FINAL

Detailed Test Plans

Evaluation of Utah Transit Authority Connection Protection System

Prepared for:

U.S. Department of Transportation
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by:

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1.0 INTRODUCTION

The purpose of this evaluation is to independently and comprehensively assess the effectiveness of the Connection Protection (CP) system implemented by the Utah Transit Authority (UTA). The objective of the CP system is to improve the reliability of transfers from the higher frequency light rail trains, TRAX, to the lower frequency bus services. The CP system examines the on-time status of TRAX trains and issues a "Hold" message to buses waiting at the connecting rail stations via the buses' onboard Mobile Data Terminal (MDT), if the lateness of train is within a pre-determined threshold relative to the scheduled departure time of the bus. The system was completed and tested in January 2002 prior to the Winter Olympic Games in Salt Lake City.

The purpose of this Test Plan document is to expand on the Evaluation Plan[1] and provide detailed evaluation test procedures, including data collection and analysis plans needed to carry out the evaluation approaches presented in the Evaluation Plan. The Evaluation Plan serves as a general resource for the evaluation objectives, hypotheses, and a high-level study approach for the evaluation.

This Test Plan document contains two component evaluation tests, namely, a System Performance Test and a User Satisfaction Test. The thrust of the System Performance Test is the collection and analysis of various system operations data, including train arrival times, bus departure times, and Connection Protection messages. The User Satisfaction Test investigates the impacts associated with Connection Protection through the perception of the users of the system, including transit passengers, bus operators, radio controllers, and bus route supervisors. Evaluation techniques include onboard passenger intercept surveys; Internet surveys with bus operators; interviews and focus group discussions with bus operators, radio controllers, and route supervisors; and analysis of customer comments/complaints.

Both test plans follow the same format, as follows:

- *Approach Overview* – provides a general overview description of the test approach.
- *Schedule* – describes major milestones of the test.
- *Pre-Test Activities* – describes the evaluation activities in support of the development of the data collection procedures and assessment of data quality.
- *Test Activities* - provides detailed data collection logistics and quality control procedures.
- *Post-Test Activities* – describes the processing and analysis of the data and reporting of the results.

Special attention has been given to the selection and development of the test scenarios and data collection procedures for both the System Performance and User Satisfaction tests to insure that the data are, to the extent possible, reliable and of high quality. While these two tests will largely be conducted independently of one another, the results will be examined to see where findings from one test can help inform findings from the other. For example, rider perceptions of

[1] *Utah Transit Authority Connection Protection System Final Evaluation Plan,* Battelle Memorial Institute, for the USDOT, August 27, 2003.

the benefits of CP will be interpreted in light of our understanding of the actual performance of the system, and data on how the system was functioning will help with the interpretation of the reactions of bus operators to CP messages. Suggestions provided by system users will be evaluated in conjunction with our understanding of how the system performed vis-à-vis the system specifications. Opportunities to derive insights from such comparative analyses across the two tests will be explored where possible.

Figure 1 presents a UTA TRAX system map and proposed locations for evaluation tests. Reasons for selecting these locations will be discussed further in the respective test plan sections.

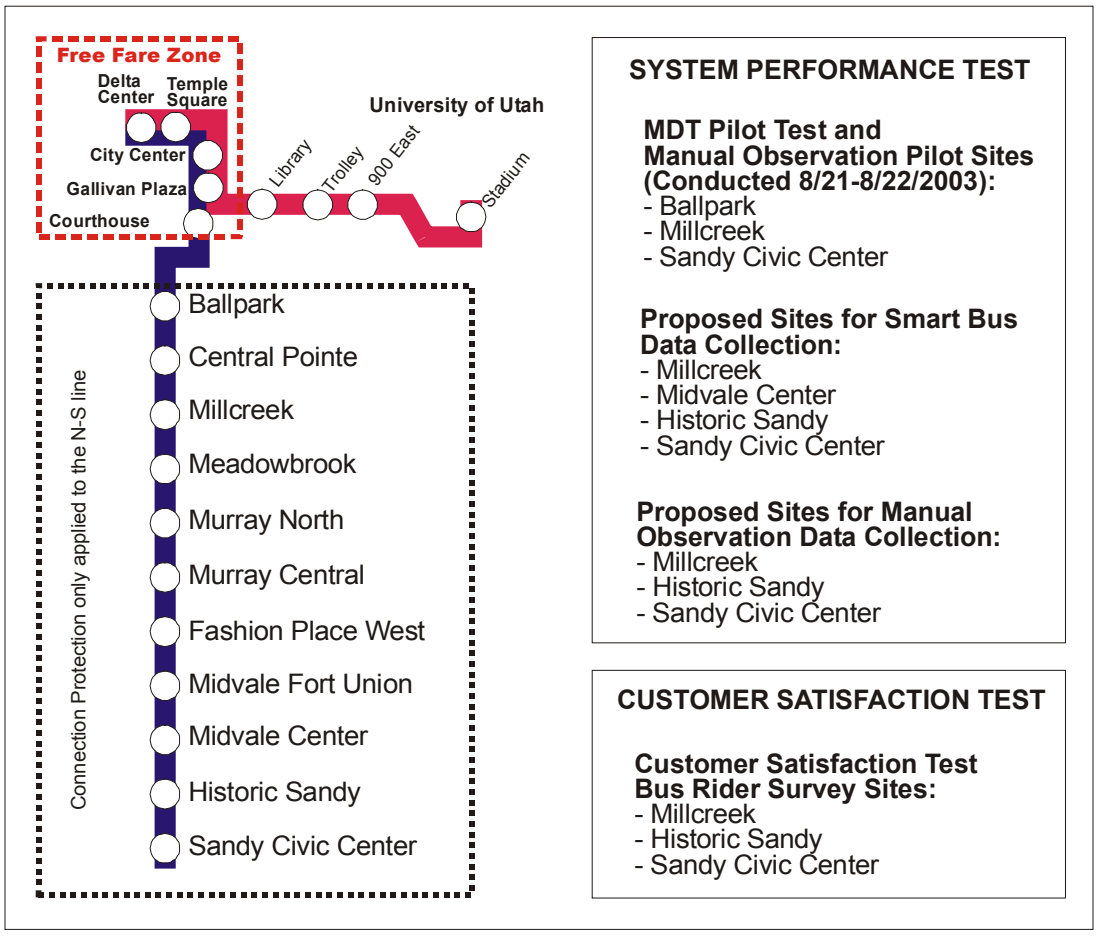

Figure 1. UTA TRAX System Map

2.0 SYSTEM PERFORMANCE TEST

The primary objective of the evaluation of system performance data is to evaluate the effectiveness of the CP system. More specifically, the objective is to evaluate the ability of the CP system to prevent missed connections and its ability to improve the number of successful train-to-bus transfers for selected scenarios. A second objective of the evaluation of system performance is to evaluate operational aspects of the system performance. However, this will not include an evaluation of the specific hardware and software that comprise the CP system. Rather, particular emphasis will be on evaluating the extent to which the CP system consistently operates the way that it was designed from an overall perspective. Finally, a third objective of the evaluation of system performance is to assess unforeseen or unintentional impacts resulting from implementing the CP system. In short, this portion of the evaluation of system performance data will be conducted to determine if the benefits of the CP system in terms of protecting riders have unforeseen costs associated with them.

2.1 APPROACH OVERVIEW

Evaluating the effectiveness of the CP system to improve successful connections of passengers from train to waiting buses necessarily requires the accurate measurement of bus departure times, and the linking of those departures to the train arrival times. That is, it is this comparison of the bus departure time to the train arrival time that will provide an assessment of whether a "successful" connection has been made for train passengers. However, accurately measuring bus departure times under reasonable cost and logistical constraints, without impacting operations is a challenging task because each possible approach has cost or operational limitations. Three complementary data collection methods will be used to capture bus departure times: 1) driver signaling bus departure times through Mobile Data Terminals (MDTs), 2) collection of automated bus departure times by UTA buses that are GPS/APC[2] equipped (i.e., "Smart-buses"), and 3) manual data collection from independent observers of the bus departure times.

Data collection through the MDTs consists of having bus operators indicate their departures from a TRAX station by sending a predetermined message through their MDT, which is part of the standard UTA radio system. Because every bus, and hence every operator, has the capability to indicate departures using the MDT, this data collection approach could have coverage at all TRAX stations. However, this data collection method is dependent upon the participation of bus operations. Additionally, departure times are available only to the minute resolution.

Smart-bus data collection will consist of assigning GPS/APC-equipped buses to specific bus routes and capturing the equipment-recorded arrival and departure times. Use of Smart-bus data will permit comparison of actual performance to historical performance when CP was not in effect. Information on both arrival and departure times, and hence wait times, is available from these buses, though this information may not be as precise as needed for the analysis of performance of CP. Additionally, only a limited number of buses are available for the evaluation, which reduces the ability to detect statistically significant differences in performance.

[2] Global Positioning System and Automatic Passenger Counter

Manual data collection through observation will be conducted at three TRAX stations to supplement the MDT data collection and to provide a means for assessing the quality of the other two methods of data collection. With this method, independent observers will manually record the arrival and departure times for every bus that departs from the TRAX station.

Data collection with the Smart-buses will occur September 2003 through November 2003, data collection via manual observation and the MDTs will occur in October 2003 and November 2003. Additional system information will be collected during the three-month data collection period. Most of the data required for the collection of system performance are already routinely collected as part of UTA's normal course of operations. Therefore, some system performance data should be available for months preceding the field period (e.g., information from Smart-buses and late trains during the summer of 2003). This earlier information will be collected and used if possible. The additional data that will be used for the evaluation of system performance include:

- TRAX Schedules – scheduled train times at each of the TRAX stations.
- Bus Schedules – scheduled bus times for each bus route that intersects a TRAX station.
- CP Assignments – bus trips (route/time combinations) at each TRAX station that have been designated for CP protection. These data are prepared as part of UTA's normal operations.
- CP Message Logs – CP messages generated by the CP system. These data are currently captured by UTA as part of normal operations. However, the data need to be archived before they are overwritten.
- Train Data – Arrival and departure times for trains at each of the TRAX stations. All light rail trains operated by UTA are equipped with GPS receivers that are used to record the real-time location of each train. UTA maintains a train tracking system that electronically collects these GPS data and monitors the performance of each train. Pertinent data (train identifier, scheduled and actual arrival/departure times, etc.) will be queried from the train tracking system.

As discussed above, all these data sources are developed as part of the normal operation of the CP system. However, it will be important to capture the information for the evaluation before it is inadvertently erased or recycled as part of daily operations.

Using the above data collection methods, the evaluation of system performance will center on assessing the ability of the CP system to prevent missed connections and its ability to improve the number of successful train-to-bus transfers. This will be accomplished by comparing the percentage of successful connections before and after CP has been implemented for a particular route (i.e., "before and after" comparisons), comparing the percentage of successful connections between those routes where CP has already been established to "similar" routes without CP (i.e., "with and without" comparisons), and examining historical data without CP, if available, on currently protected routes.

As previously discussed, all data collection efforts will occur during a three-month period defined by September 2003 through November 2003. Approximately two months into the data collection period, UTA will be asked to begin to protect additional routes that are currently unprotected. Thus, two months of data will be available for the "with and without" analysis (September and October) and two-months of "before" CP (September and October) followed by one-month of "after" CP (November) will be available for the "before and after" analysis.

2.2 SCHEDULE

The actual field data collection period will occur during UTA's August-November 2003 fall schedule and will last approximately three months (twelve weeks). This will be followed by two months of data analysis and one month of report writing. Additional details on the schedule are presented below.

Data from the trains and Smart-buses will be collected for the entire period (all non-holiday weekdays between September 1, 2003, and November 21, 2003). Due to the time needed to inform all bus operators of the procedures to follow, data collection via MDT will be delayed until mid-October. It then will continue through the end of the data collection period. Observational data will be collected on all non-holiday weekdays between October 1, 2003, and November 21, 2003. The additional CP assignments will be implemented on November 3, 2003.

2.3 PRE-TEST ACTIVITIES

There have been a number of activities that have been conducted to facilitate the preparation of the Evaluation Plan and this Detailed Test Plan. These activities are described below.

2.3.1 Pilot Data Collection Efforts

Two separate data collection activities were conducted to assess the feasibility of different methods for collecting accurate departure information from bus routes. Additionally, these pilot efforts served to increase Battelle's understanding of UTA's CP system and the availability of system performance data.

The first pilot data collection effort was conducted to examine the feasibility of using Smart-bus data for the analysis of system performance, to gain an understanding of the CP system, and to test the procedures for obtaining data necessary for the system performance evaluation. This effort occurred in early 2003 using data collected by UTA during November – December 2002. The results of this pilot effort are summarized in the Evaluation Plan. Briefly, the results of this pilot effort indicated that:

- The vast majority of bus trips that were CP protected were PM-rush trips
- Millcreek, Historic Sandy, and Sandy Civic Center TRAX stations had the most protected bus trips and received the most CP messages.
- There were unprotected bus trips identified that occurred in close proximity in time to bus trips that were already CP protected.

One of the more significant discoveries uncovered by the first pilot test was the accuracy/ reliability of the arrival and departure times logged by the Smart-bus equipment. In particular, the data collected during this pilot indicated that the arrival and departure times of the buses at the TRAX stations, as recorded by the Smart-bus equipment, were identical for roughly 60 percent of all cases. A "departure zone" workaround was implemented, but it is not clear if this approach will provide more accurate departure times. Thus, use of Smart-bus data as the primary data collection method was abandoned as a result of this first pilot test.

A second pilot test was conducted August 21-22, 2003, to investigate the feasibility of using MDTs to record bus departure times. Additionally, the possibility of manual data collection at TRAX stations was investigated and compared to the departure times recorded by drivers sending messages through the MDT. For this pilot, bus operators at three TRAX stations (Ballpark, Millcreek, and Sandy Civic Center) were asked to log (i.e., send coded message to dispatchers via the MDT) all departures over a two-day period. Concurrently, two-person teams conducted manual data collection at these same TRAX stations between the hours of 4:00 pm and 8:00 pm.

2.3.1.1 Mobile Data Terminal

The MDT data collection method required participation by both the bus operators and the radio dispatchers. Each time that a bus operator transmitted a Code 34 message (an unused data text message in the radio log system that was used as a surrogate for "bus departure") the dispatchers in the radio control center (RCC) needed to acknowledge the message and mark it (via the computer) with the time that the message came in (which may have been earlier than the time that it was acknowledged).

Bus operators were informed of the pilot test through their Operations Managers. A memo from UTA's ITS Manager (and technical contact for the CP Evaluation) described the implementation of the pilot test to the Operations Managers and asked their support in conveying the need for participation by the bus operators. It also emphasized that the data collection was solely for the purpose of determining the feasibility of using the radio system to collect departure time data during the full study and that the data would not be used for any other purposes. The exact instructions to be given to the operators were:

> *Immediately before departure from the TRAX station, after the doors are closed, but before the bus is moving, the operator should send text message #34 "Loss of Traction" to RCC (some radios may have a different message programmed, but message 34 should be sent anyway).*

During the two-day pilot test, there were 754 bus trips (377 each day) that should have departed from one of the three targeted TRAX stations (based on the April-August 2003 bus schedule database provided by UTA in June 2003). A total of 158 bus operators each day were responsible for driving buses for these trips (note that without additional data from UTA, it is not known whether the same bus operators drove each day or if there was a change in operator for some of the routes). Overall, Code 34 messages for only 11% of the expected bus trips (including none from the Millcreek buses) were recorded in the MDT log. The percent of bus operators who participated by sending at least one message also was roughly 11%. Note that

"percent completion" (i.e., percent of trips with transmitted message) for each operator was not calculated at this time. Table 1 presents a breakdown of the results.

Table 1. Results of MDT Data Collection

TRAX Station	Pilot Test Day	Expected Bus Trip Departures	Number of Code 34 Messages Received	Percent Departures Recorded	Number of Bus Operators Scheduled	Number of Bus Operators Sending Messages	Percent Operator Participatio
Ballpark	Thursday	62	25	40%	17	8	47%
	Friday	62	12	19%	17	5	29%
Millcreek	Thursday	143	0	0%	65	0	0%
	Friday	143	0	0%	65	0	0%
Sandy Civic Center	Thursday	172	14	8%	76	7	9%
	Friday	172	28*	16%	76	10	13%
Total		754	84**	11%	316	35**	11%

* one is likely a duplicate message
** includes five messages for which bus routes could not be determined

The very low participation rate by bus operators is a cause for concern, because it reduces the potential for observing a bus departure during a late-train event and it increases the possibility of introducing a participation or self-selection bias in the collected data. However, it should be noted that during the two-day pilot test, various unplanned events occurred which may have impacted the performance of the MDT data collection method. These included:

- A vehicle/train accident on Thursday morning which necessitated the formation of a "bus bridge" to transport the affected train passengers. Buses pulled for this activity may have had other distractions that prevented them from transmitting a Code 34 message. In addition, the radio dispatchers likely were preoccupied with managing the bus bridge and may have missed acknowledging some of the messages.

- UTA's systems were affected by the computer virus that spread via the Internet the week of the pilot test. All servers running the train tracking software were shut down overnight on Wednesday and significant effort was expended by UTA staff on Thursday morning in an attempt to restore the system. It is possible that attention was diverted from ensuring that radio dispatchers and operation managers were providing reminders to the bus operators to transmit Code 34 messages.

- Lightening from a thunderstorm on Friday afternoon caused a power outage. Messages may have been lost because of this event.

2.3.1.2 Manual Observations

The manual data collection method was conducted by hiring six individuals identified by the Salt Lake County Aging Services (SLCAS) office. These individuals were paired up into three teams of two, and each team was assigned one of the targeted TRAX stations. The teams were asked to record the arrival and departure times for all buses traveling through their stations between 4:00 pm and 8:00 pm each day.

