Public Transit ITS Data Collection and Analysis: Large- and Small-Agency Lessons Learned

Talking Technology and Transportation (T3) Presentation
June 20, 2007
Today’s Speakers

Host:

Charlene Wilder
Office of Mobility Innovation
Federal Transit Administration

Presenters:

Thomas Guggisberg
David Gehrs
Capital District Transportation Authority (CDTA)
Albany, NY

Michael Haynes
Chicago Transit Authority (CTA)
Chicago, IL
Disclaimer

- This presentation contains references to brand names and proprietary technologies. This information is provided in the specific descriptions of ITS applications at the presenting agencies, and does not in any way constitute an endorsement of those brands or technologies by US DOT.
ITS Peer-to-Peer Program

- Sponsored by the US DOT’s ITS Joint Program Office, in cooperation with ITS America
- Provides short-term technical assistance on ITS planning, procurement, deployment, and operational challenges
- Connects agencies with an existing base of ITS knowledge and expertise within the transportation community
- AKA “P2P”
How the P2P Visit Came About

- CDTA contacted the ITS P2P Program about increasing its understanding of how another transit agency uses data for service planning.
- ITS P2P agreed to support two CDTA staff members’ travel for a site visit with Chicago Transit.
- The two agencies produced a report detailing outcomes.
The Purpose of the P2P Visit

To share experiences and improve...

- ...the processes behind managing data and disseminating information
- ...data collection and analysis techniques
- ...large-scale ITS project deployments
- ...how we “operationalize” ITS and data
- ...how we make better use of service standards
- ...relationships with internal/external stakeholders
- ...the challenges to both large and small agencies
CTA & CDTA Side-by-Side

CTA
- $1 billion operating budget (FY2006)
- 10k+ employees
- Bus fleet of over 2,000 vehicles serving Chicago and 40 suburban communities
- Over 4 million people live in service area
- 154 regular routes
- 1.55 million daily boardings (0.95m bus 0.60m rail)
- 2,530 miles of bus routes, 224 miles of rail lines

CDTA
- $64 mil. operating budget (FY2007-2008)
- 500+ employees
- Bus fleet of 250 vehicles serving a 4-county service area that encompasses over 2300 square miles
- Over 750,000 people live in the service area
- 44 regular routes
- 35,000 daily boardings
- 400 one-way paratransit trips daily
Presentation Outline

1. Overview of ITS/Data Experiences at CDTA and CTA
2. Analysis Challenges
3. New Data Analysis and ITS Projects
4. Summary of Findings from the P2P Visit
5. P2P and Speaker Contact Information
1. Overview of ITS/Data Experiences at CDTA and CTA
Overview of ITS

Mobile Data Communications System

Fully integrated ITS Solution

- CAD/AVL = Computer Aided Dispatch/Automatic Vehicle Location GPS
- Voice and Data Communication
- Silent Alarms, Including Emergency Button
- On-board MDT = Mobile Data Terminal (Co-pilot)
- On-board Next-Stop Announcements and Display
- Real-time Passenger Information at Stops/SMS
- TSP = Transit Signal Priority
- APC = Automatic Passenger Counting
- Supervisory Schedule Interrogation
- Web/Maintenance/Scheduling System Interfaces
- Statistical Reporting – Data Capture – Incident Reporting
Overview of ITS

CAD/AVL server | Dispatch workstations | Supporting workstations, e.g. maintenance

TCP/IP

Global Positioning System

Radio Station

Radio Tx/Rx

Data Radio Interface

Passenger Information Variable Message Signs

PRIOTRANS/R

PRIOTRANS/D with interface to intersection controller
Overview of ITS

LiSA/R Receiver with antenna
LiSA/D Decoder and control unit
Traffic Signal Controller

Mobile Radio

802.11b
MP3

Covert Mic & Voice Radio

Emergency Switch

WLAN

Mobile Radio

On-Board Computer

Odometer

Door Contact

On Board Display

External Loudspeaker

54 Destination Board

54 Airport

Mobile Radio

Passenger Counter
ITS Data - Goals & Objectives

- Convert data to useful information to support operating and marketing decisions
- Provide data of the right quality, detail, relevance and timeliness to appropriate staff
- Assist staff in using data to drive decisions
Data Sources

- Farebox data – record for each customer boarding
- HASTUS (scheduling) – record for each trip, timepoint
- INIT (AVL, APC) – record for each stop (AVL) and each customer boarding (APC)
Data Integration

