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Delivering Real-Time Status and Arrival Information to Commuter Rail Passengers at Complex Stations

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13. ABSTRACT (maximum 200 words)

Software was developed for calculating real-time train status in an Automated Train Information Display System (ATIDS) at NJ Transit. Interfaces were developed for passing schedules and real-time train position and routing data from a rail traffic control system (CTC) to the ATIDS equipment. The technology was integrated into a fully automated multi-track display and annunciation system and successfully demonstrated at NJ Transit in 1997.

Operational tests revealed that the quality of the data received from the rail traffic control system was insufficient for passenger information purposes. Often, the CTC system knew that a train was present (sufficient for train dispatch purposes), but not which train it was (required for passenger information). Lessons learned were incorporated into the design of NJ Transit's next generation of rail dispatch systems.

To address the issue of customer requirements for real-time information, market research was conducted with a series of 9 focus groups comprised of both frequent and infrequent riders. It was found that many of the transit industry's most common display formats contain information of no value to customers, that information was often being provided in a needlessly cumbersome manner, and that several of the customers' more critical information needs have not yet been considered by the industry.

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Executive Summary

Research was conducted under a grant from the FTA Office of Technology by NJ Transit, North America's largest provider of State-wide bus and rail transit services, and Com-Net Software Systems, a leading supplier of passenger information systems for public transit and commercial aviation, to determine the feasibility of delivering real-time information to commuter rail passengers at complex stations. (A "complex" station is one at which trains on a given track may be destined for any of a variety of destinations, and/or where trains for a given destination may arrive on any of a variety of tracks.)

Software was developed for calculating real-time train status in an Automated Train Information Display System (ATIDS). Interfaces were developed for passing schedules and real-time train position and routing data from a centralized rail traffic control system (CTC) to the ATIDS equipment. The technology was integrated into a fully automated multi-track display and annunciation system and successfully demonstrated in 1997.

The technology worked, but operational tests revealed that the quality of the data received from the rail traffic control system was insufficient for passenger information purposes. The train identification was unreliable. The CTC system was often only able to tell with certainty that a given location had just been passed by some train (which is sufficient for train dispatch and passenger safety), but not by which train, which is required for passenger information. An interim report was issued, and lessons learned were incorporated into the design of NJ Transit's next generation of rail dispatch systems.

To address the issue of customer requirements for real-time information, market research was conducted with a series of 9 focus groups comprised of both frequent and infrequent riders. It was found that many of the public transit industry's most common display formats contain – even highlight – pieces of information with no value to customers, that information was often being provided in a needlessly cumbersome manner, and that several of the customers' more critical information needs have not yet been considered by the industry.

Key Findings:

- Station architects devote insufficient real estate (by factors of 2-3) to real-time information systems and displays.
- Local confirmation of actual train arrival at each station (through local track circuits, motion detectors, etc.) is key to accurate arrival and departure status information.
- Train number, historically the lynchpin of commuter rail passenger information, while critical to operations supervision, is useless clutter and a waste of display space to transit customers.
- It's easy for rail operators to underestimate the impact on passengers of operating trains out of their scheduled sequence – there is nothing more frustrating than getting on the wrong train and not knowing it until after departure. Especially when trains are being operated out of sequence, operators need to take special care to ensure that passengers know which train they're on, and to give them a chance to get off, if necessary, prior to departure.
- Rail Passenger Information Systems can be built to the same ITS interface standards as their bus transit counterparts.

- Providing dispatchers with a scripted, parameterized on-line form for recording incident and disruption information (rather than the usual free text form) will allow voice announcements in the field to be fully automated, even for service disruptions.
- Innovative infrared signage technologies can be used to expand the scope and reach of passenger information systems to provide equivalent services to foreign speaking and vision-impaired customers.
- The data quality required for useful passenger information far exceeds that required for system operations and service supervision.
- Equally important as the existence of a service disruption is its anticipated duration, and timely notification of subsequent service restoration.
- The same functionality that makes it possible to determine and report accurate real time status for customers can also be used to track the location, cause, extent and cost of delays and disruptions for transit management.
- A real-time passenger information system can be fully automated, but only if train identification accuracy is assured.
- Rail lines should be identified on signs and displays by letters and numbers, rather than symbols.
- Display and annunciation systems should highlight not only the trains' departure time and ultimate destination, but also their class (local, express, limited) and first stop as well.
- Interactive displays providing an alphabetical listing of every destination served from a given location, with corresponding departure times, arrival times and connection locations for the next two trains or buses, updated in real time, can be very helpful to occasional and new riders, as well as to frequent riders traveling at an unfamiliar time or to an unfamiliar destination.
- Displays in larger stations should be individually addressable, so that trains can be marked as "departed", or "roll off" from displays at a given location, even prior to actual train departure, once it is clear that passengers viewing the display at that location cannot possibly catch the train(s) in question.
- Passenger information system elements included by facilities engineering departments in parts of larger station design or construction projects tend to be at once physically over-specified and functionally incomplete. A standard functional specification for real-time passenger information would go a long way toward helping these departments understand passengers' requirements for real-time information.
- Most passenger information needs can be supported centrally, via the Internet, with browser-based interfaces to static and interactive displays and personal devices in the field.

PURPOSE

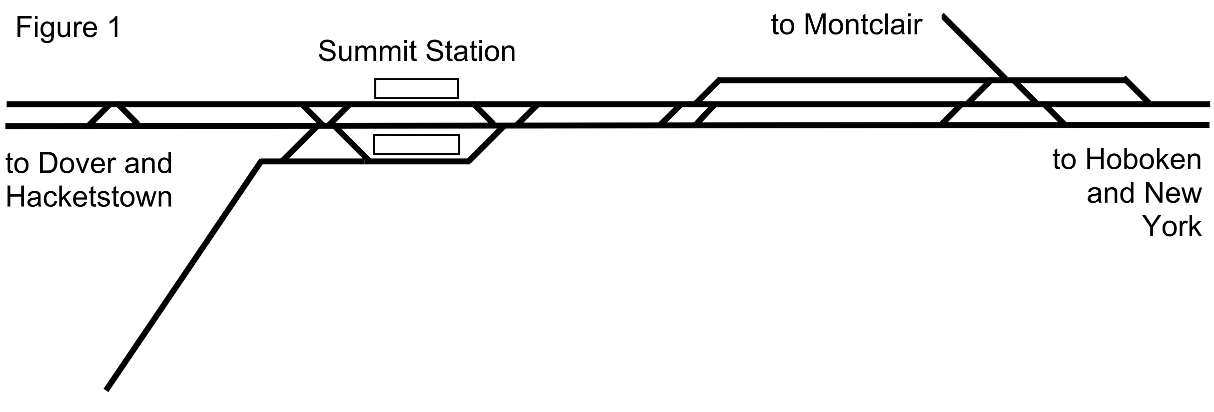
The purpose of this research project was to determine the feasibility of delivering real-time information to commuter rail passengers at complex stations. Chief among the issues addressed were:

- Customer requirements for real-time information
- Data interface requirements
- Data quality requirements
- Sources of “bad” data
- System design considerations

BACKGROUND

NJ Transit Rail Operations' Hoboken Division operates approximately 324 revenue trains each working day, with a peak frequency of 22 revenue trains per hour on its most patronized line, the Morris and Essex (M&E) -- 15% greater than even the combined frequency of Amtrak and NJ Transit trains on the heavily traveled Northeast Corridor. Given this frequency of service, with trains arriving every 2-4 minutes during the peak period at the busier on-line stations, the challenges facing the agency's customers in determining which train is theirs and on which track it will arrive are significant, as are the challenges to NJ Transit in attempting to give these customers the information they need to make these determinations in a timely manner. The advent of the hugely popular MidTown Direct service on the M&E has complicated the situation even further, since customers who once had only one choice toward Manhattan must now differentiate between trains destined for Downtown via Hoboken, New Jersey, or for Midtown via Penn Station New York. Figure 1 provides a graphic depiction of the Morris and Essex environment.

Figure 1



The problem becomes yet more acute when one considers the impact on the customer if the scheduled arrival time goes by and, for whatever reason, however unavoidable, the train has not yet arrived. Will the next train be the correct one, or will it be the one ahead? Should the passenger stand on the platform (which may or may not be sheltered from the elements), or go back inside, or wait in the car? Will the train arrive in 30 seconds or 30 minutes? On which track? Should the passenger take another train? In the larger context, should the passengers wait at all? Will they miss their connections with the subway, ferry, bus, plane or train? Should they take an alternative route or service? Should they drive instead, or perhaps hire a taxi? How soon will they know? Can they rely on the accuracy of this information? Can they count on being advised in a timely manner, every time, without fail, as the situation changes?

There are several levels of information that can be delivered to (and potentially demanded by) waiting passengers. These range in complexity from “a train is scheduled to depart in 10 minutes”, to “passengers for Maplewood and South Orange should board the last 6 cars of the train”, to “train approaching, stand back”, to “your train is operating 6 minutes late”, to “your train will depart in 3 minutes and will arrive at your destination 12 minutes late, where your bus connection will be held to depart 5 minutes after you arrive”. Each clearly represents a different level of customer service, and a different degree of sophistication in terms of both the technology employed and the information support required.

From the Agency's perspective, providing timely, reliable information that meets customer requirements can be a daunting task -- all the more so when one considers that a notable percentage of transit customers do not understand the "official" language well, or at all. How can any transit operator possibly hope to reliably identify and report every little 2 minute delay, every potential missed connection and every arriving train at every station in a way that all its customers will clearly understand? Clearly, without an automated means of determining, then disseminating timely train status information, these customer needs will go unsatisfied, and even the slightest operating delay, however unavoidable, will inevitably create confusion and uncertainty for hundreds or even thousands of passengers.

The problem is arguably most severe at the M&E's three major junction points, Summit, Newark, and Dover, New Jersey. At each of these three locations, passengers have their choice of at least two separate rail lines and four primary destinations from any platform -- and unlike many smaller on-line stations, which are bypassed by every other train or so, every train stops to board passengers. Passengers at these stations identify trains' destination not by track number, as at major terminals like Penn Station or Hoboken, but by arrival time. And arrival time may be highly variable depending on weather, mechanical difficulties, etc. The best examples of the worst conditions are found at Summit, NJ, where four lines meet on three tracks, trains depart at the rate of 2 every three minutes during the peak period, and moving to an alternate platform requires ascending and crossing a pedestrian bridge. This was the site of the first ATIDS installation, and is a good example of the kind of situation a new ATIDS system must be designed to address.

Train Information Technology

Programmable train information systems have become commonplace in rail terminals throughout the world. A “big board” typically provides pre-programmed schedule information (i.e. when the trains are scheduled to arrive and depart) derived from a static database, with dynamic status and boarding information provided by a manual operator. In these systems, train status information is usually based on field observations reported by block operators via telephone or other means. This combination of manual data acquisition followed by manual data entry at each station constitutes a particularly labor intensive means for providing train status information to waiting passengers. It is also relies on a series of fault-prone manual data transmissions that can be relatively unreliable in terms of accuracy, timeliness, completeness and consistency.

Train Detection

Automated information display and annunciation systems based on point location technology were pioneered by the Disney organization many years ago. Tag and transponder-based systems have been commercially available for some time, and have been successfully installed for use in a variety of single destination applications by the Long Island Rail Road, the Port Authority of New York and New Jersey, and other mass transit operations in North America, Asia, and Europe. Simple electrical, electro-optical and radio frequency tags and tag readers, and more recently Global Positioning System (GPS) receivers linked to a control center by wireless communication, have become the technologies of choice for detection of trains in applications where all trains on a given track are headed for the same destinations, and where train location is to be determined at a relatively small number of locations. If <u>every</u> train on a given track always makes the same stops, and is always headed for the same destination, then it is relatively easy to announce the trains on that track based simply on their passage over a nearby detector or tag reader -- all of the announcements can be the same. However, if there are several trains on a given track that each make different stops, or go to different destinations, then knowledge that <u>some</u> train, or even some specific rail car, passed over a detector will not be enough. In such cases, typical of commuter railroads throughout North America, in order to generate the proper announcement, the announcing system must additionally know <u>which</u> train (i.e. which specific train number) is approaching the station.

Train Identification

An automated display system can receive its knowledge of which train is approaching from either the train itself or from a centralized tracking application. Centralized tracking is typically accomplished at the rail operations center, in conjunction with centralized train control (CTC). Alternatively, modern transponders and tag systems, as well as the wireless communications systems typically used in GPS-based train detection, currently have the ability to support transmission of variable or "dynamic" data, such as train number and GPS position data, in addition to fixed or "static" identification codes. These devices theoretically offer the ability for an information system to dynamically determine which train is approaching without relying on a centralized tracking and control system. They also require, however, that every train and every reporting location be so equipped, and that someone on the train consistently and accurately enters the required train identification data into the on board system that supports the tag (conceivably little more than a keypad) or, in the case of GPS, the wireless communication unit. While these methods do appear to offer a viable solution, the costs associated with the addition of purely GPS or dynamic tag-based implementations to any but the smallest of rail systems can be considerable. Moreover, the reliability to be expected of a manual process for entry of train number information into the on board tag system is questionable at best, and zero for unequipped trains (e.g. freights, foreign equipment, etc.) and those with malfunctioning system components.

Cost Considerations

For a given number of supported stations, with a given number of train information displays on a given number of platforms and waiting rooms, overall system cost can be expected to vary considerably according to the number of detection locations employed, the amount and type of on board equipment required, the complexity of the system software, the type and amount of communications employed, and the amount of maintenance and operating support necessary to ensure reliable operation. In addition, system reliability can vary widely with the number and frequency of manual operations required, the number and inherent reliability of critical components, and the amount, frequency and quality of operator training and preventive maintenance provided.

In theory, there exist break-even points for transit system size below which it is economically advantageous to deploy a simple communications-based detection technology such as dynamic tag readers or GPS/cellular, and above which it makes sense to invest in a centralized tracking system. The exact position of these break-even points depends on a variety of factors, including the functionality desired of the information system, the quality/reliability required of the delivered information, the degree to which the organization's culture is likely to support reliable entry of train identification information into on board devices by members of the train crew, the number of stations to be serviced, and whether or not the transit system is already operated under Centralized Traffic Control (CTC). Assuming an overriding customer requirement for reliably accurate information, investment in a centralized tracking function is usually indicated where CTC already exists and manual on-board entry of train identification information is expected to be less than absolutely reliable.

AUTOMATED TRAIN INFORMATION DISPLAY SYSTEM DEVELOPMENT

At NJ Transit, an automated Public Address system is currently used to provide passenger information announcements timed and sequenced to coincide with the scheduled arrival times of respective trains at respective stations. This capability, while significant (in fact relatively advanced among those in common use among North American transit agencies), has been found to fall considerably short of current customer expectations. The "automated" public address system still requires manual intervention to discern the existence of a delay or service disruption and to then enter the data required to initiate an appropriate series of announcements. Additionally, because each announcement takes time for the Agency to initiate, time to transmit and time for the customer to receive and understand, and because the system cannot currently support automated electronic entry of train status information, it is not typically used for announcing every minor service delay. It remains a highly valuable asset, but its use is necessarily limited to significant delays and disruptions only.

NJ Transit recognized the need to do better. Clearly, a system that could provide reliable, timely and accurate information on train status, destination and boarding location, in a labor-efficient automated way, would fit the bill nicely. In the absence of commercially available products for addressing these needs in an automated fashion, NJ Transit's Automated Train Information Display System (ATIDS) development project was begun in 1992.

Following the 1994 award of a $300,000 research grant from the Federal Transit Administration's Office of Technology (since amended to $550,000), NJ Transit developed an ATIDS design specification and engaged a consultant team comprised of Com-Net Software Specialists, of Miamisburg, OH, and Harmon Industries, of Grain Valley, MO, to create the ATIDS processor and program an interface from the existing rail control system which would provide that processor with real-time train location data.

Work on the ATIDS prototype and its information support interface was completed in 1996. Informal ATIDS testing and software adjustments followed throughout 1997. Formal, exhaustive testing and evaluation of the integrated systems was completed February 1998, with the cooperation and assistance of NJ Transit Rail Operations, Inc. These tests determined that the combined systems held considerable potential, but before an automated system could be presented to the public, the rail control system software would require modifications to overcome usability and performance issues with respect to train tracking that often degraded the quality and timeliness of data transmitted to the ATIDS processor.

Like virtually all other train control systems installed in the 1980s and 1990s, NJ Transit's CTC system had not been designed for support of real-time passenger information. The problem was traced to an open-loop, schedule-based initial identification process that, in NJ Transit's busy rail environment, often misidentified trains as they entered the railroad. It worked perfectly well for train dispatch and rail safety, but it rapidly became clear that system requirements for support of passenger information were considerably more complex than those for a merely safe rail operation.

The Project Plan

The plan for this project has evolved over time. The initial plan was merely to develop software, build an interface to CTC, and install a real-time display system at Summit Station – all things the industry already knew how to do. Data quality and knowledge of customer requirements were just assumed.

It soon became clear, however, that there were significant lessons to be learned about data quality, and that there was a lot that the industry didn't know about exactly which information, presented in which ways, would be most valuable to its customers.

The project ended up with three phases:

- **Phase 1** would develop a prototype of the display system software and its interface to the rail dispatch system for initial testing;

- **Phase 2** would build on lessons learned from Phase 1 to deploy a display system with information suitable for public viewing, and to enhance specifications for NJ Transit's next generation of train management and control systems;

- **Phase 3** would use the system deployed in Phase 2 to conduct live experiments to empirically determine customer preferences for display technologies, information content and format under a variety of actual operating conditions.

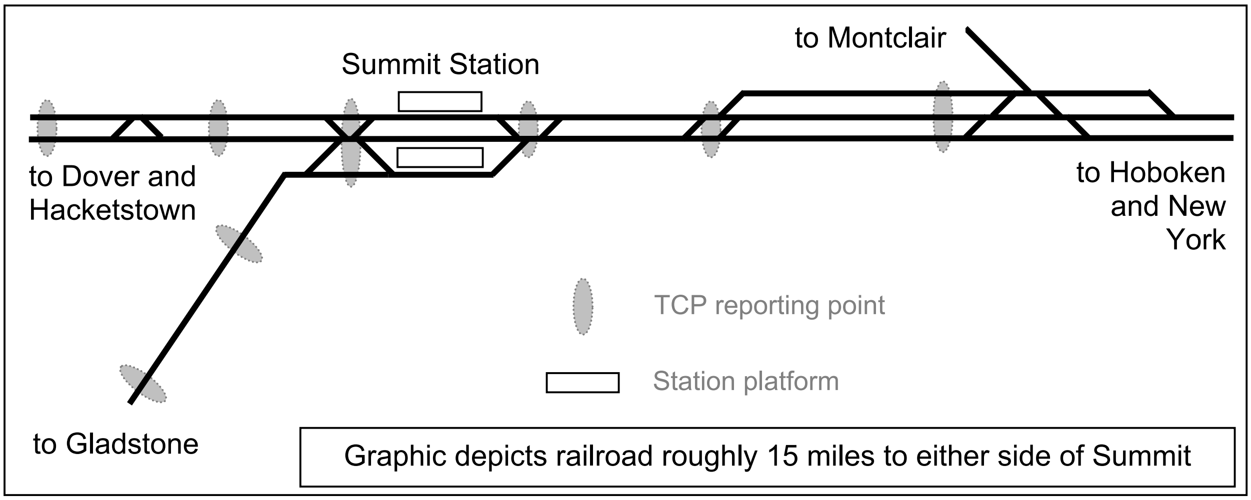
The ATIDS Approach

NJ Transit's rail traffic control system, developed by Harmon Industries of Grain Valley, Missouri, includes a device known as a Train Control Processor (TCP), which tracks the progress of individual trains as they traverse the railroad. The TCP accomplishes this by monitoring track occupancy messages generated by an otherwise conventional track signal/centralized traffic control system.