Prior to the data collection on the first day, a brief training was held at the SLCAS office to explain the purpose of the study and the specific instructions for collecting the data. Each individual was provided with a radio-controlled atomic clock (which in theory would provide the exact same time as UTA's system clocks) and a set of pre-printed data collection forms that listed the times that each bus was expected to arrive at the respective TRAX stations. Individuals were instructed to independently record the arrival and departure times (i.e., both members of each team should record the times separately, and they should not compare notes) so that a measure of inter-recorder reliability could be estimated. In addition, the definitions of departure time and arrival time listed below were explained.

- Arrival Time – time at which bus pulls up to the designated drop-off spot and opens doors to allow passengers to disembark.

- Departure Time – time at which bus pulls out of its designated pick-up location (typically different from the drop-off spot) after all passengers have boarded.

Throughout both evenings, a Battelle supervisor traveled between TRAX stations to resolve any problems that might occur and to answer any questions.

During the two-day pilot test, there were 186 bus trips (93 each day) that should have departed from one of the three targeted TRAX stations between 4:00 pm and 8:00 pm. Overall, 89 percent of the expected bus departures were recorded by the observers. Table 2 presents a breakdown of the results.

Table 2. Results of Manual Data Collection

TRAX Station	Pilot Test Day	Expected Bus Trip Departures	Data Collector #1		Data Collector #2	
			Number of Departures Recorded	Percent Departures Recorded	Number of Departures Recorded	Percent Departures Recorded
Ballpark	Thursday	14	13	93%	13	93%
	Friday	14	13	93%	14	100%
Millcreek	Thursday	32	31	97%	28	88%
	Friday	32	31	97%	29	91%
Sandy Civic Center	Thursday	47	36	77%	42	89%
	Friday	47	41	87%	37	78%
Total		186	165	89%	163	88%

In addition to the quantitative results shown above, the following observations were noted by the Battelle supervisor.

- At first, it was somewhat difficult for the data collectors to understand some of the bus behaviors (e.g., a bus would enter the station as a Route 37 Eastbound and depart as a Route 41 Southbound). Because this occurrence was not noted on the data collection forms, it caused some confusion until the data collectors figured out the pattern in these cases.

- Complete independence between the individual data collectors was not obtained. Even though they had been instructed otherwise, the Battelle supervisor noticed occasions in which one data collector confirmed his/her time with the other one. The Battelle supervisor reminded the data collectors of the need for independence when this was observed. Additionally, the thunderstorm that struck on Friday afternoon forced two of the teams to sit together in cars (each team had only one car because some of the data collectors do not have cars), thus it was difficult for them to spot bus departures/arrivals and record the times independently.

- Because of its size, no good place existed at Sandy Civic Center to observe all bus stops without the possibility of temporarily having buses obscured from view. It is possible that there could have been a delay between some departures/arrivals and when they were noticed.

- One of the atomic clocks malfunctioned, causing one data collector at Sandy Civic Center to record times using her watch. It appeared that her watch was within a minute of the time on the other atomic clock.

- The second atomic clock used at Sandy Civic Center had its "seconds" mode accidentally turned off. The Battelle supervisor discovered this part way through the first evening and reset it at that point. Until then, the data collector recorded times only to the minute.

- The data collectors at Sandy Civic Center noted that on at least two occasions, buses waited past their scheduled departure to enable train passengers to successfully transfer to the bus. Also, in one other instance, a train passenger ran after the bus in a failed attempt to catch it as it departed the station.

2.3.1.3 Comparison of MDT Log vs. Manual Observations

Bus departures that were recorded by both of the data collection methods were compared to determine how the times agreed with each other. In general, very good agreement was found. Out of the 23 bus departures that could be compared, 96% of them were within one minute of each other. Because the MDT times are recorded only to the minute, it was not possible to compare them at any finer degree of precision. Table 3 presents the comparisons for each day and TRAX station.

Table 3. Comparison of MDT and Manual Data Collection Results

TRAX Station	Pilot Test Day	Bus Trips for which Departures were Recorded by Both Methods	Number of Recorded Departures Within 1 Minute		Percent of Recorded Departures Within 1 Minute	
			Data Collector #1	Data Collector #2	Data Collector #1	Data Collector #2
Ballpark	Thursday	6	5	6	83%	100%
	Friday	4	3	4	75%	100%
Millcreek	Thursday	0	0	0	--	--
	Friday	0	0	0	--	--
Sandy Civic Center	Thursday	5	5	5	100%	100%
	Friday	8	8	8	100%	100%
Total		23	21	23	91%	100%

2.3.2 Finalization of Data Transfer Protocols

Various types of data will need to be transferred to Battelle throughout the data collection period. Regular transfers of data will ensure that any data collection problems are identified soon enough to be corrected without jeopardizing the entire data collection effort. Scheduled dates for transfer of various data types are provided in the respective subsections below. These dates will be incorporated into a tracking control checklist that will be used to monitor UTA's adherence to the schedule. Protocols for transferring each type of data are described below.

2.3.2.1 Train Schedules

Data on the scheduled train stops at each station are necessary to plan which TRAX stations will be monitored during the evaluation and to determine the adherence to the schedule by the trains. UTA has already provided spreadsheets containing the August-November 2003 train schedules. These data have been imported into the study database and have been used in planning which stations to monitor during the evaluation. No other data are needed unless UTA changes any of the schedules or the data collection period extends past November 22, 2003 (the projected end of the current schedules). If either of these situations arises, UTA will need to send updated schedule data in the same format used previously. Table 4 lists the variables included in this spreadsheet.

Table 4. Train Schedule Data Needed for System Performance Evaluation

Variable	Format	Description
SignID	Integer	Code for the change period (37=Aug-Nov 2003)
StopName	String	Street intersection of TRAX station
DirectionName	String	Direction that the train is traveling (e.g., Northbound, Eastbound, etc.)
TrainRoute	Integer	Route number of train
Sequence	Integer	Stop number of train
ScheduledTime	Integer	Scheduled departure time of train from station (number of seconds since midnight)
NodeAbbr	String	Abbreviation of TRAX station name
RouteName	String	Name of train route
TrainBlock	Integer	Code for set of train trips performed by specific train operator during the day (i.e., one train block is composed of many train trips)
TripID	Integer	Unique identifier for train trip
ServiceID	Integer	Code for type of service (e.g., weekday, holiday, Sunday, etc.)

2.3.2.2 Bus Schedules

Data on the scheduled bus stops at each station are necessary to plan which TRAX stations will be monitored during the evaluation and to determine the adherence to the schedule by the buses. UTA has already provided spreadsheets containing the August-November 2003 bus schedules. These data have been imported into the study database and have been used in the planning of which routes to monitor during the evaluation. No other data are needed unless UTA changes any of the schedules or the data collection period extends past November 22, 2003 (the projected end of the current schedules). If either of these situations arises, UTA will need to send updated

schedule data in the same format used previously. Table 5 lists the variables included in this spreadsheet.

Table 5. Bus Schedule Data Needed for System Performance Evaluation

Variable	Format	Description
SignID	Integer	Code for the change period (37=Aug-Nov 2003)
StopName	String	Street intersection of TRAX station
DirectionName	String	Direction that the bus is traveling (e.g., Northbound, Eastbound, etc.)
BusRoute	Integer	Route number of bus
Sequence	Integer	Stop number of bus
ScheduledTime	Integer	Scheduled departure time of bus from station (number of seconds since midnight)
NodeAbbr	String	Abbreviation of TRAX station name
RouteName	String	Name of bus route
BusBlock	Integer	Code for set of bus trips performed by specific bus operator during the day (i.e., one bus block is composed of many bus trips)
TripID	Integer	Unique identifier for bus trip
ServiceID	Integer	Code for type of bus service (e.g., weekday, holiday, Sunday, etc.)

2.3.2.3 CP Assignments

Data on the particular bus routes that have been assigned protection by the CP system are necessary to plan which bus routes will be monitored during the evaluation and to determine the performance of the CP system when a late train occurs. UTA has already provided spreadsheets containing the current CP assignments for the August-November 2003 change period. These data have been imported into the study database and have been used in the planning of which routes to consider in the evaluation. Assuming that additional routes are assigned protection part way through the study (see Section 2.2), UTA will need to provide an updated spreadsheet (in the same format) that contains the new assignments. Also, if UTA changes any of the protections for any other reason, an updated assignment spreadsheet will need to be provided. Table 6 lists the variables included in this spreadsheet.

Table 6. CP Assignment Data Needed for System Performance Evaluation

Variable	Format	Description
SignID	Integer	Code for the change period (37=Aug-Nov 2003)
TrainBlock	Integer	Code for set of train trips performed by specific train operator during the day (i.e., one train block is composed of many train trips)
TrainTrip	Integer	Unique identifier for train trip
TrainRoute	Integer	Route number of train
TrainDepartNode	String	TRAX station where train trip began
TrainDirection	String	Direction that the train is traveling (e.g., Northbound, Eastbound, etc.)
TrainTripTime	Time	Scheduled time when train trip began
TrainNodeTime	Time	Scheduled arrival time of train from station
BusBlock	Integer	Code for set of bus trips performed by specific bus operator during the day (i.e., one bus block is composed of many bus trips)
BusTrip	Integer	Unique identifier for bus trip
BusRoute	Integer	Route number of bus
BusDepartNode	String	Bus stop where bus trip began

BusDirection	String	Direction that the bus is traveling (e.g., Northbound, Eastbound, etc.)
BusTripTime	Time	Scheduled time when bus trip began
BusNodeTime	Time	Scheduled departure time of bus from station
NodeID	Integer	Unique identifier for TRAX station
CategoryNum	Integer	Code for type of CP Protection (e.g., minimum and maximum wait time, etc.)
ServiceID	Integer	Code for type of bus service (e.g., weekday, holiday, Sunday, etc.)
NodeAbbr	String	Abbreviation of TRAX station name

2.3.2.4 CP Messages

Data on the CP messages that were generated are necessary to determine the performance of the CP System when a late train occurs. A spreadsheet containing all CP messages generated during the data collection period will need to be provided on a regular basis so that performance can be monitored throughout the study. Each sheet should be formatted in the identical format used when samples of these data were provided in May 2003. Table 7 lists the variables to be included in this spreadsheet. Spreadsheets containing the previous month's data should be provided at the beginning of each month.

Table 7. CP Message Log Data Needed for System Performance Evaluation

Variable	Format	Description
LogNumber	Integer	Unique identifier for generated CP message
LogDate	Date	Date that CP message was generated
LogTime	Time	Time that CP message was generated
Route	Integer	Route number of bus for which CP message was generated
TripInfo	Integer	Trip ID of bus for which CP message was generated
Unit	Integer	ID of bus for which CP message was generated
Name	Integer	Operator ID of bus for which CP message was generated
Location	String	Abbreviation of TRAX station name where late train caused CP message to be generated
MinuteLate	Integer	Amount of time that train is expected to be late (expressed in seconds even though variable name indicates otherwise)
MissedFlag	String	Code for outcome of generated CP message (0=Sent, 1=Missed (too late to send), 2=Discarded (repeat message due to increasingly late train))
Comments	String	Text of CP Message generated
OldETA	Time	Previous estimated arrival time of train at station
NewETA	Time	New estimated arrival time of train at station
BusBlock	String	Code for set of bus trips performed by specific bus operator during the day (i.e., one bus block is composed of many bus trips)
BusNodeTime	String	Scheduled departure time of bus from station

2.3.2.5 Smart-bus Data

A spreadsheet containing information collected by the Smart-buses will need to be provided by UTA. A spreadsheet containing all Smart-bus data generated during the data collection period will need to be provided on a regular basis so that performance can be monitored throughout the study. Each sheet should be formatted in the identical format used when samples of these data were provided in May 2003. Table 8 lists the variables to be included in this spreadsheet.

Spreadsheets containing the previous month's data should be provided at the beginning of each month.

Table 8. Smart-bus Data Needed for System Performance Evaluation

Variable	Format	Description
DailyTripID	Integer	Unique identifier for each trip
RouteDirectionID	Integer	Code for route direction (e.g., Northbound)
CalendarID	Date	Date that bus trip occurred
RouteAbbr	Integer	Route number of bus which made the trip
TimePointAbbr	String	Abbreviation of TRAX station name where bus arrived/departed
TimePointName	String	Name of TRAX station where bus arrived/departed
ScheduledTime	Time	Time that bus is scheduled to depart TRAX station
ArrivalTime	Time	Time that bus actually arrived at TRAX station
DepartureTime	Time	Time that bus actually departed from TRAX station
RouteName	String	Name of bus route that bus is traveling
ServiceID	Integer	Code for type of bus service (e.g., weekday, holiday, Sunday, etc.)
VehicleID	Integer	Unique identifier for physical bus that is traveling the route

2.3.2.6 MDT Data

A spreadsheet containing the bus departures recorded in the MDT log system will need to be provided on a regular basis. A spreadsheet containing all MDT data generated during the data collection period will need to be provided on a regular basis so that performance can be monitored throughout the study. Each sheet should be formatted in the identical format used when the MDT data were provided at the conclusion of the second pilot test. Table 9 lists the variables to be included in this spreadsheet. Spreadsheets containing the previous week's data should be provided at the beginning of each week.

Table 9. MDT Data Needed for System Performance Evaluation

Variable	Format	Description
LogDate	Date	Date of the radio log message
LogTime	Time	Time of the radio log message
Problem	String	Description of the radio log message
Block	Integer	Code for set of bus trips performed by specific bus operator during the day (i.e., one bus block is composed of many bus trips)
Route	Integer	Route number of bus which made the trip
Unit	Integer	Unique identifier for bus operator
Direction	String	Direction that the bus is traveling (e.g., Northbound, Eastbound, etc.)
Comments	String	Entered time that radio log message was received by RCC

2.3.2.7 Manual Data Collection Forms

Completed data collection forms are to be sent to Battelle on a weekly basis. The supervisor of the manual data collectors will need to collect the completed forms from the previous week, make copies of each completed form for backup purposes, and ship the originals to Battelle by the end of the day each Monday. At Battelle, the completed forms will be subjected to a series of quality control checks and then the data will be entered into the study database. Any systematic problems discovered in the data will be relayed to the site supervisor so that the issue(s) can be addressed with the data collectors.

2.3.2.8 Late Train Data

Data on the arrival times of late trains during the field evaluation are necessary to determine the performance of the CP System when a late train occurs as depicted in Table 10.

Table 10. Late Train Data Needed for System Performance Evaluation

Variable	Format	Description
TrainNumber	String	Unique train identifier
Station	String	Full name of TRAX station
Arrival	Time	Arrival time at TRAX station
Departure	Date	Departure time at TRAX station
MinutesLate	Numeric	Number of minutes train is late
Dwell(sec)	Numeric	Number of seconds train is at the TRAX station
Comments	String	Any comments about train
RunStartTime	Time	Time that the train began the trip

2.4 TEST ACTIVITIES

As discussed in Section 2.1, the data collection activities for this test will occur over a three-month period defined as September 2003 through November 2003. Historical data, primarily collected as part of routine system administration by UTA during the summer of 2003 also will be used to the extent possible. Section 2.4.1 provides details for the data collection effort related to use of the MDT systems while Sections 2.4.2 and 2.4.3 provide similar details for the Smart-bus and manual data collection effort, respectively. Logging departure times through use of the MDT system is the primary data collection method for this evaluation. The Smart-bus and manual data collection will serve to supplement the data collected though this effort and will also serve to provide the ability to assess the quality of the collected data.

Information will be collected from the system as currently operated by UTA for the first two months of the data collection period (September and October). At the end of October, UTA will be asked to initiate CP for additional bus routes to provide an opportunity to assess the impact of CP in a "before and after" setting.

2.4.1 Mobile Data Terminal

This data collection activity will occur over the last portion of the data collection period to address the "before and after" analysis. Table 11 lists the additional routes identified by UTA for which CP will be turned on beginning in November. These routes will be the focus of the "before and after" analysis. All bus operators on each of these bus routes that will be asked to indicate their departures from a TRAX station via their mobile data terminal (MDT) that is part of the radio system. In particular, immediately before departure from the TRAX station, after the doors are closed, but before the bus is moving, each bus operator will be asked to send text message #34 "Loss of Traction" to the UTA Radio Control Center (RCC). This message, which is otherwise unused by UTA, will be logged into the radio log, time-stamped, and tagged with the appropriate identifying information (e.g., bus block number) to make it unique.

Table 11. Before and After Scenarios to be Evaluated

TRAX Station	Bus Route	Bus Direction	Bus Departure Time	Bus Frequency
Ballpark	16	Inbound	5:22	25-55 min
	16	Inbound	7:52	25-55 min
	16	Inbound	10:22	25-55 min
	16	Inbound	12:52	25-55 min
	16	Inbound	15:22	25-55 min
	16	Inbound	17:52	25-55 min
	17	Inbound	7:09	25-55 min
	17	Inbound	7:39	25-55 min
	17	Inbound	9:39	25-55 min
	17	Inbound	10:09	25-55 min
	17	Inbound	12:09	25-55 min
	17	Inbound	12:39	25-55 min
	17	Inbound	14:39	25-55 min
	17	Inbound	15:09	25-55 min
	17	Inbound	17:09	25-55 min
	17	Inbound	17:39	25-55 min
	66	Westbound	16:55	>55 min
Millcreek	131	Eastbound	22:11	>55 min
	137	Westbound	20:25	25-55 min
Murray North	140	Westbound	21:21	>55 min
	140	Eastbound	22:04	>55 min
Fashion Place	22	Inbound	7:45	<25 min
	22	Inbound	10:15	<25 min
	22	Inbound	12:45	<25 min
	22	Inbound	15:15	<25 min
	22	Inbound	17:45	<25 min
Sandy Civic Center	816	To Provo	21:44	>55 min

* same frequency as protected trip

The actual mechanics of transmitting and receiving the message are as follows:

1. Bus operator pushes this sequence of keys on the MDT – “Code”, “3”, “4”, “Send”
2. Message (along with timestamp) appears on the RCC computer screen
3. RCC dispatcher enters the time of the incoming message, bus block number, and code “34” into the radio log, which is maintained on a separate computer that is located next to the computer that displays the incoming messages. The logged message is automatically time-stamped with the time that it is entered.

