infringement sections from similar earlier VDOT contracts were used instead.

ITERIS started early, and hoped to be up and running with the Data Fusion Engine in six months. They met their original plan and came up with the Engine. However, they could not come to agreements in time with their proposed partners (Cox IM and USWC) to support the data fusion engine.

VDOT did not ask for any rights for algorithms or other systems to be developed by ITERIS. ITERIS feels that the Hampton Roads region is a good environment for ITS. There were no communication problems for ITERIS with local agencies and STC. There have been periodic meetings to apprise everyone of the project status and discuss any concerns.

- Issues with other private partners (COX, USWC etc.)
- Issues regarding Human Resource Management

A group of partners were proposed in the beginning of the project. Changing market conditions – in the fields of Internet, advertising, revenues of companies, technologies within companies, personnel changes, business focus changes (within ITERIS and USWC) – all have had their cumulative effect on the direction the project has taken. There was a change in the name of the parent company, from Odetics ITS to ITERIS. This change created some confusion within VDOT, which resulted in a problem for VDOT to secure funding. From this project, ITERIS and VDOT realize that the travel information market situation is dynamic. The structure of the public sector controlling process inhibits the private sector's ability to react to changing conditions. In a way, this contradicts the rationalization to bring the private sector into such projects.

INNOVATIVE FINANCING AND PUBLIC-PRIVATE PARTNERSHIP

- Expand on any innovative financing techniques used and their relative degree of success (not applicable)
- Were there any particular public-private partner financing mechanisms used and what were the results

Revenues are not forthcoming as of present. With changing market conditions, the venture with Cox IM, as an exclusive Internet broadcaster did not happen. ITERIS has had to change business plans and try to provide non-exclusive information dissemination through multiple channels, getting less revenue from more sources. The threshold on sensor coverage is currently leading the discussion of contracts between ITERIS and other potential subcontractors. Business models, potential partners, and other circumstances have all lead to being adaptable to new options. Ultimately, the partners need to be very flexible on the business models. Because of the significant changes in marketing and partnerships that have occurred since the signing of the contract, it has been decided to create a basic HRATIS website to which other ISPs can link in the respect. ITERIS has secured the domains www.511hamptonroads.com, www.511hamptonroads.org and www.511hamptonroads.net to be the initial HRATIS website. But the hunt for an ISP continues. ITERIS is using a well-known marketing contractor to help secure one or more ISPs to link to the hamptonroads.com website.

Furthermore, these changes have necessitated revising the original VDOT/ITERIS contract. A revised contract was submitted to VDOT on August 27, 2001. Overall, the private party needs a general contract for flexibility and the public sector needs a structured contract to enable description of deliverables. Table 10 summarizes the lessons learned to date for the HRATIS project.

Table 10. Lessons Learned Summary

Issues	Remarks/Comments - Inputs from the partners
Technical Problems	▪ Electric spikes, heating and room for equipment are some of the most noted problems that occurred during project deployment.
Data Quality	▪ Hardware failures – CCTV and detectors ▪ Communication failures ▪ Detectors have not been field validated.
2-Minute Interval for Detector Polling	▪ Was state of the art technology when installed. Future phases will install the latest technology available ▪ Mainly for performing incident management ▪ ITERIS will determine level of accuracy and data quality needed for ATIS
Data Format	▪ All the data are in open formats, for file transferring ▪ Final maps after analysis are saved in NavTech format but disseminated in JPEG format. No problems have been encountered in any of these formats.
Standards and Protocols	▪ DATEX-ASN, the NTCIP C2C protocol standards have evolved from V.8 to V.19 since 1999. ▪ For message sets, Incident Management standards have been found to be more suitable than ATIS Protocols for HRATIS data exchange requirements.
Delays	▪ Both partners feel that there have been considerable delays between various important steps in the project.
Signing Contract	▪ Other private partners would not sign the contract until VDOT signed their agreement with ITERIS. Delays in VDOT securing funding resulted in significant delays in signing the VDOT-ITERIS contract.
Business Focus Changes	▪ US Wireless Corporation changed their focus from E-911 service to traffic. ▪ COX IM changed their business focus.
Market Conditions	▪ The market advertising conditions have deteriorated, resulting in other Internet Service Providers staying away from signing the contract.
Patent Issues	▪ The possibility of a patent infringement resulted in more delays in finalizing the VDOT-ITERIS contract.
No Revenues	▪ There are no active dissemination channels as of now due to low area coverage, and deteriorated market finance conditions, especially that of Internet Advertising.
Website	▪ Because of complications in obtaining ISPs to disseminate the information, ITERIS is establishing a basic website to which ISPs can link.
Contract	▪ Changes in the plan have required ITERIS to seek a renegotiated contract with VDOT.

