9-1996

Bus Stop Based Schedule Database for the Transit Time Internet

Jun Qui
Portland State University

PR

Bus Stop Based Schedule Database for the Transit Time Internet Access System

by Jun Qiu

PR100
September 1996

This project was funded by Tri-Met and Transportation Northwest (TransNow) Regional Center under the sponsorhip of the Department of Transportation UTC Grant Program. The U.S. Government and Tri-Met assume no liability for the contents or use thereof. The contents do not necessarily reflect the views or policies of TransNow, the U.S. Department of Transportation, or Tri-Met.

Center for Urban Studies
School of Urban and Public Affairs
Portland State University
Portland, OR 97207-0751
(503) 725-4020
(503) 725-5199 FAX
http://www.upa.pdx.edu/CUS/

Contents:

Introduction

Advanced Public Transportation Systems (APTS) are a subset of Intelligent Transportation Systems (ITS). Bus Dispatch Systems (BDS) are important components of APTS. Based on the Automatic Vehicle Location (AVL) technology, the BDS generates exception reports for buses not adhering to their schedule. A Transit Time Internet Access System (TTIA) is under development. It currently reports bus schedule times and bus arrival times for time points (abbreviate as TP) along routes. The objective of a subsequent version of the TTIA is to provide user with schedule time at the bus stop level. This is a report on progress to estimate stop level schedules for the use in TTIA.

The Tri-County Metropolitan Transportation District of Oregon, Tri-Met, maintains a large database system. There are more than one hundred routes, each of which is composed of a list of the stops. There are several patterns to each route. Each pattern (path) has a different sequence of stops. In one day, there are many trips which pass by each of the stops. Also there are differences among the schedules for weekday, Saturday, and holiday. To determine schedule time at the stop level during a particular time frame is a complex problem.

The Center of Urban Studies, Portland State University, is currently involved in a research ITS project, called Transit Time Internet Access (TTIA). The tasks described this paper is one part of the project. In this paper, the research is based on the existing database system of Tri-Met. The work environment is the GIS software system, ARC/INFO 7.04. The DBMS is INFO, which is a module of ARC/INFO. The program is coded in ARC Macro Language, (AML). The AML is macro language, though it does not support SQL well. The scope of this paper is limited to the task of interpolation from the schedule time of time points to the schedule time of each bus stop.

Creating database in ARC/INFO

The database is created in INFO from data imported from the TRI-MET's. The database structure in INFO keeps the same structure as that in Tri-Met database in DB2, except for some adjustment of the sequence of the items. To interpolate the time to each stop, three tables are essential. These tables and their structures are listed as following:

1. Bus stop table

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	VERSION_KEY	6	6	I	
7	SERVICE_TYPE *	1	1	C	
8	RTE	3	3	C	
11	DIR	1	1	C	
12	PATH_NUMBER	6	6	I	
18	LOC_ID	11	11	I	
29	STOP_DISTANCE	16	16	N	10

* SERVICE_TYPE: Weekday, Saturday, or Sunday and Holiday . No data is in this item at this point. It is one of the tasks to fill it.