Although this manual process is subject to error, the UTA radio system is not currently capable of automatically recording messages to the radio log. This enhancement is envisioned for the future, but will not be in place in time for the current evaluation. Radio dispatchers have been informed of the importance of entering complete and accurate data. Entered message times will be reviewed to ensure that they are within a few minutes (and not later than) the time stamps of

the logged messages. Any large discrepancies will be brought to the attention of UTA management so that problems with dispatcher performance can be corrected.

Currently, MDTs are routinely used by drivers to communicate with the RCC for normal business activities, so bus operators will not need any additional training in the use of the MDT to send message #34. Participation of the bus operators is a critical component to the ability to collect departure times. Low participation by bus operators will have a direct impact on the extent to which an assessment of the performance of CP during a late train event in improving the probability of a successful connection can be made. Low participation by bus operators also increases the potential for a sampling bias to be introduced into the collected data. For example, operators who are more apt to record departure times may be more likely to follow CP recommended "Hold" messages than are operators who are not willing to log departure times. UTA has indicated that its management staff will have an increased role in promoting the importance of logging departure times, which will include issuing inter-departmental memos, in-person involvement with dispatchers and bus operator supervisors, and routine reminders to bus operators at the initiation of their shift and during their shift via radio to log departures.

2.4.2 Smart-bus

There are approximately 30 Smart-buses that can be utilized for the evaluation. In addition to information on the arrival/departure times for each bus at a TRAX station, information such as the number of passengers also is available for analysis from these buses. Due to the limited number of these buses and the logistical considerations for how these buses are assigned to specific bus routes, these buses will be assigned to the same bus routes for the entire three-month data collection period.

Data collected using Smart-buses largely will be used to examine "with and without" scenarios, whether "with and without" for currently protected routes that were not protected during the Summer of 2003 or compared to "similar" bus routes that are currently without CP protection. For the purposes of assigning Smart-buses, the schedules for all CP protected bus routes that intersect a TRAX station were compared to the bus schedules for all bus routes that are not currently being protected, but intersect a TRAX station. CP protected routes that have a non-CP protected route that is scheduled to depart at exactly the same time as the CP route (or prior to the CP route by a minute) were selected as candidates for assignment of a Smart-bus. Additional criteria for defining an appropriate "without" route included: bus scheduled departure time three or more minutes past the train scheduled arrival time, roughly the same frequency of buses on that route, the number of comparisons that could be covered by a single Smart-bus, and the UTA maintenance bus bay that would need to provide the Smart-bus to the route.

Table 12 summarizes the bus routes and times that are being covered by the Smart-buses. Overall, 14 different "with and without" comparison scenarios were identified and will be covered by Smart-buses. This represents significantly fewer than that proposed in the Evaluation Plan, because schedule changes by UTA have eliminated many comparisons and fewer Smart-

buses are available than anticipated. UTA schedulers will be asked to assign Smart-buses to the appropriate bus blocks[3] to cover the 14 different comparison scenarios.

Table 12. With and Without Scenarios to be Evaluated

TRAX Station	Potential "Without" Case				Corresponding CP-Protected Trip(s)			Train Time
	Bus Route	Bus Direction	Bus Departure Time	Bus Frequency	Bus Route	Bus Direction	Bus Departure Time	
Millcreek	31	Westbound	16:40	< 25 min*	37	Westbound	16:40	16:37
	31	Eastbound	17:40	< 25 min*	37	Westbound	17:40	17:37
Midvale Center	25	Clockwise	17:08	25-55 min	88	Westbound	17:08	17:05
	25	Clockwise	17:38	25-55 min	88	Westbound	17:38	17:35
	25	Clockwise	18:08	25-55 min	88	Westbound	18:08	18:05
Historic Sandy	90	Westbound	15:55	25-55 min*	94	Eastbound	15:55	15:52
	94	Eastbound	16:55	25-55 min*	90	Westbound	16:55	16:52
Sandy Civic Center	33	Northbound	7:44	25-55 min*	811	To Provo	7:44	7:39
	33	Northbound	8:14	25-55 min*	811	To Provo	8:14	8:09
	33	Northbound	16:14	25-55 min*	811	To Provo	16:14	16:09
	33	Northbound	16:42	25-55 min*	345	Outbound	16:43	16:39
	33	Northbound	17:12	25-55 min*	46	Southbound	17:13	17:09
	33	Northbound	17:42	25-55 min*	46	Southbound	17:43	17:39
	33	Northbound	18:12	25-55 min*	46	Southbound	18:13	18:09

* same frequency as protected trip

2.4.3 Observational Data

Manual data collection by independent observers will be conducted in a limited fashion to supplement the MDT data collection activity. Manual data collection also will provide information that can be used to assess the accuracy of the MDT-recorded departure times over a prolonged period of time and in an "unusual" situation (such as a system-wide problem that is generating late train events). Finally, the data collected through observational methods will provide some ability, albeit more limited, to assess the impact of CP on the successful connections.

The manual data collection will occur for a two-month period at the three TRAX stations that had the majority of CP routes and late train events in the initial pilot test: Sandy Civic Center, Historic Sandy, and Millcreek. In particular, this data collection effort will be conducted from October 2003 through November 2003, thus providing one month of data for bus arrivals and departures at these three TRAX stations before CP is initiated for additional routes, and another month of data following the initiation of CP for additional routes.

Six observers will be asked to record bus arrivals/departures at Sandy Civic Center, Historic Sandy, and Millcreek on weekdays during the hours of 3:00 pm and 7:00 pm. Two observers

[3] A bus block includes all routes and stops that are covered by a particular bus in a given day. A particular bus may cover more than one bus route and may intersect with a TRAX station multiple times during the day.

will be assigned to record all bus arrivals/departures at each of these TRAX stations during the designated time period. These data will be used for both the "with and without" and "before and after" analyses. A pre-printed data collection sheet that lists bus routes in order of their anticipated departure times will be used by the observers to record arrival and departure times of buses (see Attachment 1). So that an assessment of the inter-observer reliability can be made, each observer will be asked to complete the data collection sheet independently. Each observer will be given an radio-controlled clock to use that will resynchronize to the official U.S. time each night. Because all of UTA's system clocks also synchronize to the official U.S. time, all of the data collection methods will be based on the same time.

Observers will undergo a brief training session where the purpose of the study will be explained, the importance of collecting accurate departure times will be stressed, and the use of the data collection sheet will be illustrated. Lessons learned during the second pilot test also will be covered (i.e., necessity of temporarily moving to unobscured position at Sandy Civic Center when a bus blocks sight lines, instructions on how to work the radio-controlled clock, etc.). Each data collector will be given a written set of instructions that detail the materials covered during the training, as well as a schematic of the bus stops at his/her assigned TRAX station and a table of the possible bus behaviors (e.g., route 37 Eastbound changes to 41 Southbound) that Battelle developed from UTA's schedule following the pilot. These documents are shown in Attachment 2.

Based upon the second pilot study, observing the arrival and departure times of buses at TRAX stations is a relatively straightforward activity. An on-site supervisor will be responsible for managing the day-to-day activities of the manual data collectors. This individual will be briefed by Battelle staff on the situations and types of questions that may arise during the data collection period and will be trained on what needs to be done to answer/resolve them. Responsibilities of the supervisor include:

- Arranging for substitute observers(s) if regular observers(s) are sick or otherwise unable to perform the data collection on a given day;
- Ensuring that observers are recording arrival and departure times appropriately;
- Collecting all data collection forms and mailing them to Battelle on a weekly basis;
- Replacing any radio-controlled clocks that malfunction;
- Providing extra copies of data collection forms and supplies to observers, if needed;
- Briefing project managers on a weekly basis on any issues that arise; and
- Notifying project managers immediately of any situations that compromise the collection of complete, accurate data.

2.4.4 Quality Control Procedures

Data quality control procedures will be implemented throughout the field evaluation to ensure that complete, accurate data are being collected. Any data problems noted during these regular reviews will immediately be brought to the attention of program management and UTA staff for correction. Details on the various quality control procedures to be used for each type of data are provided below.

Train Schedules – A spreadsheet containing these data already was provided by UTA. The data will not change unless UTA changes the train schedules before the next change period (i.e., triennial scheduling period) for some unexpected reason (train schedules rarely change within a given change period – UTA will notify Battelle if any changes need to be made). Lists of train departures from each TRAX station were generated and reviewed to ensure that all TRAX stations were accounted for and no unexpected TRAX stations existed in the data. Spot checks of the data contained in the spreadsheet versus the train schedules posted on UTA's website also were made to confirm that they agreed. No further checks will need to be made unless the train schedules change, at which time the procedures described above will be repeated.

Bus Schedules – A spreadsheet containing these data already was provided by UTA. The data will not change unless UTA changes the bus schedules before the next change period for some unexpected reason (bus schedules rarely change within a given change period – UTA will notify Battelle if any changes need to be made). Lists of bus departures for each bus route from each TRAX station were generated and reviewed to ensure that all TRAX stations and bus routes were accounted for and no unexpected TRAX station / bus route combinations existed in the data. Spot checks of the data contained in the spreadsheet versus the bus schedules posted on UTA's website also were made to confirm that they agreed. No further checks will need to be made unless the bus schedules change, at which time the procedures described above will be repeated.

CP Assignments – A spreadsheet containing these data already was provided by UTA. The data will not change until UTA changes the bus routes assigned CP protection (expected on November 3, 2003 – see section 2.2). Lists of CP assignments for each bus route at each TRAX station were generated and reviewed to determine where CP was implemented. Comparisons were made between the bus and train times for each protected route to ensure that they were reasonable (i.e., not hours apart, bus not scheduled to leave before train arrives, etc.). Two problematic records were identified during this review and were pointed out to UTA for correction. Once the new CP assignments are made, the procedures described above will be repeated and checks will be made to confirm that all requested CP assignments were implemented.

CP Messages – As described earlier, these data will be provided by UTA on a roughly monthly basis. When each new spreadsheet is received, lists of CP messages for each bus route at each TRAX station will be generated and reviewed to determine whether the messages match the protected routes. Also, numbers of messages per route will be compared against the counts of late trains at each station to determine if messages are being sent each time a late train occurs that is associated with a protected bus route.

Smart-buses – As described earlier, these data will be provided by UTA on a roughly monthly basis. When each new spreadsheet is received, lists of bus arrivals and bus departures for each bus route at each TRAX station will be generated and compared against the bus schedule data to determine whether there are any missing bus arrivals and/or departures. Also, the pairs of arrival and departure times will be compared to ensure that the arrival times are before the departure times.

MDT – As described earlier, these data will be provided by UTA on a roughly monthly basis. When each new spreadsheet is received, lists of bus departures for each bus route at each TRAX station will be generated and compared against the bus schedule data to determine whether there are any missing bus departures. Also, the bus departure times from any buses that are equipped as Smart-buses will be compared against the corresponding Smart-bus data to ensure that they are in basic agreement. Similarly, the bus departure times will be compared against the observational data that are collected.

Observational Data – As described earlier, these data will be provided by the supervisor of the observational data collection on a weekly basis. When the data collection forms are received, the data will be keyed into the database. Lists of bus departures for each bus route at each TRAX station then will be generated and compared against the bus schedule data to determine whether there are any missing bus departures. Also, the bus departure times from any buses that are equipped as Smart-buses will be compared against the corresponding Smart-bus data to ensure that they are in basic agreement. Similarly, the bus departure times will be compared against the MDT data that are collected.

Late Trains – As described earlier, these data will be provided by UTA on a roughly monthly basis. When each new spreadsheet is received, lists of train arrivals at each TRAX station will be generated and compared against the train schedule data to determine whether there are any missing train arrivals.

2.5 POST-TEST ACTIVITIES

There are three primary activities that will be conducted following the data collection. First, as described in Section 2.5.1, the collected data will be manipulated in the master database into formats that are suitable for data summaries and statistical analysis. Second, statistical analysis of the data will be conducted. Finally, the results and interpretation of the statistical analysis will be documented. Sections 2.5.2 and Section 2.5.3 describe the approach for the statistical analysis and reporting, respectively.

2.5.1 Database Development

A Microsoft Access database was developed to process and store the data collected during the exploratory analysis and the pilot tests. Import modules were designed to import the data provided by UTA in spreadsheet format into the appropriate database tables. Separate tables are included in the database for bus schedules, train schedules, CP assignments, CP messages, train arrivals, Smart-bus data, MDT data, and observational data. SAS® programs were written to analyze the data directly from the Access database, rather than creating SAS® dataset copies of the data. This method safeguards against the SAS® datasets becoming out of date when new data

are added to the database. All data collected during the full field evaluation will be imported into this same database, and SAS® programs needed for the analysis will be run against the database.

2.5.2 Statistical Analysis

The following sections describe the statistical analyses that will be conducted for each evaluation objective.

2.5.2.1 Effectiveness of Connection Protection

For this evaluation, a connection between the train and the bus is defined to be "successful" if the bus departs the TRAX station at least one minute after the train arrives. Effectiveness of CP, therefore, will be measured as an increase in the percentage of connections that are successful. Several different statistical approaches will be utilized to assess the effectiveness of CP, including comparing bus trips with CP to those without CP and comparing bus trips before and after the initiation of CP.

2.5.2.2 Analysis of "With and Without" CP

There are two scenarios under which a comparison of bus trips with CP can be made to bus trips without CP for a "with and without" approach. First, a system failure or shut down could cause routes that are currently being protected to not be protected for some period of time, yielding information on what happens with those bus trips in the absence of CP. Second, comparisons between currently protected CP routes to "similar" routes that are not being protected could be made. Different statistical techniques will be utilized in each scenario.

A significant system failure or shut down during the data collection period that would result in the loss of CP for enough period of time to collect sufficient data for a statistically powerful test is not expected. Additionally, intentionally removing CP from bus trips is not in the best interest of UTA. However, because of a change in staff responsibilities at UTA, many routes that are designated for CP were inadvertently not protected during the summer of 2003. Additionally, Smart-bus information on arrivals and departures may be available for those routes. If so, then this scenario represents an opportunity to investigate the impact of CP on the routes where CP has already been implemented using each of these routes as its own control. More specifically, an analysis of variance (ANOVA) model with repeated measures component (to account for multiple observations for the same bus trip over time) would be fit to the data. This analysis would rely upon data collected through chance and does not represent a robust statistical design, but may nevertheless provide some insight into the effectiveness of CP.

Comparisons between current protected routes with similar routes that are without CP can be made for 14 different comparison scenarios (see Table 12). That is, at the beginning of the data collection period, specific efforts would be made to capture information on train-to-bus connections for these comparison scenarios. This design is equivalent to a prospective, matched case-control design where cases have been matched one-for-one with a control. Thus, each case (CP protected bus trip) would use a matched non-CP bus trip for a control. Again, an ANOVA model with a repeated measures variance/covariance structure will be utilized for the statistical analysis.

Data for this statistical analysis would be collected through two data collection methods (Smart-bus and observational data) with the limiting factors being the number of matched cases and controls (14), the length of the data collection period, and the number of late train events that were observed. Table 13 presents a summary of the anticipated precision for this statistical analysis across some of these factors as calculated using DuPont's method for power calculations for matched case-control studies (*Biometrics* 44:1157-1168). Based upon the results of the first pilot test, there were 102 late train events where a CP "Hold" message was issued during November 2002 through December 2002 for these CP bus trips. Assuming a similar rate of "Hold" messages during the two-month data collection period defined by September 2003 through October 2003, there should be enough observed events (~100) to be able to detect a change in the success rate of 10 percent to 20 percent depending upon the approximate probability of a successful connections in the two types of bus trips. However, there would not be enough power to detect a smaller improvement.

Table 13. Sample Size Requirements for the "With and Without" Designed Experiment

Approximate Probabilities of Successful Connection		Historical Number of Late Train Events Where CP "Hold" Messages Were Issued	Required Number of Late Train Events Where CP "Hold" Messages Are Issued	
Without CP	With CP		Statistical Power of 70 Percent	Statistical Power of 80 Percent
80%	84%	102	910	1,155
80%	88%	102	219	275
80%	96%	102	38	44
70%	75%	102	856	1,087
70%	80%	102	143	197
70%	90%	102	32	37
60%	66%	102	415	525
60%	72%	102	115	144
60%	90%	102	14	14

2.5.2.3 Analysis of "Before and After" CP

Estimates of the number or percentage of missed connections could be compared for some of the trips that are not currently being CP protected ("Before" cases) to similar estimates once CP has been activated for those trips ("After" cases). This has the advantage in that each trip serves as its own control, which increases the ability to statistically determine the impact of CP on these locations. If CP can be shown to be effective for these trips, then this would be strong evidence that it was likely effective for the routes already CP protected, though the converse would not necessarily be true. Analysis of variance and logistical regression techniques similar to those employed for the "with and without" analysis also will be used in this statistical analysis. Other explanatory variables also will be included in the model in an effort to separate the impact of CP from the impact of these other terms. For example, potential candidates for inclusion in the model include terms for: TRAX station, time of day, and the frequency of the bus departures for a particular bus route. The following illustrates one possible model:

$$logit(p) = \alpha + CP + TRAX + TimeDay + RouteFreq + Interactions + B + \varepsilon$$

where *p* is the probability of a successful connection, alpha is the intercept, CP is an indicator variable that is equal to 1 if bus trip is CP protected and 0 if not, TRAX is the effect due to TRAX station, TimeDay is the effect due to time of day (AM Rush, Midday, PM Rush, Evening), RouteFreq is route frequency (average duration between departures for buses on a particular bus route), *B* is a random effect due to bus trip (i.e., a random effect used to account for the correlation between observations from the same bus trip), and ε is a random error.