Using a database of expected train movements (and in future, an electronic train identification system), the Train Control Processor identifies trains upon their entry onto any controlled portion of the railroad. Once identified, the progress of any specific train, or of all trains, is automatically reported -- e.g. “Train 1234, bound for Summit, passed reporting point ABCD, lined for track 2, at 12:34.”

A graphic depiction of the TCP reporting points is provided as Figure 2.

Figure 2 – TCP Reporting Points



An external processor, part of the Automated Train Information Display System (ATIDS) prototype, receives this report, compares the actual time to scheduled time, and automatically determines on-time status. The display system processor transmits train schedule, status and track assignment information to any number of video or “big board” display devices within the station, and automatically initiates appropriate individual train arrival notifications to voice enunciators and track displays on up to 99 platforms. The ATIDS equipment then monitors the TCP message stream, as well as local track circuit detectors, to determine the actual time the trains arrive and depart the station, and displays arrival, boarding and departure status accordingly.

The complete system architecture is illustrated in Figure 3:

A complete station implementation is illustrated in Figure 4.

Figure 3 – System Architecture

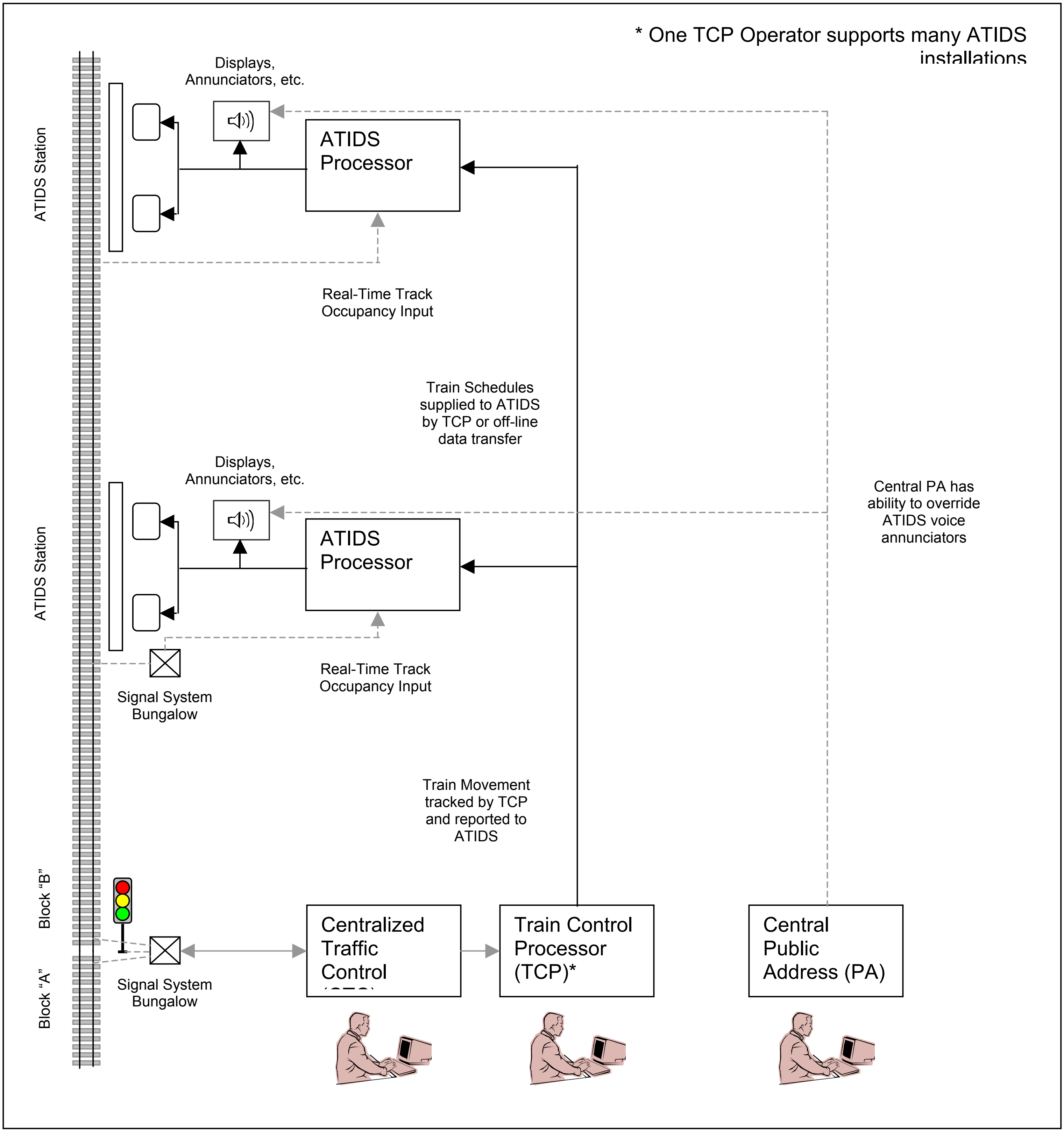
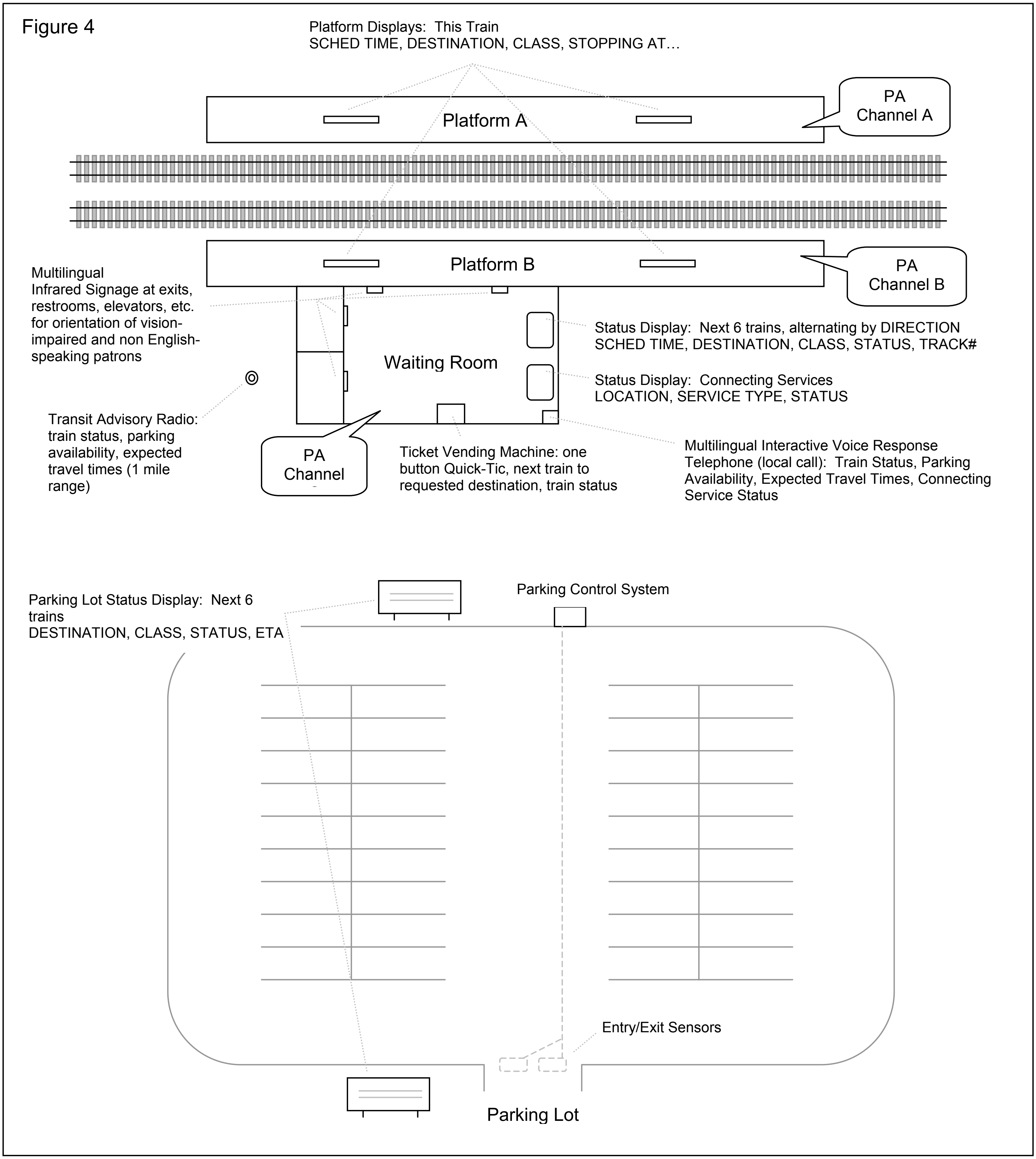


Figure 4 – Station Implementation



PHASE 1 - PROTOTYPE DEVELOPMENT: 1994 - 1997

Phase 1 of the ATIDS project involved development and testing of software and procedures for support of an automated train information display system. Lessons learned were incorporated into the development of NJ Transit's next generation of train management and control systems, which was being designed from the ground up to be able to provide real-time status and arrival information for every train at every station.

NJ Transit's Train Control Processor (TCP), together with the Centralized Traffic Control (CTC) system from which it derives its knowledge of field events, is located in Hoboken, NJ. A data communications link was established between Hoboken and Summit, NJ, a heavily utilized three-track, two-platform, four-line station, which was chosen as the ATIDS test site. The ATIDS processor was tested in operation at both Hoboken and Summit. Major project activities included:

a) Modification of the train control processor to output time-stamped train location information

b) Development of software to compare actual and scheduled time to determine on-time status in real time

c) Installation of track circuit sensors and video surveillance equipment for determining the exact time of the trains' actual arrival at Summit

d) Determination of customer requirements for train information

e) Evaluation of the quality of input received from TCP

f) Evaluation of the quality of output generated by ATIDS

g) Definition of necessary enhancements to ATIDS and TCP systems

h) Interim project report (issued 1/12/00)

System Development

The TIDS software program was initially derived from the same sources utilized in creating Flight Information Systems (FIDS) for airport use. Conceptually, the two programs are very similar. A scheduled plane, or train, arrives at an airport gate, or station track, discharges and/or loads passengers, then departs. The scheduling is executed utilizing a master schedule file, which is input periodically by the transportation company. At approximately midnight, the master schedule is examined and flights, or trains, are selected for the next schedule day. Continuous input is provided from external sources to update the status of each scheduled plane, or train, as it nears the airport gate, or station track. Displays visible to the public are utilized to update the arrival and departure status of the planes, or trains. Terminals are also provided to transportation company personnel for local update of status. It is also possible to equip the terminals with audio devices, which make voice announcements. The system operates in automatic mode with minimal input from human sources.

Development and testing of the initial TIDS system was done at ComNet. A master schedule disk was provided by NJT, which covered the development time period and contained schedules of actual trains currently running on the NJT M&E line. The system was connected in “mock-up” mode with all components connected. When physically functional, test schedule update messages were input as if coming from the Train Control Processor (TCP) and the actions of the TIDS system observed. As flaws or logic gaps were discovered they were fixed on the spot and testing continued.

Functional Testing

Following factory acceptance at the Com-Net facility, the system was shipped to NJ Transit and installed at Summit, New Jersey. Cabling and connections to the local track circuit relays at Summit that would provide the system with real-time confirmation of actual train arrival were designed and installed by NJ Transit Rail Operations personnel. The vendor made several trips to the Summit, NJ site to verify proper operation of the system in the field. Once the equipment was permanently installed at the Summit site, close coordination between ComNet and NJT personnel was maintained to report software/hardware anomalies and to provide executable software upgrades.

At one point in the development cycle, a more workable train processing “flowchart” was agreed upon and coding altered to reflect operational insights not in the original processing analysis. Finally, when the TIDS system appeared to be operational and running properly at Summit, the effort was made to make the program more generic in nature:

a. The initialization file utilized on system startup contains the numeric NJT station identification code, known to TCP, and the alphabetical 4-character code that is known to the scheduling system.

b. The alphabetical identification code is utilized to extract master file information for the individual station.

c. Various system parameters (number of tracks, track names, public station name, presence of hardwired track sensor switches, etc.) are loaded from the initialization and/or table files.

d. The Main Menu of each station may be customized to reflect any special features, which may be available at one station, but not at another.

e. The table files contain a table of reporting points customized for the specific station.

f. The initialization file is utilized to add or alter communication lines and external equipment devices to the specific station.

Operational Testing

Once it was determined that the information system was capable of performing properly in the field, the system was moved to the NJ Transit Rail Operations Center in Hoboken, NJ for prolonged testing in a supervised operational mode. An additional rail dispatcher was brought in and assigned to monitor and record the performance of the integrated ATIDS-CTC system 24 hours a day.

Prototype Performance And Reliability

Prototype performance over the period of installation at Summit, with further relocation to Hoboken Station, was very good. At Summit, the system was installed in a “computer cabinet with a closing front door. While observed in operation, with the door open, no reports of equipment failure were noticed. However, some form of cooling should be provided for a long-term solution. The Data/Video Controller (DVC) failed after being moved from Summit to Hoboken and had to be replaced from the stock of replacement DVCs at the Hoboken station. Attempts to restart or recover the failed DVC were not successful.

The ATIDS application software itself is fault-tolerant and will recover automatically, after a power interruption, to the point at which power failed. Any missed TCP messages while the processor was down would be lost which may cause the ATIDS to take a few moments to “recover” trains which were in the advance, approach, or home blocks, or were at the station. Status indications of an individual train remained as they were when the system went down and could cause some degree of confusion while the system “comes up to speed” following a system failure. Loss of TCP input caused the ATIDS to enter a self-monitored mode in which trains are handled on an individual basis. Software was present to utilize any local track occupancy circuits in an attempt to continue to identify trains as they entered the station even when the TCP link was down.

Initial System Upgrade

The initial system upgrade from the first installation at Summit consisted mostly of software changes to make the ATIDS portable to any station on the train line. To this end, the initialization file read by ATIDS when starting up now contains the following changes:

a. An option was added to identify the ATIDS station, i.e. □SUMT□ for Summit, □NWKB□ for Newark Broad Street, etc.

b. An option has been added to allow “heartbeat” messages from TCP, type □HB□, to set the local time at the ATIDS station processor.

c. An option has been added which allows ATIDS to disregard an obviously wrong TCP message (i.e. a train operating over “n” minutes early)

d. An option has been added which allows local setting of the amount of time the “BOARDING” status will be displayed, if not cleared by an actual reported departure for the train.

e. An option has been added which sets the length of time the “STAND BACK” warning will be active while the train is arriving or departing.

f. An option has been added for inclusion of the NJT numerical code for the train station as it is known to TCP. This option was included to cut processing time in the TCP input processor by filtering all input traffic for other station ID codes. If the input message is not for this station, then further processing is discontinued and the next message is awaited. This option will not be necessary if TCP traffic is altered to dial-up an individual station before transmission as the station ID will always be the correct ID.

g. A Track Translation table has been included in order to provide proper names for each of the tracks at an individual station. The three physical tracks at Summit are 1, 2, and 3, but the passengers and NJT personnel know them as 1, 2, and WALL. The track translation table allows flexibility in naming conventions as well as changing numbers if desired (e.g. 1=2, 2=3, and 3=1).

h. When a new schedule is loaded, ATIDS will scan the schedule header for the quadragraph ("SUMT", "NWKB", etc.) and extract data from the master schedule for the local daily file. In this manner, the same Master Schedule disk may be replicated and disseminated to each station for input. Each station will pick up its own scheduled times and other data for local retention.

I. The Block Definition Table at each ATIDS location must be customized to reflect advance, approach, home, and origin blocks and their respective offset times relative to the reporting point *for the individual station*.

System Evaluation: 1998-1999

a) ATIDS

ATIDS performed well during dispatcher-supervised tests at the Hoboken Operations Center. Only minimal changes to the prototype ATIDS program were found to be necessary to produce an operational program. Most discrepancies were found to be peculiar to a given station and only under specific instances of train movement. For example: certain Eastbound trains are held at Summit for an overly long time before being directed to proceed. This a due to the wait for the departure block to clear the Westbound traffic bound for the Gladstone Line. The original software was not "trimmed" enough to account for this out-of-normal occurrence. The primary visual indication of this condition is that the train "rolls off", or disappears from, the display before the train actually leaves the station. Then the train may, or may not, re-appear on the displays briefly before being logged as departed by TCP.

Some software anomalies were repaired during the two-week testing period when a ComNet programmer was present. A certain amount of fine tuning is also required in the Block Definition Table for the Newark Broad Street configuration as Westbound traffic coming from New York suddenly appears with little or no warning from TCP as there are few blocks between the system entry interlock and the actual station.

b) CTC/TCP

TCP appeared to run in very near real time during off-peak times, but delay rates climbed to over five minutes during the peak travel times of rush hour. It was determined that significant changes would have to be made to the CTC - TCP interface in order to ensure that train information could be passed between them in a timely manner. The ideal solution would have been to add timestamps to each track occupancy message as they were generated in the field, but due to the age, type and quantity of field equipment involved, this was not a feasible option. The inclusion of a CTC-generated time check into the CTC-TCP message stream was proposed as a work-around to help in cases where CTC data transmission was delayed.

c) Operator Interface

Under the present TCP configuration it is impossible to view the entire rail line at the same time. This necessitates the operator constantly switching from one screen to another. It might be advisable to provide multiple video screen outputs so that the entire line might be covered at a glance. The keyboards provided for the operator appeared to be left over from some other project (or, possibly from the TCP prototype). The keycap legends sometimes bore no relationship to their operational functions.

d) Train Identification

There was a noticeable amount of train identifications being lost on the TCP screens as the trains passed through interlockings. On several occasions they would be observed with proper identification on one side of the interlocking and then emerging with an 'UNK' designation at exit. If an operator is stationed at the TCP console and is continually viewing portions of the line, it is possible to make sure that no train IDs are lost, or become an "unknown" to the system. Another anomaly took place where trains entered a terminus and changed directions. This should cause the train to take on another ID. However, at Dover, for example, trains that do not pull completely through the station before returning Eastbound will not change their identification from a Westbound ID to an Eastbound ID.

e) Real-time train arrival confirmation

At selected stations (currently Summit only) physical relays are installed at trackside to further enhance or replace train ID input from TCP. This functionality was not tested during the evaluation period, but has been tested in the past at Summit. ATIDS is configurable as to the use or disuse of this feature.

PHASE 2 – PRODUCTION UPGRADE and PILOT TESTING: 2000-2002

Following Phase 1, it was determined that a few key software upgrades might make it feasible for rail dispatch personnel to ensure the quality of the CTC system's output with a manageable amount of manual intervention. These upgrades were completed in 2001. The resulting system suite was then subjected to additional internal testing. As expected, modifications to the TCP improved the performance and usability of the rail dispatch system, but were not sufficient to permit fully automated train identification. These modifications did, however, make it at least feasible that only a single additional dedicated operator would be required to ensure the quality of the output data.

Enhancements Completed in Preparation for Phase 2

Drawing on lessons learned during the prototype evaluation, a package of enhancements to CTC, TCP and ATIDS was developed and implemented in preparation for a Phase 2 pilot test. These enhancements included:

- To mitigate delays in data transmission from CTC to TCP, periodic timestamp messages were inserted into the CTC data stream.
- TCP was modified to accept the last CTC timestamp as the true “event time”, regardless of how much later the subsequent train status messages were actually received.
- New message types were developed and implemented in TCP, together with formatted data entry screens to support them. These messages included provisions for known train delays, delays affecting all trains at a specific location, train cancellations and extra service, as well as for notifications of the clearing or restoration of a previously reported delay or disruption.
- TCP was modified to improve the accuracy initial train identification.
- TCP was modified to allow discrete tracking of individual unidentified trains.
- TCP was modified to provide real-time notification to dispatchers of unidentified or misidentified trains passing unexpected locations.
- ATIDS was upgraded to accept the new message types.