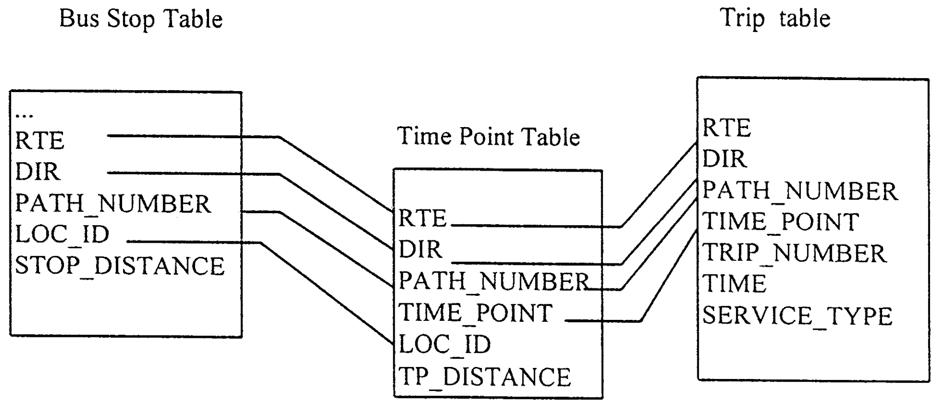
2. Time point table

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	RTE	3	3	C	
4	DIR	1	1	C	
5	PATH_NUMBER	6	6	I	
11	TIME_POINT	6	6	I	
17	LOC_ID	11	11	I	
28	TP_DISTANCE	16	16	N	10

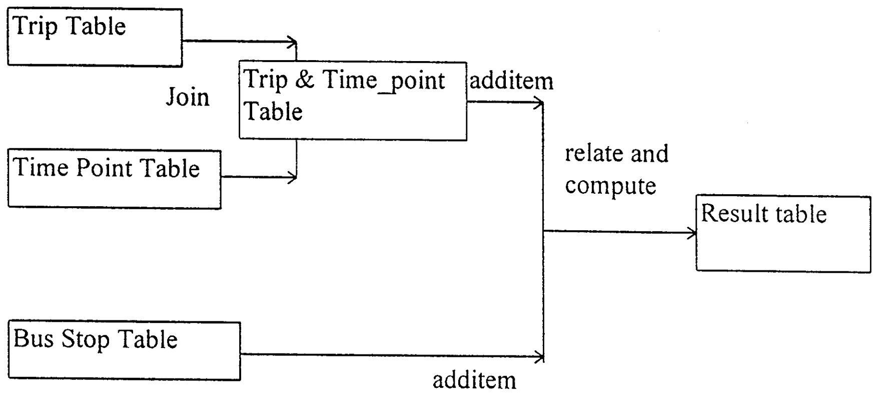
3. Trip table

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	RTE	3	3	C	
4	DIR	1	1	C	
5	PATH_NUMBER	6	6	I	
11	TIME_POINT	6	6	I	
17	TRIP_NUMBER	6	6	I	
23	TIME	11	11	I	
34	SERVICE_TYPE	1	1	C	

The database relation is created by several common items in each database tables. Their relation is described as following:



Two steps are necessary to update the database for AML programming. 1. Join the time point table to stop table. 2. Add items to the new joint table.



<u>Join stop table and time point table</u>

The item TIME_POINT is the common item to the Trip table and the Time_point table. However the relation must be based on the same route, direction and path_number. In this research, these two tables are joined by concatenating several items to make a new item: "rte-dir-path_number-time_point". Using this new item as a key warranted the joining relation. After joining the Time_point table to Trip table, the new Trip & Time_point table will have both time point information and trip information. This new table will be used in the following steps. And the primitive Time_point table is no longer used.

<u>Add items</u>

In ARC, the command "additem" is used to add the following items to the Trip & Time_points table:

DELTA_DIS (which = tp distance - up tp distance)
DELTA_TIME (which = tp time - up tp distance)
TRIP_INCRE (Which is unique to each trip)

So far the table of Trip & Time_point has both the trip and time, as well as the time point information. The following is its structure:

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC
1	RTE	3	3	C	
4	DIR	1	1	C	
5	PATH_NUMBER	6	6	I	
11	TIME_POINT	6	6	I	
17	TRIP_NUMBER	6	6	I	
23	TIME	11	11	I	
34	SERVICE_TYPE	1	1	C	
45	LOC_ID	11	11	I	
61	TP_DISTANCE	16	16	N	10
77	DELTA_DISTANCE	16	16	N	10
88	DELTA_TIME	11	11	I	
94	TRIP_INCRE	6	6	I	

The following was added to the stop table

UPDOWN_TIME (to each stop, the time between its up_tp and down_tp)
UPDOWN_DIS (to each stop, the distance between its up_tp and down_tp)
STOP_TIME (ultimate goal of the database)
TRIP_NUMBER (will be very useful for future work)
TP_DISTANCE
TIME_POINT

