USimInstallation

Release 3.0.1

Tech-X Corporation

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INTRODUCTION

Welcome to USim, a general purpose fluid plasma modeling code. USim consists of two major components:

- Ulixes computational engine
- USimComposer graphical user interface

USimComposer provides an interface that allows you to edit and validate your simulation input files, run USim simulations, and visualize results using the VisIt-based Visualization pane embedded within USimComposer. You can also edit USim input files in the text editor of your choice, perform calculations with the easy-to-run, command-line-driven USim executable, and then run the visualization tool of your choice.

USim is supported on:

- 64-bit Linux
- Macintosh OS X (10.7 - 10.10)
- Windows 7, 8, and 10 (64-bit)

A serial version of USim is available for running on single processor workstations. A parallel version of USim is provided for multi-core systems that support the Message Passing Interface (MPI).

More information about USim can be found at the USim Product Website. Send questions about installing or running USim to Tech-X Customer Support at support@txcorp.com. For technical questions about the physics, users may wish to email the USim discussion list (USim-users List). Extensive assistance in the use of USim or simulation in general is available from Tech-X Professional Services. Please contact Tech-X directly for sales, consulting, and other questions at sales@txcorp.com.

INSTALLATION

For all operating systems, installation places

- USim computational engine, ulixesser (serial) and ulixes (parallel)

- USimComposer, the graphical user interface to USim

- USim documentation (.pdf files)

on your computer.

2.1 USim Installation Instructions

2.1.1 Windows USim Software Installation

The USim distribution package for Windows (64-bit) is a self-extracting executable. Invoke the installer by double clicking on it. The default installation path is:

For 64-bit application on 64-bit Windows:

```
C:\Program Files\Tech-X (Win64)\USim-3.0
```

To open the USim software, go to the Start Menu, click on the Tech-X folder, click on USim-3.0, then click on USimComposer. See *Dialogs for Windows installation.*.

2.1.2 Mac OS X USim Software Installation

The USim distribution package for Mac OS X is a .dmg installer. Invoke the installer by double clicking on it. Drag the USim-3.0 folder into your Applications folder (visible in the installer window). From the Application folder, double click on the USimComposer icon in the USim-3.0 folder. See *Dialog for the Mac installer.*. This default installation path is:
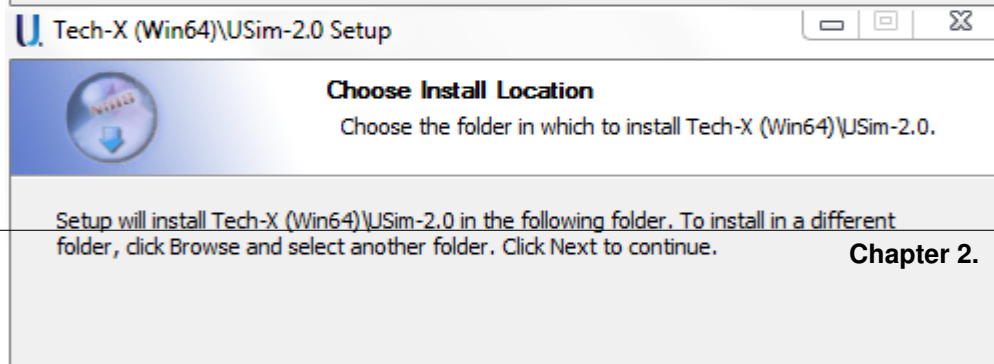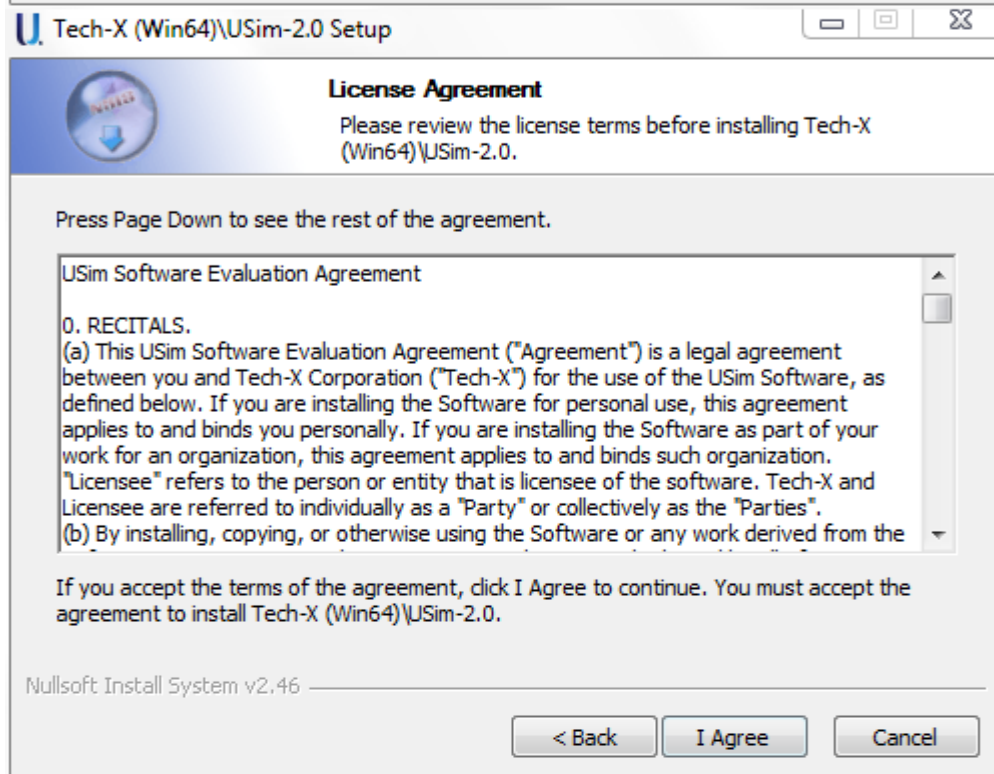
```
/Applications/USim-3.0
```

