

Living Scenery Technology 1.11 Developer Manual

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1 – Overview

1.1 – Introduction

I'm proud to present, Living Scenery Technology! What is LST? LST is a global plugin that provides ground traffic, static object placement (for access to the particle system and X-Plane's 12 FMOD), and Dataref utilities.

LST supports **Windows, Linux (compiled and tested on Ubuntu), and Mac OS X, as well as X-Plane 11.x, 12.x, and future versions.**

LST is **fast**, a large airport like Denver costs only roughly an additional 5-10% of performance with very heavy vehicles, for most cases, there will be no hit.

LST is **Freeware and will remain that way forever.** This is a **developer manual** providing an overview of **LST's** features, file formats, and utilities (developer utilities are Windows only).

1.2 – License

- **LST, Living Scenery Technology** is provided **free of charge**. That does **not** make **LST** public domain or free of copyright. You must still follow this license.
- **You may:**
 - Do whatever you want with **LST** in your own home
 - Use the provided utilities to create products (paid or free) that use **LST**
 - Create and sell products (paid or free) that use **LST**
- **You may not:**
 - Redistribute the **LST** plugin itself (the reason is, I don't want a bunch of different versions running around creating a stability nightmare)
 - Redistribute the utilities for developing for **LST**
 - Portray that you are the developer of **LST**. You don't have to give credit for **LST**, just don't indicate you made it or anything along those lines.
 - Do anything unethical or illegal
- By using this plugin or it's utilities, you agree to use it in a responsible manner that does not impact other addons or the core simulator/
- By using this plugin or it's utilities, you agree that **I am not responsible for anything bad that may happen as a result.**
- I may offer support as a courtesy; however, I am not obligated to provide support or this plugin or utilities.
- If you have any questions or want to discuss an exception, please contact me via my website, x-codrdesigns.com.

1.3 – Installation

To install Living Scenery Technology, please follow these instructions.

- Copy Living Scenery Technology into <X-Plane Root Folder>/Resources/Plugins
- Enjoy!

The developer tools are standalone executable, just put them in a folder where you can find them.

1.4 – Preferences

LST has optional preferences. It belongs in XP Path/Resources/plugins/Living Scenery Technology/Prefs.lst. The format is COMMAND,VALUE followed by a newline. Valid commands are

- TIMEMODE, SIM or REAL. Sim uses sim timing for animation, real uses real timing for animation. This defaults to real, but if you want vehicles to progress along routes faster when the sim time is running faster (for example by using shift L), set it to SIM.
- PRESISTENT_CACHE, TRUE or FALSE. Can reduce loading load when leaving then returning to a scenery area, you probably don't need to mess with this.
- DEBUG, TRUE or FALSE. Always leave this as false, unless you run into an issue and need to send me your log.txt.

2 – File Structure

LST works by checking all custom scenery folders for an Init.lst. If it finds the Init.lst, it will be read and be used to set parameters that apply to all files in that scenery folder.

LST will then check for and process the following files:

- Objects.lst – For static objects and ground routes
- Datarefs.lst – For Dataref registration and manipulation
- PCL.lst – For a Pilot Controlled Lighting System

3 – Init File

The Init.lst file sets parameters that apply to all aspects of the package, such as the boundary in which the package will be activated (PCL is unaffected by this boundary). It's format is as follows:

Line 1:	0 or 1, 1 for extra debug logging
Line 2:	Northern activation boundary
Line 3:	Southern activation boundary
Line 4:	Eastern activation boundary
Line 5:	Western activation boundary

After the first 5 lines, come Key Value Pairs. You should have one pair per line, and separate the key and value by a comma.

MINVER	The minimum version required for the package. If the current version is less than this, the package will not be loaded. The value should be a decimal
PRIMETIME	The number of seconds to run the LST simulation at a very high speed in order to “prime” routes with objects
ACTIVEDREF	The active data reference for the package. This will be set to 1 when the package is active, 0 when it is not. You likely don't need this

4 – Object File

The Objects.lst file controls the placement of static objects, and the route of dynamic objects. This is the most complex file, and it is strongly recommended you use the included utilities to generate it. The commands are as follows. All arguments are listed in the order they should be provided, and are mandatory unless otherwise noted.