So far the Stop table has the structure as following:

COL	ITEM NAME	WDTH	OPUT	TYP	N.DEC
1	VERSION_KEY	6	6	I	-
7	SERVICE_TYPE	1	1	C	-
8	RTE	3	3	C	-
11	DIR	1	1	C	-
12	PATH_NUMBER	6	6	I	-
18	LOC_ID	11	11	I	-
29	STOP_DISTANCE	16	16	N	10
45	UPDOWN_DIS	16	16	N	10
61	UPDOWN_TIME	11	11	I	-
72	STOP_TIME	11	11	I	-
83	TRIP_NUMBER	6	6	I	-
89	TP_DISTANCE	16	16	N	10
105	TIME_POINT	6	6	I	-

The result table has the same structure as the above structure. In the results table, information of the three items, SERVICE_TYPE, TRIP_NUMBER and STOP_TIME, is the goal, which is got by the program computing. Other added items are mostly intermediate items, which are used in the process of computing.

Description of the computing process

To each of the tables, the program will select a basic unit. The program operate action on the two basic units.

For the stop table, the program selects a subset according to three items: a RTE, a DIRECTION, a PATH_NUMBER. After these three level queries, there is a single path of stops. There are 10 - 90s stops to each path, depending on the length of the path. The program will read this subset and compute the stop time. One complete path subset is following as an example: (Figure 1)

A complete path information from the Bus stop table
(Figure 1, is about here)

To the Trip & Time_point table, besides anchoring a RTE, a DIRECTION, a PATH_NUMBER, two more field are needed to anchor a unique trip. These are: SERVICE_TYPE and TRIP_NUMBER. A unique trip has 5 - 10 time points. Here, the importance of adding the TRIP_INCRE item is shown. Because, in the original Trip table, the item TRIP_NUMBER may be the same between two different routes, or same routes different direction, or path. (Refer to Figure 2, as an example)

A complete trip information from the Trip & Time_point table
(Figure 2 is about here)

After decomposing the large tables into such a pair of small subsets. The program can now create relation between them and compute. To the above two subsets, the LOC_ID is the only common item, by which the relation is to be established. The program will compute on these two subsets. Then the Stop_time, Service_type, and Trip_number information is filed in each relevant items which has default value as 0 or NULL. Looping on the TRIP_INCRE computes all such pairs of subsets. The result of the computation on each pair of subsets is appended to an ultimate result table.

The advantage of this process for pre-computing and saving the stop time lies in its high query speed for user. If the TTIA1 user query through the InterNet, It is a simple database query process. The disadvantage is that this result table needs a large space to save. It should not be difficult to maintain and revise the result table. If the dispatching system makes a new trip, the database maintainer needs to purge the old trip and run the program again just on the new trip and then append the new trip information. The alternative is to interpolate the schedule time at bus stop level on the fly.

The model which is used to interpolate stop_time:

Stop_time = up_tp_time + (stop_to_up_distance / up_down_distance) * up_down_time

Where:

up_tp_time: The time to the upstream time_point.
stop_to_up_distance: the distance between the stop and its up_time point.
up_down_distance: To a stop, this is zero when the stop is a time point too
Otherwise, it is the delta_distance of its up and down TPs.
up_down_time: To a stop, this is zero when the stop is a time point too
Otherwise, it is the delta_time of its up and down TPs.

This model is simplified, because it does not consider the speed variation on the network. However Tri-Met is placing pseudo time points into its system to improve the assumption of constant speed between time points. With the help of this method, the assumption of constant speed between two adjacent time points is acceptable.