GFI Farebox

INIT AVL/APC

HASTUS (Scheduling)
Data Integration Examples

- Farebox, AVL – location of all boardings
- Farebox, scheduling – boardings by trip
- Scheduling, AVL – on-time and running time
- Farebox, scheduling, AVL – diagnostic data route, segment, and time period
Overview of ITS Data

- CAD/AVL Incident Reporting – Crystal Reports
- Statistical Reporting – CAD/AVL
  - Example: Automatic Passenger Counting, event lists/logs, on-time performance, etc.
- Integration of Fare Collection/Scheduling/AVL Data
  - Example: Trip-by-trip running times
CAD/AVL Incident Reporting

- Accident
- Bus shelter
- Daily capacity
- Driver problem
- Incident
- Mechanical
- Problem
- Radio check
- Service deviation
- Service performance
- Service protection
**Example – Incident Reporting**

![Incident Report Form]

- **Incident Type:** 55, 511, 2068
- **Date:** Thursday, January 20, 2005
- **Oper ID:** 5132
- **Operator Name:**
- **Recorded by:**
- **Dispatcher:**
- **Weather Code:**
- **School:**
- **Location:**
- **Direction:** West

**Bus Change Information**

- **Depot:**
- **Repl Veh:**
- **Repl Oper ID:**
- **Block Delay:**
- **Serv Delay:**
- **In Serv Time:**
- **Trips Lost:**
- **In Service Location:**

**Defect:**

**Status:**

- [ ] Open
- [ ] Closed
Statistical Reporting

- Passenger counts
- Driver log-ins
- Schedule adherence
- Alarms
Decision Examples

- Running times
  - Trip
    - Between timepoints
- Service frequency and span
- Route alignment
- Express/limited service
- Fare and fare products
Data Analysis from ITS Data

- Background & data flow
- Analysis architecture and development timeline
- Sample web-based reports
- Analysis methodologies & samples
ITS Project Background

- The Americans with Disabilities Act (ADA) drives need to **automate stop announcements**

- A desire for comprehensive performance data with declining resources drives **data collection**
  - Automated Passenger Counting (APC)
  - Automate running-time analysis (AVL data)

- Both systems require accurate geolocation of bus stops on board the bus from a navigation system (GPS/odometer)

- Integration of systems provides for efficient use of **complementary resources**
ITS Transit Data Integration

- System demands accurate data
- System produces very useful data

Good data from buses requires good data sent to buses!
Bus-Side Integration Components

- GPS
- Wireless LAN
- APC Sensors
- IVN-II
- TCH – Operator Log-on
- Destination Signs
AVAS Data Flow
AVAS Data Development Timeline

- **Sep 2002**: AVAS installation started
- **2003**: AVAS rollout to fleet - data evaluation
- **2003**: Initial data exploration and quality control development
- **Jan 2004**: Start of migration of data to larger database
- **2004**: Development of AVAS / APC web-based reporting tools
- **May-Sep 2004**: Development of data warehouse methods
- **2003**: AVAS rollout to fleet - data evaluation
- **2004**: Development of AVAS / APC web-based reporting tools

- **Jan-Apr 2005**: Continued development data exploration tools for Planning
- **May-Dec 2005**: Running time analysis development
- **Mar-Sep 2006**: Academic methods for headway metrics (intern work)
- **Sep-Dec 2006**: Headway metrics analysis for system-wide reporting
- **Feb-Apr 2007**: Bus bunching charting tool & Headway metrics development

- **TODAY**: Ongoing development

- **Feb-Apr 2007**: Bus bunching charting tool & Headway metrics development

**Academic methods for headway metrics (intern work)**

**Jan-Apr 2005**: Continued development data exploration tools for Planning

**Sep-Dec 2006**: Headway metrics analysis for system-wide reporting

**May-Dec 2005**: Running time analysis development

**Mar-Sep 2006**: Academic methods for headway metrics (intern work)

**Jan-Apr 2005**: Continued development data exploration tools for Planning

**Sep-Dec 2006**: Headway metrics analysis for system-wide reporting

**Feb-Apr 2007**: Bus bunching charting tool & Headway metrics development

**TODAY**: Ongoing development
AVAS Data Architecture

Raw Daily Data from Buses
clever_devices.BUS_STATE

Rollup - Twice Daily

Ridecheck Plus
APC data

AVAS Data Quality
Status of AVAS by bus

Raw Timepoint Records
ccta_history.BUS_STATE_HIST_TIMEPT

Raw Stop Records
ccta_history.BUS_STATE_HIST

Terminal Departures
Timepoint schedule adherence, rolling two week summary.

