LinkDelay *(version 4.0)*

Revision History
19 July 2010 Created by Volpe Center

The LinkDelay program is used to:

1. Merge, average, and/or convert Link Delay files, and
2. Smooth the link delays between time increments.

LinkDelay is a console-based program that runs in a command window on either Windows or Linux. The command syntax is:

```
LinkDelay [-flag] [control_file]
```

The control_file is the file name of an ASCII file that contains the control strings expected by the program. The control_file is optional. If a file name is not provided, the program will prompt the user to enter a file name. The flag parameters are also optional. Any combination of the following flag parameters can be included on the command line:

-Q[uiet] = execute without screen messages
-H[elp] = show program syntax and control keys
-K[eyCheck] = list unrecognized control file keys
-P[ause] = pause before exiting
-N[oPause] = never pause before exiting
-B[atch] = execute in batch processing mode

The program automatically creates a printout file based on the control_file name. If the file name includes an extension, the extension is removed and ".prn" is added. The printout file will be created in the current working directory and will overwrite an existing file with the same name.

Control File Examples

EXAMPLE 1 REPLACE_LINKS

The following **LinkDelay** control file merges information from a subarea Link_Delay file and a main Link_Delay file. It also does time-based smoothing (using default values):

```
TITLE              New Link Delay file from two other link delay file
REPORT_FILE              LinkDelayRptsub20.prn
REPORT_FLAG              True
PROJECT_DIRECTORY              ../
DEFAULT_FILE_FORMAT              TAB_DELIMITED

#---- Input Files ----
NET_DIRECTORY                ../network/
NET_LINK_TABLE                Link.txt
```

```
NET_LANE_CONNECTIVITY_TABLE            Lane_Connectivity.txt
LINK_DELAY_FILE              /results/20.subarea.Link_Delay
LINK_DELAY_FORMAT              BINARY
PREVIOUS_LINK_DELAY_FILE             /results/20.Link_DelayMain.txt
PREVIOUS_LINK_DELAY_FORMAT             BINARY

#---- Output Files ----
NEW_LINK_DELAY_FORMAT              BINARY
NEW_LINK_DELAY_FILE              /results/20.new.Link_Delay

#---- Parameters ----
PROCESSING_METHOD              REPLACE_LINKS
```

EXAMPLE 2 WEIGHTED_AVERAGE

The following **LinkDelay** control file merges information from two iterations, with most of the weight being given to the previous iteration. It also does time-based smoothing (using default values):

```
TITLE              New Link Delay file from two other link delay file
REPORT_FILE              LinkDelayRptsub20.prn
REPORT_FLAG              True
PROJECT_DIRECTORY              ../
DEFAULT_FILE_FORMAT              TAB_DELIMITED

#---- Input Files ----
NET_DIRECTORY                ../network/
NET_LINK_TABLE                Link.txt
NET_LANE_CONNECTIVITY_TABLE            Lane_Connectivity.txt
LINK_DELAY_FILE              /results/20.new.Link_Delay
LINK_DELAY_FORMAT              BINARY
PREVIOUS_LINK_DELAY_FILE             /results/19.Link_DelayMain.txt
PREVIOUS_LINK_DELAY_FORMAT             BINARY

#---- Output Files ----
NEW_LINK_DELAY_FORMAT              BINARY
NEW_LINK_DELAY_FILE              /results/20.Link_DelayMain.txt

#---- Parameters ----
PROCESSING_METHOD              WEIGHTED_AVERAGE
PREVIOUS_WEIGHTING_FACTOR           2
```