The result table

The result table is the stop level schedule. It includes all the information from the three bas tables, Stop, Time_point, and Trip table. The following is the structure of the result table.

```
ENTER COMMAND >ITE
 DATAFILE NAME: RESULT2                                    09/03/1996
  13 ITEMS: STARTING IN POSITION    1
 COL  ITEM NAME          WDTH OPUT TYP N.DEC
   1  VERSION_KEY           6    6   I  -
   7  SERVICE_TYPE          1    1   C  -
   8  RTE                   3    3   C  -
  11  DIR                   1    1   C  -
  12  PATH_NUMBER           6    6   I  -
  18  LOC_ID               11   11   I  -
  29  STOP_DISTANCE        16   16   N  10
  45  UPDOWN_DIS           16   16   N  10
  61  UPDOWN_TIME          11   11   I  -
  72  STOP_TIME            11   11   I  -
  83  TRIP_NUMBER           6    6   I  -
  89  TP_DISTANCE          16   16   N  10
 105  TIME_POINT            6    6   I  -
```

The STOP_TIME, SERVICE_TYPE, and TRIP_NUMBER are those that this program produces. (Refer to Figure 3)

A small set of records from the result table
Figure 3 is about here

User entered data.

As a part of TTIA1, the user enters data from his or her computer. The data will be transferred to DBMS (in this project, INFO). Suppose the INFO database received the following data originally from the user:

route
weekday or weekend to take the bus
time to take bus
direction
stop

After querying the database (specifically, the result table), the result is:

the arrival time

This can easily be done in INFO just by the following commands: SELECT and RESELECT. The following is copied from INFO, which performs a query to the database:

```
 ENTER COMMAND >SEL RESULT                          /* From the result table
 45328 RECORD(S) SELECTED

ENTER COMMAND >RES RTE = '008'                      /* select route
 19822 RECORD(S) SELECTED

ENTER COMMAND >RES SERVICE_TYPE = 'S'               /* select service type
  7070 RECORD(S) SELECTED

ENTER COMMAND >RES DIR = '0'                        /* select direction
  3619 RECORD(S) SELECTED

ENTER COMMAND >RES LOC_ID = 6777                    /* select stop location
    63 RECORD(S) SELECTED

ENTER COMMAND >RES STOP_TIME > 40000 AND STOP_TIME < 45000
     6 RECORD(S) SELECTED                           /* *select time range

ENTER COMMAND >DIS STOP_TIME
    40,228
    42,028
    43,828
    41,128
    42,928
    44,728                                          /* *a list of the arrival times
```

** The time value is in the format of seconds post midnight.

In practice, a user can not know the LOC_ID. The TTIA system does not expect a user can enter data such as LOC_ID: 6777, or TIME 40000. The user will enter his or her data by clicking on a menu or clicking some points on a map, or by other means. How to let the user enter data is the question of the software interface. It will be a future work of TTIA.

Conclusion

The database described in this paper was created on the INFO system. Using ARC/INFO to create such a large transit database system was an experiment. INFO, and other modules in ARC/INFO, e.g. ARC/PLOT and ARC, can do the DBMS operations.

However, they do not support standard SQL. Some large DBMS system, such as Oracle 7 may be more powerful. ARC/INFO has the strength in its functionality for mapping . In the future the project will need this functionality.

Tri-Met has done well in adjusting its database suitable for APTS systems. However, the contents of data files (or the tables) still have some problems. For example, in the Trip & Time table, when selecting the following time point: RTE = 014, DIR = 1, PATH_NUMBER = 2, and TIME_POINT = 1061, there are records. However, in the Time_points table, there is no such time point. In other words, there is no information about its LOC_ID or its TP_DISTANCE. The program computes arrival time by TP_DISTANCE.

The process above is a static process. The interpolate of the "exception record" is the next work of TTIA. To do this, the TRIP_NUMBER will be helpful. The TRIP_NUMBER can relate to TRAIN_NUMBER. With the TRAIN_NUMBER, the exception information may be included. This is a important task of the future work. With Loc-id, it is possible to display maps. With trip_number, then relating to TRAIN_NUMBER, it may be possible to receive exception reports. These will be future tasks.

Reference

Dueker, J, Kenneth and Vrana Ric. GIS Applications in Urban Public Transportation: A case Study of Tri-Met, :Portland, Oregon.
Groff, Jonathan. Building Database Gateways With Inter-Application Communication (IAC)
Peng, Zhongren and Dueker, J, Kenneth: Spatial Data Integration in Route_level Transit Demand Modeling
Peng, Zhongren and Dueker, J, Kenneth. An Enterprise GIS Database Design for Transit Applications.