OBJECT	Adds a static object. Args are .obj path, lat, lon, (optional set 1) alt, (optional set 1) AGL or MSL? (0 for MSL, 1 for AGL), (optional set 1) heading, (optional set 2) pitch, (optional set 2) roll
HIGHWAY	Adds a highway route that objects continuously spawn on. Args: Obj path, min spawn time, max spawn time, (optional) initial elevation in MSL (used for starting in between hard surfaces, such as in buildings). Note: A max spawn time of -1 means no randomization. A min and max spawn time of -1 means nothing will spawn here, used only for routes that can be BRANCHED to
LOOP	Adds a route one object spawns on and continues on in a loop forever. Args: Obj path
TRAIN	Adds a train route. Args: First car obj path
TRAINCAR	Adds another object to the train. Args: car obj path, spacing. Spacing defaults to seconds behind at the speed of the first waypoint. Append "m" to specify distance in meters (recommended)
SPAWNFACTOR	Optionally comes directly after a highway command to multiply the spawn times by the operand. Args: Operand

WP	Defines a waypoint on a route. Args: Lat, Lon, Speed (kph). Speed is linearly interpolated between waypoints.
WAIT	Modifies the next WP to cause objects to wait this many seconds before proceeding. Args: Wait time (seconds)
REVERSE	Modified the next WP to cause objects to be facing backwards. Args: None
DREFWAIT	Modifies the next WP to cause objects to wait for a Dataref to satisfy a condition. You can have multiple DREFWAIT commands per WP, all must be true to proceed. Valid operators are < = >. Operands can be numeric, or dataref names (which will be resolved to their current numeric values). Args: Operand 1, operator, Operand 2
DREFSET	Modifies the next WP to set a Dataref when an object reaches the WP. Args are: Dataref name, value to set, transition time (seconds for Dataref to be interpolated from current value to target value)
GONDOLASTART/END	Modifies WPs inside this pair to have objects linearly interpolate their altitude between WPs, rather than follow terrain
PITCHLESSSTART/END	Modified WPs inside this pair to have objects always have pitch 0 rather than pitch that follows the terrain
BRANCH	Modifies the next WP to have an object move to leg 0 of a different route off a random chance. These are route indexes. You must use the included utilities to set up effectively! Useful for natural seeming behavior and

	connecting multiple route. Args: target route index, chance (0-1, 0 is never branch, 1 is always branch).
BRANCHIF	Just like branch, except based on whether an Dataref satisfies a condition to branch. Args: Target route index, operand 1, operator, operand 2

Advanced Notes

- Altitudes are probed every meter along each leg, starting 2 meters above the prior probe.
 - This allows you to stay on a level if there is at least 2 meters between it and the hard surface above it.
 - The initial probe is from space (and probed twice for precision reasons). This is why you specify an initial altitude for a highway, to start on a level below the top most level.
 - Note this also means memory usage increases with length (albeit a tiny amount)
- Objects will cut corners to have a smooth turn.
 - Altitudes and pitches however are based on straight lines between waypoints.
 - While on a curve, altitude pitch and speed are linearly interpolated between their values at the endpoints on the curve.
 - A curve length depends on the sharpness of the turn, but will never exceed $\frac{1}{2}$ the length of the shortest leg that the curve starts/ends on.
- Comments are allowed by starting with a #
- TRAINS internally are just HIGHWAYS with a different kind of car on them. Meaning you could technically apply things like BRANCHing, but beware, the results may be, interesting!
 - Use modifiers with extreme caution on TRAINS.
- DREF commands are (relatively) slow due to resolving dataref names, so use them sparingly

5 – Dateref File

The Datarefs.lst file allows you to define Datarefs and mathematically manipulate them.

The file contains commands followed by arguments, there should be one command per line, and command and arguments comma separated. Arguments below are listed in the order they should appear in the command

Please note an operand is a numeric value, *or*, a Dateref name, which will be replaced with that dateref's value. Please note valid operators are + - * / and %. They work as you would expect.