EXAMPLE 3 TIME_BASED_SMOOTHING

A **LinkDelay** control file that performs time-based smoothing on a single input link_delay file is shown below:

```
TITLE              New time-smoothed link delay file from old link delay file
REPORT_FILE              LinkDelayRptsub20.prn
REPORT_FLAG              True
PROJECT_DIRECTORY              ../
DEFAULT_FILE_FORMAT              TAB_DELIMITED
```

```
#---- Input Files ----
NET_DIRECTORY                ../network/
NET_LINK_TABLE                Link.txt
NET_LANE_CONNECTIVITY_TABLE           Lane_Connectivity.txt
LINK_DELAY_FILE              /results/20.Link_Delay
LINK_DELAY_FORMAT              BINARY

#---- Output Files ----
NEW_LINK_DELAY_FORMAT             BINARY
NEW_LINK_DELAY_FILE             /results/20.Link_Delay_Smoothed

#---- Parameters ----
SMOOTH_GROUP_SIZE       3
PERCENT_MOVED_FORWARD   20
PERCENT_MOVED_BACKWARD  20
```

Control File Parameters

Control parameters are defined using a control key followed by a string or number. The control parameters can be specified in any order. If a given key is defined more than once, the last instance of the key is used. The default value for each key is 0 or "Null". Null parameters do not need to be included in the file. Note that comment lines or extraneous keys can be included in the file. They will be ignored by the program.

The keys recognized by the **LinkDelay** program are listed below. These keys can be defined in a variety of different ways to perform different tasks. The first three keys are required; others are optional.

NET_LINK_TABLE

The link table key is required. It specifies the name of the TRANSIMS link file within the network directory. The full path and file name for the link table is constructed by appending the value of this key to the value of the NET_DIRECTORY key.

LINK_DELAY_FILE

The current link delay file is required. The program uses the information in the link delay file to initialize the link volumes and travel times for each time period. The header record in the link delay file is used to determine the size of each time period. The time periods are typically 15 minutes long. If a link delay file is not provided (or the key is "NULL"), free flow speeds are used for all times of day. Free flow speeds are also used for all links and time periods not included in the link delay file.

NEW_LINK_DELAY_FILE

The new link delay file is required, and is the output of the program.

TITLE

Any text string can be used on this line. This text is printed on the top of each output page.

REPORT_FILE

The report file name is optional. If a file name is not provided, the program automatically creates a report file name based on the input control file name. The report file will overwrite an existing file with the same name if the Report Flag key is False or not specified.

REPORT_FLAG

The report flag key is optional. Its default is FALSE. If it is specified as Yes or True, the report file or default printout file will be opened in "Append" mode rather than "Create" mode. This permits the user to consolidate the output of several programs into a single report file.

MAX_WARNING_MESSAGES

When the program generates a warning message, a counter is incremented and the total number of warning messages is reported and a warning return coded (2) is set at the end of the execution. By default the program prints up to 100,000 warning messages to the print-out file. If more than 100,000 warning messages are sent, the program stops printing additional messages to the file or terminates the program with an error message based on the MAX_WARNING_EXIT_FLAG. This parameter enables the user to modify the default warning limit.

MAX_WARNING_EXIT_FLAG

If the maximum number of warning messages is exceeded, this flag directs the program in what to do. If the flag is TRUE (the default), the program is terminated with an error message about the warning messages. If the flag is FALSE, the program continues execution, but no additional warning messages are sent to the screen or written to the printout file. The warning message counter continues to count the messages and reports the total at the end of the execution.

PROJECT_DIRECTORY

The project directory key is not required. If it is specified, it is added to all non-network file names required by the program. If it is not specified, all non-network file names should fully specify the file path.

DEFAULT_FILE_FORMAT

Default format for files other than network files. Default is VERSION3. Other possible values include BINARY, FIXED_COLUMN, COMMA_DELIMITED, SPACE_DELIMITED, TAB_DELIMITED, CSV_DELIMITED, DBASE, LANL and SQLITE3.

NET_DIRECTORY

The network directory key is not required. If it is specified, it is added to all network table names. If it is not specified, the network table names should fully specify the file path.

NET_LANE_CONNECTIVITY_TABLE

The network lane connectivity table key is required. It specifies the name of the TRANSIMS lane connectivity file within the network directory. The full path and file name for the lane

connectivity table is constructed by appending the value of this key to the value of the NET_DIRECTORY key.