Figure 1

(Internal index) VERSION_KEY, SERVICE_TYPE , RTE , DIR, PATH_NUMBER, LOC_ID, STOP_DISTANCE, UPDOWN_DIS, UPDOWN_TIME, STOP_TIME, TRIP_NUMBER, TP_DISTANCE, TIME_POINT

1	00,024		033	1	4	8223	0.000000000	0.0000000000	0	0	0	0.0000000000	0
2	00,024		033	1	4	3672	426.8838600000	0.0000000000	0	0	0	0.0000000000	0
3	00,024		033	1	4	3680	808.6588600000	0.0000000000	0	0	0	0.0000000000	0
4	00,024		033	1	4	3657	2,670.6058599999	0.0000000000	0	0	0	0.0000000000	0
5	00,024		033	1	4	3652	4,479.4852699999	0.0000000000	0	0	0	0.0000000000	0
6	00,024		033	1	4	3797	5,612.5343099999	0.0000000000	0	0	0	0.0000000000	0
7	00,024		033	1	4	3856	7,023.6853999999	0.0000000000	0	0	0	0.0000000000	0
8	00,024		033	1	4	9418	7,260.3933999999	0.0000000000	0	0	0	0.0000000000	0
9	00,024		033	1	4	3785	14751.2277599990	0.0000000000	0	0	0	0.0000000000	0
10	00,024		033	1	4	3858	16209.4627599990	0.0000000000	0	0	0	0.0000000000	0
11	00,024		033	1	4	3837	18656.2647999990	0.0000000000	0	0	0	0.0000000000	0
12	00,024		033	1	4	2171	26208.9179299990	0.0000000000	0	0	0	0.0000000000	0
13	00,024		033	1	4	2642	28173.8120399990	0.0000000000	0	0	0	0.0000000000	0
14	00,024		033	1	4	5580	31525.7681399990	0.0000000000	0	0	0	0.0000000000	0
15	00,024		033	1	4	5581	32099.1631399990	0.0000000000	0	0	0	0.0000000000	0
16	00,024		033	1	4	7788	32914.6581399990	0.0000000000	0	0	0	0.0000000000	0

Note:
The column SERVICE_TYPE is defaulted as Null. The last several columns are defaulted as 0.
The program is to compute all these items and fill the computed values in result table.:

UPDOWN_DIS,
UPDOWN_TIME,
STOP_TIME,
TRIP_NUMBER,
TP_DISTANCE,
TIME_POINT

Figure 2

(Internal index) RTE, DIR, PATH_NUMBER, TIME_POINT, TRIP_NUMBER, TIME, SERVICE_TYPE, LOC_ID, TP_DISTANCE, DELTA_DIS, DELTA_TIME, TRIP_INCRE

1	033	1	3	3,301	1,070	74,220	U	8,758	0.0000000000	0.0000000000	0	167
2	033	1	3	335	1,070	74,460	U	136	8,576.8374499999	8,576.8374499990	240	167
3	033	1	3	334	1,070	74,760	U	3,791	16945.0534199990	8,368.2159699990	300	167
4	033	1	3	333	1,070	75,060	U	3,795	27077.7065099990	10132.6530900000	300	167
5	033	1	3	322	1,070	75,420	U	8,223	39014.9891099990	11937.2826000000	360	167
6	033	1	3	310	1,070	75,960	U	3,858	55526.6779199990	16511.6888100000	540	167
7	033	1	3	9,968	1,070	76,380	U	7,806	72201.8677699990	16675.1898500000	420	167
8	033	1	3	4,449	1,070	76,740	U	3,007	76790.3714599990	4,588.5036900000	360	167

Note:
This subset has the information of trip number, time, and time point, etc.