The Phase 2 TCP control screens and the ATIDS interface specifications developed to support them are shown in Appendices 1 and 2, respectively.

However, by the time the TCP upgrades were completed, NJ Transit had begun building a new operations center and was in the process of implementing a new train management and control system. The additional dispatcher personnel that would be required to maintain correct train IDs in the TCP during Phase 3 testing were now heavily involved in preparations for this new system and were no longer available to the project. The originally planned full system deployment at Summit, NJ, which would have included displays, annunciators, track indicators and stand back warnings, but which could not possibly function satisfactorily without correct information from the TCP, was postponed indefinitely.

Additional Recommended Enhancements (not implemented):

1. An ATIDS display set up screen is required. What data elements do I want this display to show? In what format, translated how? With what roll-on/roll-off settings and train direction filters (arrivals, departures, trains of direction NESW, etc.)

2. ATIDS needs a train status roll on time (minutes before scheduled arrival), different from train record roll on/roll off time.

3. ATIDS needs to monitor changes in train status and track assignments, and generate special notification messages if changes are significant to passengers.

4. ATIDS needs to store scheduled times at all designated TCP reporting points (station specific) for all trains. This will allow continuous updates of train status at each of many reporting points.

5. ATIDS needs to self-configure to appropriate station location via set-up screen.

6. ATIDS needs to support a scheduled “dwell time” in station -- alternatively, a schedule that shows times for both arrival and departure.

7. ATIDS needs a separate “connections” display, and means for determining if connection will be held for late trains.

8. Add “scheduled connection” field to TCP interface terminal with alarm if train will miss scheduled connection time. Provide means to confirm intent to hold (or to not hold) connecting train and so inform passengers. Phase 2 - set this up to work even if trains being connected to/from are not operated by NJ Transit, or if connection is with a bus, plane or ferry.

9. Add “count down” display in ATIDS: e.g. “Next (train/bus/ferry) to (destination) departs in (mm) minutes, (track/lane/gate) (number)”.

PHASE 2A – Semi-Automatic Implementation at Broad Street Station: 2003

In light of the non-availability of required dispatcher support, it soon became apparent that the planned Phase 2 tests could not be accomplished within the FTA’s timeframe for project completion. The tests, together with the full system deployment they were intended to support, were cancelled during the summer of 2002.

Despite the cancellation, however, NJ TRANSIT was still able to put to work for its customers most of the components that had been purchased for the automated system at Summit in a conventional semi-automated “gate board” system for the single Westbound track at Newark Broad Street station instead. This system identifies the next train expected in the station, and provides a clear enumeration of the subsequent stops the train will make. It relies on manual operators, rather than the train control processor (TCP), to ensure the correct sequence of trains and provide confirmation that trains have indeed arrived. The system was installed during the summer of 2003 for operation on a part-time basis during the afternoon peak. It has been successful in greatly reducing passenger confusion and anxiety at the station during that period.

PHASE 3 - DETERMINING CUSTOMER PREFERENCES: 2002-2003

Rather than delay the remainder of the research effort until the new train management and control system was fully implemented, Phase 3 was converted from a live experiment to a market research effort. A series of 9 focus groups were convened to investigate customer requirements and preferences for real-time information. The research firm of Howard/Stein-Hudson Associates, Inc. (HSH) was hired to facilitate these focus groups.

Focus group participants were asked first to identify the types of real-time information that were of most value to them, and then to rate a variety of options for delivering and presenting that information. Among the concepts tested were:

- Use of symbols to identify rail lines
- Use of colored backgrounds to identify rail lines
- Use of colored text to identify rail lines
- Displaying trains with rows ordered by departure time (without grouping by line)
- Displaying trains with rows first grouped by line and then ordered by departure time within each group
- Displaying trains with rows first grouped by train direction and then ordered by departure time
- Displaying trains with and without train numbers (train numbers are the internal identifiers by which the railroad operator knows the trains)
- Use of direction-specific displays (separating different directions of travel onto different displays)
- Use of large, graphics-capable high density color LED display boards rather than flip panel or flip dot displays
- Use of additional displays for destination-specific information (e.g. "next trains to New York…")
- Use and placement of gate boards (listing all stops for the next train(s) accessible through that gate)
- Use of "gate boards" at platform level (listing all stops for the current train on that platform)
- Train crew announcements of real-time information onboard
- Alphabetical destination displays, showing expected departure time, expected time of arrival at the destination, track number, and connection locations (if any) for the next two trains to every destination accessible from the station
- Countdown displays ("next train in 10..9..8..7..6..5..4..3..2..1 minutes")

Findings

- Passengers find abbreviations, letters and numbers far easier to learn and recognize than symbols;
- Passengers need to know whether or not the train on the platform right now is going to stop at their destination;
- Passengers need to know whether they should to rush to catch a train in the station, or if another one will be along shortly;
- Passengers on late trains need to know if they are going to miss their scheduled connections;
- Passengers need to know if their scheduled connection is going to be late in getting them to their final destination, and they need to know it before they get off the train they're on;
- Passengers identify their trains by scheduled departure time, not train numbers;

- Passengers need to know if they should take the very next train, or if a later express will get them to their destination sooner
- Passengers don't want to be encouraged to rush for a train they can't possibly catch

Conclusions

- A real-time passenger information system can be fully automated, but only if train identification accuracy is assured;
- Including train numbers on displays intended for public viewing is a waste of display space;
- Rail lines should be identified on signs and displays by letters and numbers, rather than symbols;
- Display and annunciation systems should highlight not only the trains' departure time and ultimate destination, but also their class (local, express, limited) and first stop as well;
- Stand-alone interactive displays (kiosks) providing an alphabetical listing of every destination served from a given location, with corresponding departure times, arrival times and connection locations for the next two trains or buses, updated in real time, can be very helpful to occasional and new riders, as well as to frequent riders traveling at an unfamiliar time or to an unfamiliar destination.
- Trains should be marked as "departed", or "roll off" from displays at a given location, prior to actual departure, once it is clear that passengers viewing the display at that location cannot possibly catch the train(s) in question

LESSONS LEARNED

- The need for accurate train identification is often under-appreciated, as is the complexity of providing it;
- In the general case, there is a delay between the time a train passes a reporting location and the time that event is actually reported to the rail control system. There is another delay between the time the event is reported to the rail control system and the time it is reported to the passenger information system. These delays will typically vary according to the number of trains on the railroad, and may amount to several minutes under worst-case conditions. For this reason, it is critical that events be time-stamped as close to the field as possible. It is also critical that information systems that rely on a centralized rail control system for train location data make train arrival announcements based on a calculated expected time of arrival (ETA) rather than wait for positive notification of train arrival from the rail control system;
- NJ Transit's work predated the recent flurry of ITS standards development activity. The agency had to design their data interfaces from scratch. Development of industry standards for data interchange between rail control systems, and between rail control systems and passenger information systems, would go a long way toward enabling the industry to meet passenger requirements for real time information in a more cost-effective way;
- When conducting focus group research, assume that moderators will paraphrase any question you give them to ask. Also assume they don't know the business well enough to infer the real point of the question on their own. So it's important to give them the business context for each question, as well as the questions themselves;
- The exact timing of arrival and departure announcements can be improved by the use of local track occupancy sensors connected directly to the display systems at each respective station;
- Rail station architects may have little knowledge of customers' needs for real-time information. By a factor of at least two, real estate provided for electronic information

displays are often too small, with coverage in too few station areas, and too few in number in the areas that are covered;
- Passenger information system elements included by facilities engineering departments in parts of larger station design or construction projects tend to be at once physically over-specified and functionally incomplete. A standard functional specification for real-time passenger information would go a long way toward helping these departments understand passengers' real requirements for real-time information.
- Even when faced with detailed information indicating that traditional displays do not fully satisfy customer requirements, practitioners tend to stick with what they know.
- Most passenger information needs can be supported centrally, via the Internet, with browser-based interfaces to displays, kiosks and personal devices in the field.

FUTURE RESEARCH

Qualitative Research

NJ Transit's focus group research addressed customer preferences, but not priorities for investment. Additional research is required to determine customer priorities for passenger information investments in the context of other competing needs such as seating capacity, service frequency, travel speed, security, reliability and comfort, as well as in relation to the many other non-transit government programs which also compete for public funding. Future research should address, at a minimum:

What's more important?
- Being able to get a seat when your train arrives, or knowing about even minor delays while you're waiting for it;
- Being able to get a seat when your train arrives, or knowing the status of your next connection while you're onboard;
- Knowing about even small delays while you're waiting for your train, or knowing the status of your next connection while you're onboard;
- Knowing about even small delays while you're waiting for your train, or shaving 10 minutes off your travel time.

Quantitative Research

No quantitative research that addresses customer satisfaction with various modes of real-time information display under varying environmental and operating conditions is readily available. A search of the US Department of Transportation database revealed that not one of the 11 potentially relevant reports in the research database (those identified under the key words "passenger information", "train information", or "real-time information" – interestingly, there were no hits under "usability", "customer requirements", or "customer preferences") addresses customer preferences, needs or satisfaction. Three articles published by the Association for Computing Machinery, however, while not directly addressing the problem at hand, did offer potentially valuable insights.

Noam Tractinsky's "Asthetics and Apparent Usability: Empirically Assessing Cultural and Methodological Issues" (ACM CHI 97), while actually far from an "empirical" study ("apparent", i.e. presupposed, usability was assessed without attempting actual use), provided a refreshing perspective that, in retrospect, had not been given serious enough consideration during the early development of the ATIDS display -- namely that in addition to being functional, the information on the display should be pleasing to view. This suggested that alternative font types and sizes should be investigated in addition to alternative information layouts and content.

Ellen Hoadley's "Investigating the Effects of Color" (Communications of the ACM, Feb 1990) notes, among other things, that in previous studies, color had been found to improve performance in a search and locate task, and to improve performance in a decision judgment task -- both intuitively expected and highly relevant to customers' effective use of the ATIDS displays. This supports the intuitive desire to investigate the use of color to highlight rail lines, direction of travel, on-time status, etc. Unfortunately, it is impossible to assess the degree to which her own research on the information extraction itself is applicable to this project because the details of the tabular layout she investigated were not shown in the paper.

Four of the scales presented in Chin, Diehl and Norman's "Development of an instrument measuring user satisfaction of the human-computer interface" (ACM CHI '88) were found to be directly applicable to real-time information display systems could be adapted for use in further research. They are:

- OVERALL REACTION TO THE SYSTEM (terrible -- wonderful),
- CHARACTERS ON THE SCREEN (hard to read -- easy to read),
- HIGHLIGHTING SIMPLIFIES TASK (not at all -- very much), and
- ORGANIZATION OF INFORMATION ON SCREEN (confusing -- very clear).

The author's own prior works, "Development of an Advanced Public Transportation Systems Strategy for New Jersey Transit" (with Ardell Hoveskeland, DeLeuw, Cather and Co, 285p, 1996) and "Procurement of Advanced Public Transportation Systems" (66p, 1997), both unpublished but quoted extensively in trade publications and industry training materials, did discuss the measurement of customer satisfaction with respect to passenger information in broad terms, but failed to address the matter in sufficient detail to be of much real use in this project. The Federal Transit Administration's "Advanced Public Transportation Systems: The State of the Art" for 1998 and 1999 do include sections on In-Terminal/Wayside Transit Information Systems, but these merely restate the author's own reports on the development of the ATIDS system to date, along with similar reports from others on a variety of other somewhat less advanced technologies. Likewise, a review of the USDOT's Intelligent Transportation Systems (ITS) evaluation program indicates that it, too, is of little help -- it is concerned more with evaluating and documenting the feasibility of ITS technologies than with identifying customer expectations or optimizing systems to maximize customer satisfaction.

It appears, then, that in many respects, a follow on program would represent original research. It should deliberately eschew a laboratory setting for the bulk of its work, as the prime requirement on the findings is that they be directly applicable to the real world. Since there does not appear to be a realistic way of cost-effectively simulating or controlling for the many factors and stresses involved in anything but a real-world setting, the research should be carried out "live", with real trains, real customers, real delays and real pressures. Previous studies by NJ Transit's Market Research unit have indicated that customers are highly motivated to assist in the betterment of the services they receive and are almost universally willing to provide detailed feedback, without extrinsic compensation, if offered a quick and easy means of doing so. This spirit of cooperation should be nurtured and capitalized upon in further research.

A follow-on evaluation could utilize the services of a firm that specializes in the use of portable interactive on-line survey kiosks. Such a firm would set up unobtrusive, multilingual survey kiosks at critical locations throughout the target station. This highly cost-effective approach would enable the surveying of 6-9 customers simultaneously -- in their native language -- while automatically logging the survey time and duration, together with the response time for each item. The need for solicitation of qualifying and identifying information should be held to an absolute minimum by cross referencing (off-line) the time and platform location for each survey submitted with the scheduled and actual observed track assignments and times of train arrival and departure. The surveys should be designed to allow completion in 2 minutes or less.

Throughout the course of this follow-on evaluation project, which would run for approximately two months, the format and content of the ATIDS displays would be varied on a daily basis. At a relatively busy location such as NJ Transit's Summit Station, the displays would be viewed and evaluated under actual operating conditions by roughly 1800 customers each day. The feedback received from these customers would be fed into a multidimensional database, from which specific hypotheses would be tested and interactions identified via a business intelligence software package such as Brio in conjunction with the multiple regression/ANOVA features of a statistical tool such as SPSS. The impact of the various factors could then be weighed to determine the optimal display design(s) for the specific operating conditions and the specific mix of customers found on the target line(s).

REFERENCES

1. Tractinsky, N; “Asthetics and Apparent Usability: Empirically Assessing Cultural and Methodological Issues”; Association for Computing Machinery, CHI 1997

2. Hoadley, E; "Investigating the Effects of Color"; Communications of the ACM, Feb 1990

3. Chin, Diehl and Norman; "Development of an instrument measuring user satisfaction of the human-computer interface"; Association for Computing Machinery, CHI 1988

4. Kemp and Hoveskeland; "Development of an Advanced Public Transportation Systems Strategy for New Jersey Transit"; NJ TRANSIT, 1996

5. Kemp, J; "Procurement of Advanced Public Transportation Systems", NJ TRANSIT, 1997

6. "Advanced Public Transportation Systems: The State of the Art"; Federal Transit Administration, 1998

7. "Advanced Public Transportation Systems: The State of the Art"; Federal Transit Administration, 1999

Appendix 1 – TCP Operator Entry Screens for ATIDS Operational Testing

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
HABITAT COMMAND LINE
DISPLAY,APPLICATION                  NJT                   09-NOV-1998 15:52:30
                       ATIDS OPERATOR MESSAGE CONSOLE ME1

_ TRAIN DELAYS - (BEGINNING AT __:__), NJ TRAIN ______, (OR ALL _ DIRECTION
  NJ ______ SERIES TRAINS), (OR ALL _ DIRECTION TRAINS WITH THE EXECPTION OF
  NJ ______ SERIES TRAINS) WILL BE DELAYED AN ADDITIONAL _:__ PASSING ____, DUE
  TO __ AT ____.  THIS CONDITION IS EXPECTED TO CONTINUE FOR THE NEXT __ HOURS.
                                                                     VALIDATE _

_ CANCELLED TRAIN - NJ TRAIN ______ HAS BEEN CANCELED (PAST ____), DUE TO __
  AT ____.                                                           VALIDATE _

_ SLOW TRAIN - NJ TRAIN ______ (OR ALL (_ DIRECTION) TRAINS ON THE ___ LINE) ARE
  EXPECTED TO MAKE ONLY __ PERCENT OF NORMAL SPEED (OR SPEND AN EXTRA __ MINUTES
  AT EACH STATION STOP) BETWEEN ____ AND ____ (FOR THE NEXT __ HOURS), DUE TO
  __.                                                                VALIDATE _

_ SUSPENDED SERVICE - (BEGINNING AT __:__), (_ DIRECTION) SERVICE ON THE ___
  LINE WILL BE SUSPENDED (BETWEEN ____ AND ____), DUE TO __ AT ____. ALTERNATIVE
  SERVICE IS (NOT) BEING PROVIDED (BY __). THIS CONDITION IS EXPECTED TO
  CONTINUE FOR THE NEXT __ HOURS.                                    VALIDATE _

_ CONNECTING SERVICE DELAY - (BEGINNING AT __:__), (_ DIRECTION) CONNECTING __
  SERVICE AT ____ (TO ____) WILL BE DELAYED _:__ DUE TO __ (AT ____).  THIS
  CONDITION IS EXPECTED TO CONTINUE FOR THE NEXT __ HOURS.           VALIDATE _

_ EXTRA SERVICE - EXTRA SERVICE PATTERNED AFTER NJ TRAIN ______ WILL DEPART THE
  TERMINAL AT __:__ AND RUN AS TRAIN ______.                         VALIDATE _

_ RUN LOCAL/EXPRESS - NJ TRAIN ______ (OR ALL _ DIRECTION ______ SERIES TRAINS)
  WILL RUN LOC BETWEEN ____ AND ____ (FOR THE NEXT __ HOURS).        VALIDATE _

_ BOARDING INSTRUCTIONS - PASSENGERS DESTINED FOR ____ THROUGH ____ SHOULD BOARD
  THE _ (FIRST, LAST, MIDDLE) __ CARS OF NJ TRAIN ______.            VALIDATE _


  VALIDATION - CAUSE: ............................             ABORT/CLEAR _
               LOCATION: .........................                    SEND _


_ GO TO ATIDS SYSTEM STATUS SCREEN          _ GO TO ATIDS CODES REFERENCE SCREEN
                                            _ GO TO ATIDS SERVICE STATUS SCREEN
TCP MESSAGE LINE
TCP HELP LINE
+------------------------------------------------------------------------------+
|                              HABITAT MESSAGE AREA                            |
+------------------------------------------------------------------------------+
```

```
          1         2         3         4         5         6         7         8
 12345678901234567890123456789012345678901234567890123456789012345678901234567890
 HABITAT COMMAND LINE
 DISPLAY,APPLICATION                          NJT                 09-NOV-1998 15:52:30
                         ATIDS SYSTEM STATUS CONSOLE ME1

 ATIDS STATION ....                             ATIDS STATION ....
  .. TRAINS REPORTED > 5 MIN EARLY               .. TRAINS REPORTED > 5 MIN EATLY
  .. TRAINS REPORTED > 10 MIN LATE               .. TRAINS REPORTED > 10 MIN LATE
  .. TRAINS WITH UNKNOWN STATUS                  .. TRAINS WITH UNKNOWN STATUS
  .. UNKNOWN BLOCK IDENTIFIERS                   .. UNKNOWN BLOCK IDENTIFIERS
  .. UNKNOWN TRAINS                              .. UNKNOWN TRAINS
  .. SCHEDULE FILE DATE                          .. SCHEDULE FILE DATE
  .. CODE TABLE VERSION                          .. CODE TABLE VERSION
  .. AUTOMATED PUBLIC REPORTING _                .. AUTOMATED PUBLIC REPORTING _
  .. MESSAGING ENABLED _                         .. MESSAGING ENABLED _

 ATIDS STATION ....                            ATIDS STATION ....
  .. TRAINS REPORTED > 5 MIN EARLY               .. TRAINS REPORTED > 5 MIN EARLY
  .. TRAINS REPORTED > 10 MIN LATE               .. TRAINS REPORTED > 10 MIN LATE
  .. TRAINS WITH UNKNOWN STATUS                  .. TRAINS WITH UNKNOWN STATUS
  .. UNKNOWN BLOCK IDENTIFIERS                   .. UNKNOWN BLOCK IDENTIFIERS
  .. UNKNOWN TRAINS                              .. UNKNOWN TRAINS
  .. SCHEDULE FILE DATE                          .. SCHEDULE FILE DATE
  .. CODE TABLE VERSION                          .. CODE TABLE VERSION
  .. AUTOMATED PUBLIC REPORTING _                .. AUTOMATED PUBLIC REPORTING _
  .. MESSAGING ENABLED _                         .. MESSAGING ENABLED _