2.1.3 Linux USim Software Installation

The USim distribution package for Linux is a gzipped tarball. Unpack the gzipped tarball into the directory in which you wish to install USim. A typical location would be

```
/usr/local/USimComposer
```

The unzip and untar command is

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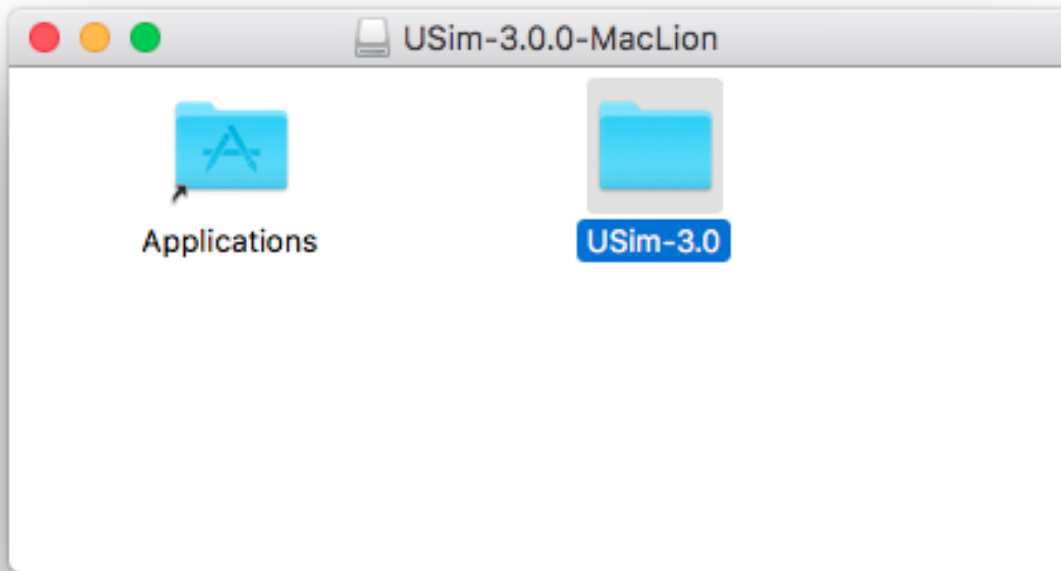
Fig. 2.2: Dialog for the Mac installer.

```
$ tar -zxvf USim-3.0.0-Linux64.tar.gz
```

To run USimComposer, execute the command

```
$ cd USim-3.0.0-Linux64
$ ./USimComposer.sh
```

from within the installation directory.

2.2 Included Software

Upon completing the installation process (described in *USim Installation Instructions*), the following software will be installed on your computer.

2.2.1 USimComposer

USimComposer is a graphical user interface for

- Creating and editing USim input files
- Executing USim
- Analyzing USim generated data
- Visualizing USim generated data
- Viewing the documentation

The USimComposer editor and validator have built-in functions and graphical components that help you to create well-formed input files. Example input files, ranging in complexity from beginning to advanced, are included with USimComposer. New USim users can use these examples as templates. Advanced USim users can use USimComposer to validate the syntax of their own input files, whether their files have been created using USimComposer or by using a text editor.