Figure 3

(Internal index) VERSION_KEY, SERVICE_TYPE , RTE , DIR, PATH_NUMBER, LOC_ID, STOP_DISTANCE, UPDOWN_DIS, UPDOWN_TIME, STOP_TIME, TRIP_NUMBER, TP_DISTANCE, TIME_POINT

```
ENTER COMMAND >DIS
25507  00,024   W    008 0  00,001   0000007767    0.0000000000 7,241.9159499990   360   20,580 1,005     0.0000000000 9,968
25508  00,024   W    008 0  00,001   0000007800  529.0660000000 7,241.9159499990   360   20,606 1,005     0.0000000000     0
25509  00,024   W    008 0  00,001   0000007777 1,033.1115199999 7,241.9159499990  360   20,631 1,005     0.0000000000     0
25510  00,024   W    008 0  00,001   0000007803 1,548.5785599999 7,241.9159499990  360   20,656 1,005     0.0000000000     0
25511  00,024   W    008 0  00,001   0000007782 2,067.4174699999 7,241.9159499990  360   20,682 1,005     0.0000000000     0
25512  00,024   W    008 0  00,001   0000007751 2,584.5825299999 7,241.9159499990  360   20,708 1,005     0.0000000000     0
25513  00,024   W    008 0  00,001   0000007758 2,846.8220699999 7,241.9159499990  360   20,721 1,005     0.0000000000     0
25514  00,024   W    008 0  00,001   0000009298 3,356.2150699999 7,241.9159499990  360   20,746 1,005     0.0000000000     0
25515  00,024   W    008 0  00,001   0000001612 4,422.8491999999 7,241.9159499990  360   20,799 1,005     0.0000000000     0
25516  00,024   W    008 0  00,001   0000001097 7,228.2047399999    0.0000000000    0   20,940 1,005  7,241.9159499999 9,035
25517  00,024   W    008 0  00,001   0000009362 8,284.9331299999 3,118.2537999990  240   21,020 1,005     0.0000000000     0
25518  00,024   W    008 0  00,001   0000004042 8,828.2645399999 3,118.2537999990  240   21,062 1,005     0.0000000000     0
25519  00,024   W    008 0  00,001   0000004053 9,333.4733399999 3,118.2537999990  240   21,100 1,005     0.0000000000     0
25520  00,024   W    008 0  00,001   0000004055 9,843.7733399999 3,118.2537999990  240   21,140 1,005     0.0000000000     0
25521  00,024   W    008 0  00,001   0000009305 10447.9187699990    0.0000000000    0   21,180 1,005  10360.1697499990    80
25522  00,024   W    008 0  00,001   0000004047 10865.8657699990 5,306.7555400000  240   21,202 1,005     0.0000000000     0
25523  00,024   W    008 0  00,001   0000006842 11686.5565599990 5,306.7555400000  240   21,239 1,005     0.0000000000     0
25524  00,024   W    008 0  00,001   0000009342 12606.8868799990 5,306.7555400000  240   21,281 1,005     0.0000000000     0
25525  00,024   W    008 0  00,001   0000006843 13125.3656599990 5,306.7555400000  240   21,305 1,005     0.0000000000     0
25526  00,024   W    008 0  00,001   0000006834 13633.2196599990 5,306.7555400000  240   21,328 1,005     0.0000000000     0
25527  00,024   W    008 0  00,001   0000006815 14548.5301899990 5,306.7555400000  240   21,369 1,005     0.0000000000     0
25528  00,024   W    008 0  00,001   0000006777 15106.3541899990 5,306.7555400000  240   21,394 1,005     0.0000000000     0