There are two sources of data that can be used for this analysis, both of which will provide approximately one month of "before" and another month of "after" information. The primary mechanism for data to be used in this analysis is from the MDT data collection effort. A secondary source of information will be from the observational data. As previously discussed, the MDT data collection has the ability to capture departure information from every bus trip, regardless of TRAX station, bus route, or bus equipment (other than the standard MDT). However, it remains unclear the extent to which operators will participate in the study and provide departure times.

Based upon data collected from the first pilot effort, there will be roughly two late train events that would trigger a CP message for each bus trip in a month. Using this average, precision for a given sample size or participation level was calculated through varying the estimated parameter in an ANOVA repeated measures model by Monte Carlo simulation. Table 14 summarizes the implications of various levels of participation on the ability to detect significant improvements in the probability of a successful connection due to CP using both the MDT and observational data.

Table 14. Expected Level of Improvement That Can Be Statistically Identified as Significant Using Both the MDT and Observational Information

Probability of Successful Connection Before CP	Expected Level of Improvement That Can Be Statistically Identified As Significant With 80 Percent Power			
	100% Participation	80% Participation[a]	60% Participation[a]	40% Participation[a]
95%	3%	3%	4%	4%
90%	3%	3%	4%	4%
85%	3%	3%	4%	4%
80%	3%	3%	4%	4%
75%	3%	3%	4%	5%
70%	3%	4%	4%	5%
65%	4%	4%	5%	6%
60%	4%	4%	5%	6%
55%	4%	5%	5%	6%
50%	4%	5%	5%	6%

a. Assumes equal participation across both late and non-late train events.

As discussed in Section 2.4.3, manual data collection will occur at only three TRAX stations (Sandy Civic Center, Historic Sandy, and Millcreek). This limits the number of late train events that would trigger a CP message to be issued that could be observed. However, virtually every bus departure at each of these stations will be logged to the second. Table 15 summarizes the expected level of improvement that can be statistically identified as significant using only the observational data at these three stations.

Table 15. Expected Level of Improvement that can be Statistically Identified as Significant Using Only Observational Data at Millcreek, Historic Sandy, and Sandy Civic Center

Probability of Successful Connection Before CP	Expected Level of Improvement That Can Be Statistically Identified As Significant With 80 Percent Power
95%	NA
90%	7%
85%	7%
80%	7%
75%	8%
70%	9%
65%	10%
60%	11%
55%	12%
50%	12%

The percentages given in Table 14 indicate that a significant improvement of between three percent and six percent can be observed with 80 percent power using a significance test with 95 percent confidence. The improvement in the successful transfer rate based upon data collected during the first pilot effort was on the order of magnitude of 10 percent to 15 percent, which would be identified as significant if observed in the main data collection period. Similarly, a significant improvement of between 7 percent and 12 percent will be detected with 80 percent power and 95 percent confidence using data only from the observational data at the three TRAX stations. This is important because these will be the only data that have departure information that has not been rounded to the nearest minute.

2.5.2.4 Operational Aspects of System Performance

A second objective of the evaluation of system performance data is to evaluate operational aspects of the system performance. However, this will not include an evaluation of the specific hardware and software that comprise the CP system. Rather, particular emphasis will be on evaluating the extent to which the CP system consistently operates the way that it was designed from an overall perspective.

Analysis of the operational aspects of system performance will largely consist of preparing summary or descriptive statistics for various system operational performance elements. In particular, summary statistics that illustrate the extent to which messages are being issued when they are supposed to be and the number of messages that are actually being received by the bus operators will be examined. For example, descriptive statistics such as means, standard errors, and percentiles will be prepared for:

- Number of messages issued
- Percent of messages issued among those expected
- Number (percent) of messages that were not received
- Number (percent) of messages that were erroneously sent

Additionally, a limited analysis of the "Missed" messages will be conducted. These messages represent cases where the bus operator had not logged into the system or cases where the scheduled departure time of the bus was before the CP message was issued. There are a significant number of "Missed" messages that could occur during the three-month field period.

For example, over the course of a 153-day period in late summer/early fall of 2002 there were 263 messages that were "Missed" messages, which represents 16% of all messages that were issued.

Other operational aspects, such as the extent to which the CP system is operational on a day-to-day basis, will be explored and summarized if possible.

2.5.2.5 Unintentional Impacts

The ability to examine unforeseen or unintentional impacts of implementing CP is largely dependent upon the extent to which data will be available for examination and summary. For example, data on arrival/departure times at other bus stops is dependent upon Smart-bus data collection. If the data are available, descriptive statistics will be used to examine issues such as impacts to subsequent stops, speed, and bus occupancy. In all cases, comparisons will be made between events where a CP message was issued to events where a CP message was not issued. That is, this comparison would be made using only CP bus trips, and each bus trip would serve as its own control. For example, the lateness of the bus (with respect to the schedule) at the next subsequent stop (time point) following the TRAX station will be compared between CP and non-CP events. This analysis would give insight into whether the bus driver tended to increase speed to "make up" for a CP hold.

Another impact that will be considered includes examination of the cost benefits for riders who in the absence of CP would not have had a successful connection. For example, data from the automated passenger counters in the Smart-buses will be used to summarize the number of riders that had a successful connection because of CP and the anticipated time and cost savings associated with those riders.

2.5.3 Reporting

A draft evaluation report that includes the results and interpretations of the system performance test will be prepared and submitted for review and comment. Based on comments received, a final report will be prepared.

2.6 REQUIRED RESOURCES

The estimated level of efforts required to complete this test is provided in Section 4.2.

3.0 USER SATISFACTION TEST

This section describes the detailed test plan for the qualitative assessment of customer and operator satisfaction with the CP system. It represents an elaboration of the Evaluation Plan, with a main focus on the development of a sampling strategy and schedule of interviewer assignments, based on the anticipated TRAX rail and bus schedules for the data collection period, and on the content of the questionnaire. Plans for collecting data from bus operators, dispatchers, and transit system managers, as well as analysis of complaint logs, are also presented. This test plan assumes the reader has reviewed the final Evaluation Plan dated August 27, 2003.

3.1 APPROACH OVERVIEW

The rider survey approach is to employ students from Brigham Young University (BYU) to survey transit riders who travel on rail-bus routes that historically have experienced higher risk of late trains and actual or potentially missed rail-to-bus connections. Both protected and unprotected bus departures will be covered in the survey. Three TRAX rail stations have been selected that have exhibited the highest number of late trains. The afternoon rush hours and late evening scheduled bus runs constitute the universe of bus runs from which the interview sample will be selected. Students will be assigned to ride selected buses at these locations and time periods, to distribute short written questionnaires to the bus riders, and to collect all completed questionnaires within the next few bus stops. They will then return to the base station and repeat the process. This test aims to yield at least 400 completed survey questionnaires over a period of one week (4 week days). Bus riders who have transferred from the TRAX train, as well as a sample of riders already on the connecting bus, will be surveyed.

In addition to the bus rider surveys, bus operators, radio controllers, and transit system managers will be interviewed to understand their perspectives on the CP system. Customer complaint logs also will be examined and factored into the evaluation.

3.2 SCHEDULE

The target week for the bus rider survey is October 21 to 24, 2003. BYU plans to recruit approximately 20 undergraduate students and three graduate student supervisors, one for each of the TRAX stations where the interviewers will board their assigned buses. A BYU graduate assistant will oversee the three supervisors. BYU faculty, the graduate assistant, and a member of the Battelle evaluation team will provide interviewer training. The BYU statistics department will be available to provide support for the survey design and data analysis as needed.

Bus operators, radio controllers, and managers will be interviewed during a site visit that week by a Battelle evaluator, with assistance from the BYU graduate assistant. In addition, the scheduling of a bus operator Internet survey will be coordinated with UTA and the operators' route supervisors. It is anticipated that this survey will be on-going for about a week to give as many bus operators in the system as possible an opportunity to complete the survey. Small bus operator focus groups will be conducted prior to the Internet survey at a convenient time.

3.3 PRE-TEST ACTIVITIES

Preparations for the conduct of the rider survey in late October 2003 have included the development of the following elements:

- Selection of interview sites and interview time period;
- Design of the sampling plan and interviewer assignments (e.g., which buses on which days at which times, total target sample size);
- Preparation for interviewer training;
- Development of questionnaires for riders transferring from TRAX to bus, and other riders on the bus;
- Development of plans and interview protocols for bus operators, system managers, and radio controllers; and
- Development of plans to collect complaint logs pertaining to CP.

3.3.1 Interview Sites

Three TRAX stations have been selected for the conduct of the intercept surveys with bus riders. The underlying intent is to intercept and interview transit riders who travel on TRAX trains and connect at the station with bus routes that historically have experienced late trains and actual or potentially missed rail-to-bus connections. As has been learned from the exploratory analysis of historical data and documented in the evaluation plan report, Millcreek, Historic Sandy, and Sandy Civic Center TRAX stations have experienced the majority of late train and potential missed bus connections. Most of these events occurred in the late afternoon/evening time period, and for this reason, these sites and time period have been selected for the rider interviews.

An additional consideration is the obviously high consequence to riders of a missed connection for the last bus run of the evening. To cover this possibility, the time period for the interviews will be between approximately 3:50 PM and the last scheduled bus of the evening at each station, which occurs at 12:10 am at Historic Sandy, 11:02 pm at Sandy Civic Center, and 11:25 pm at Millcreek.

3.3.2 Sampling Plan

The first step in developing a detailed sampling plan is to delineate all the relevant TRAX rail scheduled arrivals at the three selected TRAX stations, along with all the departure times for all connecting buses that stop at those stations within the designated late afternoon and evening hours. Such a comprehensive, integrated rail-bus schedule was developed and is shown in Attachment 3. All rail and bus times were derived from the official UTA schedules posted on the Internet, and they take account of the schedule changes that were implemented on August 24, 2003. Bus runs that terminate at the station were eliminated. Also, all Northbound TRAX trains at Sandy Civic Center, which is at the south end of the north-south TRAX line, are not shown, because there would be no connecting passengers from that station on northbound departures; rather, they would be only on the southbound arriving trains.

This schedule shows 144 buses that depart from these three stations between 3:55 pm and 12:10 am. Out of all these departures, there are 39 bus departures (27.1%) that currently are protected under the Connection Protection program. The protected and unprotected bus

departures provide a "with and without" sample design that will allow the evaluation of the role that CP plays in travelers' experiences and satisfaction with transit service.

Some bus departures are scheduled within only a few minutes of the TRAX train arrival at the station, thereby increasing the risk of a missed connection. Others have a much longer lag built into their schedules, thereby reducing the risk of a missed connection. The survey will include riders on protected and unprotected routes with a range of scheduled wait times between the scheduled train arrival and bus departures from each station. This approach allows for a measure of control over several factors that might influence customer satisfaction, including geography of the locations, some traveler attributes, and trip timing. By selecting only three TRAX stations, the survey logistics are simplified over trying to survey at more stations. Interviewers can focus on a few places and become familiar with the routes, and the limited number of student interviewers can be more easily supervised and can achieve more complete coverage at fewer compared with more sites. This should result in more complete and reliable results. Furthermore, this concentrated approach offers synergy with the system performance test that will focus on the same locations and travel times.

The interviews are scheduled to take place between October 21 and 24, 2003 (Tuesday through Friday). This week was selected as a reasonably "normal" week for travel in the Salt Lake area, avoiding a large convention scheduled for the first week in October. Travelers are expected to include daily commuters, students, and other regular and occasional transit riders. The targeted sample size is 400 completed interviews.

Battelle is working with the BYU survey supervisor and a graduate student assistant to recruit the student interviewers and design as completely as possible the detailed interview assignments for each interviewer. There are some uncertainties that require retaining a measure of flexibility in the survey design plans. For example, it is not known how many individuals may actually transfer to each of the candidate connecting buses. Some buses, in fact, may experience no transfers, as well as few, if any, riders arriving at the TRAX station onboard the bus. As a general principle, it will be preferable to assign interviewers to buses with more transferring riders than fewer. In addition, it is not known how long an interviewer will need to ride on a bus to be able to collect all the completed interviews. This depends on a number of unknown factors, as follows:

- The total number of willing respondents on each bus;
- The time it will take respondents to complete the survey (which will be affected by bus crowding, the duration of their ride to their departure stop, and their ability to understand and respond to the questions);
- The actual turn-around time from when the interviewer boards the bus departing the TRAX station to the interviewer disembarking that bus with all completed interviews in hand and returning to the original TRAX station starting point on a return bus such that he or she can begin the process over again with another scheduled bus departure (depending on the sequence of bus stops after departing the TRAX station and the time to travel between stops, the interviewer may need to remain onboard the bus for several stops before all completed surveys can be collected); and
- The likelihood that the same individual riders may be encountered on each bus run from one day to the next, or alternatively, the number of new riders on these runs who have not

been exposed to the opportunity to take the survey (whether they actually completed a survey or declined to do so).

Although the survey will be made as short and clear as possible to make it easy and quick for respondents to finish, the response process cannot be fully controlled. That, coupled with a desire to have each interviewer collect every completed survey, means the timing of the process cannot be predicted closely enough to make a fixed schedule of specific individual interviewer assignments to particular buses and times. The uncertainties suggest that the sampling plan can specify desired targets but must remain inherently flexible to adjust to the actual experience at each TRAX station. Both the interviewers and supervisors will be trained to manage a solid survey process in this somewhat unpredictable, fluid environment.

The broad guidelines for the sampling plan include the following:

- Conduct surveys with travelers on both protected and unprotected bus routes. Because the protected routes constitute only a little more than a quarter of all the bus departure times, all protected buses will be surveyed. The same protected bus departures will be surveyed on several of the weekdays to increase the likelihood of covering occasional travelers as well as frequent travelers.
- Cover all the end-of-run bus departures in the evening.
- Cover each of the protected and unprotected pairs of bus departures that are the focus of the System Performance Test.
- Cover all connecting bus departures associated with late trains, if any happen to occur during the planned survey periods.
- Sample all the unprotected bus departures and seek full coverage across the four weekdays of the survey.
- Assign individual interviews at each of the three TRAX stations to the initial departing buses, and guide subsequent assignments depending on the timing of returning interviewers. On subsequent days of the week, cover gaps in assignments to maximize coverage.
- Seek to include every transferring TRAX train passenger that is transferring to a targeted departing bus.

The graduate student supervisors will be responsible for directing the undergraduate student interviewers to their bus assignments. They will keep careful track of these assignments, which will constitute a daily record of which bus departures have been covered. The supervisors will maintain the supply of survey questionnaires. Separate questionnaires will be prepared and provided for passengers transferring from the train to the bus, and for riders arriving at the TRAX station on the bus. These questionnaire forms will be different colors to help avoid confusion.

The student interviewers will maintain a log book with the following information:

- Bus number and departure time covered;
- Number of passengers transferring from rail to the subject bus;
- The total number of passengers on the bus at the time of departure from the TRAX station (and therefore by deduction, the number of non-transferring bus riders);
- Number of survey forms of each type handed out;

- Number of survey forms completed and collected;
- Number of refusals among first requests; and
- Number of travelers saying they have already been asked to complete the survey.

A draft and final version of the log format will be prepared, with assistance from BYU. The supervisors will check the accurate recording of information in the log and assist where needed, and will collect the completed forms at the end of each interviewer's assigned work period.

3.3.3 Interviewer Training

The BYU evaluation advisor will work with the Battelle survey manager to prepare a short training session for all the student interviewers and then conduct the training in advance of the survey week. The training will be scheduled a week or two in advance of the surveying, and will focus on the following elements:

- Background and objectives of the evaluation;
- Individual assignments (TRAX station and times);
- Importance of timeliness and attention to the survey procedures;
- Dealing with unforeseen issues that prevent an interviewer from meeting his/her scheduled assignments;
- Importance of interviewers' role in assuring complete and high quality results;
- The role of the supervisor and his/her working relationship with interviewers;
- Detailed discussion of the survey questionnaire content and instruction on how to answer respondent questions about the survey or the questions (including scripted-out explanations for each question to aid the interviewers' understanding of the survey);
- Approaching the transit riders, introduce the survey, and achieve cooperation from them;
- Dealing with various problems and difficult situations that may arise;
- Dealing with language or reading difficulties;
- Role playing as practice for the interviews (including a scripting of a pitch to give at the front of the bus about the survey);
- Filling out the log form accurately;
- Scanning surveys for completeness;
- Strategies for achieving complete surveys; and
- Address any questions the interviewers may have.

3.3.4 Development of Survey Questionnaires

Questions for the two rider surveys were drafted and then given to UTA and BYU for review. Revisions to the surveys then were made based on comments received. On October 9, a pre-test of the surveys was conducted in conjunction with the training of the graduate student supervisors. The objective of this pre-test was to confirm the clarity, understandability, and content of the questions, as well as to identify any potential issues with the intercept strategy. Approximately 60 completed surveys were obtained from actual UTA riders during the pre-test. Minor revisions were made to the surveys following the pre-test.

The final survey questionnaires are shown in Attachments 4 and 5. Each survey is contained on one side of one page, and has only check box response categories for clarity and ease of completion while riding on the bus. There is a final question inviting the respondent to write in

comments or suggestions to UTA. There are two forms of the survey, one for riders transferring from a TRAX train to the bus, and one for riders who depart from the TRAX station on the bus but did not arrive on a TRAX train (i.e., they arrived on that bus or they arrived at the station by a means other than the TRAX train and boarded the bus there). Each of the two survey forms will be printed on different colored paper to clearly distinguish them.

3.3.5 Development of Interview Protocols

Discussion guides for conducting interviews with the bus operators, route supervisors and system managers, and radio controllers have been drafted and are shown in Attachments 6 and 7. Small group discussions are planned to be conducted on a convenience basis with approximately twelve bus operators, depending on operator availability during a planned site visit. Individual interviews are planned with a sample of the route supervisors, again depending on shift timing and individual availability during the next site visit. All seven of the radio controllers will be interviewed, likely in several small groups, with the same caveats regarding availability during the site visit. The discussion guides are being reviewed by UTA and will be further refined as needed prior to the interviews.