 ATIDS STATION ....                            ATIDS STATION ....
  .. TRAINS REPORTED > 5 MIN EARLY               .. TRAINS REPORTED > 5 MIN EARLY
  .. TRAINS REPORTED > 10 MIN LATE               .. TRAINS REPORTED > 10 MIN LATE
  .. TRAINS WITH UNKNOWN STATUS                  .. TRAINS WITH UNKNOWN STATUS
  .. UNKNOWN BLOCK IDENTIFIERS                   .. UNKNOWN BLOCK IDENTIFIERS
  .. UNKNOWN TRAINS                              .. UNKNOWN TRAINS
  .. SCHEDULE FILE DATE                          .. SCHEDULE FILE DATE
  .. CODE TABLE VERSION                          .. CODE TABLE VERSION
  .. AUTOMATED PUBLIC REPORTING _                .. AUTOMATED PUBLIC REPORTING _
  .. MESSAGING ENABLED _                         .. MESSAGING ENABLED _


                                                                           SEND _

 _ GO TO ATIDS OPERATOR MESSAGE SCREEN         _ GO TO ATIDS CODES REFERENCE SCREEN
                                               _ GO TO ATIDS SERVICE STATUS SCREEN

 TCP MESSAGE LINE
 TCP HELP LINE
 +-------------------------------------------------------------------------------+
 |                              HABITAT MESSAGE AREA                             |
 +-------------------------------------------------------------------------------+
```

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
HABITAT COMMAND LINE
DISPLAY,APPLICATION                NJT                    09-NOV-1998 15:52:30
                    ATIDS CODES REFERENCE SCREEN CONSOLE ME1

CAUSE CODES:
EQ - EQUIPMENT PROBLEM                      DE - DERAILMENT (PSGR TRAIN)
CA - CATENARY PROBLEM                       DF - DERAILMENT (FREIGHT TRAIN)
SI - SIGNAL PROBLEM                         SB - STUCK BRIDGE
PO - POLICE ACTIVITY                        BO - BRIDGE OPENING
ME - MEDICAL EMERGENCY                      PM - PLATFORM MAINTENANCE
SN - HEAVY SNOW                             SM - STATION MAINTENANCE
PS - HEAVY PASSENGER LOAD                   CW - CONSTRUCTION WORK
CR - CREW SHORTAGE                          ES - EQUIPMENT SHORTAGE
SW - SWITCH PROBLEM                         BM - BRIDGE MAINTENANCE
RM - ROW MAINTENANCE                        PF - ELECTRICAL POWER FAILURE
TR - TRACK PROBLEM                          DT - DISABLED TRAIN
CM - CATENARY MAINTENANCE                   FL - FLOODING
FD - FIRE DEPARTMENT ACTIVITY               HW - HIGH WINDS
MR - MISSROUTED TRAIN                       IC - ICE
UN - UNKNOWN CAUSE                          LC - LATE CONNECTION
SR - SLIPPERY RAILS                         LP - LOCOMOTIVE PROBLEM
ST - LABOR STRIKE

AGENCY CODES:
NJ - NJT RAIL            NB - NJT BUS                NM - NWK APT MONORAIL
CS - NS/CSX              LA - LAKELAND BUS           PT - PATCO
AM - AMTRAK              AB - ACADEMY BUS            SA - SCHEDULED AIRLINE
PA - PATH                SB - SUBURBAN BUS
NY - NYCTA               AI - AIRLINK
MN - METRO NORTH         NW - NEW YORK WATERWAY
LI - LIRR                NS - NEWARK CITY SUBWAY
SE - SEPTA               AC - AC JITNEYS

LOCATION CODES - STANDARD 4 LETTER STATION IDENTIFIERS, PLUS:
33RD - 33RD STREET      JSQ  - JOURNAL SQ          DRB  - DELAWARE R. BRIDGE
WTC  - WORLD TRADE CENTER PTMY - PORT MORRIS YARD   DVRY - DOVER YARD
SUNY - SUNNYSIDE YARD   RRB  - RARITAN R. BRIDGE   GLDY - GLADSTONE YARD
HUDT - HUDSON TUNNELS   HRB  - HKNSACK R. BRIDGE
HUDR - HUDSON RIVER     PRB  - PASSAIC R. BRIDGE


_ GO TO ATIDS OPERATOR MESSAGE SCREEN     _ GO TO M&E STATION IDENTIFIERS SCREEN
                                          _ GO TO ATIDS SERVICE STATUS SCREEN
TCP MESSAGE LINE
TCP HELP LINE
+------------------------------------------------------------------------------+
|                              HABITAT MESSAGE AREA                            |
+------------------------------------------------------------------------------+
```

```
                  1         2         3         4         5         6         7         8
         12345678901234567890123456789012345678901234567890123456789012345678901234567890
HABITAT COMMAND LINE
DISPLAY,APPLICATION                   NJT                     09-NOV-1998 15:52:30
                    M&E STATION IDENTIFIERS SCREEN CONSOLE ME1

LINES/BRANCHES:
HOB - HOBOKEN                         MBL - MAIN/BERGEN LINES
MID - MIDTOWN DIRECT                  MLN - MAIN LINE
M&E - MORRIS & ESSEX                  BLN - BERGEN LINE
MST - MORRISTOWN LINE                 PVL - PASCACK VALLEY LINE
MTC - MONTCLAIR BRANCH                PJL - PORT JERVIS LINE
GLD - GLADSTONE LINE                  WRF - WATERFRONT CONNECTION
HKT - HACKETTSTOWN LINE               ACL - ATLANTIC CITY LINE
BNT - BOONTON LINE                    PRI - PRINCETON LINE
NEC - NORTHEAST CORRIDOR
NJC - NORTH JERSEY COAST



STATIONS:
PSNY - PENN STATION NY       SUMT - SUMMIT                NPVD - NEW PROVIDENCE
HOBO - HOBOKEN               CHAT - CHATHAM               MYHL - MURRAY HILL
MMC  - MMC                   MADS - MADISON               BKHT - BERKLEY HEIGHTS
NWKB - NEWARK BROAD ST       MRSC - CONVENT STATION       GILL - GILLETTE
BLFW - WATSESSING AVE        MRST - MORRISTOWN            STRL - STIRLING
BLFD - BLOOMFIELD            MRSP - MORRIS PLAINS         MGTN - MILLINGTON
GNRM - GLEN RIDGE            MTTB - MOUNT TABOR           LYON - LYONS
MTCB - MONTCLAIR BAY ST      DNVL - DENVILLE              BSKR - BASKING RIDGE
EORG - EAST ORANGE           DOVR - DOVER                 BDVL - BERNARDSVILLE
EOBC - BRICK CHURCH          LKHP - LAKE HOPATCONG        FARH - FAR HILLS
ORNG - ORANGE                NTCG - NETCONG               PPAK - PEAPACK
ORHI - HIGHLAND AVE          ITCM - MOUNT OLIVE           GLAD - GLADSTONE
SOMT - MOUNTAIN STATION      HKTN - HACKETTSTOWN
SORG - SOUTH ORANGE
MPLW - MAPLEWOOD
MLBN - MILLBURN
MLSH - SHORT HILLS






_ GO TO ATIDS OPERATOR MESSAGE SCREEN       _ GO TO ATIDS CODES REFERENCE SCREEN
                                            _ GO TO ATIDS SERVICE STATUS SCREEN
TCP MESSAGE LINE
TCP HELP LINE
+------------------------------------------------------------------------------+
|                              HABITAT MESSAGE AREA                            |
+------------------------------------------------------------------------------+
```

```
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
HABITAT COMMAND LINE
DISPLAY,APPLICATION                   NJT                  09-NOV-1998 15:52:30
                    ATIDS SERVICE STATUS SCREEN CONSOLE ME1

INDIVIDUALLY DELAYED TRAINS:
 TRAIN   ...... ...... ...... ...... ...... ...... ...... ...... ...... ......
 LOC     ....   ....   ....   ....   ....   ....   ....   ....   ....   ....
 CANX      _      _      _      _      _      _      _      _      _      _

LINE DELAYS:
 LOC     ....  ....  ....  ....  ....  ....  ....  ....  ....  ....  ....  ....
 DELAY   .:..  .:..  .:..  .:..  .:..  .:..  .:..  .:..  .:..  .:..  .:..  .:..
 EXPIRES ..:.. ..:.. ..:.. ..:.. ..:.. ..:.. ..:.. ..:.. ..:.. ..:.. ..:.. ..:..

CANX  _ _ _ _ _ _ _ _ _ _ _ _

SERVICE SUSPENSIONS:
 DIR     .     .     .     .     .     .     .     .     .     .     .     .
 BETWEEN ....  ....  ....  ....  ....  ....  ....  ....  ....  ....  ....  ....
 AND     ....  ....  ....  ....  ....  ....  ....  ....  ....  ....  ....  ....
 EXPIRES ..:.. ..:.. ..:.. ..:.. ..:.. ..:.. ..:.. ..:.. ..:.. ..:.. ..:.. ..:..
 CANX      _     _     _     _     _     _     _     _     _     _     _     _

SPEED RESTRICTIONS:
 DIR     .     .     .     .     .     .     .     .     .     .     .     .
 BETWEEN ....  ....  ....  ....  ....  ....  ....  ....  ....  ....  ....  ....
 AND     ....  ....  ....  ....  ....  ....  ....  ....  ....  ....  ....  ....
 EXPIRES ..:.. ..:.. ..:.. ..:.. ..:.. ..:.. ..:.. ..:.. ..:.. ..:.. ..:.. ..:..
 CANX      _     _     _     _     _     _     _     _     _     _     _     _

CONNECTING SERVICE DELAYS:
 AGENCY  ..    ..    ..    ..    ..    ..    ..    ..    ..    ..    ..    ..
 DELAY   .:..  .:..  .:..  .:..  .:..  .:..  .:..  .:..  .:..  .:..  .:..  .:..
 LOC     ....  ....  ....  ....  ....  ....  ....  ....  ....  ....  ....  ....
 EXPIRES ..:.. ..:.. ..:.. ..:.. ..:.. ..:.. ..:.. ..:.. ..:.. ..:.. ..:.. ..:..
 CANX      _     _     _     _     _     _     _     _     _     _     _     _

TRAINS RUNNING LOCAL/EXPRESS:
 TRAIN   ...... ...... ...... ...... ...... ...... ...... ...... ...... ......
 CANX      _      _      _      _      _      _      _      _      _      _

                                                                          SEND _

_ GO TO ATIDS OPERATOR MESSAGE SCREEN       _ GO TO ATIDS CODES REFERENCE SCREEN
TCP MESSAGE LINE
TCP HELP LINE
+------------------------------------------------------------------------------+
|                              HABITAT MESSAGE AREA                            |
+------------------------------------------------------------------------------+
```

Appendix 2 – ATIDS/TCP Message Specification

Note: The TCP-ATIDS interface developed during this project predates the current family of TCIP and IEEE rail passenger information standards. The following message definitions are provided for information only. They are not TCIP-compliant.

All messages transmitted by TCP are in the form:

STX	STA#	STA	MSQ	LENGTH	ASCII Message Text	ETX	LRC

where: STX = ASCII Start of Text (02 hex)
STA# = 4 character station ID of station expected to acknowledge message
STA = 4 character station ID of sending station
MSQ = message sequence number (0-255)
LENGTH = number of ASCII characters in ASCII Message Text (0-255)
ETX = ASCII End of Text (03 hex)
LRC = the exclusive OR of all message characters including the STX and ETX

ATIDS will immediately ACK (06 hex) or NAK (15 hex) all messages received from TCP, and visa versa

Additionally, messages returned by ATIDS in reply to Status Requests are also of the form:

STX	STA#	STA	MSQ	LENGTH	ASCII Message Text	ETX	LRC

where: STX = ASCII Start of Text (02 hex)
STA# = 4 character station ID of station expected to acknowledge message
STA = 4 character station ID of sending station
MSQ = message sequence number (0-255)
LENGTH = number of ASCII characters in ASCII Message Text (0-255)
ETX = ASCII End of Text (03 hex)
LRC = the exclusive OR of all message characters including the STX and ETX

ASCII Message Text sent by ATIDS in response to TCP status requests is 26 bytes long, of the form:

CTIME	NRE	NRL	NRN	NRM	NRB	NRT	SKED	CODE	AUTO

where: CTIME = (8 char) current ATIDS system time HH:MM:SS
NRE = (3 char) number of trains currently being reported > 5 minutes early
NRL = (3 char) number of trains currently being reported > 10 minutes late
NRN = (3 char) number of trains for which status is currently unknown
NRB = (3 char) number of unrecognized BIDs received since last request
NRT = (3 char) number of unrecognized train IDs received since last request
SKED = (1 char) code for validity of master schedule (01 hex = OK, 02 hex = not OK)
CODE = (1 char) code for validity of code table (01 hex = OK, 02 hex =not OK)
AUTO = (1 char) code for status of automated reporting (01 hex = enabled, 02 hex = suppressed)

ASCII Message Text generated automatically by the TCP is 49 bytes long, of the form:

A	B	C	D	E	F	G	H	I	J	K

where A is an 8 character time (HH:MM:SS), with a valid range 00:00:00 to 23:59:59
B is a 2 character alpha, with valid values “AD”, “AP”, “HO”, “ID”, “HB”, “SR”
C is an 8 character time (HH:MM:SS), with a valid range 00:00:00 to 23:59:59
D is a 6 character alphanumeric or blank
E is a 1 character alpha, with valid values “N”, “S”, “E”, “W” or blank
F is a 2 character alphanumeric
G is a 10 character date (DD/MM/YYYY) or blank
H is a 2 character alphanumeric or blank
I is a 2 character alphanumeric or blank
J is a 2 character numeric or blank
K is a 6 character alphanumeric or blank

ASCII Message Text generated manually by a TCP Operator is 58 bytes long, of the form:

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P

where A is an 8 character time (HH:MM:SS), with a valid range 00:00:00 to 23:59:59
B is a 2 character alpha, with valid values “DE”, “CA”, “SC”, “CO”, “SR”, “RE”, “SU”, “DI”, “RL”, “BI”, “RE”, “CM, “ST”
C is a 5 character abbreviated time (HH:MM), with a valid range 00:00 to 23:59 or blank
D is a 4 character abbreviated time (H:MM) with valid range 0:00 to 9:59 or blank
E is a 4 character alpha or blank
F is a 4 character alpha or blank
G is a 6 character alphanumeric or blank
H is a 1 character alphanumeric or blank
I is a 2 character numeric or blank
J is a 2 character alphanumeric
K is a 2 character alphanumeric or blank
L is a 2 character alphanumeric or blank
M is a 4 character alphanumeric or blank
N is a 4 character numeric
O is a 2 character numeric or blank
P is a 6 character alphanumeric or blank

Key for ATIDS data base field identifiers noted in this specification is as follows:

ADVB = advance block ID
ADVT = reported time at advance block
SADV = scheduled time at advance block
APPB = approach block ID
APPT = reported time at approach block
SAPP = scheduled time at approach block
HOMB = home block ID
HOMT = reported time at home block
ATA = actual time of arrival
ATD = actual time of departure
ETA = expected time of arrival at station
ETD = expected time of arrival at station
ETR = estimated time of schedule restoration
SKDA = scheduled time of arrival at station
SKDD = scheduled time of departure at station
ITRK = internal record of track number for arrival/departure
PTRK = publicly displayed track number for arrival/departure
DLAY = expected departure delay (in minutes)
TRNS = train number series
CAUS = cause code
DLOC = location of delay
TDEP = scheduled time for departure from origin
TDIS = time at which automatic status reporting is to be disabled
TRES = time at which automatic status reporting is to be resumed
TP = train type (Arrival, Departure, Through, Unscheduled)
IS = internal status
PS = public status (LAte, ON time, BoarDing, DeParted, ARriving, CAncelled, EXtra, indeterminate DElay, UNknown)
SS = secondary status (all LOcal stops, EXpress to ..., TErminating at)
DIR = train direction
SRC = source of status information (Automatic, Manual, None)
AGN = agency issuing train number
AGR = agency responsible for automated reporting of train position
CE = cause codes enabled flag
TDE = timed disable enable
TCPR = Time of last TCP interface restoration
REF# = TCP operator message reference number from which current status has been derived

NOTE 2: in describing the actions required of the ATIDS processor, values to be extracted from the text of TCP ATIDS messages are shown in parentheses, e.g. (STA#).

ADvance message

message type:	Advance Location report
message code:	AD
initiated by:	TCP
meaning:	tell station (STA#) that train (TRN#) passed point (BID) at time (ETIME) on track (TRK#) in direction (DIR)
transmitted:	upon TCP detection of train entry into designated “advance” block for designated station in designated direction

ATIDS action:	determine if message applies to station
	if (BID) present as an advance block in direction (DIR), locate train (TRN#) in daily file, continue;
	if (BID) not present as an advance block in direction (DIR), enter (MSG), (BID) and (DIR) into Block Definition Changes Table, return.
	if train (TRN#) present in daily file and TP = “U”, log (BID) in ADVB, log (ETIME) in ADVT, log (TRK#) in ITRK, return.
	if train (TRN#) present in daily file and TP = “A” or “D”, log (BID) in ADVB, calculate and enter scheduled time at ADVB in SADV, log (ETIME) in ADVT, log (TRK#) in ITRK, calculate status of train and place in IS, update ETA; continue;
	if SRC = “N”, set SRC = “A”; continue;
	if SRC = “A” and time is past time for public status roll-on, set PS = IS, return.
	if train (TRN#) not present in daily file, generate train (TRN#) file record, set TP to “U”, log (BID) in ADVB, log (ETIME) in ADVT, return.

message format:	

CTIME	MSG	ETIME	TRN#	DIR	AGENCY	SDATE	CODE	AGN	TRK#	BID

Label	Size	Definition
CTIME	8	Current time HH:MM:SS
MSG	2	Message Type “AD”
ETIME	8	Time of Event HH:MM:SS
TRN#	6	Train ID
DIR	1	Direction train is traveling (“E”, “W” or blank if unknown)
AGENCY	2	Agency assigning Train ID
SDATE	10	date of effective timetable DD/MM/YYYY (new field on TCP maintenance screen?)
CODE	2	not used (blank)
AGN	2	not used (blank)
TRK#	2	track on which train is traveling
BID	6	Harmon Block Identifier for advance location

APproach message

message type:	Approach Location report
message code:	AP
initiated by:	TCP
meaning:	tell station (STA#) that train (TRN#) passed point (BID) at time (ETIME) in direction (DIR), and is lined for track (TRK#) in the station
transmitted:	upon TCP detection of train entry into designated "approach" block for designated station in designated direction

ATIDS action:	if (STA#) = ATIDS Station ID, locate (BID) in block definition file, continue; (if not, return.)
	if (BID) present as an approach block in direction (DIR), locate train (TRN#) in daily file, continue;
	if (BID) not present as an approach block in direction (DIR), enter (MSG), (BID) and (DIR) into Block Definition Changes Table, return.
	if train (TRN#) present in daily file and TP = "U", log (BID) in APPB, log (ETIME) in APPT, log (TRK#) in ITRK, return.
	if train (TRN#) present in daily file and TP = "A" or "D", log (BID) in APPB, calculate and enter scheduled time at APPB in SAPP, log (ETIME) in APPT, calculate status of train and place in IS, , calculate and update ETA, continue;
	if SRC = "N", set SRC = "A"; continue
	if SRC = "A" , set PS = IS, log (TRK#) in PTRK, return.
	if train (TRN#) not present in daily file, generate train (TRN#) file record, set TP to "U", log (BID) in APPB, log (ETIME) in APPT, log (TRK#) in ITRK, return.