The USimComposer Run pane invokes USim with user definable settings for number of steps, number of data dumps, and restart file, if any. It also allows selection of serial versus parallel USim.

The visualization in USimComposer is provided by the graphical analysis tool VisIt. VisIt is embedded within USimComposer. Data generated by USim or by analysis programs automatically appears in the Visualization pane.

All documentation can be seen from within USimComposer, fully cross-referenced.

2.2.2 Ulixes

The computational engine, Ulixes, runs both as a serial and parallel code for multi-processor / multi-core systems that support MPI. USim now comes in the specialized USim packages. USim is embedded within USimComposer.

2.2.3 Python

Python is an open-source, interpreted scripting language managed by the Python Software Foundation. For more information about Python, see: http://www.python.org/

USim uses Python to process input files, allowing users to set up simulations with math functions, variable substitutions, and macros.

USim uses its own embedded version of the Python interpreter to pre-process input files and execute any Python code in an input file. Python is embedded within USimComposer.

2.2.4 MPI

The Message Passing Interface (MPI) is an application programming interface (API) for communicating between processes that execute in parallel. There are many implementations. The Linux and Mac versions come with the OpenMPI (http://www.open-mpi.org/) implementation of MPI. The Windows versions come with the Microsoft MPI implementation (http://www.microsoft.com/). The appropriate MPI implemention is embedded within USimComposer.

2.3 USim Documentation

The USim documentation is included with the installation as a PDF, as well as being accessible from within the USimComposer interface, and online at the Tech-X web site (https://www.txcorp.com/).

2.3.1 USim Quick Start

USim-quick-start provides numerous tutorials for both beginning and advanced USim users.

2.3.2 USim In Depth

USim-in-depth contains comprehensive USim documentation, including directions for running Ulixes from the command line. When you are ready to create your own simulation, consult this document for in-depth information about USim features.

2.3.3 USim Reference

USim-reference is a quick-reference manual for USim users to look up specific Ulixes features and code block syntax for use in editing a USim input file.

2.3.4 USim Installation

USim Installation Instructions guides the user through the installation process for USim. Release notes are also provided in this document.

LICENSE INSTALLATION

3.1 Windows or Linux

To install the license file, follow the following steps

1. Save the file *license.txt* supplied by Tech-X Corp. personnel to your computer. Be sure not to edit this file in *any* way.

2. Open USimComposer

3. Go to 'Tools'>>'Settings'

4. In the Settings menu, go to 'License Settings'

5. Click 'Add'

6. Navigate the file browser to the license and select it

7. Click 'OK'

8. Click on the license in the 'Installed Licenses' list.

9. Click 'Activate'.

3.2 On Mac OS X

To install the license file, follow the following steps

1. Save the file *license.txt* supplied by Tech-X Corp. personnel to your computer. Be sure not to edit this file in *any* way.

2. Save it to your computer

3. Open USimComposer

4. Go to the 'Preferences' menu. Two ways: a. Press Command + , b. Or go to USimComposer Main Menu and select 'Preferences'

5. In 'Preferences,' go to 'License Settings'

6. Click 'Add'

7. Navigate the file browser to the license and select it

8. Click 'OK'

9. Click on the license in the 'Installed Licenses' list.

10. Click 'Activate'.

RELEASE NOTES

The release notes describe new features for the USim computational engine and the USimComposer graphical user interface. Deprecated features and bug fixes are also noted within the release notes.

4.1 New and Updated Features in 3.0

1. Third order finite volume discretizations for hyperbolic PDE's
2. High performance preconditioners for multiphysics systems
3. Improved MHD, two-temperature MHD, extended MHD and two-fluid models
4. Improved advanced EoS for MHD
5. Simplified input files for basic simulations (hydrodynamics, MHD)

4.2 New and Updated Features in 2.2

1. Preconditioners for diffusion-type problems.
2. Reduced memory footprint for finite volume operators
3. Many bug-fixes throughout the simulation engine, documentation and user-interface.
4. Improved user interface including better run output, vector plots, and better controls for license
5. Bug fixes and improved documentation with 2.2.2

4.3 New and Updated Features in 2.0

1. Turbulence Model (k-epsilon)
2. Addition of an Exodus II grid reader
3. Support for 3D unstructured grids
4. New examples including radio communication blackout, ablation, interspecies collisions, 10 moment model and time dependent boundary conditions
5. Isotropic and anisotropic Poisson solver (linear and non-linear).
6. Added anisotropic diffusion, species collisions, ablation, user defined chemistry tables
7. Improved MHD divergence cleaning algorithms

8. Accelerators for time integration

9. Improved user interface including better run output, vector plots, and better controls for license

4.3.1 USim Computational Engine

The USim 2.0 computational engine consists of the USim packages providing users with affordable simulation solutions targeted at their application area. Detailed information is provided in the figure *Features in USim Engine 2.0*.