“BLIS”

Run Time
Segment Run Times
Route Level Run Times
Used by Planning

Run Time

Headway
Time between buses
On-Time Performance
Basis for Performance Metric Development

Manual Mode

AVAS Web Site
Bus-Hour History
Bus Stop History
History of Bus/Run/QB
Buses Running a Route
Bus Use by Type
Web-Based Data Exploration

- Terminal departure performance (BLIS)
- Maintenance status & system performance history
- Daily route history
- Daily or hourly bus history
- Stop-level history
- Monthly bus use by garage and type
- Trip/route summaries from Ridecheck Plus
- Max load and route profiles (from RCP data)
- Run-time analysis to build better schedules
# AVAS Bus Full Day History

The page presented here is intended to assist Operations and Planning staff display a history of a given bus, run or operator for a single day by using the AVAS historical data (Route, Run and Operator Events).

Enter **Bus Number**: 6031  **Date**: 02-22-2006

If you find this page useful on a semi-weekly basis or more please let me know and how we might improve the interface. Direct all comments to: Mike Haynes 312-681-4224 (internal extension x14224).

**AVAS Route Report for Bus : 6031 for: 02-22-2006.**

<table>
<thead>
<tr>
<th>Event Time</th>
<th>Pattern</th>
<th>Event</th>
<th>Run ID</th>
<th>Operator</th>
<th>Schd. Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>05:37:16</td>
<td></td>
<td>Run ID</td>
<td>K081</td>
<td>36708</td>
<td>Automatic</td>
</tr>
<tr>
<td>06:56:03</td>
<td>[7]CONGRESS PLAZA - HARRISON+CENTRL</td>
<td>Route</td>
<td>K081</td>
<td>36708</td>
<td>Automatic</td>
</tr>
<tr>
<td>08:52:06</td>
<td>[7]CONGRESS PLAZA - HARRISON+CENTRL</td>
<td>Route</td>
<td>K081</td>
<td>36708</td>
<td>Automatic</td>
</tr>
<tr>
<td>10:45:01</td>
<td>[7]CONGRESS PLAZA - HARRISON+CENTRL</td>
<td>Route</td>
<td>K086</td>
<td>43135</td>
<td>Automatic</td>
</tr>
<tr>
<td>20:11:35</td>
<td></td>
<td>Operator ID</td>
<td>K076</td>
<td>20811</td>
<td>Automatic</td>
</tr>
</tbody>
</table>

Your query took: 15.00 seconds.
## AVAS Bus Stop Log

The page presented here is intended to assist Operations and Planning staff locate a bus in by using the AVAS historical data.

Enter Bus Number: 6031  Date: 02-22-2006  Start Time: (24hr) 08:53  Duration: (min) 30  

Note, 60 minutes takes less than 20 seconds to load at (HQ).
If you find this page useful on a semi-weekly basis or more please let me know and how we might improve the interface.
Direct all comments to: Mike Haynes 312-681-4224 (internal extension x14224).