The commands are as follows:

DREF	Creates a new Dateref with the specified name. Make sure it is unique!
VALUE	Continuously set's the dateref's value to the evaluated expression. Arguments are operand 1, operator, operand 2.
CAP	Caps a Dateref between min and max values. Arguments are Dateref name, min, max.
KEYFRAME	Defines a keyframe table, that is, a dateref's value is interpolated between values based on the value of another Dateref. Arguments are the target Dateref, and the Dateref to keyframe it to.
KV	Defines a keyframe in a keyframe table. Arguments are the value of the controlling value, and the value to set what at this value.

6 – PCL File

When present, the PCL.lst file controls pilot controlled lighting. The system works by listening for push to talk commands, and when the click criteria has been met (as defined by the file), a Dataref value is set for a certain amount of time. The file format is as follows:

FREQ	The frequency of the PCL system. The value should be an integer in hz
ONTIME	How long the lights stay on
DREF	The dataref for the PCL system. The value should be a string. Will be set to 0, 1, 2, or 3, for off, low, med, or high, respectively
LOCLICKS	The number of clicks for to trigger low lighting
MEDCLICKS	The number of clicks to trigger medium lighting
HICCLICKS	The number of clicks to trigger high lighting
LAT	The latitude of the PCL system. The value should be a double.
LON	The longitude of the PCL system. The value should be a double.
RANGE	The range of the PCL system in meters. The value should be a double.
CLICKTIME	The number of seconds for a series of clicks to be considered a series of clicks for the PCL system. Ie you must click 5 times in 15 seconds to activate the system.

7 – Utilities

Living Scenery Technology comes with several utilities to aid in the development of routes and conversion from Marginal's GroundTraffic.

5.1 – Living Scenery Technology Converter

The Living Scenery Technology Converter converts a GroundTraffic.txt to Living Scenery Technology Init and Objects files. Highways and routes are converted, along with pause and backup commands. Object references are maintained as are spacing and speed. However, advanced features such as “when”, “set”, “reverse” and “and” are not supported as they do not have a direct counterpart in LST. Further, trains will be defined, but will need significant tweaking. View the resulting files to determine what needs to be changed. Lastly, only the first car defined in a highway will be converted. Subsequent cars will be ignored. Give variety to your highway using EXPORT_EXTEND commands in your Library.txt. To use the tool, simply run it, and provide information as prompted, it is fairly straightforward.

5.2 – Living Scenery Technology Generator

The Living Scenery Technology Generator is a tool that generates Living Scenery Technology files based on a DSF with strings that define a route and provides useful utilities such as calculating a spawn delay and formatting a DREFOP command based on provided values. When you first launch the utility, you will be prompted to enter a number to select when operation you want to perform. Enter the desired number to proceed to this operation. See the below sections for details on each operation.

5.2.1 – 1.) Generate Routes from DSF

Slightly contrary to the name, this allows you to generate routes from a scenery package. You will need to use WED 2.6 to create routes with the Shape tool. Each node's Z value is used for speed, and it's property text is used for modifier commands for that WP. You can add multiple commands by separating them with semicolons. Likewise, the route arguments (such as HIGHWAY, LOOP, TRAIN and TRAINCARs) are set with the shape's property text. BRANCHes are done by collocating the start point of one shape on another shape's node. You can specify args with

BRANCHIF_Operand1,Operator,Operand2, or BRANCH_Chance. Please see the example scenery.

5.2.2 – 2.) Calculate Spawn Delay

Chances are you don't need this. This option allows you to calculate a spawn delay (in seconds) from a given speed and desired distance. Unlike GroundTraffic, Living Scenery Technology spawns objects after a certain time, rather than distance. Therefore, it can be useful to calculate this delay for developers used to providing a meters value. To use this, simply provide information as prompted.

5.2.3 – 3.) Generate DREFOP Command

You don't need this in 1.11+! This option allows you to get the DREPOP command formatted properly by providing the parameters (see section 3.10). To use this option, simply provide information as required, then you will be provided with the appropriate DREFOP command.

5.2.4 – 4.) Adjust Route Spacing

This option allows you to apply an offset to the spawn delay of all HIGHWAYs in an objects.lst. Simply follow the prompts to use this tool.

8 – Built-in Datarefs

6.1 – Distance Travelled Dataref

This is a dataref that is per object. It specifies how far the object has traveled since the last waypoint in meters. This is useful for animating tires. The Dataref name is **lst/anim_obj_dist_travelled**.