TIME_OF_DAY_FORMAT

The default time of day format will display values in 24 hour clock time. Other options include SECONDS, HOURS, 24_HOUR_CLOCK, and 12_HOUR_CLOCK.

PREVIOUS_LINK_DELAY_FILE

If two link delay files are being combined, this is the name of the previous link delay file.

PREVIOUS_WEIGHTING_FACTOR

If two link delay files (previous and current) this factor gives the weight for the previous file, in instances where the Processing_Method is WEIGHTED_AVERAGE. Its default is 1, and it should be a value greater than or equal to 0.5. Let
PREV_VAL = value in the Previous_Link_Delay_File
CURR_VAL= value in the Link_Delay_File
PREV_FACTOR = Previous_Weighting_Factor
NEW_VAL = value in the New_Link_Delay_File

In the absence of time smoothing,
NEW_VAL = 0.5 + (PREV_VAL * PREV_FACTOR + CURR_VAL) / (PREV_FACTOR + 1)

If the previous_weighting_factor is set to 0, then previous weighting will be based on volume data.

PROCESSING_METHOD

Possible values are WEIGHTED_AVERAGE, REPLACE_LINKS, and SIMPLE_AVERAGE

WEIGHTED_AVERAGE uses the previous weighting factor (above) to produce a weighted average between values in the previous link delay file and the current link delay file. If a link exists in the previous file but not in the current, a value of 0 will be assumed for the current volume, and free-flow speed will be assumed for the current speed.

SIMPLE_AVERAGE uses a simple average (like WEIGHTED_AVERAGE with PREVIOUS_WEIGHTING_FACTOR = 1)

REPLACE_LINKS simply uses the values in the current link delay file, when they are available, and only uses values from links in the previous link delay file that don't exist in the current link delay file.

The following table shows the impacts of these processing methods on volumes. The inputs are 15-minute volumes for some link in two link delay files (current and previous). The results are the new volumes for that link. The following cases are illustrated: REPLACE_LINKS,

WEIGHTED_AVERAGE with weight of 1 (same as SIMPLE_AVERAGE), and WEIGHTED_AVERAGE with weights of 2, 3, and 9. In this example, time smoothing is turned off (SMOOTH_GROUP_SIZE = 0).

Time	Inputs		Results				
	Link_Delay	Previous	Replace	1	2	3	9
7:45	MISSING	800	800	400	533	600	720
8:00	971	960	971	966	964	963	961
8:15	1141	1128	1141	1135	1132	1131	1129
8:30	1131	1188	1131	1160	1169	1174	1182
8:45	1125	1249	1125	1187	1208	1218	1237
9:00	486	375	486	431	412	403	386
9:15	43	MISSING	43	43	43	43	43

Note that the missing current volume for the 7:45 time slot causes link delay to assume zero volume. This behavior may not be desirable when performing user equilibrium using link delays from a subarea. Since the subarea is by definition a subset of the links in the network, volumes for all links outside the subarea will be averaged with zero, and speeds will be averaged with free-flow.

To properly combine link delays from the subarea and the full network:

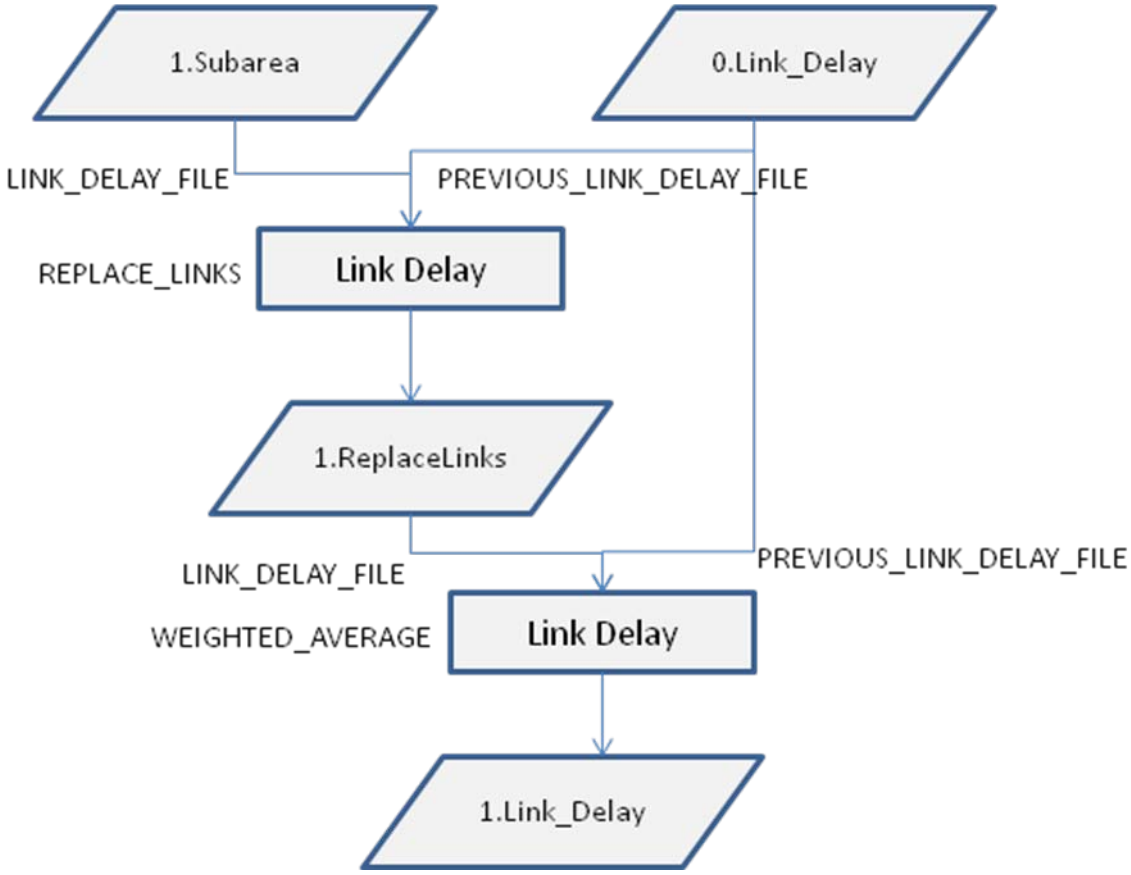
1. Run LinkDelay with PROCESSING_METHOD set to REPLACE_LINKS, the subarea delays as the LINK_DELAY_FILE, and the full network delays as the PREVIOUS_LINK_DELAY_FILE.

   The result of this step is a single link delay file for the entire network, with the new microsimulator delays for the subarea and the previous iteration delays for the rest of the network. No averaging has been performed yet.

2. Run LinkDelay with PROCESSING_METHOD set to WEIGHTED_AVERAGE, the combined file as the LINK_DELAY_FILE, and the full network delays used in the previous step as the PREVIOUS_LINK_DELAY_FILE.

   The result of this step is a file of weighted-average link delays from the current iteration and the previous iteration, including the current microsimulator delays for the subarea.

The diagram below illustrates the above process as a flowchart. The parallelograms represent link_delay files. The rectangles represent instances of the LinkDelay program.



TIME_PERIOD_SORT

Default value is FALSE. The default sort is link number and then time period. The Microsimulator generates a file sorted by time period and then link number. If this key is TRUE, the output link delay file is sorted by time period and link number.