- **USimBase (Base USim Simulation package):**

  - USimBase is a flexible, multiplatform, fluid dynamics simulation tool for running problems on regular, body-fitted and unstructured meshes.

- **USimHS (USim simulation package for reacting high speed flow)**

  - USimHS is a modeling tool for hypersonic aeronautics problems.

- **USimHEDP (USim simulation package for High Energy Density Plasmas)**

  - USimHEDP is a full suite of plasma modeling tools for problems such as magnetic reconnection and laser-plasma interactions.

There are a few problems that require elements from both USimHS and USimHEDP. A specific example is radio communication blackout with full EM wave propagation in a multi-fluid plasma.

4.3.2 USimComposer GUI Features

The USimComposer graphical user interface (GUI) allows the user to edit and validate simulation input files, run simulations in either serial or parallel (thereby utilizing multiple cores or even computational nodes that do not share memory), and visualize results. Detailed information is provided in the figure *Features in USimComposer 2.0*.

Features of USim Engine 2.0

Package	USimBase	USimHS	USimHEDP	New in 2.0
General				
Works in all dimensionalities	√	√	√	
Distributed memory parallelism	√	√	√	
Periodic boundaries	√	√	√	
Open source data format with visualization annotations	√	√	√	
Structured Meshes	√	√	√	
Adapatable Meshes	√	√	√	
3D Unstructured Meshes	√	√	√	
Cylindrical coordinates	√	√	√	
Spherical coordinates	√	√	√	
Reads Exodus II mesh format	√	√	√	√
Accelerators for time integration		√	√	√
New Examples	√	√	√	√
Fluid Flow				
Single temperature compressible flow	√	√	√	
Multi temperature compressible flow		√		
Navier-Stokes Equations		√		
Reaction Chemistry		√		
Accelerators for time integration		√		
Multiple Species		√		
User defined chemistry tables		√		√
Turbulence Model (k-epsilon)		√		√
Ablation		√		√
Magnetized Flow				
Ideal Magnetohydrodynamics	√	√	√	
Gas Dynamic Magnetohydrodynamics			√	
Separate densities for ions and electrons			√	
Separate velocities for ions and electrons			√	
Separate temperatures for ions and electrons			√	
Anisotropic temperatures for ions and electrons			√	
Full Maxwell's Equations			√	
Anisotropic diffusion			√	√
Species collisions			√	√
Improved MHD divergence cleaning algorithms			√	√
Isotropic and anisotropic Poisson solver (linear and non-linear)			√	√
Equation of State				
Ideal Gas Equation of State	√	√	√	
Real Gas Equation of State		√		
General Equation of State		√	√	

Fig. 4.1: Features in USim Engine 2.0

Features of USimComposer 2.0

Package	USimBase	USimHS	USimHEDP	New in 2.0
Whole GUI				
Improved interface for managing licenses	√	√	√	√
Dialog for saving images	√	√	√	
Help				
Access to full hierarchical documentation	√	√	√	
Setup stage				
Opening existing runs	√	√	√	
Creating runs from examples	√	√	√	
Key parameters easily adjustable in examples	√	√	√	
Simplified editor for input files	√	√	√	
Full editor for input file	√	√	√	
Search capability in input files	√	√	√	
Validate capability of input files	√	√	√	
Run stage				
Editing of run parameters	√	√	√	
Control to run in serial or parallel modes	√	√	√	
File browser	√	√	√	
Log views	√	√	√	
Improved view of standard output	√	√	√	√
Visualize stage				
Data view driven by the type and dimensionality of data	√	√	√	
Field analysis view: 2D slices and 1D linouts	√	√	√	
Control over labels, colors, rendering	√	√	√	
Time slider	√	√	√	
Saving image	√	√	√	
Visualizing while run is being performed	√	√	√	
Vector Plots	√	√	√	√

Fig. 4.2: Features in USimComposer 2.0