<table>
<thead>
<tr>
<th>Event Time</th>
<th>Stop (Click on Stop for Stop History)</th>
<th>Event</th>
<th>Dwell Time(s) / Stop Passing Speed(mph)</th>
<th>Wheelchair</th>
<th>FON</th>
<th>FOF</th>
<th>ROFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>08:53:14</td>
<td>CONGRESS PLAZA + MICHIGAN</td>
<td>Serviced Stop</td>
<td>26 sec</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>08:54:09</td>
<td>CONGRESS PLAZA + MICHIGAN</td>
<td>Unknown Stop</td>
<td>15 sec</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>08:55:06</td>
<td>MICHIGAN + JACKSON</td>
<td>Serviced Stop</td>
<td>62 sec</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>08:58:04</td>
<td>ADAMS + WABASH</td>
<td>Serviced Stop</td>
<td>9 sec</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>08:58:38</td>
<td>ADAMS + STATE</td>
<td>Unserviced Stop</td>
<td>31 sec</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>08:59:54</td>
<td>ADAMS + CLARK</td>
<td>Unknown Stop</td>
<td>11 sec</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>08:59:52</td>
<td>ADAMS + WELLS</td>
<td>Serviced Stop</td>
<td>22 sec</td>
<td>0</td>
<td>9</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>09:01:51</td>
<td>ADAMS + S. WACKER</td>
<td>Serviced Stop</td>
<td>7 sec</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>09:05:17</td>
<td>ADAMS + CANAL</td>
<td>Serviced Stop</td>
<td>39 sec</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>09:06:59</td>
<td>Ad C6</td>
<td>TimePoint</td>
<td>64 sec</td>
<td>0</td>
<td>6</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>09:07:23</td>
<td>CLINTON + QUINCY</td>
<td>Serviced Stop</td>
<td>15 sec</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>09:08:07</td>
<td>CLINTON + JACKSON</td>
<td>Serviced Stop</td>
<td>73 sec</td>
<td>0</td>
<td>22</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>09:10:03</td>
<td>CLINTON + VAN BUREN</td>
<td>Unserviced Stop</td>
<td>3 sec</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>09:10:34</td>
<td>CLINTON + BLUE LINE (CONGRESS</td>
<td>Unserviced Stop</td>
<td>27 sec</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>09:10:50</td>
<td>CLINTON + HARRISON</td>
<td>Serviced Stop</td>
<td>18 sec</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>09:11:38</td>
<td>HARRISON + JEFFERSON</td>
<td>Serviced Stop</td>
<td>3 sec</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>09:12:56</td>
<td>HARRISON + HALSTED</td>
<td>Serviced Stop</td>
<td>26 sec</td>
<td>0</td>
<td>5</td>
<td>3</td>
<td>14</td>
</tr>
<tr>
<td>09:13:47</td>
<td>HARRISON + 900 WEST</td>
<td>Serviced Stop</td>
<td>9 sec</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>09:14:19</td>
<td>HARRISON + MORGAN</td>
<td>Serviced Stop</td>
<td>16 sec</td>
<td>0</td>
<td>2</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>09:14:58</td>
<td>HARRISON + 1100 WEST</td>
<td>Unserviced Stop</td>
<td>35 sec</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>09:15:16</td>
<td>MenRac</td>
<td>TimePoint</td>
<td>39 sec</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>09:15:20</td>
<td>HARRISON + RACINE</td>
<td>Serviced Stop</td>
<td>14 sec</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>09:15:49</td>
<td>HARRISON + LYTLLE (EXTENDED)</td>
<td>Unserviced Stop</td>
<td>27 sec</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>09:15:59</td>
<td>HARRISON + ADA (EXTENDED)</td>
<td>Unserviced Stop</td>
<td>34 sec</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>09:16:09</td>
<td>HARRISON + LOOMIS</td>
<td>Unserviced Stop</td>
<td>15 sec</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>09:16:30</td>
<td>HARRISON + LAFLIN</td>
<td>Unserviced Stop</td>
<td>33 sec</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>
Quick Historical Map (Google Map)
Background on AVAS data processing

Complexity of data analysis
- Volume of data (3.2m records per day, 17GB per month)
- System-wide metrics from automated data sources are not yet refined to state-of-the-practice methods, as no official standards define how to turn AVL data into simple metrics

Presentation issues
- Turning raw data into information is a challenge, especially to present results effectively
- Effective presentation tools including web pages and map-based technologies are time-consuming to develop

Bottom line
- Development of a meaningful metric is not a trivial task
- We are reaching out to the academic community as well as developing a strong back-end data structure to support a multitude of analysis and presentation methodologies
Analysis Methods

Terminal / Timepoint Schedule Adherence (BLIS)

- Terminal Departure On-Time Performance
  - BLIS (reports on manual mode use)
  - Two weeks in scope
  - Easy join to schedule

Run-Time Analysis

- Run-Time
  - Monthly
  - Complex SQL and aggregation to obtain segment/route run times

Headway & On-Time Analysis

- Headway & On-Time
  - Monthly
  - Complex SQL to obtain bus-bus time intervals and metrics
  - Deals with manual mode data
  - Still in development
Route X49: Western Express - Travel Time Observations
(Southbound) (Berwyn to 97th St)

Trip Travel Time (minutes)
Hour of Day (24 hour time)

15-minute variability
30-minute variability

AVAS Trip Travel Time Observation

(August to November 2005)
Headway Analysis

- Bus bunching
  - Buses on same route arriving within one minute of each other
  - Easy to analyze and compute from headway data