The draft Internet survey for bus operators is shown in Attachment 8. Discussions with UTA have led to refinements to that instrument, and further refinements are likely before it is finalized. The survey has been posted on the Battelle server and made available in test mode to selected UTA staff. These individuals have been "taking the survey" as a way of pretesting the content and wording. In addition, Battelle is verifying that the data entries from respondents are accurately and completely reflected in the database. At the end of the pre-test phase, the database will be cleaned and made ready for bus operators to take the survey on computers either at work or home, or wherever else they are able to obtain Internet access. Operators will be invited to enter their ID numbers if they would like to become eligible for an incentive drawing (likely a dinner for two). Otherwise, they may take the survey anonymously.

3.3.6 Development of Procedures for Analyzing Complaint Logs

On an earlier field trip to Salt Lake City, the survey team met with the UTA staff who manage the complaint logs and obtained a sample of the information contained in the logs. There are no specific pre-test activities associated with the assessment of complaints. The evaluation team will obtain all the complaint logs judged pertinent to the Connection Protection program, such as reports of missed connections, for the period from the program's inception through the current evaluation period. These will be content analyzed for complaint patterns that may be helpful to a more complete understanding of customer response to the program, though it is recognized that the sample of complaint filers is not representative of all bus riders, or bus riders who may have experienced connection problems.

3.4 TEST ACTIVITIES

The qualitative test includes three components: a bus rider survey that will collect data separately for rail-to-bus transferring riders and bus-only riders; in-person interviews with bus operators, route supervisors, managers, and radio controllers; and an analysis of UTA's

complaint log files focusing on any complaints or comments pertinent to this evaluation of the Connection Protection program.

3.4.1 Bus Rider Surveys

The bus rider surveys are currently scheduled to be conducted from October 21 through 24 (Tuesday through Friday) at Millcreek, Historic Sandy, and Sandy Civic Center TRAX stations. Approximately 20 BYU student interviewers will be assigned survey time periods between approximately 4:00 PM and midnight at the three TRAX stations. One graduate supervisor will be assigned to each of these three stations to guide and monitor the survey activities, and a BYU graduate assistant will oversee and work with these three supervisors.

The supervisor will provide each interviewer with a specific bus assignment and two sets of questionnaires, one set for rail-to-bus transfer riders and one set for bus riders who did not transfer from rail at this station. The supervisor also will provide the interviewers with needed survey supplies, including a clipboard, an ample supply of UTA pens, and the interviewer log form. The supervisor will record the date and TRAX station name on each questionnaire, and each questionnaire will be numbered consecutively. The interviewer will write the bus route number on the questionnaire at the time it is collected back from the respondent. The interviewer will stand near the bus entry door, visually identify who appears to be transferring from a TRAX train, and intercept those persons and invite them to participate in the survey. The interviewer will enter onto the log form the number of persons boarding the bus, the number transferring from the train, and the number of acceptances and rejections for the survey. Interviewers will be instructed to not delay the bus from departing when the operator is ready to leave.

The interviewer will board the bus after all passengers are on board and the bus is ready to depart. He/she will enter the actual time of departure and the total number of passengers on board onto the log form. The interviewer will distribute the appropriate survey forms to willing respondents on the bus who are not transferees from the train. Then, the interviewer will make a brief announcement to the riders on the bus explaining the following (a basic script will be prepared for the interviewers in advance):

- The purpose of the survey;
- The interviewer is there to help answer any questions respondents may have;
- Respondents should complete and return the survey to the interviewer before they leave the bus;
- Respondents who complete the survey may keep the UTA pen that was given to them with the survey;
- Respondents should participate in this survey only once (note that the survey period lasts one week and that they could be asked more than once).

During the ride to the first stop after the rail station departure, the interviewer will seek to answer any questions respondents may have about the survey and collect the completed survey forms, checking to assure completeness and clarity of responses. The interviewer will continue on the bus past the first stop if necessary to collect the remaining survey forms. All forms will be collected, even if some are incomplete or discarded on the bus. To keep the process as uncomplicated as possible, mail back surveys will not be used; therefore, all surveys must be

collected on these bus rides, even the incomplete surveys. The interviewer will note the number of returned surveys on the log form.

The interviewer will leave the bus after collecting the surveys and return by another bus to the same TRAX station and await assignment by the supervisor to another bus run. All completed and partially completed surveys will be handed over to the supervisor. This will continue until the end of the interview period. The interviewer will discuss any problems or issues encountered with his/her supervisor, who will seek to resolve any on-going problems and note the issue(s) on the supervisor log.

Using the TRAX rail and bus schedules shown in Attachment 3, the supervisors will make assignments to the interviewers throughout the afternoon and evening survey period, seeking to cover all CP protected bus routes and as many other bus routes as possible. Any late train events that may occur during the survey period will receive special attention, and the supervisor will seek to have passengers on a late train who are transferring to a bus covered by the survey. Generally, however, interviewer assignments to buses will depend on the number of available interviewers and the number of passengers boarding the bus; though this will be a judgment call by the supervisor, as it is likely to be difficult to estimate ridership prior to rail-to-bus boardings.

3.4.2 Conduct Interviews and Operator Survey

In-person interviews will be conducted with a sample of bus operators and route supervisors and all of the bus radio controllers to evaluate the performance of the CP system from their perspective. There are an estimated 700 bus operators and about 27 route supervisors. Approximately 12 bus operators and an equal number of route supervisors will be interviewed, depending on availability during a scheduled site visit. There are 7 radio controllers, all of whom will be interviewed, depending again on their availability. In addition, in order to achieve more complete coverage of the bus operators, a short Internet survey will be conducted with the operators whose runs go through TRAX stations. All operators will be notified about the survey through the biweekly UTA newsletter, and an incentive drawing will be offered to encourage participation. The objective with each of these respondent groups is to gather qualitative data on their perspective of the benefits and impacts of the CP program, both as it may affect their jobs and as they perceive the effect on riders on the system. Test procedures for each of these data collection strategies are discussed in this section.

Bus operators Interviews will be scheduled with bus operators at a time to be worked out with the route supervisors. A sample of operators who have driven on protected runs and operators who have driven on non-protected but otherwise comparable bus runs will be interviewed at a mutually convenient time and place. The planned format will be several small group discussions with approximately 3 to 6 drivers in a group, if that proves to be feasible. These are expected to be arranged in the evening at convenient times and most likely at one of the UTA bus depots. These discussions will take the general form of a focus group, and the discussion will follow a protocol guide along the lines of the draft guide provided in Attachment 6. These discussions will be moderated by a member of the Battelle evaluation team, and one of the UTA graduate student survey supervisors also will be present to assist with the discussion and note taking. Four such discussion groups are planned: two with CP drivers and two with non-CP drivers.

After completing these discussion groups, an Internet survey will be conducted with a larger sample of bus operators, including operators with CP experience and operators who have not experienced CP. This survey will be short, easily accessible on computers at the bus depots, and will allow the collection of operator data from a much larger sample of operators than would be feasible with in-person interviews or small discussion groups. The Internet survey is shown in Attachment 8.

Route Supervisors / Managers / Radio Controllers A separate set of interviews will be conducted individually with route supervisors and radio controllers who oversee UTA's bus operations and manage the CP program. The appropriate individuals will be identified and the interviews will be scheduled for a convenient time and place. The objective is to understand the perspective of those who are managing and running CP regarding the benefits and any issues encountered in the system. A draft interview protocol is shown in Attachment 7.

3.4.3 Collect Complaint Logs

In addition to the survey data, comment/complaint logs since the inception of the light rail system will be obtained from UTA and analyzed in terms of the issues raised that are pertinent to the CP system. Where possible, these files will be coded by bus route and location. It is recognized that these data are anecdotal and will not be amenable to formal statistical analysis, but rather will offer additional qualitative understanding of issues related to CP. To the extent possible, after inspecting the available data, comparisons will be made station by station (or bus route by bus route) to look for differences in issues and differences between protected and non-protected bus-rail connections, as well as differences before and after the implementation of CP.

3.5 POST-TEST ACTIVITIES

Post-test activities include the analysis of the data collected from the surveys, interviews, discussion groups, and comment/complaint logs, followed by the preparation of draft and final reports on the findings from the evaluation.

3.5.1 Data Analysis

The data analyses will be conducted to assess the extent to which the project's objectives have been met; that is, what is the extent of bus traveler, operator, and management satisfaction with the performance of the CP system? Because this component of the CP system evaluation is qualitative, the analysis will focus on the reported perceptions and experiences of these different groups of respondents to the evaluation's surveys and interviews.

The analysis will provide descriptive findings from the survey questions and a summary of findings from the qualitative discussions and interviews. In addition, the analyses of the survey data will seek to identify the factors that help explain differences in the perceived benefits of CP by rider and trip characteristics. Perspectives from different points of view, including riders, operators, and system managers will contribute to an overall assessment of the CP system. Furthermore, this assessment will be integrated where possible with findings from the system performance component of this program evaluation. The rider survey data and the bus operator survey data both will include experience with CP and without CP. That is, some bus riders and

some bus operators will only have travel experience on routes that have been protected, and others not. The analysis will look for differences in responses among these sub-samples.

The data will be analyzed using the Statistical Package for the Social Sciences (SPSS). SPSS provides for easy management of the study variables and produces output that can be readily converted to presentable tables and graphics, though some of the results will be formatted and presented using MS Excel charts and graphs and MS Word tables. Regardless, all presentation of findings will be integrated in the MS Word report.

3.5.2 Reporting

A draft evaluation report that includes the results and interpretations of the customer satisfaction tests will be prepared and submitted for review and comment. Based on comments received, a final report will be prepared.

3.6 REQUIRED RESOURCES

The estimated level of efforts required to complete this test is provided in Section 4.2.

4.0 SCHEDULE AND LEVEL OF EFFORTS ESTIMATE

4.1 SCHEDULE

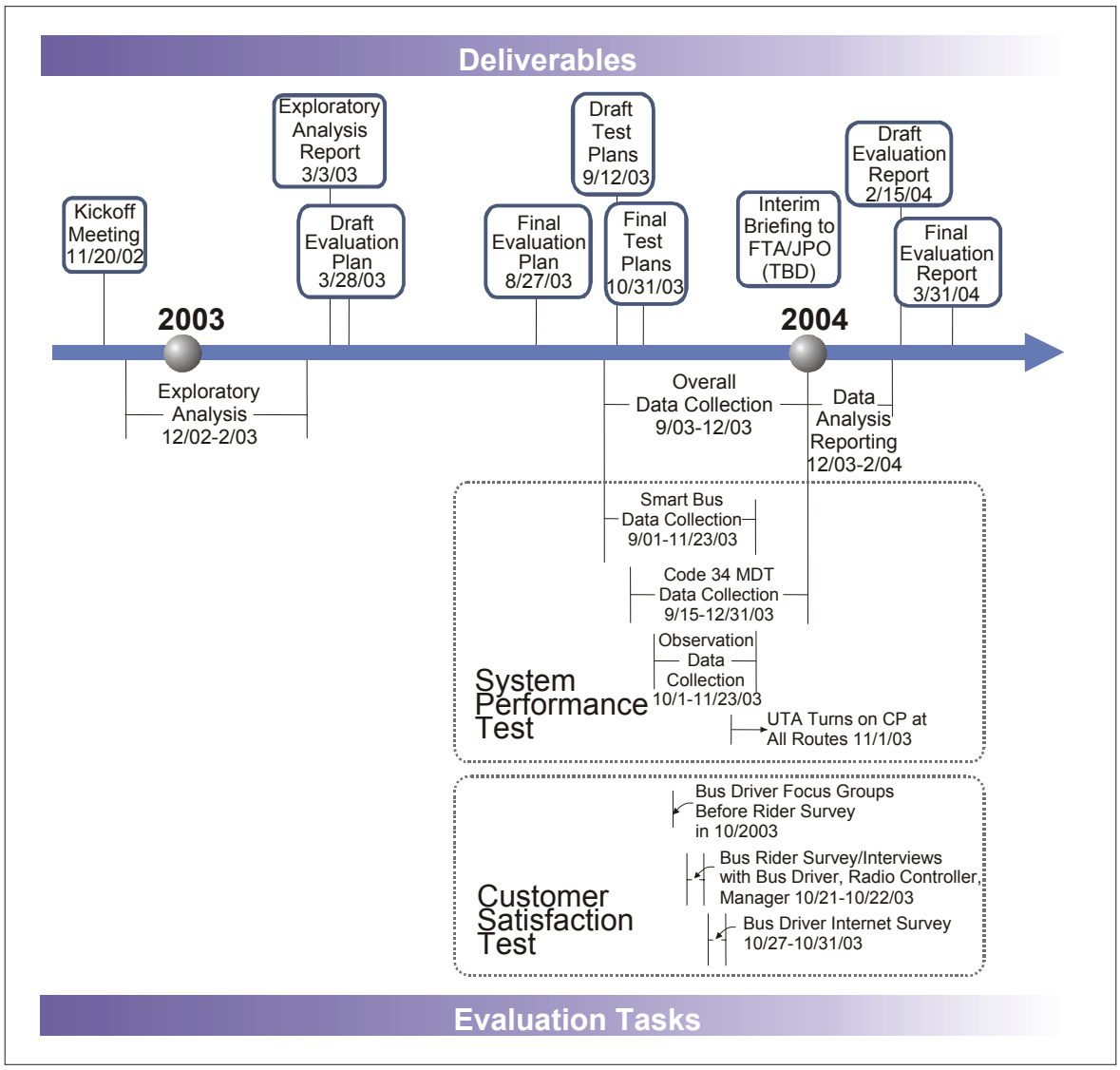

Figure 2. Schedule of Milestones and Deliverables

4.2 LEVEL OF EFFORTS ESTIMATE

Table 16 shows the estimated 1,335 hours of Battelle staff (including BYU) time needed to complete this evaluation. This table, however, does not include the estimated 960 hours (40 days x 6 people x 4 hrs/day) for the proposed manual data collection using human observers. The total hours including the manual data collection is 2,295. Table 17 shows the anticipated travel needed to complete the study.

Table 16. Estimated Resource Requirements for Evaluation of UTA's Connection Protection System

Staff	Staff Hours by Task				
	Pre-test Activities	Test Activities	Post-Test Data Management and Analysis	Post-Test Reporting	Total Hours
System Performance Test					
B. Pierce	20	30	40	35	125
A. Pate	20	80	30	30	160
E. Slone	-	-	100	20	120
S. Smith	-	-	20	-	20
A. Marshall	4	4	-	8	16
Sub Total	44	114	170	93	**421**
Customer Satisfaction Test					
C. Cluett	20	70	40	60	190
J. Panjeti	-	-	-	40	40
M. Nemeth	-	20	-	-	20
M. Tomanov	-	-	100	-	100
BYU	36	360	20	20	436
Sub Total	56	450	160	120	**786**
Project Management					
J. Jenq	10	20	10	60	**100**
Interim Briefing					
J. Jenq	-	-	-	20	20
B. Pierce	-	-	-	8	8
Sub Total	0	0	0	28	**28**
Total Hours	110	584	340	301	**1,335**

Table 17. Anticipated Travel for Evaluation of UTA's Connection Protection System

Staff	From	To	Duration	Purpose
B. Pierce	Columbus	Salt Lake	3 days/2 nights	Data Collection
A. Pate	Columbus	Salt Lake	3 days/2 nights	Data Collection
C. Cluett	Seattle	Salt Lake	3 days/2 nights	Data Collection
C. Cluett	Seattle	Salt Lake	4 days/3 nights	Data Collection
J. Jenq	Phoenix	Salt Lake	3 days/2 nights	Data Collection
J. Jenq	Phoenix	DC	2 days/1 night	Interim Briefing
B. Pierce	Columbus	DC	1 day	Interim Briefing

Attachment 1

Manual Data Collection Forms

UTA System Performance Evaluation - Manual Data Collection Form

Name _____ Date _____

Scheduled Time	Bus Route		Arrival Time	Departure Time	End
		HISTSNDY			
2:37	24	NORTHBOUND			☐
2:54	24	SOUTHBOUND			☐
2:54	90	EASTBOUND		XXXXXXXX	■
2:54	94	WESTBOUND		XXXXXXXX	■
2:55	94	EASTBOUND	XXXXXXXX		☐
2:55	90	WESTBOUND	XXXXXXXX		☐
3:07	24	NORTHBOUND			☐
3:24	24	SOUTHBOUND			☐
3:37	24	NORTHBOUND			☐
3:54	94	WESTBOUND		XXXXXXXX	■
3:54	24	SOUTHBOUND			☐
3:54	90	EASTBOUND		XXXXXXXX	■
3:55	90	WESTBOUND	XXXXXXXX		☐
3:55	94	EASTBOUND	XXXXXXXX		☐
4:07	24	NORTHBOUND			☐
4:24	94	WESTBOUND		XXXXXXXX	■
4:24	24	SOUTHBOUND			☐
4:25	94	EASTBOUND	XXXXXXXX		☐
4:25	90	WESTBOUND	XXXXXXXX		☐
4:37	24	NORTHBOUND			☐
4:54	24	SOUTHBOUND			☐
4:54	94	WESTBOUND		XXXXXXXX	■
4:54	90	EASTBOUND		XXXXXXXX	■
4:55	90	WESTBOUND	XXXXXXXX		☐
4:55	94	EASTBOUND	XXXXXXXX		☐