25529  00,024   W    008 0  00,001   0000006799 15666.9251899990    0.0000000000    0   21,420 1,005  15666.9252899990    83
25530  00,024   W    008 0  00,001   0000006811 16244.5682999990 6,301.0201400000  240   21,442 1,005     0.0000000000     0
25531  00,024   W    008 0  00,001   0000006808 16798.6572999990 6,301.0201400000  240   21,463 1,005     0.0000000000     0
25532  00,024   W    008 0  00,001   0000006797 17358.2052999990 6,301.0201400000  240   21,484 1,005     0.0000000000     0
25533  00,024   W    008 0  00,001   0000006785 17918.6412999990 6,301.0201400000  240   21,505 1,005     0.0000000000     0
25534  00,024   W    008 0  00,001   0000006775 18389.8477299990 6,301.0201400000  240   21,523 1,005     0.0000000000     0
25535  00,024   W    008 0  00,001   0000006783 18859.9587299990 6,301.0201400000  240   21,541 1,005     0.0000000000     0
25536  00,024   W    008 0  00,001   0000006806 19250.8427299990 6,301.0201400000  240   21,556 1,005     0.0000000000     0
25537  00,024   W    008 0  00,001   0000006801 19698.6807299990 6,301.0201400000  240   21,573 1,005     0.0000000000     0
25538  00,024   W    008 0  00,001   0000006810 20149.6917299990 6,301.0201400000  240   21,590 1,005     0.0000000000     0
25539  00,024   W    008 0  00,001   0000006787 20950.7831499990 6,301.0201400000  240   21,621 1,005     0.0000000000     0
25540  00,024   W    008 0  00,001   0000006819 21451.5411499990 6,301.0201400000  240   21,640 1,005     0.0000000000     0
25541  00,024   W    008 0  00,001   0000006773 21967.9451499990    0.0000000000    0   21,660 1,005  21967.9454299990    81
25542  00,024   W    008 0  00,001   0000006814 22435.2014499990 6,671.8924000000  300   21,681 1,005     0.0000000000     0
25543  00,024   W    008 0  00,001   0000006781 22895.7154499990 6,671.8924000000  300   21,701 1,005     0.0000000000     0.
25544  00,024   W    008 0  00,001   0000006795 23312.3384499990 6,671.8924000000  300   21,720 1,005     0.0000000000     0
25545  00,024   W    008 0  00,001   0000006792 24111.8714499990 6,671.8924000000  300   21,756 1,005     0.0000000000     0
25546  00,024   W    008 0  00,001   0000006771 24782.7854499990 6,671.8924000000  300   21,786 1,005     0.0000000000     0
25547  00,024   W    008 0  00,001   0000006790 25574.7620699990 6,671.8924000000  300   21,822 1,005     0.0000000000     0
25548  00,024   W    008 0  00,001   0000006803 26096.3755999990 6,671.8924000000  300   21,845 1,005     0.0000000000     0
25549  00,024   W    008 0  00,001   0000006780 26832.4575999990 6,671.8924000000  300   21,878 1,005     0.0000000000     0
25550  00,024   W    008 0  00,001   0000001275 27277.5036199990 6,671.8924000000  300   21,898 1,005     0.0000000000     0
25551  00,024   W    008 0  00,001   0000001267 28639.8376199990    0.0000000000    0   21,960 1,005  28639.8378299990    85
```