- Long gaps
  - Using New York City methodology
    (http://www.mta.info/mta/ind-perform/month/nyct-b-wait.htm)
    - Headway plus 3 or 5 minutes for peak or midday, respectively
    - CTA’s automated system has 300 times more data with 1/10th of the manpower!
  - Broken AVAS can lead to gaps that are not really present; results are adjusted to compensate
Percent of Observed Bus Intervals 60-Seconds or Less for Sept – December 2006
2. **Analysis Challenges**
Challenges & Suggestions

- ITS deployment involves so many departments
- ITS data analysis is needed in both operations and planning
- Reports from vendor applications do not often meet needs
- Retaining analytical IT staff is essential to development process
- Establish cross-agency support for deployment
- Consolidate IT resources to facilitate analysis agency-wide
- Develop in-house data warehouse and reporting (use external resources for clearly defined projects)
Challenges & Suggestions

- Defining benefits in the form of useful information or reporting tools – defining reporting output
- Maintaining systems, hardware and data to support this task
- Soliciting support from both management and operations staff for continued use of ITS tools over time
- Assist staff in using data to drive decisions
- Project management delays

- Provide data of the right quality, detail, relevance and timeliness to appropriate staff
- Set clear expectations between vendor and agency to supporting systems
- Convert data to useful information to support operating and marketing decisions
- Provide easy to use tools and access to information
- Well defined project plans, deliverables and project teams
3. New Data Analysis and ITS Projects
New ITS Data Analysis Initiatives

- **Headway / On-time / Trips Completed**
  - Working on developing more reports from headway, run-time and the raw data store to compute meaningful metrics
  - Looking to use data to both improve operations through planning and report on operations

- **Service Standards**
  - Working to use processed APC data to apply to service standards find discrepancies
  - Effort is now reaching a more mature phase as we have renewed staff interest

- **Route-by-Stop Analysis**
  - Using AFC data to scale up APC data to find stops with the highest passenger activity
  - Data presented using GIS to help identify the most important stops
New ITS Data Analysis Initiatives

- Test trial on Routes 1, 10, 80, and 85
- Graphics (map) output
- Common data interface
- Common user interface
- User-defined reporting
- Simple data transfer from other systems
- Staff training
New ITS Initiatives

- **Bus Time – Real-time next-bus predictions**
  - Communications integration of a mobile access router with cellular card and existing on-board ITS (AVAS)
  - Web-based bus predictions currently piloted on one route

- **TSP – Transit Signal Priority**
  - Working to integrate with existing on-board ITS
  - Pilot expected by end of 2007
New ITS Initiatives

- Mobile Data Communications System Project Completion
- Fare Collection/AVL/Scheduling System Data – Web Portal
- Information Management Study
- Trip Planner – Web
- Real-Time Information Signs
- Enterprise Web Portal
- Transportation Development Plan
- Bus Rapid Transit - BRT
4. Summary of Findings from the Peer-to-Peer Visit
Summary of Findings

- Small & large agencies have the same problems
  - Operations “buy-in”
  - Project deployment Issues are the same
  - Dedicated staffing for “new” technologies is necessary for “success”
  - Challenge of coordinating needs of Planning, Marketing, Operations

- Project tips
  - Next-stop arrival information – include route and bus number
  - Dedicated vehicle for maintaining real-world data
  - Use fellow agencies experiences to eliminate unnecessary project delays
5. P2P and Speaker Contact Information
To inquire about utilizing the ITS Peer-to-Peer Program:

- Call 1-888-700-PEER (1-888-700-7337)
- E-mail p2p@volpe.dot.gov
- Program Contacts:
  
  Terry Regan               Ron Giguere
  US DOT Volpe Center      ITS Joint Program Office

To learn more, visit www.pcb.its.dot.gov/res_peer.asp
Speaker Contact Information

**Capital District Transportation Authority**
Thomas Guggisberg - Director of Information Technology  
thomas@cdta.org - 518-437-8326

David Gehrs - Planner/Analyst  
DavidG@cdta.org - 518-437-6853

**Chicago Transit Authority**
Michael Haynes - Project Manager  
michael.haynes@transitchicago.com - 312-681-3619

**FTA Office of Mobility Innovation**
Charlene Wilder – ITS Program Manager  
charlene.wilder@fta.dot.gov -
Questions?