UTA System Performance Evaluation - Manual Data Collection Form

Name _____ *Date* _____

Scheduled Time	*Bus Route*	*Arrival Time*	*Departure Time*	*End*
5:07	24 NORTHBOUND			☐
5:24	90 EASTBOUND		XXXXXXXX	■
5:24	24 SOUTHBOUND			☐
5:24	94 WESTBOUND		XXXXXXXX	■
5:25	90 WESTBOUND	XXXXXXXX		☐
5:25	94 EASTBOUND	XXXXXXXX		☐
5:37	24 NORTHBOUND			☐
5:54	24 SOUTHBOUND			☐
5:54	90 EASTBOUND		XXXXXXXX	■
5:54	94 WESTBOUND		XXXXXXXX	■
5:55	90 WESTBOUND	XXXXXXXX		☐
5:55	94 EASTBOUND	XXXXXXXX		☐
6:07	24 NORTHBOUND			☐
6:24	90 EASTBOUND		XXXXXXXX	■
6:24	94 WESTBOUND		XXXXXXXX	■
6:24	24 SOUTHBOUND			☐
6:25	94 EASTBOUND	XXXXXXXX		☐
6:25	90 WESTBOUND	XXXXXXXX		☐
6:54	90 EASTBOUND		XXXXXXXX	■
6:54	94 WESTBOUND		XXXXXXXX	■
6:54	24 SOUTHBOUND			☐
6:55	90 WESTBOUND	XXXXXXXX		☐
6:55	94 EASTBOUND	XXXXXXXX		☐
7:14	124 INBOUND			☐

UTA System Performance Evaluation - Manual Data Collection Form

Name _____ *Date* _____

Scheduled Time	*Bus Route*		*Arrival Time*	*Departure Time*	*End*
		MILLCREEK			
2:40	37	WESTBOUND	XXXXXXXX		☐
2:40	31	WESTBOUND			☐
2:40	31	EASTBOUND			☐
2:41	37	EASTBOUND		XXXXXXXX	■
2:55	41	SOUTHBOUND	XXXXXXXX		☐
3:09	31	EASTBOUND			☐
3:10	31	WESTBOUND			☐
3:10	37	WESTBOUND	XXXXXXXX		☐
3:11	37	EASTBOUND		XXXXXXXX	■
3:25	41	SOUTHBOUND	XXXXXXXX		☐
3:25	31	EASTBOUND			☐
3:27	41	NORTHBOUND		XXXXXXXX	■
3:31	31	WESTBOUND			☐
3:40	31	EASTBOUND			☐
3:40	37	WESTBOUND	XXXXXXXX		☐
3:41	37	EASTBOUND		XXXXXXXX	■
3:45	31	WESTBOUND			☐
3:55	31	WESTBOUND			☐
3:55	41	SOUTHBOUND	XXXXXXXX		☐
4:10	31	EASTBOUND			☐
4:10	31	WESTBOUND			☐
4:10	37	WESTBOUND	XXXXXXXX		☐
4:11	37	EASTBOUND		XXXXXXXX	■
4:25	37	WESTBOUND	XXXXXXXX		☐
4:25	41	SOUTHBOUND	XXXXXXXX		☐

UTA System Performance Evaluation - Manual Data Collection Form

Name _____ *Date* _____

Scheduled Time	*Bus Route*	*Arrival Time*	*Departure Time*	*End*
4:27	41 NORTHBOUND		XXXXXXXX	■
4:38	31 EASTBOUND			□
4:40	31 WESTBOUND			□
4:40	37 WESTBOUND	XXXXXXXX		□
4:41	37 EASTBOUND		XXXXXXXX	■
4:54	31 EASTBOUND			□
4:55	37 WESTBOUND	XXXXXXXX		□
4:55	41 SOUTHBOUND	XXXXXXXX		□
4:57	41 NORTHBOUND		XXXXXXXX	■
5:03	31 WESTBOUND			□
5:10	37 WESTBOUND	XXXXXXXX		□
5:11	37 EASTBOUND		XXXXXXXX	■
5:21	41 SOUTHBOUND	XXXXXXXX		□
5:23	31 EASTBOUND			□
5:25	31 WESTBOUND			□
5:27	41 NORTHBOUND		XXXXXXXX	■
5:40	31 EASTBOUND			□
5:40	37 WESTBOUND	XXXXXXXX		□
5:41	37 EASTBOUND		XXXXXXXX	■
5:55	41 SOUTHBOUND	XXXXXXXX		□
5:55	31 WESTBOUND			□
5:56	31 EASTBOUND			□
5:57	41 NORTHBOUND		XXXXXXXX	■
6:10	37 WESTBOUND	XXXXXXXX		□
6:10	31 WESTBOUND			□
6:11	37 EASTBOUND		XXXXXXXX	■

UTA System Performance Evaluation - Manual Data Collection Form

Name _____ *Date* _____

Scheduled Time	*Bus Route*	*Arrival Time*	*Departure Time*	*End*
6:25	31 WESTBOUND			☐
6:25	31 EASTBOUND			☐
6:25	41 SOUTHBOUND	XXXXXXXX		☐
6:27	41 NORTHBOUND		XXXXXXXX	■
6:40	37 WESTBOUND	XXXXXXXX		☐
6:41	37 EASTBOUND		XXXXXXXX	■
6:45	31 WESTBOUND			☐
6:53	31 EASTBOUND			☐
6:57	41 NORTHBOUND		XXXXXXXX	■
7:11	131 EASTBOUND	XXXXXXXX		☐
7:11	37 EASTBOUND		XXXXXXXX	■
7:17	131 WESTBOUND		XXXXXXXX	■
7:25	137 WESTBOUND	XXXXXXXX		☐
7:27	41 NORTHBOUND		XXXXXXXX	■

UTA System Performance Evaluation - Manual Data Collection Form

Name _____ *Date* _____

Scheduled Time	*Bus Route*	*Arrival Time*	*Departure Time*	*End*
	SNDYCCTR			
2:34	41 NORTHBOUND	XXXXXXXX		☐
2:35	24 SOUTHBOUND			☐
2:43	222 SOUTHBOUND		XXXXXXXX	■
2:51	41 SOUTHBOUND		XXXXXXXX	■
2:52	222 NORTHBOUND	XXXXXXXX		☐
2:56	24 NORTHBOUND			☐
2:57	12 NORTHBOUND	XXXXXXXX		☐
3:05	24 SOUTHBOUND			☐
3:07	811 TO SANDY TRAX		XXXXXXXX	■
3:13	222 SOUTHBOUND		XXXXXXXX	■
3:14	33 NORTHBOUND	XXXXXXXX		☐
3:21	33 SOUTHBOUND		XXXXXXXX	■
3:22	222 NORTHBOUND	XXXXXXXX		☐
3:22	12 SOUTHBOUND		XXXXXXXX	■
3:28	24 NORTHBOUND			☐
3:29	811 TO PROVO			☐
3:34	41 NORTHBOUND	XXXXXXXX		☐
3:35	24 SOUTHBOUND			☐
3:42	12 NORTHBOUND	XXXXXXXX		☐
3:43	222 SOUTHBOUND		XXXXXXXX	■
3:44	47 SOUTHBOUND	XXXXXXXX		☐
3:51	41 SOUTHBOUND		XXXXXXXX	■
3:52	222 NORTHBOUND	XXXXXXXX		☐
3:54	33 SOUTHBOUND		XXXXXXXX	■
3:56	24 NORTHBOUND			☐

UTA System Performance Evaluation - Manual Data Collection Form

Name _____ *Date* _____

Scheduled Time	*Bus Route*	*Arrival Time*	*Departure Time*	*End*
4:04	41 NORTHBOUND	XXXXXXXX		☐
4:05	24 SOUTHBOUND			☐
4:07	811 TO SANDY TRAX		XXXXXXXX	■
4:13	222 SOUTHBOUND		XXXXXXXX	■
4:14	811 TO PROVO			☐
4:14	33 NORTHBOUND	XXXXXXXX		☐
4:21	41 SOUTHBOUND		XXXXXXXX	■
4:22	222 NORTHBOUND	XXXXXXXX		☐
4:24	12 SOUTHBOUND		XXXXXXXX	■
4:24	33 SOUTHBOUND		XXXXXXXX	■
4:26	24 NORTHBOUND			☐
4:34	41 NORTHBOUND	XXXXXXXX		☐
4:35	811 TO SANDY TRAX		XXXXXXXX	■
4:35	24 SOUTHBOUND			☐
4:42	12 NORTHBOUND	XXXXXXXX		☐
4:42	33 NORTHBOUND	XXXXXXXX		☐
4:43	345 OUTBOUND	XXXXXXXX		☐
4:43	222 SOUTHBOUND		XXXXXXXX	■
4:44	811 TO PROVO			☐
4:45	47 SOUTHBOUND		XXXXXXXX	■
4:51	41 SOUTHBOUND		XXXXXXXX	■
4:52	222 NORTHBOUND	XXXXXXXX		☐
4:54	33 SOUTHBOUND		XXXXXXXX	■
4:56	24 NORTHBOUND			☐
4:59	811 TO PROVO			☐
5:00	47 SOUTHBOUND	XXXXXXXX		☐

UTA System Performance Evaluation - Manual Data Collection Form

Name _____ *Date* _____

Scheduled Time	*Bus Route*	*Arrival Time*	*Departure Time*	*Exit*
5:04	41 NORTHBOUND	XXXXXXXX		☐
5:05	24 SOUTHBOUND			☐
5:07	811 TO SANDY TRAX		XXXXXXXX	■
5:09	12 SOUTHBOUND		XXXXXXXX	■
5:10	345 OUTBOUND		XXXXXXXX	■
5:12	33 NORTHBOUND	XXXXXXXX		☐
5:13	46 SOUTHBOUND	XXXXXXXX		☐
5:13	222 SOUTHBOUND		XXXXXXXX	■
5:14	811 TO PROVO			☐
5:22	222 NORTHBOUND	XXXXXXXX		☐
5:23	41 SOUTHBOUND		XXXXXXXX	■
5:26	24 NORTHBOUND			☐
5:26	33 SOUTHBOUND		XXXXXXXX	■
5:28	345 OUTBOUND	XXXXXXXX		☐
5:34	41 NORTHBOUND	XXXXXXXX		☐
5:35	24 SOUTHBOUND			☐
5:37	811 TO SANDY TRAX		XXXXXXXX	■
5:39	12 SOUTHBOUND		XXXXXXXX	■
5:42	12 NORTHBOUND	XXXXXXXX		☐
5:42	33 NORTHBOUND	XXXXXXXX		☐
5:43	46 SOUTHBOUND	XXXXXXXX		☐
5:43	222 SOUTHBOUND		XXXXXXXX	■
5:44	811 TO PROVO			☐
5:52	222 NORTHBOUND	XXXXXXXX		☐
5:53	41 SOUTHBOUND		XXXXXXXX	■
5:55	345 OUTBOUND		XXXXXXXX	■

UTA System Performance Evaluation - Manual Data Collection Form

Name _____ *Date* _____

Scheduled Time	*Bus Route*	*Arrival Time*	*Departure Time*	*End*
5:56	33 SOUTHBOUND		XXXXXXXX	■
5:56	24 NORTHBOUND			□
5:58	345 OUTBOUND	XXXXXXXX		□
5:59	811 TO PROVO			□
6:01	47 SOUTHBOUND		XXXXXXXX	■
6:04	41 NORTHBOUND	XXXXXXXX		□
6:05	24 SOUTHBOUND			□
6:05	811 TO SANDY TRAX		XXXXXXXX	■
6:09	12 SOUTHBOUND		XXXXXXXX	■
6:12	33 NORTHBOUND	XXXXXXXX		□
6:13	46 SOUTHBOUND	XXXXXXXX		□
6:13	222 SOUTHBOUND		XXXXXXXX	■
6:15	47 SOUTHBOUND	XXXXXXXX		□
6:19	41 SOUTHBOUND		XXXXXXXX	■
6:22	222 NORTHBOUND	XXXXXXXX		□
6:25	345 OUTBOUND		XXXXXXXX	■
6:26	33 SOUTHBOUND		XXXXXXXX	■
6:28	345 OUTBOUND	XXXXXXXX		□
6:29	811 TO PROVO			□
6:34	41 NORTHBOUND	XXXXXXXX		□
6:35	24 SOUTHBOUND			□
6:39	12 SOUTHBOUND		XXXXXXXX	■
6:41	12 NORTHBOUND	XXXXXXXX		□
6:43	46 SOUTHBOUND	XXXXXXXX		□
6:43	222 SOUTHBOUND		XXXXXXXX	■
6:50	811 TO SANDY TRAX		XXXXXXXX	■

UTA System Performance Evaluation - Manual Data Collection Form

Name _____ *Date* _____

Scheduled Time	*Bus Route*	*Arrival Time*	*Departure Time*	*Exit*
6:53	41 SOUTHBOUND		XXXXXXXX	■
6:55	345 OUTBOUND		XXXXXXXX	■
6:56	33 SOUTHBOUND		XXXXXXXX	■
7:02	124 INBOUND	XXXXXXXX		□
7:02	143 NORTHBOUND	XXXXXXXX		□
7:04	133 INBOUND	XXXXXXXX		□
7:05	24 SOUTHBOUND			□
7:07	12 SOUTHBOUND		XXXXXXXX	■
7:16	47 SOUTHBOUND		XXXXXXXX	■
7:23	41 SOUTHBOUND		XXXXXXXX	■
7:27	125 OUTBOUND		XXXXXXXX	■
7:29	811 TO PROVO			□

Attachment 2

Manual Data Collection Instructions

UTA–System Performance Evaluation

Procedures for Manual Data Collection of Bus Arrival and Departure Times at TRAX Stations

Arrival and departure times for all buses entering and leaving specific TRAX stations will be collected by data collectors identified by the Salt Lake County Aging Services office. Instructions are provided below on the procedures to be followed to collect these data.

Definitions of arrival and departure times are as follows:

- Arrival Time – time at which bus pulls up to its designated drop-off spot and opens doors to allow passengers to disembark

- Departure Time – time at which bus pulls out of its designated pick-up location (typically different from the drop-off spot) after all passengers have boarded

Instructions for collecting the data are as follows:

1. Data collection will occur every weekday between 3:00 pm and 7:00 pm beginning October 1, 2003, and ending November 21, 2003.

2. Data collectors will be assigned in teams of one or two to specific TRAX stations. The TRAX stations that will be monitored are: Millcreek, Historic Sandy, and Sandy Civic Center. Depending on the results from the first couple weeks of data collection, two additional TRAX stations (Central Pointe and Midvale Center) may be added.

3. Pre-printed data collection forms (see attached) showing the buses scheduled to arrive and depart from each TRAX station will be used for data recording.

4. Arrival and departure times in hours, minutes, and seconds (hh:mm:ss) are to be recorded using the radio-controlled clocks provided to each data collector (see back of this sheet for instructions on using the clocks). As a backup, data collectors should synchronize their watches and/or car clocks to the time on the radio-controlled clock at the beginning of each data collection shift. If the radio-controlled clock should fail for any reason, the watch or car clock could then be used for the remainder of the shift.

5. Data collectors should position themselves at the TRAX station so that they can observe all buses entering and leaving their assigned drop-off/pick-up locations. Sitting in a parked car is acceptable as long as the view of the buses is not blocked. Sitting on the train platform is not a good idea because a train stopped at the platform will block the view of the buses.

6. Data collectors working in teams of two should independently record the arrival and departure times (i.e., both members should record the times separately, and they should not compare notes).

7. Completed data collection forms for the previous week are to be given to Sandy Olsen at the Salt Lake County Aging Services office each Monday.

8. Some buses will change route numbers after arriving at the TRAX station. Refer to the attached table for a listing of buses that change route numbers. This table also will be taped, along with a drawing of the bus drop-off/pick-up locations, to the back of each clipboard.

9. Some arrival and departure times are XXXXX'd out on the data collection forms. This means that the bus is either ending or beginning its trip at the TRAX station (often times a bus that changes route numbers). As a result, the bus route entry on the form will not have an arrival or departure time (depending on whether it is beginning or ending its trip) that needs to be recorded.

UTA –System Performance Evaluation

Instructions for Using the WT-300 Radio-Controlled Atomic Clocks

Radio-controlled atomic clocks have been purchased for use on the UTA data collection program so that accurate, synchronized times are ensured. Below are instructions for using the clocks correctly.

1. **Do not press the "Mode/Min" button for longer than a second, or the clock may reset to midnight and thus will not be synchronized with the correct time.**

2. Pressing the "Mode/Min" button (lower right button on front of clock) once will toggle between displaying the alarm clock time and the seconds mode. If the alarm clock time is showing, press and release the button to return to seconds mode (needed because times are required in hh:mm:ss) format.

3. Clocks should be placed in a SE-facing window with their backs facing outward each night. This will enable them to communicate with the atomic clock in Fort Collins, Colorado, and re-synch with the official time. The little triangle/semicircles icon in the lower left-hand corner of the display will indicate that the clock is successfully synchronized.