SMOOTH_GROUP_SIZE

Smooth_Group_Size is the number of time periods included in a moving average smoothing process. 3 is normally used for 15 minute time periods (i.e., +1 and -1 period). Possible values are 0, 3, 5, 7, 9, with a default of 3. If a value of 0 is used, time-based smoothing is disabled. The table below illustrates the impact of various parameters (0, 3, and 5) for SMOOTH_GROUP_SIZE on a single link with 15-minute volumes and travel-times. Note that a single LINK_DELAY input file is used in this case. Time-based smoothing can also be used in conjunction with the use of two link delay input files.

Time	Inputs	Results			Input	Results		
	Volume	0	3	5	Time	0	3	5
6:45				2				14.9
7:00				14				14.9
7:15			8	51			14.9	14.8
7:30			79	165			14.7	14.4
7:45			324	364			13.9	13.9
8:00	971	971	714	680	11.9	11.9	12.9	13
8:15	1141	1141	1000	882	12.0	12.0	12.2	12.4
8:30	1131	1131	1056	931	12.0	12.0	12	12.1
8:45	1125	1125	886	810	12.1	12.1	11.9	12
9:00	486	486	546	545	11.5	11.5	11.8	12.1
9:15	43	43	222	285	10.8	10.8	12.4	12.6
9:30			55	119			13.6	13.6
9:45			7	38			14.6	14.3
10:00				9				14.7
10:15				2				14.8

PERCENT_MOVED_FORWARD

The Percent_Moved_Forward defines the percentage of the current period volume that is added to the next time period. It defaults to 20 percent. The range is 0..(100 – 50 / [smooth group size])

PERCENT_MOVED_BACKWARD

The Percent_Moved_Backward defines the percentage of the current period volume that is added to the previous time period. It defaults to 20 percent. The range is 0..(100 – 50 / [smooth group size])

The table below illustrates the impacts of several values of PERCENT_MOVED_FORWARD and PERCENT_MOVED_BACKWARD on a single link. The values used are

- 20% FORWARD and 20% BACKWARD (the default), labeled as 20_20
- 5% FORWARD and 5% BACKWARD, labeled as 5_5
- 0% FORWARD and 20% BACKWARD , labeled as 0_20

Time	Input	Results			Input	Results		
	Volume	20_20	5_5	0_20	Time	20_20	5_5	0_20
7:15		8		8		14.9		14.9
7:30		79	7	102		14.7	14.9	14.6
7:45		324	126	492		13.9	14.5	13.4
8:00	971	714	868	1052	11.9	12.9	12.3	11.9
8:15	1141	1000	1111	1131	12.0	12.2	12	12
8:30	1131	1056	1126	1058	12.0	12	12	12
8:45	1125	886	1040	767	12.1	11.9	12	11.8
9:00	486	546	511	265	11.5	11.8	11.5	11.6

9:15	43	222	99	22	10.8	12.4	11.4	12.8
9:30		55	9			13.6	14.4	
9:45		7				14.6		

NUMBER_OF_ITERATIONS

The Number_of_Iterations defines how many times the moving average process is applied to the full set of time periods (default is 3). The range is 1 to 25.

The table below illustrates the effects of several values (1, 3 and 7) of NUMBER_OF_ITERATIONS on a single link.

Time	Input	Results			Input	Results		
	Volume	1	3	7	Time	1	3	7
7:00				3				14.9
7:15			8	16			14.9	14.9
7:30			79	67			14.7	14.7
7:45		194	324	188		14.3	13.9	14.4
8:00	971	811	714	399	11.9	12.5	12.9	13.8
8:15	1141	1105	1000	651	12.0	12	12.2	13.1
8:30	1131	1132	1056	845	12.0	12	12	12.5
8:45	1125	998	886	891	12.1	12	11.9	12.1
9:00	486	525	546	775	11.5	11.5	11.8	12
9:15	43	123	222	549	10.8	11.8	12.4	12.2
9:30		9	55	312		14.1	13.6	12.7
9:45			7	139			14.6	13.5
10:00				48				14.2
10:15				12				14.6
10:30				2				14.8

CIRCULAR_GROUP_FLAG

The CIRCULAR_GROUP_FLAG determines how the end time periods are smoothed. If TRUE (the default), the volumes and speeds are smoothed across the first and last time periods. In other words, 0:00 and 0:15 are smoothed with 23:45 and 24:00.