6.2 – Per Object Animation Dataref

This is a dataref that is also per object, it increases, just like the `total_time_running` dataref, except it varies with location. This allows you to place the same object, with the same animation tied to this Dataref, and they won't be in sync. The dataref name is **lst/anim_obj_time**.

9 – Multi Package Sceneries

7.1 – Packages.lst

In order to support multiple LST files per package, create a new text file named “Packages.lst” in your scenery root folder, where the LST files would normally be. Inside this file should be the paths to a folder containing LST files. This path should not have preceding or trailing slashes. You may use / or \ as a directory separator – they will be replaced with the system directory separator at runtime. Note this only affects loading, the packages behave like they're in the same folder as Packages.lst, and expect local paths to be entered appropriately.

An example Packages.lst for a scenery package that has LST files in the folders “Sub Pack A” and “Sub Pack B/LST Files” is below.

```
Sub Pack A  
Sub Pack B/LST Files
```

10 – A Very Long Changelog

1.5 – Changelog

- **Version 1.11.2; 3/23/2024**
 - **Bug Fix:**
 - **Fixed:**
 - Crash when unable to locate object
- **Version 1.11.1; 2/15/2024**
 - **Bug Fix:**
 - **Improved:**
 - Logging is more reliable and cleaner.
 - Data access now has bounds checks, when something goes wrong, plugin should stop without crashing sim.
 - **Fixed:**
 - Fixed trains not deactivating after leaving scenery area causing crash when returning.
- **Version 1.11; 1/10/2024**
 - **Feature:**
 - **Added:**
 - Smooth turning around corners
 - Per object instance animation Dataref for animation variations
 - Enabled PCL system (controlled by sceneries, activated by XP's PTT, or LST's PTT command)
 - **Improved:**
 - Made docs more concise and clear
 - DREFWAIT and DREFSET vs giant DREFOP command
 - **Fixed:**
 - Various file reading issues
- **Version 1.10; 9/2/2023**
 - **Feature + Bug Fix:**
 - **Added:**
 - DEBUG and PRESISTENT_CACHE to Prefs.lst
 - MINVER, PRIMETIME, and ACTIVEDREF to Init.lst.
 - Optional initial alt for HIGHWAYS and LOOPS
 - PITCHLESSSTART and PITCHLESSEND for objects to always have 0 pitch.
 - **Improved:**
 - Objects are culled based on LOD (to handle X-Plane bug causing this not to be automatic)

- Trains don't fall apart anymore. Their relative spacing is fixed and always absolute.
 - All loading is now async
 - **Fixed:**
 - Linux version compiled wrong
 - Various small bugs.
- **Version 1.09.4; 6/26/2023**
 - **Feature + Bug Fix:**
 - **Added:**
 - Official support for Apple Silicon (M1s and M2s)
 - **Fixed:**
 - Legacy Object/DREF commands not working
 - Datarefs possibly not being registered early enough
- **Version 1.09.1/2/3**
 - **Removed accidental debug logging**
- **Version 1.09; 6/4/2023**
 - **Feature + Bug Fix**
 - **Added:**
 - Support for Dataref Keyframe Tables
 - Plugin preferences. Now uses real time, sim time can be specified in preferences.
 - **Improved:**
 - Support for symlinks and Windows Shortcuts
 - **Fixed:**
 - Non-ASCII file names caused a crash
 - LOOPS caused memory leak/crash
- **Version 1.08.1; 4/27/2023**
 - **Bug Fix:**
 - **Fixed:**
 - Trains go off route on last WP
- **Version 1.08; 4/26/2023**
 - **Feature + Bug Fix**
 - **Added:**
 - BRANCHIF support, allowing for objects to branch based on a dataref.
 - SPAWNFACTOR support, allowing for highways to have their spawn times multiplied by a dataref.
 - CAP support for Datarefs, Datarefs can be limited.
 - **Improved:**
 - Support for multiple DREFOPs per WP.
 - You no longer need to specify types for DREFOPs, BRANCHIFs, or VALUEs (legacy commands still work).