4. Do not use the clock for any other purposes than data collection (i.e., do not use it as an alarm clock).

5. Do not drop, abuse, or store the clock in extreme temperatures.

6. If the clock malfunctions, return it to Sandy Olsen for replacement.

Contact Information for Manual Data Collection Efforts

Sandy Olsen
Salt Lake County Aging Services
801-468-2234

Alan Pate
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Jeff Jenq
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Chris Cluett
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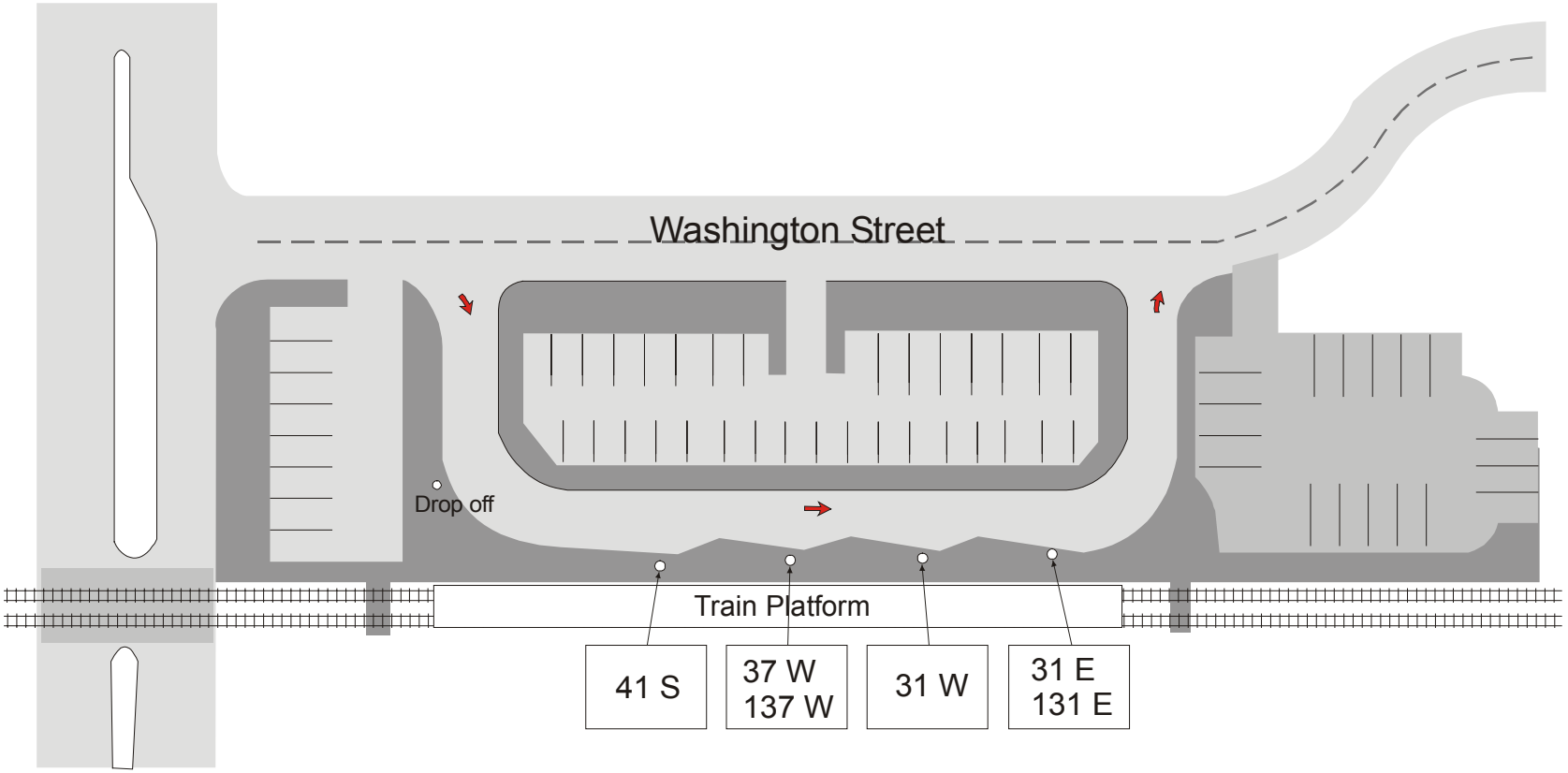
206-528-3333
cluett@battelle.org

UTA –System Performance Evaluation

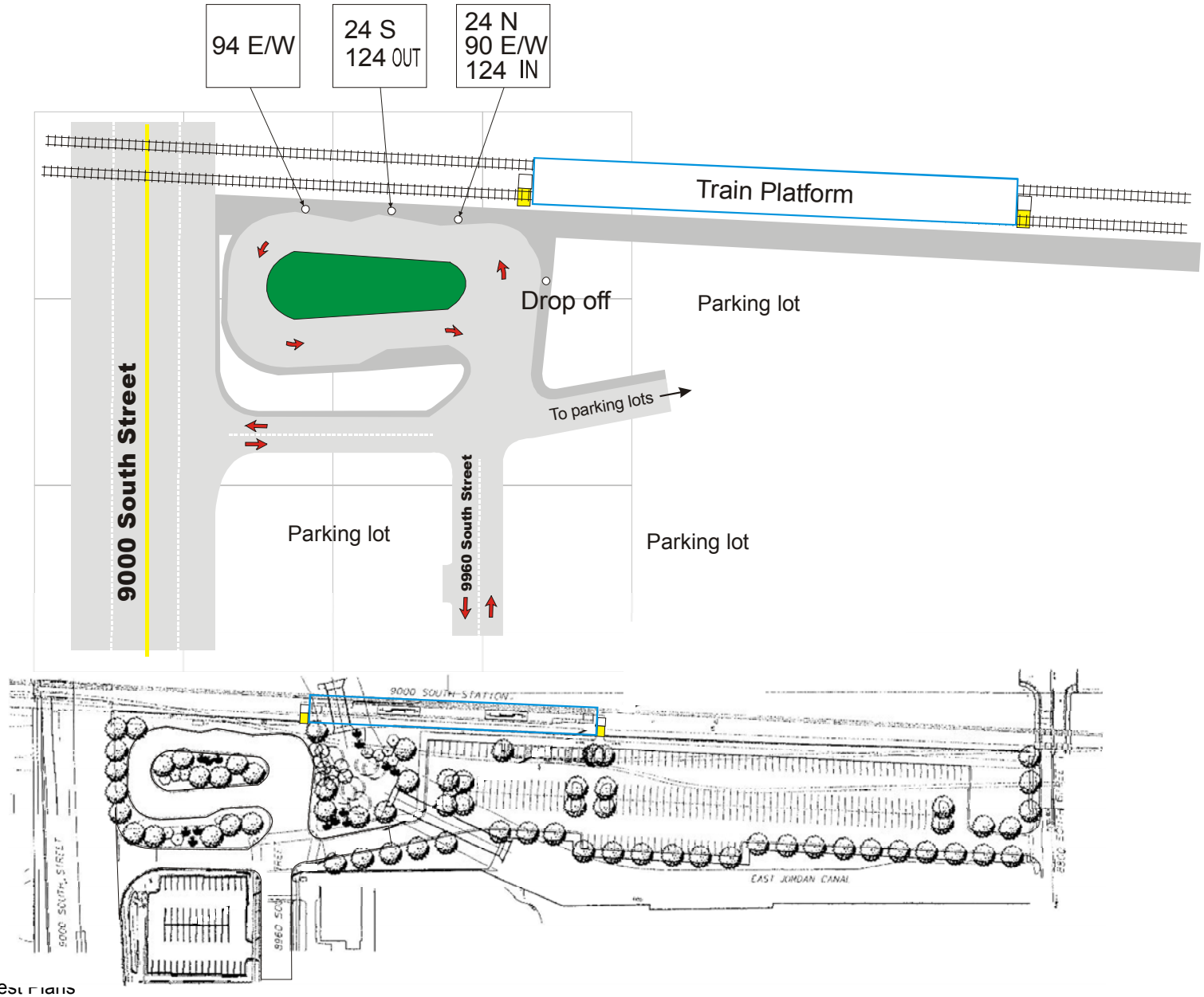
Bus Routes Arriving and Departing TRAX Stations During Manual Data Collection Hours
(shaded bus routes change at TRAX station)

TRAX Station	Bus Arrives as Route #	Bus Departs as Route #
Central Pointe	30 East	30 East
Central Pointe	30 West	30 West
Central Pointe	35 North	35 South
Central Pointe	442 North	442 North
Central Pointe	442 South	442 South
Millcreek	31 East	31 East
Millcreek	31 West	31 West
Millcreek	37 East	37 West OR 41 South
Millcreek	41 North	37 West
Millcreek	131 West	137 West
Midvale Center	25 Clockwise	25 Clockwise
Midvale Center	27 Out	27 In OR 88 West
Midvale Center	88 East	88 West
Midvale Center	125 Out	125 Out
Midvale Center	222 North	222 North
Midvale Center	222 South	222 South
Historic Sandy	24 North	24 North
Historic Sandy	24 South	24 South
Historic Sandy	90 East	94 East
Historic Sandy	94 West	90 West
Sandy Civic Center	12 South	12 North
Sandy Civic Center	24 South	24 South
Sandy Civic Center	24 North	24 North
Sandy Civic Center	33 South	33 North OR 41 North OR 345 Out
Sandy Civic Center	41 South	33 North OR 41 North
Sandy Civic Center	46 South	46 South
Sandy Civic Center	47 South	47 South
Sandy Civic Center	222 South	143 North OR 222 North
Sandy Civic Center	345 Out	345 Out
Sandy Civic Center	811 Sandy	811 Provo

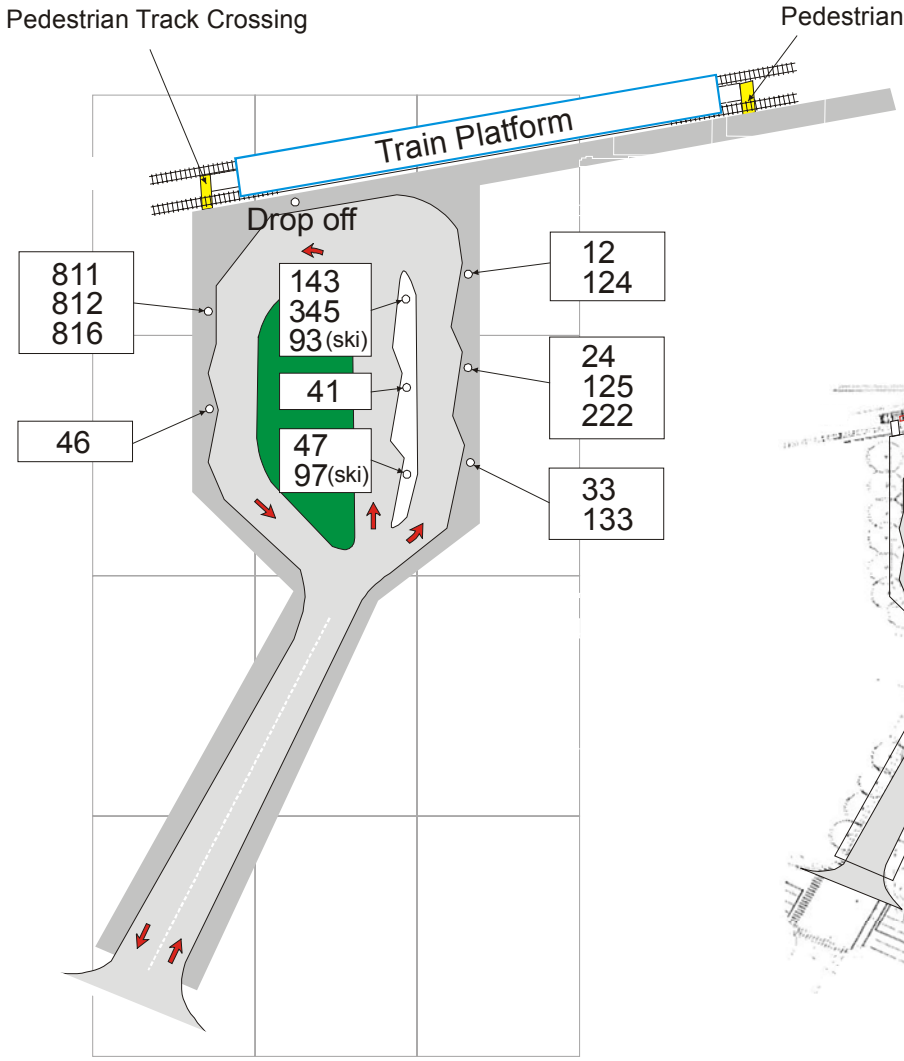
3300 South - Millcreek



9000 South - Historic Sandy



10000 South - Sandy Civic Center



Attachment 3

UTA TRAX Train and Bus Schedules

UTA TRAX Train and Bus Schedules

Historic Sandy 9000S TRAX 35 buses (12 Protected; 23 Un-Protected)		Sandy Civic Ctr 10000S TRAX 69 Buses (20 Protected; 49 Un-Protected)		Millcreek 3300 S TRAX 40 Buses (7 Protected; 33 Un-Protected)	
701 SB TRAX	3:52 PM	41 NB	4:04 PM	701 NB TRAX	4:01 PM
90 WB	3:55 PM	24 SB	4:05 PM	701 SB TRAX	4:07 PM
94 EB	3:55 PM	701 SB TRAX	4:09 PM	31 WB	4:10 PM
701 NB TRAX	4:01 PM	811 to Provo	4:14 PM	31 EB	4:10 PM
701 SB TRAX	4:07 PM	33 NB	4:14 PM	37 WB	4:10 PM
24 NB	4:07 PM	222 NB	4:22 PM	701 NB TRAX	4:16 PM
701 NB TRAX	4:16 PM	701 SB TRAX	4:24 PM	701 SB TRAX	4:22 PM
701 SB TRAX	4:22 PM	24 NB	4:26 PM	37 WB	4:25 PM
24 SB	4:24 PM	41 NB	4:34 PM	41 SB	4:25 PM
90 WB	4:25 PM	24 SB	4:35 PM	701 NB TRAX	4:31 PM
94 EB	4:25 PM	701 SB TRAX	4:39 PM	701 SB TRAX	4:37 PM
701 NB TRAX	4:31 PM	12 NB	4:42 PM	31 EB	4:38 PM
24 NB	4:37 PM	33 NB	4:42 PM	31 WB	4:40 PM
701 SB TRAX	4:37 PM	345 OB	4:43 PM	37 WB	4:40 PM
701 NB TRAX	4:46 PM	811 to Provo	4:44 PM	701 NB TRAX	4:46 PM
701 SB TRAX	4:52 PM	222 NB	4:52 PM	701 SB TRAX	4:52 PM
24 SB	4:54 PM	701 SB TRAX	4:54 PM	31 EB	4:54 PM
90 WB	4:55 PM	24 NB	4:56 PM	37 WB	4:55 PM
94 EB	4:55 PM	811 to Provo	4:59 PM	41 SB	4:55 PM
701 NB TRAX	5:01 PM	47 SB	5:00 PM	701 NB TRAX	5:01 PM
24 NB	5:07 PM	41 NB	5:04 PM	31 WB	5:03 PM
701 SB TRAX	5:07 PM	24 SB	5:05 PM	701 SB TRAX	5:07 PM
701 NB TRAX	5:16 PM	701 SB TRAX	5:09 PM	37 WB	5:10 PM
701 SB TRAX	5:22 PM	33 NB	5:12 PM	703 SB TRAX	5:11 PM
24 SB	5:24 PM	46 SB	5:13 PM	701 NB TRAX	5:16 PM
90 WB	5:25 PM	811 to Provo	5:14 PM	41 SB	5:21 PM
94 EB	5:25 PM	222 NB	5:22 PM	701 SB TRAX	5:22 PM
703 SB TRAX	5:26 PM	701 SB TRAX	5:24 PM	31 EB	5:23 PM
701 NB TRAX	5:31 PM	24 NB	5:26 PM	31 WB	5:25 PM
701 SB TRAX	5:37 PM	345 OB	5:28 PM	701 NB TRAX	5:31 PM
24 NB	5:37 PM	703 SB TRAX	5:28 PM	701 SB TRAX	5:37 PM
701 NB TRAX	5:38 PM	41 NB	5:34 PM	31 EB	5:40 PM
701 NB TRAX	5:46 PM	24 SB	5:35 PM	37 WB	5:40 PM
701 SB TRAX	5:52 PM	701 SB TRAX	5:39 PM	701 NB TRAX	5:46 PM
24 SB	5:54 PM	12 NB	5:42 PM	701 SB TRAX	5:52 PM
90 WB	5:55 PM	33 NB	5:42 PM	31 WB	5:55 PM
94 EB	5:55 PM	46 SB	5:43 PM	41 SB	5:55 PM
701 NB TRAX	6:01 PM	811 to Provo	5:44 PM	31 EB	5:56 PM
24 NB	6:07 PM	222 NB	5:52 PM	701 NB TRAX	6:01 PM
701 SB TRAX	6:07 PM	701 SB TRAX	5:54 PM	701 SB TRAX	6:07 PM
701 NB TRAX	6:16 PM	24 NB	5:56 PM	31 WB	6:10 PM
701 SB TRAX	6:22 PM	345 OB	5:58 PM	37 WB	6:10 PM
24 SB	6:24 PM	811 to Provo	5:59 PM	701 NB TRAX	6:16 PM
90 WB	6:25 PM	41 NB	6:04 PM	701 SB TRAX	6:22 PM
94 EB	6:25 PM	24 SB	6:05 PM	31 WB	6:25 PM
701 NB TRAX	6:31 PM	701 SB TRAX	6:09 PM	31 EB	6:25 PM
701 SB TRAX	6:37 PM	33 NB	6:12 PM	41 SB	6:25 PM
701 NB TRAX	6:46 PM	46 SB	6:13 PM	701 NB TRAX	6:31 PM
701 SB TRAX	6:52 PM	47 SB	6:15 PM	701 SB TRAX	6:37 PM
24 SB	6:54 PM	222 NB	6:22 PM	37 WB	6:40 PM
90 WB	6:55 PM	701 SB TRAX	6:24 PM	701 NB TRAX	6:46 PM
94 EB	6:55 PM	345 OB	6:28 PM	31 WB	6:48 PM
701 NB TRAX	7:01 PM	811 to Provo	6:29 PM	701 SB TRAX	6:52 PM
701 SB TRAX	7:07 PM	41 NB	6:34 PM	31 EB	6:53 PM
124 IB	7:14 PM	24 SB	6:35 PM	701 NB TRAX	7:01 PM
701 NB TRAX	7:16 PM	701 SB TRAX	6:39 PM	701 SB TRAX	7:07 PM
701 SB TRAX	7:22 PM	12 NB	6:41 PM	131 EB	7:11 PM