message format:	

CTIME	MSG	ETIME	TRN#	DIR	AGENCY	SDATE	CODE	AGN	TRK#	BID

Label	Size	Definition
CTIME	8	Current time HH:MM:SS
MSG	2	Message Type "AP"
ETIME	8	Time of Event HH:MM:SS
TRN#	6	Train ID
DIR	1	Direction train is traveling ("E", "W" or blank if unknown)
AGENCY	2	Agency assigning train ID
SDATE	10	date of effective timetable DD/MM/YYYY (new field on TCP maintenance screen?)
CODE	2	not used (blank)
AGN	2	not used (blank)
TRK#	2	Platform track at STA# to which train is routed (0 if none)
BID	6	Harmon Block Identifier for approach location

HOme message

message type:	Home Location report
message code:	HO
initiated by:	TCP
meaning:	tell station (STA#) that train (TRN#) passed point (BID) at time (ETIME) in direction (DIR), and is lined for track (TRK#) in the station
transmitted:	upon TCP detection of train entry into designated "home" block for designated station

ATIDS action:	if (STA#) = ATIDS Station ID, locate (BID) in block definition file, continue; (if not, return.)
	if (BID) present as a home block, locate train (TRN#) in daily file, continue;
	if (BID) not present as a home block, enter (MSG), (BID) and (DIR) into Block Definition Changes Table, return.
	if train (TRN#) present in daily file and (DIR) = home block direction and TP = "A" or "D", log (BID) in HOMB, calculate and enter scheduled time at HOMB in SHOM, log (ETIME) in HOMT, log (TRK#) in ITRK, calculate status of train and place in IS, update ETA, continue
	if SRC = "N", set SRC = "A"; continue
	if SRC = "A" , set PS = IS, set PTRK = ITRK, return.
	if train (TRN#) present in daily file and (DIR) not= home block direction, calculate and log ATD, return.
	if train (TRN#) not present in daily file and (DIR) = home block direction, generate train (TRN#) file record, set TP to "U", log (TRK#) in ITRK, calculate and enter ETA, log (BID) in HOMB, log (ETIME) in HOMT, return.
	if train (TRN#) not present in daily file and (DIR) not= home block direction, return.

message format:	

CTIME	MSG	ETIME	TRN#	DIR	AGENCY	SDATE	CODE	AGN	TRK#	BID

Label	Size	Definition
CTIME	8	Current time HH:MM:SS
MSG	2	Message type "HO"
ETIME	8	Time of Event HH:MM:SS
TRN#	6	train ID
DIR	1	Direction train is traveling ("E", "W" or blank if unknown)
AGENCY	2	Agency assigning Train ID
SDATE	10	date of effective timetable DD/MM/YYYY (new field on TCP maintenance screen?)
CODE	2	not used (blank)
AGN	2	not used (blank)
TRK#	2	Platform track at STA# to which train is routed (0 if none)
BID	6	Harmon Block Identifier for home location

ID Change message

message type:	Train ID Change
message code:	ID
initiated by:	TCP
meaning:	the train previously known as train (TRN#) is actually train (NTRN)
transmitted:	upon change of train ID by action of TCP operator, Automatic Train Identification System, or TCP itself

ATIDS action:	if (STA#) = ATIDS Station, Line, Branch or Group ID, continue (if not, return.)
	if (TRN#) present in daily file, continue (if not, return)
	if (NTRN) already present in daily file, cache train (NTRN) times and status data
	if (NTRN) not already present in daily file, generate train (NTRN) file record
	copy existing train (TRN#) times and status data into (NTRN) record
	copy previously cached (NTRN) times and status data into (TRN#) record, return

message format:	

CTIME	MSG	ETIME	TRN#	DIR	AGENCY	SDATE	CODE	AGN	TRK#	BID

Label	Size	Definition
CTIME	8	Current time HH:MM:SS
MSG	2	Message type “ID”
ETIME	8	Time of Event HH:MM:SS
TRN#	6	train ID as previously known
DIR	1	direction of affected train (“E” or “W”, blank if unknown)
AGENCY	2	Agency assigning old Train ID
SDATE	10	date of effective timetable DD/MM/YYYY (new field on TCP maintenance screen?)
CODE	2	Source of ID change (**OP**erator, **AE**I tag reader, **TC**P)
AGN	2	Agency assigning new Train ID
TRK#	2	track number at time of change
NTRN	6	new train ID

Heart **B**eat message

message type:	TCP Heart Beat
message code:	HB
initiated by:	TCP
meaning:	despite the fact that no event messages have been sent recently, TCP event transmission is still active
transmitted:	whenever more than 10 minutes has passed without transmission of an automated event message by TCP
ATIDS action:	for all trains with AGR = (AGENCY), set TCP = (CTIME) if date of current code table for agency (AGR) = (CDATE), and version number of current code table for agency (AGR) = (VER#), set (AGR) CE = 1 (if not, set (AGR) CE = 0)
message format:	

CTIME	MSG	ETIME	TRN#	DIR	AGENCY	SDATE	CODE	AGN	TRK#	BID

Label	Size	Definition
CTIME	8	Current time HH:MM:SS
MSG	2	Message type "HB"
ETIME	8	last recorded CTC time stamp HH:MM:SS
TRN#	6	not used (blank)
DIR	1	not used (blank)
AGENCY	2	agency for which automated event reporting is being confirmed
SDATE	10	date of effective timetable DD/MM/YYYY (new field on TCP maintenance screen?)
CODE	2	not used (blank)
AGN	2	not used (blank)
TRK#	2	not used (blank)
BID	6	not used (blank)

Status **R**equest message

message type:	ATIDS system status request
message code:	**SR**
initiated by:	TCP
meaning:	ATIDS station report operating status
transmitted:	periodically by TCP
ATIDS action:	transmit current status variables

message format:

CTIME	MSG	ETIME	TRN#	DIR	AGENCY	SDATE	CODE	AGN	TRK#	BID

Label	**Size**	**Definition**
CTIME	8	Current time HH:MM:SS
MSG	2	Message type "SR"
ETIME	8	last recorded CTC time stamp HH:MM:SS
TRN#	6	not used (blank)
DIR	1	not used (blank)
AGENCY	2	agency issuing timetable for which currency is to be checked
SDATE	10	date of effective timetable DD/MM/YYYY (new field on TCP maintenance screen?)
CODE	2	current version of code table
AGN	2	agency issuing code table for which validity is to be checked
TRK#	2	not used (blank)
BID	6	not used (blank)

DElay message

message type:	Line Delay
message code:	DE
initiated by:	Operator
meaning:	tell affected stations that train (TRN#), all (DIR) direction trains, or all (DIR) direction (TRN#) series trains, with the exception of (EXEP) series trains, will be delayed an additional (DLY) minutes passing (LOC2), or will be indeterminably delayed, due to (CODE) at (LOC), and that this condition is expected to continue for the next (DUR) hours
transmitted:	upon entry of line delay notification by TCP Operator
ATIDS action:	determine if message applies to station for all affected trains in affected direction, less trains in any unaffected sub-series noted in (EXEP), if ATD is blank, and TP = “A” or “D”, and (DLY) = “9:99”, set SRC = “M”, set PS = “DE”, set CAUS = (CODE), set DLOC = (LOC), set ETR = (CTIME) + (DUR), return (if not, continue) for all trains in affected (TRNS) series in affected direction (DIR), less trains in any unaffected sub-series noted in (EXEP), if ATD is blank, and TP = “A” or “D”, and SKDD + (DLY) > ATIDS Clock Time, set SRC = “M”, set PS = “LA”, set CAUS = (CODE), set DLOC = (LOC), set DLAY = (DLY), set ETR = (CTIME) + (DUR), return (if not, continue) for all trains in affected (TRNS) series in affected direction (DIR), less trains in any unaffected sub-series noted in (EXEP), if ATD is blank, and TP = “A” or “D”, and SKDD + (DLY) <= ATIDS Clock Time, set SRC = “M”, set PS = “LA”, set CAUS = (CODE), set DLOC = (LOC), set DLAY = ATIDS Clock Time – SKDD + 5 minutes, or (DLY) + 5 minutes, whichever is greater, set ETR = (CTIME) + (DUR), return.
message format:	

CTIME	MSG	ETIME	DLY	LOC	LOC2	TRN #	DIR	PCT	AGENCY	CODE	AGN	VER	REF#	DUR	EXE P

Label	**Size**	**Definition**
CTIME	8	Current time HH:MM:SS
MSG	2	Message type “DE”
ETIME	5	Effective time of start of delay HH:MM (if later than current time)
DLY	4	length of delay H:MM (“9:99” if indeterminate delay)
LOC	4	4 character code for location of cause of delay
LOC2	4	4 character code for delay location
TRN#	6	train ID or train ID series – blank if all trains
DIR	1	direction affected (“E”, “W”, or “B” for both) – blank if single train affected
PCT	2	not used (blank)
AGENCY	2	Agency assigning Train ID
CODE	2	code for cause of delay
AGN	2	Agency assigning cause codes
VER	4	version number of cause code table
REF#	4	operator message reference number
DUR	2	expected duration of condition HH (hours) – blank if single train affected
EXEP	6	train ID series excepted – blank if single train affected

CAncel message

message type:	Cancelled Train
message code:	CA
initiated by:	Operator
meaning:	tell affected stations that train (TRN#) has been cancelled due to (CODE) at (LOC)
transmitted:	upon entry of train cancellation notification by TCP Operator
ATIDS action:	if (STA#) = ATIDS Station, Line, Branch or Group ID, locate (TRN#) in daily file, continue (if not, return.) if train (TRN#) present in daily file, and ATD is blank, and TP = "A" or "D", set SRC = "M", set PS = "CA", set CAUS = (CODE), set DLOC = (LOC), return.
message format:	

CTIME	MSG	ETIME	DLY	LOC	LOC2	SVC	DIR	PCT	AGENCY	CODE	AGN	VER	REF#	DUR	EXEP

Label	**Size**	**Definition**
CTIME	8	Current time HH:MM:SS
MSG	2	Message type "CA"
ETIME	5	not used (blank)
DLY	4	not used (blank)
LOC	4	4 character code for location of cause of cancellation
LOC2	4	4 character code beyond which train has been canceled (or blank, if canceled entirely)
TRN#	6	train ID of cancelled train
DIR	1	not used (blank)
PCT	2	not used (blank)
AGENCY	2	Agency assigning Train ID
CODE	2	code for cause of cancellation
AGN	2	Agency assigning cause codes
VER	4	version number of cause code table
REF#	4	operator message reference number
DUR	2	not used (blank)
EXEP	6	not used (blank)

COnnecting Service Delay message

message type:	Connecting Service Delay
message code:	CO
initiated by:	Operator
meaning:	notify stations of a delay on a connecting service at (LOC)
transmitted:	upon entry of connecting service delay information by TCP Operator
ATIDS action:	if (STA#) = ATIDS Station, Line, Branch or Group ID, continue (if not, return.)
message format:	

CTIME	MSG	ETIME	DLY	LOC	LOC2	SV C	DIR	PCT	AGENCY	CODE	AGN	VE R	REF#	DUR	EXEP

Label	**Size**	**Definition**
CTIME	8	Current time HH:MM:SS
MSG	2	Message type “CO”
ETIME	5	effective time of connecting service notice HH:MM (if other than current time)
DLY	4	extent of connecting service delays H:MM (9:99 if indeterminate suspension)
LOC	4	location of connection
LOC2	4	location of cause of delay on connecting service
SVC	6	affected service
DIR	1	direction of connecting services affected
PCT	2	not used (blank)
AGENCY	2	Agency operating connection
CODE	2	cause of delays on connecting services
AGN	2	Agency assigning cause codes
VER	4	version number of cause code table
REF#	4	operator message reference number
DUR	2	expected duration of delay condition on connecting services HH
EXEP	6	not used (blank)

Service **R**estoration message

message type:	Service Restoration
message code:	SR
initiated by:	Operator
meaning:	notify stations of the restoration of previously delayed or disrupted service
transmitted:	upon entry of service restoration information by TCP Operator
ATIDS action:	if (STA#) = ATIDS Station, Line, Branch or Group ID, continue (if not, return.)
message format:	

CTIME	MSG	ETIME	DLY	LOC	LOC2	SVC	DIR	PCT	AGENCY	CODE	AGN	VER	REF#	DUR	EXEP

Label	**Size**	**Definition**
CTIME	8	Current time HH:MM:SS
MSG	2	Message type “SR”
ETIME	5	effective time of service restoration HH:MM (if other than current time)
DLY	4	not used (blank)
LOC	4	not used (blank)
LOC2	4	not used (blank)
SVC	6	not used (blank)
DIR	1	not used (blank)
PCT	2	not used (blank)
AGENCY	2	Agency that issued the message referenced by REF#
CODE	2	not used (blank)
AGN	2	not used (blank)
VER	4	not used (blank)
REF#	4	reference number of operator message that reported the disruption now being restored
DUR	2	not used (blank)
EXEP	6	not used (blank)

SUspended Service message

message type:	Suspended Service
message code:	SU
initiated by:	Operator
meaning:	notify stations of a suspension of service between (LOC) and (LOC2)
transmitted:	upon entry of service suspension information by TCP Operator
ATIDS action:	if (STA#) = ATIDS Station, Line, Branch or Group ID, continue (if not, return.)
message format:	

CTIME	MSG	ETIME	DLY	LOC	LOC2	TRN #	DIR	PCT	AGENCY	CODE	AGN	VER	STA#	DUR	EXEP

Label	**Size**	**Definition**
CTIME	8	Current time HH:MM:SS
MSG	2	Message type “SU”
ETIME	5	effective time of suspended service notice HH:MM (if other than current time)
DLY	4	not used (blank)
LOC	4	location of beginning of service suspension
LOC2	4	location of end of service suspension
TRN#	6	affected service (train number series, line or division)
DIR	1	direction of services affected (“E”, “W”, or “B” for both)
PCT	2	not used (blank)
AGENCY	2	Agency operating service
CODE	2	cause of service suspension
AGN	2	Agency assigning cause codes
VER	4	version number of cause code table
STA#	4	station or station group for which message is intended
DUR	2	expected duration of service suspension HH
EXEP	6	train ID subseries excepted

DIsable Automatic Status message

message type:	Disable automatic status reporting
message code:	DI
initiated by:	Operator
meaning:	override ATIDS processors at affected stations to disable automatic status reporting
transmitted:	upon entry of automatic status override by TCP Operator
ATIDS action:	if (STA#) = ATIDS Station, Line, Branch or Group ID, continue (if not, return.) if ETIME is blank, then for all trains in (DIR) direction, set TDIS = (CTIME), set TRES = (CTIME)+(DUR), set SRC = "M", return if ETIME is not blank, then for all trains in (DIR) direction, set TDIS = (ETIME), set TRES = (ETIME)+(DUR), set TDE = 1, return.
message format:	

CTIME	MSG	ETIME	DLY	LOC	LOC 2	TRN #	DIR	PCT	AGENCY	CODE	AGN	VER	REF#	DUR	EXEP

Label	**Size**	**Definition**
CTIME	8	Current time HH:MM:SS
MSG	2	Message type "DI"
ETIME	5	Effective time HH:MM (if different from current time)
DLY	4	not used (blank)
LOC	4	not used (blank)
LOC2	4	not used (blank)
TRN#	6	not used (blank)
DIR	1	affected direction ("E", "W", or "B" for both)
PCT	2	not used (blank)
AGENCY	2	not used (blank)
CODE	2	not used (blank)
AGN	2	not used (blank)
VER	4	not used (blank)
REF#	4	operator message reference number
DUR	2	duration over which automated reporting should be disabled HH (hours)
EXEP	6	not used (blank)

REsume Automatic Status Reporting message

message type:	Resume automatic status reporting
message code:	RE
initiated by:	Operator
meaning:	notify ATIDS processors at affected stations to resume automatic status reporting
transmitted:	upon entry of automatic status restoration command by TCP Operator
ATIDS action:	if (STA#) = ATIDS Station, Line, Branch or Group ID, continue (if not, return.) if ETIME is blank, then for all trains in (DIR) direction, set TDE = 0, set SRC = "A", return if ETIME is not blank, then for all trains in (DIR) direction, set TRES = (ETIME), return.
message format:	

CTIME	MSG	ETIME	DLY	LOC	LOC 2	TRN #	DIR	PCT	AGENCY	CODE	AGN	VE R	REF#	DUR	EXEP

Label	**Size**	**Definition**
CTIME	8	Current time HH:MM:SS
MSG	2	Message type "RE"
ETIME	5	Effective time HH:MM (if different from current time)
DLY	4	not used (blank)
LOC	4	not used (blank)
LOC2	4	not used (blank)
TRN#	6	not used (blank)
DIR	1	affected direction ("E", "W", or "B" for both)
PCT	2	not used (blank)
AGENCY	2	not used (blank)
CODE	2	not used (blank)
AGN	2	not used (blank)
VER	4	not used (blank)
REF#	4	operator message reference number
DUR	2	not used (blank)
EXEP	6	not used (blank)

SChedule message

message type:	Schedule
message code:	SC
initiated by:	Operator
meaning:	tell affected stations that an extra train, train (TRN#), is in operation in the (DIR) direction
transmitted:	upon entry of extra train notification by TCP Operator
ATIDS action:	if (STA#) = ATIDS Station, Line, Branch or Group ID, continue (if not, return) locate (TRN#) in daily file, continue (if not, return.) if train (REF#) already present in daily file, continue (if not, return) if train (TRN#) not already present in daily file, generate train (TRN#) file record using train (TREF) as a model; set TP to "U", set TDEP = (ETIME), set SKDA = train (TREF)'s SKDA + (ETIME) – train (TREF)'s TDEP, set DIR = (DIR) set PS = "EX", return.
message format:	

CTIME	MSG	ETIME	DLY	LOC	LOC2	TRN #	DIR	PCT	AGENCY	CODE	AGN	VER	REF#	DUR	TREF

Label	**Size**	**Definition**
CTIME	8	Current time HH:MM:SS
MSG	2	Message type "SC"
ETIME	5	Departure time from origin HH:MM
DLY	4	not used (blank)
LOC	4	not used (blank)
LOC2	4	not used (blank)
TRN#	6	train ID of extra train
DIR	1	direction of operation ("E" or "W")
PCT	2	not used (blank)
AGENCY	2	code for agency assigning extra train ID
CODE	2	not used (blank)
AGN	2	code for agency assigning reference train ID
VER	4	not used (blank)
REF#	4	operator message reference number
DUR	2	not used (blank)
TREF	6	Train ID of train used for schedule reference

Run **L**ocal (or Express) message

message type:	Run Local or Express
message code:	RL
initiated by:	Operator
meaning:	tell affected stations that train (TRN#) or train series (TRNS) will make additional local stops (or will run express) between (LOC) and (LOC2)
transmitted:	upon entry of local or express stops notification by TCP Operator
ATIDS action:	if (STA#) = ATIDS Station, Line, Branch or Group ID, continue (if not, return) locate (TRN#) in daily file, continue (if not, return.) if train (TRN#) present in daily file, set SS = "LO", set CAUS = (CODE), return.
message format:	

CTIME	MSG	ETIME	TYPE	LOC	LOC2	TRN#	DIR	PCT	AGENCY	CODE	AGN	VER	REF#	DUR	TRNS

Label	**Size**	**Definition**
CTIME	8	Current time HH:MM:SS
MSG	2	Message type "RL"
ETIME	5	not used (blank)
TYPE	4	"LOC" for local, "EXP" for express
LOC	4	location where local/express stopping begins
LOC2	4	location where local/express stopping ends
TRN#	6	train ID of train that will run local or express, or blank if entire train ID series affected
DIR	1	direction of operation ("E" or "W", blank if one train only)
PCT	2	not used (blank)
AGENCY	2	code for agency assigning train ID
CODE	2	code for cause of revised stopping pattern
AGN	2	agency assigning cause codes
VER	4	current version of cause code table
REF#	4	operator message reference number
DUR	2	duration over which new stopping pattern applies HH (hours), or blank if one train only
TRNS	6	Train ID series of trains that will run local or express, or blank if one train only