NET_DEFAULT_FORMAT

Default format for network files.

NET_LINK_FORMAT

The link file format key can be used to specify the input file format. The default format is VERSION3; a tab delimited file compatible with the TRANSIMS Version 3.x software. Other options include BINARY, FIXED_COLUMN, COMMA_DELIMITED, SPACE_DELIMITED, TAB_DELIMITED, and DBASE

NET_LANE_CONNECTIVITY_FORMAT

The lane connectivity file format key can be used to specify the input file format. The default format is VERSION3; a tab delimited file compatible with the TRANSIMS Version 3.x software. Other options include BINARY, FIXED_COLUMN, COMMA_DELIMITED, SPACE_DELIMITED, TAB_DELIMITED, and DBASE

DEMAND_FILE_FORMAT

The demand file format key can be used to change the default file format. The default format is VERSION3; a tab delimited file compatible with the TRANSIMS Version 3.x software. Other options include BINARY, FIXED_COLUMN, COMMA_DELIMITED, SPACE_DELIMITED, TAB_DELIMITED, DBASE, and SQLITE3.

LINK_DELAY_FORMAT

NEW_LINK_DELAY_FORMAT

PREVIOUS_LINK_DELAY_FORMAT

The file format keys can be used to specify the input or output file formats. The default format is VERSION3; a tab delimited file compatible with the TRANSIMS Version 3.x software. Other options include BINARY, FIXED_COLUMN, COMMA_DELIMITED, SPACE_DELIMITED, TAB_DELIMITED, and DBASE.

Sample Printout

A sample printout file generated by the **LinkDelay** program is shown below. It is an ASCII text file with a maximum of 95 characters per line and 65 lines per page. The file can be viewed or printed using a variety of text editors. For best results in a word processor, use a 10-point Courier font and 0.5 inch margins on all sides.

```
*****************************************
|                                       |
|        LinkDelay - Version 4.0.9      |
|   Copyright (c) 2009 by AECOM Consult |
|         Mon Jul 19 08:39:15 2010      |
|                                       |
*****************************************

Control File = ..\control\20.subarea.LinkDelay.ctl
```

```
Report_File  = LinkDelayRptsub20.prn (Append)

New Link Delay file from two other link delay file

Project Directory = ../

Default File Format = TAB_DELIMITED

Network Directory = ../network/
Link File = ../network/Link.txt
Lane Connectivity File = ../network/Lane_Connectivity.txt

Link Delay File = ..//results/20.subarea.Link_Delay
Link Delay File Format = BINARY

New Link Delay File = ..//results/20.new.Link_Delay
New Link Delay File Format = BINARY
Time of Day Format = 24_HOUR_CLOCK

Previous Link Delay File = ..//results/20.Link_DelayMain.txt
Previous Link Delay File Format = BINARY
Previous Weighting Factor = 1.00

Processing Method = REPLACE_LINKS

Smooth Group Size = 3
Percent Distributed Forward = 20.0 percent
Percent Distributed Backward = 20.0 percent
Number of Iterations = 3
Circular Group Flag = TRUE


Number of Link File Records = 4798
Number of Directional Links = 7980

Number of Lane Connectivity File Records = 20908
Number of Lane Connectivity Data Records = 14058

Number of Link Delay File Records = 138987, Periods = 96
Percent of Link Directions with Travel Time Data = 7.8%
Percent of Link Time Periods with Travel Time Data = 96.7%
Percent of Link Connections with Travel Time Data = 6.7%
Percent of Connection Periods with Travel Time Data = 90.0%

Number of Previous Link Delay File Records = 1549924

Number of New Link Delay File Records = 1547496

Mon Jul 19 08:39:29 2010 -- Process Complete (0:00:14)
```