Historic Sandy 9000S TRAX 35 buses (12 Protected; 23 Un-Protected)	
701 NB TRAX	7:26 PM
701 NB TRAX	7:31 PM
701 SB TRAX	7:37 PM
701 NB TRAX	7:46 PM
701 SB TRAX	7:52 PM
701 NB TRAX	8:01 PM
701 SB TRAX	8:07 PM
124 IB	8:14 PM
701 NB TRAX	8:16 PM
701 SB TRAX	8:22 PM
701 NB TRAX	8:31 PM
701 SB TRAX	8:37 PM
124 OB	8:40 PM
701 NB TRAX	8:46 PM
701 SB TRAX	8:52 PM
701 NB TRAX	9:01 PM
701 SB TRAX	9:07 PM
124 IB	9:14 PM
701 NB TRAX	9:16 PM
701 SB TRAX	9:22 PM
701 NB TRAX	9:31 PM
701 SB TRAX	9:37 PM
124 OB	9:40 PM
701 NB TRAX	9:46 PM
701 SB TRAX	9:52 PM
701 NB TRAX	10:01 PM
701 SB TRAX	10:07 PM
124 IB	10:14 PM
701 NB TRAX	10:16 PM
701 SB TRAX	10:22 PM
701 NB TRAX	10:31 PM
701 SB TRAX	10:37 PM
124 OB	10:40 PM
701 NB TRAX	10:46 PM
701 SB TRAX	10:52 PM
701 NB TRAX	11:01 PM
701 SB TRAX	11:07 PM
124 IB	11:14 PM
701 NB TRAX	11:16 PM
701 SB TRAX	11:22 PM
701 NB TRAX	11:31 PM
701 SB TRAX	11:37 PM
124 OB	11:40 PM
701 NB TRAX	11:46 PM
701 SB TRAX	11:52 PM
701 SB TRAX	12:07 AM
124 OB	12:10 AM

Sandy Civic Ctr 10000S TRAX 69 Buses (20 Protected; 49 Un-Protected)	
46 SB	6:43 PM
701 NB TRAX	6:49 PM
701 SB TRAX	6:54 PM
124 IB	7:02 PM
143 NB	7:02 PM
133 IB	7:04 PM
24 SB	7:05 PM
701 SB TRAX	7:09 PM
701 SB TRAX	7:19 PM
701 SB TRAX	7:24 PM
811 to Provo	7:29 PM
125 IB	7:36 PM
701 SB TRAX	7:39 PM
701 SB TRAX	7:54 PM
124 IB	8:02 PM
143 NB	8:02 PM
133 IB	8:04 PM
701 SB TRAX	8:09 PM
701 SB TRAX	8:24 PM
125 IB	8:36 PM
701 SB TRAX	8:39 PM
811 to Provo	8:44 PM
701 SB TRAX	8:54 PM
124 IB	9:02 PM
143 NB	9:02 PM
133 IB	9:04 PM
701 SB TRAX	9:09 PM
701 SB TRAX	9:24 PM
125 IB	9:36 PM
701 SB TRAX	9:39 PM
816 to Provo	9:44 PM
701 SB TRAX	9:54 PM
124 IB	10:02 PM
143 NB	10:02 PM
133 IB	10:04 PM
701 SB TRAX	10:09 PM
701 SB TRAX	10:24 PM
125 IB	10:36 PM
701 SB TRAX	10:39 PM
816 to Provo	10:44 PM
701 SB TRAX	10:54 PM
124 IB	11:02 PM
143 NB	11:02 PM
701 SB TRAX	11:09 PM
701 SB TRAX	11:24 PM
701 SB TRAX	11:39 PM
701 SB TRAX	11:54 PM
701 SB TRAX	12:09 AM

Millcreek 3300 S TRAX 40 Buses (7 Protected; 33 Un-Protected)	
701 NB TRAX	7:16 PM
701 SB TRAX	7:22 PM
137 WB	7:25 PM
701 NB TRAX	7:31 PM
701 SB TRAX	7:37 PM
701 NB TRAX	7:46 PM
701 SB TRAX	7:52 PM
137 WB	7:55 PM
701 NB TRAX	8:01 PM
701 SB TRAX	8:07 PM
131 EB	8:11 PM
701 NB TRAX	8:16 PM
701 SB TRAX	8:22 PM
137 WB	8:25 PM
701 NB TRAX	8:31 PM
701 SB TRAX	8:37 PM
701 NB TRAX	8:46 PM
701 SB TRAX	8:52 PM
137 WB	8:55 PM
701 NB TRAX	9:01 PM
701 SB TRAX	9:07 PM
131 EB	9:11 PM
701 NB TRAX	9:16 PM
701 SB TRAX	9:22 PM
137 WB	9:25 PM
701 NB TRAX	9:31 PM
701 SB TRAX	9:37 PM
701 NB TRAX	9:46 PM
701 SB TRAX	9:52 PM
701 NB TRAX	10:01 PM
701 SB TRAX	10:07 PM
131 EB	10:11 PM
701 NB TRAX	10:16 PM
701 SB TRAX	10:22 PM
137 WB	10:25 PM
701 NB TRAX	10:31 PM
701 SB TRAX	10:37 PM
701 NB TRAX	10:46 PM
701 SB TRAX	10:52 PM
701 SB TRAX	11:07 PM
703 SB TRAX	11:13 PM
701 SB TRAX	11:22 PM
137 WB	11:25 PM
703 SB TRAX	11:27 PM
701 SB TRAX	11:37 PM
703 SB TRAX	11:41 PM
701 SB TRAX	11:52 PM

Color Key
TRAX Train Routes
Protected Bus Routes
Unprotected Bus Routes

Attachment 4

UTA Rail-to-Bus Transfer Rider Survey

UTA Rail-to-Bus Transfer Rider Survey

1. How often do you ride the bus (one-way trip) **in a typical week** (Monday through Friday)?

☐ 1 time or less a week	☐ 6 to 7 times a week
☐ 2 to 3 times a week	☐ 8 to 9 times a week
☐ 4 to 5 times a week	☐ 10 or more times a week

2. How many times **in the past month** (past 30 days) have you missed your scheduled bus connection **at this TRAX station** because the TRAX train was late?

☐ No times in the past month	☐ 2 to 3 times
☐ 1 time	☐ 4 or more times

3. What are you **most likely to do** when you miss your bus connection? *(check one box)*

☐ Never missed my bus	☐ Call family member or friend to get me.
☐ Wait for the next bus	☐ Ask someone for a ride
☐ Walk	☐ Other (specify:_____)
☐ Call a cab	

4. If you miss your bus, **how long** do you **usually** have to wait for the next bus, or for some other means of transportation? *(check one box)*

☐ Never miss my bus	☐ Wait 31 minutes to 45 minutes
☐ Wait 15 minutes or less	☐ Wait more than 45 minutes
☐ Wait 16 to 30 minutes	

5. If your train is late, does the bus driver wait for you?

☐ Never	☐ Always
☐ Occasionally	☐ Don't know / my train is never that late
☐ Most of the time	

6. **In the past month** how often have you taken an earlier TRAX train to make it more likely you will not miss your preferred bus connection at this station?

☐ Never	☐ Most of my trips
☐ Some of my trips	☐ Always

7. How important is it to you **to be sure** you will make your scheduled bus connection?

☐ Very important	☐ Not very important
☐ Somewhat important	☐ Unimportant

8. **If your bus departs late** from the TRAX station due to a late train arrival, do you ever miss your next bus transfer down the line?

☐ Don't have any bus transfers down the line	☐ Never missed a later transfer
☐ Never have departed late from the TRAX station	☐ Sometimes miss later transfer
	☐ Frequently miss later transfer

9. Your characteristics. *(check one box in each column)*

Gender	**Age category**	**Is there any reason that makes it difficult for you to make your rail-to-bus connection?**
☐ Female	☐ Less than 20 years	☐ No
☐ Male	☐ 21 to 64	☐ Yes (specify:_____)
	☐ 65 or older	

10. Overall, **how satisfied** are you with your experiences connecting from the train to your preferred bus?

☐ Very satisfied	☐ Somewhat dissatisfied
☐ Somewhat satisfied	☐ Very dissatisfied

11. Any comments or suggestions for UTA regarding rail-to-bus connections? **(Write on back)**

Attachment 5

UTA Bus Rider Survey

UTA Bus Rider Survey

1. How often do you ride the bus (one-way trip) **in a typical week** (Monday through Friday)?

☐ 1 time or less a week	☐ 6 to 7 times a week
☐ 2 to 3 times a week	☐ 8 to 9 times a week
☐ 4 to 5 times a week	☐ 10 or more times a week

2. How many times **in the past month** (past 30 days) have you been on this bus when it arrived late at this station?

☐ No times in the past month	☐ 2 to 3 times
☐ 1 time	☐ 4 or more times

3. How many times **in the past month** (past 30 days) has this bus waited past its scheduled departure time at this TRAX station because the train was late?

☐ No times in the past month	☐ 2 to 3 times
☐ 1 time	☐ 4 or more times

4. When the train is late, does the bus driver discuss the need to wait for train passengers or ask the bus passengers if it is OK to wait?

☐ Never	☐ Most of the time
☐ Occasionally	☐ Always

5. Is it a problem for you if your bus is delayed because of a late train connection?

☐ No problem at all	☐ Somewhat of a problem
☐ Not much of a problem	☐ A big problem

6. If your bus departs late from the TRAX station due to a late train arrival, do you ever miss your next bus transfer down the line?

☐ Don't have any bus transfers down the line	☐ Never missed a later transfer
☐ Never have departed late from the TRAX station	☐ Sometimes miss later transfer
	☐ Frequently miss later transfer

7. How many times **in the past month** (past 30 days) has this bus arrived late at your final destination?

☐ No times in the past month	☐ 2 to 3 times
☐ 1 time	☐ 4 or more times

8. Your characteristics. *(check <u>one</u> box in each column)*

Gender	**Age category**
☐ Female	☐ Less than 20 years
☐ Male	☐ 21 to 64
	☐ 65 or older

9. Overall, how satisfied are you with how the bus operators deal with late train connections?

☐ Very satisfied	☐ Somewhat dissatisfied
☐ Somewhat satisfied	☐ Very dissatisfied

10. Do you have any comments or suggestions for UTA regarding rail-to-bus connections?

_____

_____

_____

_____

Attachment 6

UTA Bus Operator Group Discussion Guide

UTA Bus Operator Group Discussion Guide

1. Ground rules

(1) Individual identities are confidential
(2) No right or wrong answers
(3) Schedule to keep—limited to ½ hour
(4) Audio-taping for notes only; tape will be erased. Use only if everyone consents.
(5) Purpose of the interview: is to discuss how you handle late train events
    (a) Discuss how you handle late train events
    (b) Discuss awareness of and perceived value of Connection Protection program

2. Introductions

(1) Explain role/function of the evaluation
(2) This is an informal discussion, part of several different data collections
(3) First name only
(4) How many years driving a bus?
(5) How long with Utah Transit Authority?

3. Discuss connection protection program

(1) Have you heard of this CP program?
(2) If so, what do you know about it?
(3) Have you ever received a message asking that you hold your bus beyond your scheduled departure?
(4) How often do you get these kinds of messages?
(5) How do your bus passengers feel about such delays?
    (a) Do the opinions of your passengers influence how you deal with decisions to wait for connecting passengers?
(6) In the absence of a CP message, how do you deal with late train events?
(7) Would you say a bus operator gets to know their regular customers personally?
    (a) If so, how does that influence how you respond if they are late for their bus?
(8) If you have to hold, how easy or difficult is it for you to make up that time in your schedule?
(9) What is your management's attitude toward schedule adherence?
    (a) Do they encourage you to wait for late passengers or do they just leave that decision up to your judgment?
(10) Overall, from your point of view, what are the pros and cons of the CP program?
    (a) What do you like best about CP? Least?
    (b) Is the performance of the CP system reliable and consistent?
    (c) What is the perspective of your passengers on this?
    (d) Do you think the program should be applied to all bus runs that connect with a TRAX station?
    (e) Does CP impact your job in any particular ways? If so, how?

4. Wrap up

(1) Anything else you would like to say about these matters?

Attachment 7

UTA Route Supervisor and Radio Controller Interview Guide

UTA Route Supervisor and Radio Controller Interview Guide

1. Ground rules

(1) Individual identities are confidential
(2) No right or wrong answers
(3) Schedule to keep—limited to ½ hour
(4) Audio-taping for notes only; tape will be erased. Use only if everyone consents.
(5) Purpose of the interview: is to discuss the function and effectiveness of CP
    (a) Discuss how you handle late train events
    (b) Discuss your guidance to bus operators
    (c) Discuss awareness of and perceived value of CP program

2. Introductions

(1) Explain role/function of the evaluation
(2) This is an informal discussion, part of several different data collections
(3) First name only
(4) How long with Utah Transit Authority?
(5) How many years doing this job?

3. Discuss connection protection program

(1) What is your understanding of the objective of the CP program?
(2) Tell me how the CP program works and your specific role in it?
(3) What are the main causes of late train events that trigger CP notices to the bus operators?
(4) How frequently is CP actually implemented?
(5) How does UTA view the trade-off between allowing schedule delays to assure successful connections, versus maintaining schedule adherence?
    (a) Are bus operators encouraged to wait for late trains beyond their scheduled departure times, whether or not they are on a run covered by CP?
    (b) How do bus operators generally respond to late train events in situations where CP is not operational
(6) What is your sense of how the bus drivers view CP? Do they generally like it or not? Why or why not?
(7) What is your sense of the benefit UTA and the customers are deriving from the CP program?
(8) Are you getting specific feedback on the programs performance? If so, what is it telling you?
    (a) From bus operators?
    (b) From customers?
    (c) Other sources?
(9) Overall, from your point of view, what are the pros and cons of the CP program?
    (a) What do you like best about CP? Least?
    (b) How well or effectively would you say the program is working?
    (c) Are there improvements to the program you would like to see?
    (d) Do you think the program should be applied to all bus runs that connect with a TRAX station? Why / why not?
    (e) Does CP impact your job in any particular ways? If so, how?

4. Wrap up

(1) Anything else you would like to say about these matters?

Attachment 8

UTA Bus Operator Internet Survey

UTA Bus Operator Internet Survey

Battelle is conducting this Internet survey on behalf of Utah Transit Authority (UTA) and the U.S. Department of Transportation to evaluate systems that can help transit riders avoid missed connections. UTA's system is called the **Connection Protection** program (CP).

Please plan to answer these questions on your own, without first discussing them with others. We want your personal opinions, both pro and con, about the CP system.

Your participation in this study is completely voluntary. All of the information you provide in this interview will be kept strictly confidential and will not be disclosed to anyone but the researchers conducting the study. Your employer will not know which individuals provided which answers to these questions.

The survey has 21 easy questions that should take between 5 and 10 minutes to complete.

1. For how long have you been a bus operator for UTA?

   Years: _____ Months: _____

2. Do you know about the UTA Connection Protection (CP) program that alerts bus operators to hold their bus past the normal scheduled departure time to allow TRAX train passengers to make their bus connection if their train arrives late at the station?
   - ❑ I've not heard about that
   - ❑ I've heard about it, but I don't know much about it
   - ❑ I know what this is

3. Have you ever received a CP message from the radio operator asking that you hold your bus at a TRAX station beyond your scheduled departure time?
   - ❑ No *(skip to question 5)*
   - ❑ Yes

4. Approximately how many such CP messages have you received in the past 30 days?

   Number of CP messages: _____

5. Do you know most of your regular passengers by sight?
   - ❑ No
   - ❑ Yes

6. If you don't receive a message and the train is late enough that some passengers are likely to miss your bus, what do usually you do?
   - ❑ I leave the station on schedule, even if the train is late and even though some passengers may miss my bus.
   - ❑ I wait for my passengers to arrive, even if the train is late, so they don't miss their bus.

7. How often do you wait past your scheduled departure time for the passengers whom you believe are likely to be connecting from TRAX but are late?
   - ❑ Never
   - ❑ Sometimes
   - ❑ Always

8. What is the longest amount of time you are willing to delay your departure past your scheduled departure time in order to allow late passengers to board your bus?

   Number of minutes of delay: _____

9. Do the opinions of your passengers affect your decisions about whether to wait for late riders beyond your scheduled departure?
   - ❑ No
   - ❑ Yes

10. Do you ask your on-board passengers whether they mind waiting before you decide to wait?
    - ❑ Never
    - ❑ Sometimes
    - ❑ Always

11. Does it matter to you if waiting for a late train causes you to get behind in your schedule?
    - ❑ No
    - ❑ Yes

12. What about your on-board passengers? Do they mind waiting for a late train that causes your bus to get behind schedule?
    - ❑ No
    - ❑ A few may mind
    - ❑ Many are likely to mind

13. If you have to wait past your scheduled departure to pick up late riders, generally how difficult or easy is it on most of your runs to make up time and get back on schedule?
    - ❑ Impossible
    - ❑ Very difficult
    - ❑ Somewhat easy
    - ❑ Very easy

The following are several statements about your opinions. Please indicate the extent to which you agree or disagree with each statement.

STATEMENT	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
14. The Connection Protection program that sends messages to bus operators to wait for passengers connecting from late trains is a worthwhile program.	1	2	3	4	5
15. The Connection Protection program really isn't necessary because I wait for passengers when the train is late anyway.	1	2	3	4	5
16. UTA is supportive of bus operators making their own decisions about schedule adherence.	1	2	3	4	5
17. I don't like being told that I have to wait longer than a scheduled departure.	1	2	3	4	5
18. Maintaining my scheduled departures is more important to me than accommodating late passengers.	1	2	3	4	5
19. The Connection Protection program should be used on all bus routes that continue on to stops after a stop at a TRAX station	1	2	3	4	5

20. What aspects of the Connection Protection program do you like most?

_____

21. What aspects of the Connection Protection program do you like least?

_____

Thank you for your participation!

Please offer any additional comments, suggestions, or other observations.

_____