Note:
The above is a small set of the result table. It has information from all the three other tables. It has the time value interpolated to bus stop level.

Appendix 1: Algorithm

<u>Algorithm for main function</u>
Purpose: The main routine selects subsets, joins tables, and adds items. It controls the loops. It reads and writes files.

Pre-requirement: The tables has been added the needed items

Algorithm
Do loop, so all the trips will be included
1) Select subset which has information of a single trip from Trip_Time table, by a trip index
2) Use "cursor first" in AML to get the items value of the first record.
3) Define variables to save the value of RTE, DIR, SERVICE TYPE, etc. of this trip
4) Select subset which has information of a single path from Bus Stop table, by RTE, DIR, PATH_NUMBER.
5) Call sub routines to interpolate stop time
6) End loop

The algorithm above was coded in AML. The AML program was run in ARC/PLOT. In AML, there are some way to switch among several modules of ARC/INFO. For example, using directive "&data," the program change work platform among ARC, ARCPLOT and INFO. ARC/PLOT provide commands "Reselect," "Aselect" and "ClearSelect" for selecting subsets from tables. And the command "infofile" is used to write the selected subset to a new data file.

<u>The algorithm for subroutines</u>
Purpose: The subroutine computes the stop_time to for selected subset. Also it writes the SERVICE _TYPE and other intermediate items to the result table

ARC/INFO has a command to deal with each record of an INFO data file: "Cursor". Here, the CURSOR is not the meaning of the flickering dot on a monitor. It is a concept in INFO (In other SQL DBMS, the same command is “fetch”), which is used to access each record in the table.

1). Computing delta time and delta distance. (in Summary)
    Read the subset which is from Trip & Time table
    compute delta distance of two adjunct time points, add to tables SAD022
    compute delta time of two adjunct time points, add to table SAD022

2). Computing the stop distance
    Relate the two intermediate subset by LOC_ID
    Read the other subset which is from Bus Stop table
    Compute up_down TP distance of two adjunct time points.

Compute up down TP time of two adjunct time points.
Compute stop_time.
Fill all the computed value to their relevant items which are default as 0 or Null

Appendix 2

Because of the problem of no match Time_point mentioned before in the conclusion. The program will have wrong result on some routes, e.g. 014. After Tri_MET modify this problem, this program may run once to all the routes. Right now, the program run on route 008 and 017 as tests. Because these two routes do not have the above problem.

All the following steps can be written into AML MACRO. However, to do this must wait till the TRI_MET modify its data files. The future work is write in a database server which supports SQL.

Guide for creating database in INFO

* Trip table:	SAD022.FIN
* Time Point table:	SAD023.FIN
* Bus Stop Table:	SAD024.FIN

1. Update the tables structure of, and
   After the update, the items are in the sequence of
   RTE, DIR, PATH_NUMBER, TIMEPOINT
   Do this in Arcplot:
   ```
   reselect sad022.fin (or sad023.fin)
   infofile sad022.fin sad022.fin ~
   RTE DIR PATH_NUMBER TIME_POINT TRIP_NUMBER TIME ...
   ```

2. Redefine an item 'str' from 1 to 16 as Character.
   Do this in INFO

3. Reselect the route 008 (then 017), which will be used to test the program.
   Do this in Arcplot:
   ```
   clearsel
   resel SADO24.FIN info route = '008'
   infofile SAD024.FIN INFO SAD024A.FIN
   clearsel
   resel SADO22.FIN info route = '008'
   infofile SAD022.FIN INFO SAD022A.FIN
   clearsel
   ```
   For other routes, just change the '008'

4. Additems to SADO22A.FIN: LOC_ID, TP_DISTANCE
   Do this in Arc

4. Additems in ARC.
The following items are added to SAD022A.FIN

DELTA_DIS (which = tp distance - up tp distance)
DELTA_TIME (which = tp time - up tp distance)

The following was added to the stop table (SAD024)

UPDOWN_TIME (to each stop, the time between its up_tp and down_tp)
UPDOWN_DIS (to each stop, the distance between its up_tp and down_tp)
STOP_TIME (ultimate goal of the database)
TRIP_NUMBER
TP_DISTANCE
TIME_POINT

5. Join table SAD023A.FIN to SAD022A.FIN
Do this in INFO

```
SEL SAD022.FIN
REL SAD023.FIN BY STR
CAL LOC_ID = $1LOC_ID
CAL TP_DISTANCE = $1TP_DISTANCE
```

6. Add an items named TRIP_INCRE for unique trip_number to SAD022A.FIN (Which is now have both Trip and Time_point information). Save as TRY_CURSOR.
Do this in ARC
Then run the program *add_incre.aml* in ARC/PLOT to fill the contents in

7. Get the TRIP_INCRE maximum value by observing the data file. This can be do dynamically by a subroutine. Use "fetch last" in SQL can do thia. In INFO, first sort on TRIP_INCRE descendt, then use "cursor first".

8. Run the program *try_main2.aml* in ARC/PLOT.
Some indices for controlling loops change according to different route: the index for path_number, and trip_number. For each route, these indices in the main function need to be changed, the subroutines keep unchanging.

9. Do these steps again on route 017. The file name changes. The value of control flow in main porgram need to be changed.