CONCLUSIONS

A framework for the evaluation of the Hampton Roads Advanced Traveler's Information System (HRATIS) is described. This evaluation framework not only reflects the national evaluation guidelines developed by FHWA, but also extends the guidelines by proposing sources of performance data and null hypotheses to be tested.

The evaluation plan firstly identified goal areas and proposed corresponding performance measures. The goals include safety, mobility, customer satisfaction, environment, lessons learned, and cost/benefit analysis. The proposed performance measures are crashes, travel time, speed, market penetration, technical, institutional and financial issues encountered during the project implementation, and costs and benefits. Secondly, data collection strategies for the performance measures are developed. Four types of data/information sources are 1) traffic and incident/crash measures and information technology measures, 2) simulation measures, 3) user survey measures, and 4) lessons learned, financial data, system architecture and standards. Thirdly, null hypotheses that evaluate HRATIS impact for above goal areas are proposed. The baseline data established and the lessons learned are summarized below.

Safety related data collected are the number of accidents categorized by freeway section and detection source, and the number of secondary accidents by freeway section. The Hampton Roads STC database contains a total of 2338 accidents including 55 secondary accidents during the year 2000. Major sources of accident detection were FIRT (59 %), followed by VSP radio (25 %) and TMS Camera (13 %).

Travel times and speeds from GPS equipped vehicle trial runs, and loop detector data collected during the same periods of time are used as main sources of mobility data. The quality and the level of aggregation of the detector data currently available is not sufficient for estimating minute changes during incidents, even on the longest route (Interstate 64), for which the route travel time is nearly 30-35 minutes in both directions, under normal conditions. This situation is expected to be remedied with future deployment phases which include RTMS and acoustic sensors. The travel times obtained for the four major interstate routes will be used in future evaluations.

Customer satisfaction survey found that 1) a majority of people (77%) responded that they have access to more than one commuting route, 2) the major sources of traffic information are radio (58%) and television (66%), 3) the use of Internet is fairly low at 15%, even though 70% of people have access to the Internet, 4) traffic reports are likely to change a respondent's route (66%) and departure time (60%), 5) over a half of respondents (56%) stated that traffic reports lessened their anxiety or frustration, while only 36% said the reports saved them money, and 6) over a third of respondents (37%) felt that traffic reports are sometimes accurate while 8% felt they are never accurate.

A few items from the lessons learned report that are noteworthy are as follows. Technical issues encountered during the HRATIS implementation included significant space restriction for HRATIS equipment, electrical fluctuations, loop detector data quality and occasional failures of communication network, CCTV and loop detectors. Major institutional issues that occurred were associated with contracting issues with US Wireless and Cox IM; specifically, none of ITERIS private partners wanted to sign contract until VDOT signed theirs with ITERIS. Innovative financing and private partnership issues: no revenues forthcoming at present due to the changes in market conditions. For example, the venture with Cox IM, the exclusive Internet broadcaster, has not happened. ITERIS and VDOT are examining the options for a revised contract. The bankruptcy filing by US Wireless Corporation leads to changes in the data strategy. Finally, the lack of ISP interest required ITERIS to create a basic website to which others can link.

This methodology and the associated baseline performance data for the HRATIS evaluation project provide the tools to monitor the performance over the life of this project. The baseline data will be used for comparisons with data collected in subsequent years. The before and after data comparison based on the testing of the null hypotheses proposed in this report will determine the impact and/or success of HRATIS project. Further investigations and discussions on lessons learned report are expected.

The comprehensive approach taken here includes observed traffic and safety data, and information flow, along with the survey and lessons learned information that comprise the majority of previous ITS deployment evaluations. The proposed and completed stages of the baseline evaluation indicate that the approach taken is feasible and will provide the path for continuing evaluation of the HRATIS.

REFERENCES

1. ITS Evaluation Resource Guide, issued by Transportation Equity Act for 21st Century, http://www.its.dot.gov/eval/ResourceGuide/EvalGuidelines_ResourceGuide.htm

2. Intelligent Transportation Systems: Evaluation Guidelines for the Transportation Equity Act for the 21st Century :Operational Tests and Deployment Projects, http://www.its.dot.gov/eval/ResourceGuide/EvalGuidelines_EvaluationGuidelines.htm

3. COMPARE, ITS Strategic Deployment Plan, Update 2000, prepared for Hampton Roads MPO ITS Committee, by PB Farradyne, May, 2000.

4. Turbo Architecture software, FHWA and ITERIS, 2000.

5. Cambridge Systematics, *ITS Deployment Analysis System: User's Manual*, 2000.

6. COMSIS, *MINUTP User's Manual*, 1995.