Boarding **I**nstructions message

message type:	Boarding Instructions
message code:	BI
initiated by:	Operator
meaning:	tell affected stations that passengers destined for (LOC) through (LOC2) on train (TRN#) should board on the first/last/middle (NCARS) cars of the train
transmitted:	upon entry of boarding instructions by TCP Operator
ATIDS action:	if (STA#) = ATIDS Station, Line, Branch or Group ID, continue (if not, return) locate (TRN#) in daily file, continue (if not, return.) if train (TRN#) present in daily file, set SS = “LO”, set CAUS = (CODE), return.
message format:	

CTIME	MSG	ETIME	DLY	LOC	LOC 2	TRN #	DIR	PCT	AGENCY	END	NCARS	VER	REF#	DUR	TRNS

Label	**Size**	**Definition**
CTIME	8	Current time HH:MM:SS
MSG	2	Message type “BI”
ETIME	5	not used (blank)
DLY	4	not used (blank)
LOC	4	first location affected
LOC2	4	last location affected (or blank)
TRN#	6	train ID
DIR	1	not used (blank)
PCT	2	not used (blank)
AGENCY	2	code for agency assigning train ID
END	2	end of train to board (F = first, L = last, M = middle)
NCARS	2	number of cars to board
VER	4	not used (blank)
REF#	4	operator message reference number
DUR	2	not used (blank)
EXEP	6	not used (blank)

Cancel **M**essage message

message type:	Cancel or Change Message
message code:	CM
initiated by:	Operator
meaning:	tell affected stations to delete or modify status previously received via operator message
transmitted:	upon entry of message cancellation or modification order by TCP Operator
ATIDS action:	
message format:	

CTIME	MSG	ETIME	DLY	LOC	LOC 2	TRN #	DIR	PCT	AGENCY	CODE	AGN	REF0	REF#	DUR	TRNS

Label	**Size**	**Definition**
CTIME	8	Current time HH:MM:SS
MSG	2	Message type “CM”
ETIME	5	effective time of message modification HH:MM (if different from current time)
DLY	4	new delay
LOC	4	not used (blank)
LOC2	4	not used (blank)
TRN#	6	not used (blank)
DIR	1	not used (blank)
PCT	2	not used (blank)
AGENCY	2	not used (blank)
CODE	2	not used (blank)
AGN	2	not used (blank)
REF0	4	reference number of operator message being modified or cancelled
REF#	4	operator message reference number
DUR	2	new duration HH (hours)
EXEP	6	not used (blank)

Slow **T**rain message

message type:	Slow Train Message
message code:	ST
initiated by:	Operator
meaning:	tell affected stations that train (TRN#) or all (DIR) direction trains on the (LINE) line will make only (PCT) percent of normal speed (or will spend an extra (DLY) minutes at each station) between (LOC) and (LOC2) for the next (DUR) hours due to (CODE).
transmitted:	upon entry of slow train notification by TCP Operator
ATIDS action:	
message format:	

CTIME	MSG	ETIME	DLY	LOC	LOC 2	TRN #	DIR	PCT	AGENCY	CODE	AGN	VER	REF#	DUR	EXEP

Label	**Size**	Definition
CTIME	8	Current time HH:MM:SS
MSG	2	Message type “ST”
ETIME	5	not used (blank)
DLY	4	extra delay at each station H:MM
LOC	4	location from which condition applies
LOC2	4	location to which condition applies
TRN#	6	ID of affected train or rail line
DIR	1	affected direction (if TRN# is a Line ID)
PCT	2	percent by which normal speed will be reduced between LOC and LOC2
AGENCY	2	agency assigning train ID
CODE	2	code for cause of delay
AGN	2	agency assigning cause codes
VER	4	current version of cause code table
REF#	4	operator message reference number
DUR	2	expected duration of delay condition (hours)
EXEP	6	not used (blank)

Appendix 3 - Functional Specification for an Automated Train Information Display System

[Note: additional detail to be furnished with final report]

Inputs (in TCIP-compliant XML format):

1. Schedules (times and normal track assignments (if any) at every stop and controlled point, for each train)
2. Estimated Time of Arrival at each controlled point, together with anticipated departure track assignment (may be provided directly from dispatch system, or via separate ETA Module)
3. Voice Annunciator files (proper pronunciation of station names, etc)
4. Schedule adjustments (cancellations, extra trains)
5. Real-time confirmation of train arrival/departure

System Function:

1. Interpolate from ETAs and track assignments at Controlled Points to determine ETA and track assignments at station
2. Identify and specially announce deviations from anticipated track assignments
3. Identify and specially announce deviations from scheduled sequence of trains
4. Drive displays, automated voice announcements and multi-lingual infrared signage tailored to specific parking lots, waiting rooms, gates and platforms
5. Roll train schedules onto and off of displays at specific locations within the station, according to business rules individually user-configured for each location and class of train
6. Roll train status and arrival information onto and off of displays at specific locations within the station, according to business rules individually user-configured for each location and class of train
7. Support and distinguish trains and schedules from multiple agencies (even if train numbers have been duplicated across agencies)
8. Support dynamic drag and drop display configuration – the operator should be able to configure any display to carry whatever information, in whatever format, they desire.

Outputs:

1. Waiting Room Display
2. Waiting Room Announcements
3. Waiting Room Infrared Signage
4. Parking Lot Display
5. Concourse Display (Gate Board)
6. Concourse Announcements
7. Concourse Infrared Signage
8. Platform Display
9. Platform Announcements
10. Platform Infrared Signage

Specification for Automated Passenger Information Announcements:

Italic print indicates "announce only if known"

Automated Announcements are listed in Transmission Priority Order (1 = highest transmission priority)

AUTOMATED ANNOUNCEMENT	WHEN FIRST ANNOUNCED	ACTIVE SPEAKERS	CONDITION	REPETITION PERIOD	WHEN LAST ANNOUNCED
1. Attention (station) passengers, the (scheduled time) (direction) (class) to (terminus), previously announced on (old track ID), will now arrive on (new track ID).	upon change of preannounced track	main waiting area and affected platforms	change to previously announced track assignment	none	n/a
2. Passengers may (access method) to reach (new track ID)	appended to items 1 and 10	same as item 1/10	**transmission of announcement 1 or 10**	none	n/a
3. Attention (station) passengers, we regret to inform you that NJ Transit has been forced to cancel the (scheduled time) (direction) (class) to (terminus), due to (cause). The next train to (terminus) will arrive at approximately (expected time of arrival) (day).	scheduled time of affected train minus 5 minutes	main waiting area and all platforms serving affected direction	cancellation of train	5 minutes	scheduled time of affected train plus 5 minutes
4. Attention pasengers on the (line name) line, we regret to inform you that NJ Transit has been forced to suspend (direction) (class/regular) service (to/from) (location) due to (cause) at (problem location) until approximately (time) (day).	scheduled time of first affected train minus 5 minutes	main waiting area and all platforms serving affected direction(s)	suspension of services on a line	scheduled time of any affected train minus 2 minutes	earlier of estimated or actual time of repair

AUTOMATED ANNOUNCEMENT	WHEN FIRST ANNOUNCED	ACTIVE SPEAKERS	CONDITION	REPETITION PERIOD	WHEN LAST ANNOUNCED
5. Alternative (mode) service (to/from) (location) (is being provided by/is available from) (provider).	appended to item 4	same as item 4	if alternative service has been identified	none	n/a
6. Alternative (mode) services depart from (location), (distance) (direction) from the station.	appended to item 5	same as item 5	if boarding location of alternative service has been defined	once only	n/a
7. Attention passengers on the (line name) line, all *(direction)* trains (from or to) (origin or terminus) are being delayed (minimum) *to (maximum)* minutes at (delay location) due to (cause). This is expected to continue until approximately (time) (day).	when first known	main waiting area and all platforms serving affected direction	global service disruption/delay	scheduled time of any train to/from affected origin/terminus	earlier of estimated or actual time of restoration
8. Attention (station) passengers, the next train to stop on (track ID) will be the (scheduled time) (direction) (terminus) (class), making stops at (sequence of stops). Please stand back from the yellow line.	actual time of arrival minus 1 minute	main waiting area and affected platform	all through trains scheduled to originate or stop at station	none	n/a
9. Attention (station) passengers, the next train to arrive on (track ID) does not take passengers. Please stand back from the yellow line.	actual time of arrival minus 1 minute	main waiting area and affected platform	all terminating trains and all trains not scheduled to stop at station	none	n/a

AUTOMATED ANNOUNCEMENT	WHEN FIRST ANNOUNCED	ACTIVE SPEAKERS	CONDITION	REPETITION PERIOD	WHEN LAST ANNOUNCED
10. Attention (station) passengers, the (scheduled time) (direction) (class) to (terminus) is expected to arrive in (minimum) *to (maximum)* minutes. This train, normally expected on (normal track ID) will arrive today on (track ID).	estimated time of arrival minus user defined delay threshold (nominally 5 minutes)	main waiting area and all platforms serving affected direction	train on **other than normal track** and estimated time of station **arrival** is **less than user defined delay threshold** (nominally 5 minutes) **after scheduled departure** time (i.e. i.e. different track and nominally "on time")	greater of ½ user defined delay threshold or 3 minutes	actual time of arrival minus 2 minutes
11. Track (new #) is located directly across the platform from track (old #)	appended to items 1 and 10	same as item 1/10	if new track accessed from **same platform**	none	n/a
12. Attention (station) passengers, the (scheduled time) (direction, class to terminus) is operating (minimum) to (maximum) minutes late due to (cause) *at (problem location)*.	scheduled time of affected train minus user defined delay threshold (nominally 5 minutes)	main waiting area and all platforms serving affected direction	estimated time of station **arrival** is **greater than or equal to user defined delay threshold** (nominally 5 minutes) **after scheduled departure** time (i.e. nominally "late")	greater of ½ user defined delay threshold or 5 minutes	estimated time of arrival minus 5 minutes

AUTOMATED ANNOUNCEMENT	WHEN FIRST ANNOUNCED	ACTIVE SPEAKERS	CONDITION	REPETITION PERIOD	WHEN LAST ANNOUNCED
13. Attention (station) passengers, the (scheduled time) (direction, class to terminus) is expected to arrive *on (track ID)* in approximately (minimum) minutes.	estimated time of arrival minus user defined delay threshold (nominally 5 minutes)	main waiting area and all platforms serving affected direction	train on **normal track** and estimated time of station **arrival** is **less than user defined delay threshold** (nominally 5 minutes) after scheduled **departure** time (i.e. normal track and nominally “on-time”)	greater of ½ user defined delay threshold or 3 minutes	actual time of arrival minus 2 minutes
14. Please remember to buy your ticket before you board the train.	appended to item 13	same as item 13	transmission of anouncement 13	none	n/a
15. Attention passengers bound for (affected location). Please be advised that connecting (mode) services are reporting (minimum) *to (maximum)* (minute/hour) delays (or cancellations) *due to (cause)*. This is expected to continue until approximately (time) (day).	when first known	main waiting area and all platforms serving affected direction	reported disruption of connecting services at downstream station	scheduled time of any train to affected location minus 2 minutes	earlier of estimated or actual time of restoration
16. Attention passengers on the (line name) line, due to (cause), (direction) train service *between (station 1) and (station 2)* will operate every (headway) minutes from (first extra departure) to (last extra departure) on (date).	later of (first modified departure -36 hours) or when first known	main waiting area and all platforms serving affected direction	modified service	scheduled time of any train - 4 minutes	last extra departure - 4 minutes

AUTOMATED ANNOUNCEMENT	WHEN FIRST ANNOUNCED	ACTIVE SPEAKERS	CONDITION	REPETITION PERIOD	WHEN LAST ANNOUNCED
17. Attention (station) passengers, the next scheduled (direction) train is the (scheduled departure time) (class) to (terminus), scheduled to depart in (scheduled departure minus current time) minutes.	estimated time of arrival minus user defined delay threshold (nominally 5 minutes)	main waiting area and all platforms serving affected direction	lack of train ETA and status information from any source	none	n/a

Key to variable fields:

direction eastbound, westbound, northbound, southbound
class“class” of service: local, express, limited -- may vary over length of train's run
mode type of connecting service: PATH, Amtrak, New York City Transit, Long Island Railroad, Airlink Bus, SEPTA, New York Waterway, Local Bus, Airline
minimum minimum likely length of time in minutes or hours
maximum maximum likely length of time in minutes or hours
cause track problems, signal problems, a stalled train, police activity, a fire, snow and ice, traffic congestion, electrical problems, installation of improved ______, etc.

Note 1: if no “normal” track has been specified in the schedule, default to message 13 vice message 10.

Appendix 4 - Moderators Guide for Real-Time Information Market Research

1. Introduction by Moderator (0:00– 0:05) 5 Minutes

Moderator thanks everyone for coming. She/He states that we are conducting this focus group in order to understand our customer's views on how NJ Transit communicates information to them. All of this will be used to help customers be more informed and make their travel easier and more comfortable.

Moderator explains how a focus group works:
Facilitator will present topics
Participants encouraged to give their opinions
No right or wrong answers
Basic ground rules:
Don't interrupt speakers
No side conversations
Moderator may need to cut off discussion at different points in order to cover all topics
Feel free to get up and eat, use restrooms, etc.
At the end of the focus group, each participant will receive his/her payment.

Participants are told that the meeting will be audio taped so that a summary can be written. For the same reason, the staff will be taking notes as the focus group is conducted. There will be no attribution of any of the comments to a specific person and nowhere in the summary will the names of the participants appear.

Also, participants are told that the additional people in the room are observers from NJ TRANSIT who are interested in this project. The moderator explains that the observers are here to gain immediate, first-hand knowledge of what is said, but they won't be participating in the discussion tonight.

The moderator asks if there are any questions.

2. Introduction of the Participants (0:05-0:20) 15 minutes

Participants are asked to introduce themselves, telling moderator:
Participants name? How do you commute to work? What services do you use? Origin, transfer and destination points? Time of day? How frequently per week? What is their overall impression of your commuting experience?

I would like to start by talking about how you receive information about various aspects of your travel on NJ Transit. I'm going to pass out a rating sheet and I'm going to ask you to rate NJ Transit on how effectively we communicate information to our customers, where 1 is very dissatisfied and 10 is very satisfied. Feel free to write down any additional comments you might come up with to go along with your rating.

3. Information Medium **(0:20-0:30)**
10 minutes

Through what medium do you receive information from NJ Transit?

- Seat drops?
- FYI?
- Posters?
- Train announcements?
- Display Systems?
- Website?
- Newspapers?
- Word of mouth?
- Customer service?
- Front line employee/
- Schedules?
- My Transit?

4. Frequency of Information **(0:30-0:40)**
10 minutes

What information do you need on a regular basis? How would you like to receive this information? How often? What information do you need on an infrequent basis? How would you like to receive this information and how often?

5. Information Content **(0:40-0:55)**
15 minutes

What is the content of the information that you usually receive?

- Transportation service disruptions?
- Weather advisories?
- Schedule changes?
- Stations openings and closings?
- Service status? Delays?
- Status of connecting services?
- Promotions and special offers?

6. NJ Transit Communication Rating **(0:55-1:10)**
15 minutes

Now I would like to take this time for you to rate our ability to communicate with our customers. How do you rate the quality and importance of the information we provide? How do you rate the timeliness of the information?

7. Future Information Mediums **(1:10-1:25)**
15 minutes

How would you like to get information from NJ Transit in the future? Would you like us to focus on providing more information through a specific medium that was mentioned earlier? Do you have a new way that you would like to receive information?

8. Content of Future Information **(1:25-1:40)**
15 minutes

What kind of information would you like to get from NJ Transit in the future? Is there information that you would like to know that we are not providing? What information is most important to have? Least important? If NJT could do one thing to improve communication what would that one thing be?

9. Conclusion **(1:40-1:45)**

At the conclusion, facilitator thanks participants and gives them their honorarium. Make sure all rating sheets are complete.

Exhibits:

DESTINATION	LINE	TRK	DEPART	ARRIVE	CHANGE AT
Aberdeen	NJCL	3	7:16a	8:08a	
Aberdeen	NJCL	3	7:58a	8:49a	
Allendale	MBL	B	7:19a	8:07a	
Allendale	MBL	D	8:00a	8:43a	
Allenhurst	NJCL	3	7:16a	8:47a	Long Branch
Allenhurst	NEC	3	8:39a	10:06a	Newark-NJCL
Annandale	NEC	3	6:45a	8:26a	Newark-RVL
Annandale	NEC	3	2:53p	4:17p	Newark-RVL
Asbury Park	NJCL	3	7:16a	8:51a	Long Branch
Asbury Park	NJCL	3	8:39a	10:10a	Newark-NJCL
Avenel	NJCL	3	7:16a	7:46a	
Avenel	NJCL	3	3:36p	4:06p	
Basking Ridge	M&E	3	6:39a	8:25a	Summit
Basking Ridge	M&E	3	7:19a	8:45a	Summit

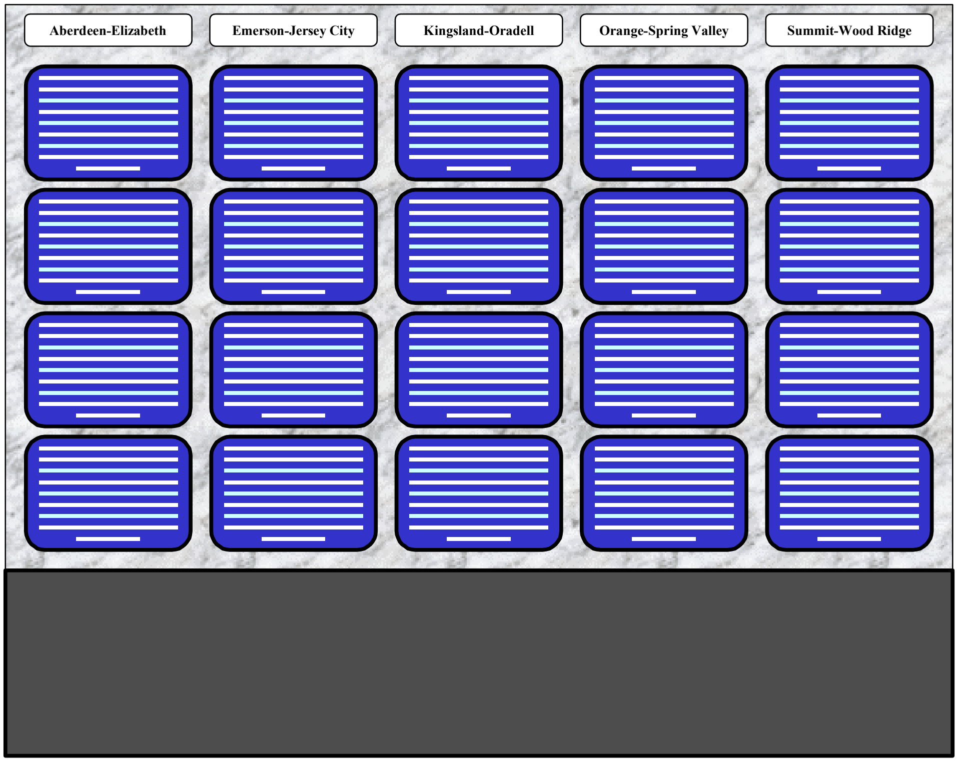
Thursday, August 15, 2002 6:30am

"Airport Style" Alphabetical Destination Display: next two trips to each available destination (slide 1)

DESTINATION	LINE	TRK	DEPART	ARRIVE	CHANGE AT
Harmon Cove	#2	Bus	6:43a	7:00a	
Harmon Cove	#2	Bus	7:03a	7:20a	
Hawthorne	MBL	B	7:19a	7:46a	
Hawthorne	MBL	B	8:00a	8:27a	
Hazlet	NJCL	3	7:16a	8:12a	
Hazlet	NJCL	3	7:58a	8:53a	
High Bridge	NEC	3	6:45a	8:33a	Newark-RVL
High Bridge	NEC	3	2:53p	4:26p	Newark-RVL
Hillsdale	PVL	D	2:45p	3:19p	
Hillsdale	PVL	D	4:46p	5:21p	
Hoboken	MBL	A	6:36a	6:46a	
Hoboken	MBL	C	7:02a	7:12a	
Jersey City	#2	Bus	6:57a	7:12a	
Jersey City	#2	Bus	7:01a	7:16a	

Thursday, August 15, 2002 6:30am

“Airport Style” Alphabetical Destination Display: next two trips to each available destination (slide 2, with bus destination)



Video Display Bank (wall mounted or free standing cabinet): next two trips to each available destination (20 monitors required)

Appendix 5 - Facilitator's Notes from Focus Group Research

Compilation of highlights from 8 focus groups comprised of bus, rail and highway commuters.