- All operands in DREFOPs, VALUEs and BRANCHIFs can be explicit values, or Datarefs.
 - Clearer logging.
 - Large rewrite of internals for better maintenance and reliability.
 - Comments, REVERSE, GONDOLASTART/END no longer require a comma following the command
 - **Fixed:**
 - File paths not being found due to improper handling of line endings on Mac and Linux
 - Spawn time randomization severely wrong
- **Version 1.07; 1/26/2023**
 - **Bug Fix**
 - **Fixed:**
 - Train elevation imprecision at low altitudes
 - Plugin using old plugin naming scheme
- **Version 1.06; 12/2/2025**
 - **Bug Fix**
 - **Fixed:**
 - Last route not being added if text after last WP.
 - Fixed last leg of LOOP having slight chance of BRANCHing to the first route
 - Various fixes in LST Converter
 - New Route spacing adjustment tool for LST Generator
- **Version 1.05; 10/25/2022**
 - **Feature + Bug Fix**
 - **Added:**
 - Optional route priming. Developers can set the package to run at 1.5 seconds per frame until it has effectively run x number of seconds in order to “prime” their roads.
 - Timing is now based off sim time. The objects speed up with sim time, and pause works. Note objects are limited to a max speed of 1.5 seconds per frame for internal reasons.
 - **Improved:**
 - Operations can now occur on the last leg
 - Smooth turning of train cars
 - **Fixed:**
 - Actually implemented the better AGL precision that *should* have been in 1.04 😬
- **Version 1.04; 9/24/2022**
 - **Bug Fix**
 - **Added:**
 - Ability to restart plugin after a fatal error without restarting the sim

- Support for zero length legs (used to result in DBZ error). Useful for multiple DREFOPs
 - **Improved:**
 - Support for routes above 3000 meters
 - Improved AGL precision
 - **Fixed:**
 - TRAINs and LOOPs not properly respawning after leaving an area and returning
 - Apparently an X-Plane 11 bug (I'm told 1.03 didn't work and 1.04 does)
- **Version 1.03; 9/11/2022**
 - **Bug Fix**
 - **Fixed:**
 - Incorrect file paths on Mac
 - Never spawning LOOP objects
- **Version 1.02; 9/7/2022**
 - **Bug Fix**
 - **Fixed:**
 - DBZ Error on LOOP commands
- **Version 1.01; 9/6/2022**
 - **Bug Fix**
 - **Fixed:**
 - Wrong plugin description
 - Broken VALUE command
- **Version 1.0; 9/5/2022**
 - **Initial Release**
- **Version 0.94; 8/31/2022**
 - **Release Candidate**
 - **Added:**
 - BRANCH command
 - Non random spawn times (enter -1 in max spawn)
 - Non spawning routes (enter -1 in min spawn)
 - Mac version
 - Updated Linux version
 - Clamped spawn times to integers in LST Converter
 - Increased init ranges in LST Converter and LST Generator
 - **Fixed:**
 - REVERSE command not working
 - Objects having prior leg's parameters for one frame
- **Version 0.93; 8/29/2022**
 - **Close Beta release**
 - **Fixed:**

- Routes using the object from the next route.
 - **Known bugs:**
 - Linux version out of date (and crashed when max and min spawn times are the same)
 - Mac version not compiled
 - No user manual
- **Version 0.92; 8/29/2022**
 - **Close Beta** release
 - **Fixed:**
 - LST Converter adding whitespace to resource in highway
 - **Known bugs:**
 - Linux version out of date (and crashed when max and min spawn times are the same)
 - Mac version not compiled
 - No user manual
- **Version 0.91; 8/28/2022**
 - **Closed Beta** release
 - **Fixed:**
 - Fixed spacing values being in scientific notation on very long decimals in LST Converter
 - Fixed route being lost due to space in object name in LST Converter
 - Fixed gondola altitude jumping below terrain at start of leg on steep slopes
 - Fixed missing package name in logging
 - Fixed missing object name in logging when object could not be found
 - **Added:**
 - Added ability to load local objects not exporter via Library.txt
 - Added manual table of contents
 - **Known bugs:**
 - Linux version out of date (and crashed when max and min spawn times are the same)
 - Mac version not compiled
 - No user manual
- **Version: 0.9; 8/21/2022**
 - Initial **Closed Beta** release
 - **Known bugs:**
 - Linux plugin crashes from DBZ when min spawn time and max spawn time are the same
 - Mac plugin not yet compiled