<u>Introduction</u>

What is your typical commute? What is your experience like?

- I work across the street from the train station. I can usually get a seat home.
- Have a one-seat ride to work. If I go to the city for recreation, I have to make a connection.
- Get the train at 7:32, then connect to the bus at 7:41. I get to work at 8:00.
- I drive from home. My travel time is too long on the train. I leave home at 8 am and it takes 25 minutes, however it is a very unpredictable ride.
- I come from Philadelphia via Amtrak. My ride is 1 hour 15 minutes
- In the afternoon my train is less reliable, because it often encounters problems en route
- Boards train at 7:23 AM, transfers to ferry.
- Boards express train at 6:35 AM, transfers to subway.
- Drives to station, then train, then transfer to subway.
- Takes train two or three times per week. Train much better option than the bus.
- Travels during off hours, train to subway
- Either bus or train from home to transfer point, then by bus
- Bus on Sundays. Train on weekdays.
- Bus from home to train station, transfers to another bus at train station.
- Work shift 12:00A.M. – 7:00A.M. Takes train to bus.

What kinds of information are important to you when you travel on public transit, and how do you currently obtain that information?

- It is crucial that all clocks have the same time
- People must know when the connections leave, so they can know if they need to rush or not.
- Information should clearly differentiate between boarding time and when the train arrives and departs the station. People do not understand that the posted time is the time the train pulls away from the platform. People get to platform and the train is gone.
- Get info from Customer Service
- Rely on own experience for most info
- Schedule is memorized
- Go online for schedules
- Want to know if the train is on time
- Television News in the morning
- Listen to announcements at stations, sometimes very hard to understand
- Carries schedule in case traveling at odd times
- Used website initially but then changed to printed schedule
- Check train time on permanent poster at station
- Local newspaper for parking rules, etc.
- Ask ticket agent what is coming up

- Called the automated telephone source
- Bus schedule
- Uses customer service for information
- Phone service (often gives incorrect answers)
- PA system
- Want to know how long it will take
- Stops along the way to destination
- Want to know about schedule delays and what is going on
- Current news

<u>Dynamic Signage Needs</u>

How important is real time information when you travel?

- Real Time information is vital for commuters. Commuters are traveling to get somewhere by a specific time, they are not leisure travelers.
- For comfort level and anxiety, people want to know how much time there is until the next train. This lets people decide whether to buy a newspaper, coffee, go to the restroom.
- Critical - want to know if going to arrive on time, either for connection or to work.
- Connections are main reason important. By knowing, the anxiety is reduced, can start to do something about the delay i.e. make calls.
- Very important - mainly for connections, sometimes only have 3 or 4 minutes to make the connection.
- Extremely important, it makes the difference between running or walking
- If the trains are delayed, notice should be posted to reflect the delay.
- Must be correct. At terminal, some signs say “boarding,” when train is really not.
- For people catching a connecting train, it is important to have information about the connection as early as possible -- on the train before they get off, on the track or on the stairwell of the terminal

Have you noticed other real time signage related to travel?

- Airports
- In England at the bus shelter, there is information about the next bus. It shows the customer that the public transportation industry really cares about the customer.
- Metro in D.C.
- In Atlanta, they tell you where you are going to have to connect
- In Paris color coded/different routes helps to differentiate where to go
- Signs on trains giving the destinations
- In London consistent of use of tracks
- Victoria Station
- Inside the train, have all of the destinations—like Paris Metro, city subways
- Japanese and German trains have next destinations posted
- London Underground tells you when the next train arrives
- NYC – When next subway is coming
- London uses maps with routes that light up

What is most helpful?

- The various stations the train will go to should be listed at the track
- Potential routing options to a given destination
- Link the information for the trip. A person needs to know before getting on the first leg when the second leg is leaving, and if it is on time.
- There needs to be continuous real time information for all segments.
- Need enough timely information to make educated decisions
- Occasional rider needs to feel a level of comfort.
- Information should be at a Main Board.
- Announcements should be made every X minutes
- Information should be reinforced at the gate; this is the train you are going to board
- Whether the train is delayed or not.
- What track they need to go to and direction they have to go in.
- May be the information could be color coded – make it easier to understand quickly.
- Want to know which train is a local vs. express.
- Provide information onboard the train too.
- List intermediate stations as well as final destinations
- Where is the train
- Track and time
- Where is the connection
- My destination—the specific place I want to go
- The real time
- All clocks in station should be synchronized
- Announcements need to be comprehensible
- Announcements need to be timely and repeated often
- Give information about when next train will come

Let's talk about when there are delays.

What is the most critical thing you what to know when there are delays?

- How long a delay is and what my options are.
- Regarding delays - a lot more difficult to deal with when you are on the train, you don't know what is happening. Good idea to give information on board.
- How long is the delay
- Are you going to miss connection or should you take another route? This may help you decide to stay on train
- Should I stay on this train rather than transfer to a delayed train that would be packed
- Cause of delay—peace of mind can help to judge how bad it is and make other plans
- State the estimated trip time
- Accidents causing delay – good to know on bus to or from the station
- Schedule – on time service
- Need to know if there is a delay while waiting for a bus. Bus stop could be wired to let passengers know when the bus will reach the station and any other critical stops. This would provide a level of comfort
- Need communication about what is happening
- Important to know information at home

Where is the best place for you to find out about delays?

- Radio
- Announcements at the station
- Pager
- Observe the number of people accumulated at the platform, or if one is driving one can look out window to see crowd – indicates a problem on the line
- Check website, METRO Traffic, and/or Radio
- At Station check Big Board
- Use experience to choose route/alternative
- Would like to know at the office, therefore can decide to take a bus instead of train. Don't want to have committed to a route and be in middle of trip before finding out about a problem.
- E-mail service to let you know of delays would be great
- Wherever there is alternative taxi service/ground transportation
- Why not display real time information on the train?

Within a major terminal or transfer station, what dynamic information do you need to get you from point A to point B?

- What time the next connection is, and how long until train after that one – should I walk or run.
- When the person sees the stairs, need clear directions where to go
- People must know if their train is running or not
- Everything depends on how connections are timed.
- People need all information, including delays on connections to weigh against alternative trip options.
- When a person gets off, must immediately have a sense of where they need to be
- Where my train is and how long I have to get there.
- I need to know how long the transfer to my next train is going to take so I can build in lead time.
- Next train to my destination and time of departure.
- Make use of internationally standardized signs so everyone can understand them, color is a good way to do this, e.g. Metro in DC.
- Color code your ticket to the route or line you are transferring to
- What is the quickest way? Most efficient way possible
- Large signs in large type. The current signage is very small
- Signs with arrows. Simplicity is best. Signs that help people that are walking, not ones where you have to stop and stare
- Clearly define rail lines
- Could use color coding
- Make signs clear
- Where to buy a ticket
- Where do buses pick up and drop off?

Testing Dynamic Signage

Do you like the idea of using symbols for each line?

- Easy reference, color easy to pick out especially for foreign travelers or non- English speakers.
- Color blindness - not able to discern some colors so the symbol may help.
- Why not numbers instead of symbols?
- Its cute, its neat.
- Some strongly liked it as long as the symbols were clearly differentiated.
- Good for foreign travelers new to the system.
- “I look for the “I” sign with a dot when I am traveling to find what I am looking for; standardized symbols are the key”.
- Don’t understand why the symbols would help regular commuters.
- Will help color-blind people
- Will help foreign visitors
- People who use lines infrequently would be helped, not the “autopilot” commuters
- Easier than reading words on a board. Don’t have to read everything on the board if symbols are used.
- Would help visually handicapped patrons
- Symbols not much value but colors help more
- Likes the idea because poor sight causes problems reading without glasses.
- So simple. People can easily relate to symbols
- One would become familiar with symbols. Easy to recognize and memorize.
- Symbols could be confusing if too similar. Be sure they are clear and distinguishable.
- Excellent because it would narrow down the options, particularly for non-English speaking individuals or those who can’t read
- Cuts down on the thinking.
- Better than just using words, draws more attention, and is friendlier
- Easier to get information with less reading
- Symbols will work, but color is primary
- Combination of color and symbols is good
- Symbols are not universal and may not match up with where trains go. Beware of symbols that may mean different things to different people

TV monitor/ Plasma Screen

What information do you need on a monitor or plasma screen? How should it be displayed?

- Riders need to know where they need to go, where they are, and when is their next train. Directions for the platform should be posted.
- The Signage should pull people out of track level to main concourse. Depending on location, it may be unsafe to have people congregate at the platform level.
- At the main concourse level people need specific information on routes, times and destinations
- People need accurate information to know whether to walk or run to their connecting train
- The most important concern about monitors is readability. Monitors should be crisp, clear and have big letters so that people do not need to squint.
- Information is vital for more obscure transfers

- People need to know where to go, and then they need the real time info
- Time and location of my train.
- Destination
- Should be on escalators where everyone can see them.
- Whether train is on time.
- Track and time most important.
- Delays
- An example is the NYC Subway #2 – moving display to say where you are going. This makes you feel more comfortable.
- Placement of monitor attracts crowds and you cannot get around the people. Need to think about where to get an easy view and smooth flow. Monitors should be mounted higher and there should be more of them.
- Is the train still on the same track
- If you get there earlier than usual commute time, where is the train
- Should be visible before you get to the track. Perhaps they can be placed on escalators or as you are transferring
- Directions to an open bathroom
- Gate change
- It should be displayed above the ticket booth

What do you like in a TV monitor or plasma display format?

- Information about boarding status is vital
- Lines across the board need clear delineation – makes it easier to read
- Avoid ambiguity – be consistent. A given station should have one and only one name
- People need to know status, when it is scheduled to leave, and when the train will actually leave
- Riders need to know if the train is on time, what track, and if it is running at all.
- Clearly differentiate between boarding time, scheduled departure time and actual departure time. People do not realize posted time is the time the train pulls out of the station.
- Riders need to know what the first stop is
- Riders must be told if the train is express or local
- Posting all the travel options turns the board into an advertisement for all the different services an agency offers
- Signs must address the needs of customers who have a train schedule, as well as those who do not
- The track level should be clearly posted.
- For commuters, and people who know where they are going, color-coding is the best way.
- Symbols can distract people
- Symbols will be lost in all the information
- Don't think most people go by train number
- Not too many boxes
- Include final destination or line
- Depending on whether I'm going to work or coming home, it may not matter which specific line or train I'm getting on -- just need to know next train going my way
- Is it an Express or Local?
- Provide a status field

- Show whole rail system on the Big Board. As choices narrow at other levels don't need the whole system.
- Once you see your color then you can read left to right.
- Show current time
- Need to be able to pick my train out straight away
- Keep it easy on the eyes
- I don't pay attention to train number.
- Maybe should show the line rather than the train number.
- Status a good idea, perhaps have approximate arrival time instead of train number.
- Make them more spacious, easier to read.
- Simple and in your face.
- Current time should be BIG!
- Not too busy
- Take care not to overload people with information, especially the infrequent traveler
- Like the use of color to identify lines/directions/status
- Need level and location, not just track
- Delayed/cancelled or not
- Like it color coded, makes it easier to filter out extra info you don't need
- Not too glaring
- Type should be black not gray
- Time should be at top, and big
- Clock face better than digital
- Destination first, then train time
- Like the idea of it showing different destinations
- Simple is good
- Don't like train numbers
- SIMPLE
- Different formats for different purposes/locations within the station
- Like the idea of color and symbols
- Don't like the use of the same color for multiple lines
- First priority is destination, then the time of the train. Train number is not important
- Separation between columns is good and the train symbols are okay, but more color would make it easier to recognize.
- Group by line/destination, then within group by time
- Should provide train number somewhere on display so commuters can know if trains stop at their station
- Bright and easy to view from afar
- A black background makes it easy to read
- With a black background can pick out yellows and reds better
- White background makes it easier to see other colors
- Black background makes it easier to see symbols
- Bus users like to put the bus number (vehicle ID) first – when you see this bus number (equipment number), you know you're getting on the right trip.

7. <u>Big Board</u>

What information are you looking for when you are looking at the Big Board?

- Biggest thing there
- It provides a good landmark for meeting people
- It is the main distribution point for information
- Sooner get information, less anxious
- First look for destination
- Look for one agency's service as opposed to another's, then the destination and time
- Need icons for non-English speakers.
- Track and Time of departure
- Delays
- Status
- Show the exact place you are going
- Grand Central Terminal (New York City) board is good example
- Status most important—on time or if delay, how long; and boarding information too -- needs to say more than just "on time"
- Provide weather advisory
- Better to have more than one board at each end of a larger station

What do you like in a big board format?

- Not too cluttered
- Allow a rider to zero into the desired rail line, then search only that line for pertinent information
- Give information clearly
- Educational, shows all the different lines and connections
- Current time should be large -- at top right corner
- Symbols used well
- Chronological good
- OUTBOUND & INBOUND should be kept on separate displays
- Identification of Rail Line is most important at multiple line stations
- Advisories, not just extent of delay but say why
- Not too much information
- Proper grouping of trains
- Show if train is a local or express
- Clear and easy, like use of symbols
- Should have the track number before the train number
- Shouldn't have to extract too much information before I get to the information I need
- Like the advisories in case of delays
- Do not need the train #
- Time should be BIG
- Current time at top synchronized
- Don't have to read everything
- Inbound and outbound clear
- Easy to read
- Departure Time should not be first, Destination should be first
- Include track level for multilevel facilities

- Group by train line with times grouped within each train line
- No need for train numbers
- Time clock should be big enough to read
- Use color as much as possible
- Liked advisories shown at the bottom of screen
- Add a flash indicator to notify commuters of an advisory
- Display the same information in the same format throughout the station
- The direction term “Inbound” was confused with “arrivals”
- “Arrivals” and “departures” are clear. “Inbound” and “outbound” are not clear. Use compass direction instead (Westbound, Eastbound)
- Show more trains instead of just next 30 minutes
- Should make a sound when info changes

Now that you have seen the symbols on the boards, do you still have the same reaction that you did when you first saw them?

- Like symbols a lot, changed mind
- Appreciate them on big board
- Symbols are way too small to make an impact
- Need to re-think method to display symbols
- Make the symbols very distinctive
- Foreigners may understand symbols who cannot understand English

8. <u>Station Destination Signs</u> (signs providing detailed information about service to a specific destination)

What kind of signs, or information would newcomers to the system need?

- Always have the system map posted so people can figure out where we they are going and how they will connect to get there
- ADA Accessibility for each station should be indicated
- If you do not know where you are in the state and you are told to go to city “x”, you will need very good direction.
- Track number
- Next time train is coming
- People need to know about their specific destination, not the final destination of the train.
- The Long Island Rail Road has signs that show each destination and how to get to the train. If you are a regular user this is not useful, but if you are an infrequent user it is useful.
- Color coded map
- Maps all over the place
- Alphabetical list of destinations – entries for every station in the system
- Interactive computer screen to type in or touch-select your station
- Travel discounts and information
- Where you are in relation to other stops, and how many stops to go
- Which direction to make a transfer
- Giant regional maps with routes that light up – like in London

How would you like to learn about a trip or route that was new to you?

- Internet
- Palm Pilot
- Kiosk - where information can be called up by individual
- Must be as simple as possible
- Push a button to light up a board to show you your route e.g. Paris Metro
- On a screen
- In too much of a rush to stop and ask someone, need some way of finding out when on the move
- If I was a first time visitor may need that contact with a human being
- Interactive—punch in information
- Depends on how much time you have …if you have time
- Electronic means - services provided directly by people are a high cost and many have a problem communicating
- Like the Human touch
- Interactive console, which people can type in
- A touch screen like the 1-800 number
- Ticket agent
- Maps, clear and helpful
- Look at Information Board

What do you think of a station destination sign that provides information on the next few trains or buses to your specific destination? (see exhibits from facilitator's guide, appendix 4, above)

- Defines how train is going to your station -- via where
- Nice to know it goes to your station
- Good to show bus information too as an alternative
- Good for people who are not familiar with service
- Good to know when train is projected to arrive so you can coordinate a ride from the station
- Most thought a bank of screens was too many monitors, all thought kiosk (stand-alone interactive display enclosure) was best
- People are computer literate enough to use interactive devices
- Both kiosks and screens would be nice
- Danger of putting too much info on one little screen – limit number of trains and destinations shown at any one time
- Like the touch screen concept, convenient and easy
- Have touch screens instead of keyboards
- All thought these signs were somewhat or very important for new travelers but Big Board is better for regular travelers
- Good starting point until one gets used to the system
- Good to know what following train is
- Bank of monitors could be too busy
- Touch screen method would be good for new passengers
- Kiosks could have long lines – would need more than one

9. Track Indicator Boards and Gate Boards

As you approach the track to board your train what dynamic signage needs do you have?

- People need to know about their next step, their connection, not fixed information
- People like listing 1st train, 2nd train, 3rd etc.
- Riders need to know the on-time status of the train
- Don't mix columns with rows of information, confusing
- Provide a Countdown feature – next train to ___ in XX minutes
- Include real-time status
- Train # not needed
- List the stops the train makes
- "Stops at" then list: - don't need extra words
- Could also be used on platform, especially if 2 trains at platform
- Like that it gives the next two trains
- Very clean and crisp
- Should be at gate/platform
- Definitely needs to be at the track too
- Info everyone needs. Keep using symbols, so hopefully people will learn them
- Boarding status
- Show my specific destination
- Nice and simple
- Liked vertical organization
- Time clock still too small
- Add last station the train left from
- Very easy to read and recognize
- Understandable
- Need time clock big enough to read
- Add column for minutes remaining until departure
- Should be located at the track, gate, and inside the train so commuters can know what stop comes next
- Where to transfer – if I have a connection with another train, how many stops away will it be
- If there is a possibility to get another (wrong) train on that platform
- Prefer name of destination station first. "Next train to" not necessary
- I would like to know when the following train leaves
- Track number or letter should stand out prominently.
- Wish name of line was in color
- Good to list stations for new travelers to the train
- Add ETA for stops

10. Other Comments:

- All trains to a given destination should be on the same track for consistency
- Would like to see real time status and connection information on the train itself
- Next stop information should be displayed onboard the train itself
- Station Destination format (next few trains or buses to a specific destination) should also be available via the Internet

Appendix 6 - Research Plan for Quantitative Research

Evaluation of the Effect of Display Format, Presentation and Content on Transit Customers' Satisfaction with an Automated Real-Time Train Information Display System under Actual Operating Conditions

Context

A major rail operator may run hundreds of revenue trains each working day, with peak frequencies more than 20 trains per hour on its most patronized lines. Given this frequency of service, with trains arriving every 2-4 minutes during the peak period at the busier on-line stations, the challenges facing an agency's customers in determining which train is theirs and on which track it will arrive are significant, as are the challenges to the agency in attempting to give these customers the information they need to make these determinations in a timely manner. The recent move toward new rail lines and expanded services has complicated the situation even further, since customers who once had only one choice of service toward the metropolitan center must now often differentiate between trains destined for different parts of the city.

There are several levels of information that can be delivered to (and potentially demanded by) waiting passengers. These range in complexity from "a train is scheduled to depart in 10 minutes", to "passengers for Maplewood and South Orange should board the last 6 cars of the train", to "train approaching, stand back", to "your train is operating 6 minutes late", to "your train will depart in 3 minutes and will arrive at your destination 12 minutes late, where your bus connection will be held to depart 5 minutes after you arrive". Each clearly represents a different level of customer service, and a different degree of sophistication in terms of both the technology employed and the information support required.

From the Agency's perspective, providing timely, reliable information that meets customer requirements can be a daunting task -- all the more so when one considers that a notable percentage of transit customers do not understand the "official" language well, or at all. How can any transit operator possibly hope to reliably identify and report every little 2 minute delay, every potential missed connection and every arriving train at every station in a way that all its customers will clearly understand? Clearly, without an automated means of determining, then disseminating timely train status information, these customer needs will go unsatisfied, and even the slightest operating delay, however unavoidable, will inevitably create confusion and uncertainty for hundreds or even thousands of passengers.

The problem is arguably most severe at major junction points. At each of these locations, passengers often have to choose between at least two separate rail lines and several primary destinations from any platform -- and unlike many smaller on-line stations, which are bypassed by every other train or so, every train stops to board passengers. Passengers at these stations intuitively identify trains' destination not by track number, but by arrival time. And arrival time may be highly variable depending on weather, mechanical difficulties, etc.

This evaluation will utilize the services of a firm specializing in the use of portable interactive on-line survey kiosks. The firm will set up unobtrusive, multilingiual survey kiosks at critical locations throughout the study station. This highly cost-effective approach will allow the agency to survey 6-9 customers simultaneously -- in their native language -- while automatically logging the survey time and duration, together with the response time for each item. The need for solicitation of qualifying and identifying information should be held to an absolute minimum by cross referencing (off-line) the time and platform location for each survey submitted with the scheduled and actual observed track assignments and times of train arrival and departure. The surveys should be designed to be completed in 2 minutes or less.

Throughout the course of the evaluation project, which will run for approximately two months, the format and content of the ATIDS displays should be varied on a daily basis. The displays will then be viewed and evaluated under actual operating conditions by the many customers who regularly patronize the station each day. The feedback received from these customers will be fed into a multidimensional database, from which specific hypotheses will be tested and interactions identified. The impact of the various factors will then be weighed to determine the optimal display design(s) for the specific operating conditions and the specific mix of customers found on the agency's rail lines.

Done correctly, these evaluations should help us not only to select suitable display formats from among those we've proposed and presented, but to better understand our customers' information requirements in general.

Evaluation Plan

The evaluation plan calls for a conventional survey design process, followed by a somewhat unconventional treatment phase in which some 200 test groups of 5-50 individuals each will be repetitively subjected to 18 separate display treatments, under a variety of different test conditions, over a period of 57 days. The tests will be run 7 days a week, in sequence, with treatments repeating every 19 days.

Procedure:

1. convene focus group (users) - identify what information customers expect to see where, and when (Completed. See Appendix 5, above)
2. brainstorm factors and dependent variables
3. focus group (users) - develop/test unambiguous scales and identify preferences for colors used in highlighting trains by line, direction, destination
4. design electronic survey
5. pilot test survey
6. revise survey
7. pilot test revised survey
8. publicize upcoming display evaluation at Summit Station
9. administer baseline survey at Summit Station (treatment #0)
10. apply treatment #1
11. administer survey #1
12. apply treatment #2
13. administer survey #2

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122 apply treatment #18 (third time)
123. administer survey #57
124. analyze data
125. report findings at customer forum

Hypotheses

H1 customers' preferences for information display change depending on operating condition
H2 seasoned customers' preferences for information display change depending on operating condition less than new customers' do
H3 customers' preferences for information display are driven more by delay as percentage of overall headway than by absolute delay
H4 new customers prefer "airline style" display format over "railroad style"
H5 seasoned customers have no preference of airline style versus railroad style display formats
H6 customers prefer railroad style versus airline style display formats
H7 customers prefer display formats in which scheduled time rather than train number is the preeminent row identifier
H8 the presence of bi or multilingual text messages will not detract from English speaking customers' appreciation of the system
H9 tasteful color coding of trains by direction will increase customer appreciation of the system
H10 including screens showing "next train to __" will increase customer appreciation
H11 alternating between two or more display formats on one screen will not significantly affect customer appreciation of the system
H12 customers prefer "will arrive at __" status over "__ minutes late"
H13 inclusion of a graphic representation of trains on the railroad will increase customer appreciation of the system
H14 inclusion of past trains as well as future trains will increase customer appreciation of the system
H15 customers prefer that different directions (east/west) be displayed on different screens
H16 customers prefer to see arriving (terminating) trains as well as departing (continuing) trains
H17 inclusion of customer service announcements will detract from customer appreciation of the system
H18 provision of real-time status information reduces customers' perception of train delays

Sample Test Plan

Treatment	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
"next train to ___" display															•	•	•	•
"on time" or "will arive at ___" train status	•	•									•			•				
"on time" or "___ minutes late" train status			•	•	•	•	•	•	•	•		•	•		•	•	•	•
include graphic depiction of railroad												•	•					
train number, destination, scheduled time, class, (status)			•				•							•				
scheduled time, destination, class, (status)				•				•			•	•	•		•		•	•
scheduled time, destination, class, train number, (status)					•				•									
train number, estimated time, destination, class, (status)						•				•						•		
color highlight for line/direction/destination							•	•	•	•	•	•	•		•	•	•	•
include past trains (with "arrived" or "departed" status)		•		•	•	•	•	•	•	•		•	•		•	•	•	•
include arriving trains					•			•							•	•	•	•
all directions on same display	•												•				•	•
one direction on any given display		•	•	•	•	•	•	•	•	•	•	•		•	•	•		
alternate display formats												•	•			•		
dedicated display for each format	•	•	•	•	•	•	•	•	•	•	•			•	•		•	•
bi-lingual message text (English/Spanish)		•				•				•				•				
multilingual message text				•				•							•			
customer service messages	•			•					•									

Table of Results

A multidimensional table of results for this evaluation will be created in a business intelligence software tool. It would be impossible to depict it here. The tool will allow us to automatically "slice and dice" or filter the data along any desired axes. A variety of statistical tools, primarily including "T" tests and ANOVA, would be used. A preliminary list of variables is attached.

Resource Requirements

Required resources include:

- software license chargeback ($1,800)
- Survey Kiosks (12 Kiosks; 2 month rental = $32,000)
- Data Reduction (30 hours @ $100/hr = $3,000)
- Printing (10,000 copies @ $0.02 ea = $200)
- Survey administrator presence (16 hr/day x 57 days x $70/hr = $64,000)
- Software tool set up (60 hours @ $100/hr = $6,000)
- Passenger Information Operator (18 hr/day x 57 days x $90/hr = $92,000)

Total = $199,000

Benefit-Cost Analysis

The net benefit of any system evaluation is equal to the net benefit to be gained through use of the system if built with the benefit of the evaluation in question, minus the net benefit to be gained through use of the system if built without the benefit of the evaluation in question, minus the cost of the evaluation.

Net Benefit of Evaluation =
Net Benefit of System (w/ eval) - Net Benefit of System (w/o eval) - Cost of Evaluation

Net Benefit of System = Benefit of System - Cost of System

Net Benefit of Evaluation =
Delta System Benefit - Delta System Cost - Cost of Evaluation

Benefit of System without evaluation = 3% customer loyalty increase ($200,000 increase in annual revenue), 1% increase in Governor's voter approval rating

Benefit of System with evaluation = 10% customer loyalty increase ($660,000 increase in annual revenue), 2% increase in Governor's voter approval rating

Delta Benefit = $460,000 x 6 year life = $2,760,000 + 1% Governor's approval rating

Cost of System without evaluation = $300,000 plus $90,000 rework

Cost of System with evaluation = $310,000 plus $8,000 rework

Delta Cost = -($72,000)

Cost of Evaluation = $199,000

Net Benefit of Evaluation = $2,760,000 - (-$72,000) - $199,000 = $2,633,000 + 1% Governor's approval rating

1 year payback -- good investment!

Appendix A - preliminary list of variables

INDEPENDENT VARIABLES - PRELIMINARY

ATIDS display variables:

1. display format:
   a) "big board" listing all trains
   b) big board plus individual display showing "next train to _____"

2. status format:
   a) "on time" or "will arrive at __"
   b) "on time" or "__ minutes late"
   c) schedule only; no status provided

3. display mode:
   a) textual display of train status
   b) textual display plus graphic depiction of railroad

4. Train Identification:
   a) train number, destination, scheduled time, class, (followed by status)
   b) scheduled time, final destination, class, (followed by status)
   c) scheduled time, final destination, class, train number, (followed by status)
   d) "airline style": train number, scheduled time (if not yet due) or estimated time of departure (if delayed), final destination, class, (followed by "on time" or "__ minutes late")

5. Train ID highlight:
   a) with color highlight for line/direction/destination, versus
   b) without color highlights

6. Schedule period:
   a) display future trains only, versus
   b) display past and future trains

7. Arrivals/departures:
   a) display departing trains only, versus
   b) display departing and arriving trains

8. Directionality:
   a) trains in all directions shown on same display, versus
   b) trains in one direction only shown on any given display

9. Display consistency:
   a) alternate between two or more display formats on one display, versus
   b) dedicated display for each display format

10. Text message content:
    a) service advisories only, versus
    b) service advisories plus customer service announcements

11. Text message languages:

a) English
b) English plus Spanish
c) English plus Korean
d) English plus Chinese
e) English plus Sanscrit
f) English, Spanish and Korean
g) English, Spanish and Chinese
h) English, Spanish and Sanscrit
i) English, Spanish, Korean and Sanscrit
j) English, Spanish, Chinese and Sanscrit
k) English, Spanish, Korean, Chinese and Sanscrit

12. "Big Board" Character Size
    a) 1"
    b) 1.5"
    c) 2"

13. "Next Train to ___ " Character Size
    a) 1"
    b) 2"
    c) 3"

Operating condition variables

1. train arrival sequence:
   a) arrive in scheduled sequence, versus
   b) arrive slightly out of sequence (one train skipped)
   c) arrive very much out of sequence (two or more trains skipped)

2. arrival track:
   a) arrive on normal track, versus
   b) arrive on different track

3. absolute delay (customer's train):
   a) no delay
   b) 3 minute delay
   c) 6 minute delay
   d) 10 minute delay
   e) 15+ minute delay

4. absolute delay (other trains in same direction):
   a) no delay
   b) 3 minute delay
   c) 6 minute delay
   d) 10 minute delay
   e) 15+ minute delay

5. delay as percentage of relevant headway (customer's train):
   a) 0%-2%
   b) 3%-6%

c) 7%-17%
d) 18%-33%
e) 34%+

6. delay as percentage of overall headway (other trains in same direction):
   a) 0%-2%
   b) 3%-6%
   c) 7%-17%
   d) 18%-33%
   e) 34%+

7. overall headway (minutes between trains)
   a) 1-5
   b) 6-12
   c) 13-20
   d) 21-30
   e) 30+

8. relevant headway (minutes between trains to relevant destination)
   a) 1-5
   b) 6-12
   c) 13-20
   d) 21-30
   e) 30+

9. departure time variance (average schedule deviation of intended train - 1-15 minutes, integer)

Customer profile variables

1. frequency of train use at this time of day (trips per month)
   a) 1-4
   b) 5-10
   c) more than 10

2. frequency of train use overall (trips per month)
   a) 1-4
   b) 5-10
   c) more than 10

3. frequency of boardings at this station (boardings per month)
   a) 1-4
   b) 5-10
   c) more than 10

4. length of customer relationship (months)
   a) less than 1
   b) 1-3
   c) more than 3

5. arrival lead time (how many minutes the customer allowed prior to scheduled departure)
   a) 0-5
   b) more than 5

6. purpose of travel:
   a) commuting to work
   b) commuting from work
   c) business trip
   d) vacation, shopping, recreation
   e) other

7. preferred language:
   a) English
   b) Spanish
   c) Korean
   d) Chinese
   e) Sanscrit
   f) other

DEPENDENT VARIABLES - PRELIMINARY

1. Overall reaction to the system (6 point Likert scale; terrible -- wonderful),

2. Legibility of characters on the screen (6 point Likert scale; easy to read -- hard to read),

3. Satisfaction with Terminology (6 point Likert scale; easy to understand -- hard to understand)

4. Highlighting simplifies identification of appropriate train (6 point Likert scale; not at all -- very much)

5. Organization of information on screens (6 point Likert scale; confusing -- very clear)

6. Completeness of information (6 point Likert scale; provides all the information I need -- provides none of the information I need)

7. Utility of information provided (6 point Likert scale; all of the information was of value to me -- none of the information was of value to me)

8. overall satisfaction with transit service provided (6 point Likert scale; terrible -- wonderful)

9. overall reaction to survey process (6 point Likert scale; terrible -- wonderful)

10. perception of usual train status (early, on-time, 1-3 minutes late, 4-6 minutes late, 7-10 minutes late, more than 10 minutes late)

QUALITY CONTROL VARIABLES - PRELIMINARY

1. Respondent's response time (measured automatically)
   A) OUTSIDE +/-3 SIGMA CONTROL LIMIT
   b) between +/-3 sigma and +/-2 sigma of mean response time
   c) between +/-2 sigma and +/-1 sigma of mean response time
   d) within +/-1 sigma of mean response time

2. % surveys begun but not completed (measured automatically)

3. Available survey time (measured automatically)

4. Time to complete (measured automatically)

5. Consistency of survey response (calculated automatically)

6. Response is for
   a) today
   b) another day

ADDITIONAL SURVEYED PARAMETERS - PRELIMINARY

1. Other required information
   a) status of other agencies' services
   b) connecting bus status
   c) airline status
   d) ferry status
   e) other

2. Likelihood that availability of information of this type will lead customer to increase transit use and/or use for different types of travel (6 point Likert scale; unlikely -- highly likely)

3. Likelihood that availability of information of this type will lead customer's family to increase transit use and/or use for different types of travel (6 point Likert scale; unlikely -- highly likely)

Appendix B
Pre-Test Briefing Material - Preliminary draft of English version of multilingual flyer to be distributed to Summit Station passengers prior to and throughout duration of testing:

"This transit agency is asking for your impressions of a new passenger information system. Each day for the next two months, automated displays and speakers at this station will be used to announce train schedules, on-time status, track assignments and special service advisories in a variety of display formats that we'd like you to evaluate for us. We'll be asking you about the legibility and completeness of the information on the display screens, how well it's organized, how easy it is to understand, and whether or not it meets your needs for real-time status and arrival information. The format, and in some cases the content, of the information shown on the displays will be changed each day; so we'd appreciate if you would provide us feedback with every visit to the station throughout the duration of the test.

You've probably not seen information like this before -- actual on-time status, to the minute, for every train. In most cases, you'll know in advance whether your train is running even a few minutes late, exactly when it will arrive, and what track it will arrive on.

We expect to complete development of Automated Train Information Display Systems at critical stations over the next few years. The remaining design issue is the format of the displays -- just how do our passengers want this information presented to them, and do their needs change depending on time of day or operating condition? We're hoping you will tell us just that.

Automated survey kiosks have been installed throughout the station to collect your impressions of each day's display presentation. The survey is completely voluntary, completely anonymous, and can be completed in less than two minutes. Please do take this simple opportunity each day you're here to help us define the best possible system to meet your real-time information needs. Thank you. And have a safe trip."

Appendix C
Electronic Survey Instrument - Preliminary Draft of English version (a preceding page allows customers to select from among the list of available languages: English, Spanish, Korean, Chinese, or Sanskrit -- an "other" response will also be provided for data collection purposes, but will ultimately refer back to one of the preceding five)

Please use the electronic pen to select your response:

1. The characters on the train information display screen are:

easy to read ◊ ◊ ◊ ◊ ◊ ◊ hard to read

2. The words and phrases used on the displays are:

easy to understand ◊ ◊ ◊ ◊ ◊ ◊ hard to understand

3. Does the color highlighting make it easier to identify your train?

not at all easier ◊ ◊ ◊ ◊ ◊ ◊ very much easier

4. The organization of the information on the display screens is:

very confusing ◊ ◊ ◊ ◊ ◊ ◊ very clear

5. The display screens provide:

all of the information I need ◊ ◊ ◊ ◊ ◊ ◊ none of the information I need

6. How much of the information provided on the displays was actually of value to you?

all of it was of value to me ◊ ◊ ◊ ◊ ◊ ◊ none of it was of value to me

7. Your overall reaction to the information display system:

terrible ◊ ◊ ◊ ◊ ◊ ◊ wonderful

8. How likely is the availability of information of this type to lead **you** to increase your use of this agency's rail services, or to use them for different types of travel?

highly unlikely ◊ ◊ ◊ ◊ ◊ ◊ highly likely

9. How likely is the availability of information of this type to lead **other members of your family** to increase their use of this agency's rail services, or to use them for different types of travel?

highly unlikely ◊ ◊ ◊ ◊ ◊ ◊ highly likely

10. How important is it for this agency to provide real-time status for other transit services on the displays at this station?

Service A..................................very important	◊	◊	◊	◊	◊	◊	not important
Service B......………..............very important	◊	◊	◊	◊	◊	◊	not important
Connecting buses............................very important	◊	◊	◊	◊	◊	◊	not important
Airlines……...……….............very important	◊	◊	◊	◊	◊	◊	not important
Connecting Commuter Railroads................very important	◊	◊	◊	◊	◊	◊	not important
AMTRAK..................................very important	◊	◊	◊	◊	◊	◊	not important
Ferries…………....................very important	◊	◊	◊	◊	◊	◊	not important
others not listed............................very important	◊	◊	◊	◊	◊	◊	not important

11. What is your overall impression of this agency's passenger rail service?

terrible ◊ ◊ ◊ ◊ ◊ ◊ wonderful

12. How often do you ride the train at this time of day?

- 1-4 days per month ◊
- 5-10 days per month ◊
- more than 10 days per month ◊

13. How often do you ride the train overall?

- 1-4 days per month ◊
- 5-10 days per month ◊
- more than 10 days per month ◊

14. How often do you board the train at this station?

- 1-4 days per month ◊
- 5-10 days per month ◊
- more than 10 days per month ◊

15. How long have you been a rail customer of this agency?

- less than 1 month ◊
- 1-3 months ◊
- 4-12 months ◊
- more than 12 months ◊

16. How far in advance of your train do you normally arrive at the station?

- 0-5 minutes ◊
- more than 5 minutes ◊

17. To what station are you riding the train today?

- Station A ◊
- Station B ◊
- Station C ◊
- a station on the ___ Line ◊
- other Eastbound station ◊
- other Westbound station ◊

18. In the past week, has your train usually been:

- early ◊
- on time ◊
- 1-3 minutes late ◊
- 4-6 minutes late ◊
- 7-10 minutes late ◊
- more than 10 minutes late ◊

19. Why are you traveling now?

- Commuting to work ◊
- commuting from work ◊
- business trip ◊
- vacation, shopping, recreation ◊
- other ◊

20. This survey response is for displays you observed:

- today ◊
- another day ◊

21. What is your overall reaction to this survey and evaluation process?

terrible ◊ ◊ ◊ ◊ ◊ ◊ wonderful

Thank you for your response. Your feedback will help us to install the best information systems possible. Please continue to provide your opinions on the different displays you see each day throughout the (number) remaining days of this evaluation.