Windows 7 and PYGI Development for 4.0.3

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Introduction: Windows Adaptation of 4.0.3

- Operating System Situation
- Visual Studio
- Compilation
- Execution

Windows Operating System Progression

- Windows XP support ends @ INL in Dec 2012
- Windows VISTA is unpopular
- Windows 7 is fully supported at INL and elsewhere
- Possible methods of building RELAP5-3D on Win 7
  1. Adapt old RELAP5-3D Windows XP Makefiles
  2. Apply Visual Studio (MS Makefile w/ GUI)
  3. Use RELAP5-3D Linux install scripts on CYGWIN

Selection of Installation Method

- Use Makefiles and the nmake utility for pre Windows 7 installation
  - Makefile issues
    - INL IT has no support for nmake
    - Constant issue updating non-Linux Makefiles and auxiliaries

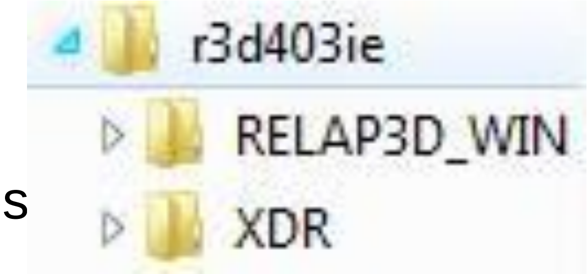
- CYGWIN, a Linux environment for Windows platforms
  - Will allow use of Linux Makefiles, no update issue
  - executables run ***<u>only</u>*** within CYGWIN environment
    - unacceptable for most Windows RELAP5-3D users
    - XDR/PIB file header problems

- Visual Studio is the native Windows development environment
  - There is some support for it at INL
  - There is some support for using it with C++/Fortran

Visual Studio (VS) Solution

- A VS solution is a collection projects and configuration options
  - Projects contain links to source files and configuration options
  - Configuration options include build order, include paths, etc…
  - Projects either build libraries (like the environmental library) or executables (such as the fluid property generators or relap5.exe)

- Generic build template
  - Version folder, e.g. r3d403ie
  - XDR = eXtended Data Representation libraries
  - RELAP3D_WIN = VS solution for RELAP5



r3d403ie
RELAP3D_WIN
XDR

- RELAP3D_WIN solution currently has up to 31 projects
  - relapfiles: All folders & source code files for the RELAP product
  - Project folders: one folder for each project of RELAP3D_WIN

Visual Studio Projects

Libraries & Programs	Description
Modules	Created from files in envrl and relap5 folders
envrl (Environmental)	Creates envrl.lib from files in envrl and modules
Relap5	Creates relap5.exe from files in relap5, modules, and envrl.lib
sta2b	Creates sta2b.exe. It takes an ASCII input file and outputs an XDR format tpf-file and an ASCII .pr file
stgXYZ	Creates stgXYZ.exe from stgXYZ project for fluid XYZ. Used to create the fluid property table tpfXYZ.

Visual Studio Fluids Projects

- The following fluids project names correspond to a folder in relapfiles
- These produce a .exe executable file named after the project
- Issue with XDR tpf – Linux versions work

Project Name	Location in relapfiles directory
stgli	Lithium
stglipb	LiPb
stgms1	Stgms1
stgms2	Stgms2
stgms3	Stgms3
stgms4	Stgms4
stgn2	Nitrogen
stgna	Sodium
stgnak	NaK

Project Name	Location in relapfiles directory
stgbipb	BiPb
stgblood	Blood
stgd20	D2O
stgdowa	DowThermA
stgglyc	Glycerol
stgh2	Hydrogen
stgh2o	H2O
stghe	Helium
stgk	Potassium

Build Order

- Build order is one of the configuration properties
- Projects that depend on modules or libraries must be built after
- Build order
  - XDR
  - cPibAccess
  - Modules
  - Pib
  - Envrl
  - All fluid projects
  - Relap5
- Executable product installation includes licensing in the build order

Configuration for C-Language coding

- C Libraries
  - The cPibAccess, license, and XDR projects are static C libraries.
  - The libraries use Multi-threaded (/MT) Runtime Libraries and do not use Precompiled Headers.
  - All other options are default selections for a static C library project.
- C Executable programs (E.g. licensing)
  - The executable programs are built using the C static libraries.
  - The executables use Multi-threaded (/MT) Runtime Libraries and do not use Precompiled Headers.
  - All other options are default selections for a C application (.exe) project.

Configuration for Fortran coding

- FORTRAN Libraries: Modules, envrl.lib, relap.lib, and pib.lib
  - All four are static libraries
- FORTRAN Executable programs (E.g. fluids, relap5.exe)
- All of the FORTRAN programs use the following compiler options:
  - Preprocess Source File is turned on and the preprocessor definitions are located in a file called define.inc RELAP3D_WIN directory.
  - The define.inc file is included in the Additional Options: @..\define.inc.
  - Data values are set to Default Integer KIND = 4, Default Real KIND = 8 (/real_size:64), and Default Double Precision KIND = 8.
  - Run-time Check Array and String bounds are set to Yes (/check:bounds)

Building a RELAP5-3D Executable from Source

- Need the following:
  - VS 2010 or newer
    - *Note:* VS projects are not backwards compatible
  - INTEL Parallel Studio XE 2011
    - Or compatible FORTRAN and C++ compiler
  - A copy of the RELAP5-3D source code
  - A copy of the RELAP3D_WIN solution
  - A copy of the windows XDR libraries

Status

- Windows 7 installation complete for version 4.0.3 using
  - Visual Studio 9.0 (VS 2010)
  - Intel Fortran/C++ 12.0
- A generic build solution is available for those with source code
- The standard installation problems run with no errors

PYGMALION A RELAP5-3D User Aid Program

- PYGI (Pygmalion) purpose
- PYGI Upgrade Goals
- Current Status

PYGMALION Purpose

- Primary purpose is to move information from a steady-state restart-plot file into a new input file
  - Control Volume data moved: pressure, liquid specific internal energy, vapor specific internal energy, and void fraction for each control volume
  - Junction data moved: PYGI writes liquid and vapor velocities as the initial condition
  - Component data moved: Pump, compressor and turbine info
  - Control variables data moved: control variable calculated value
- PYGI is not restricted to steady-state data
  - Used to create a new starting deck, partway through a transient, for a parameter study

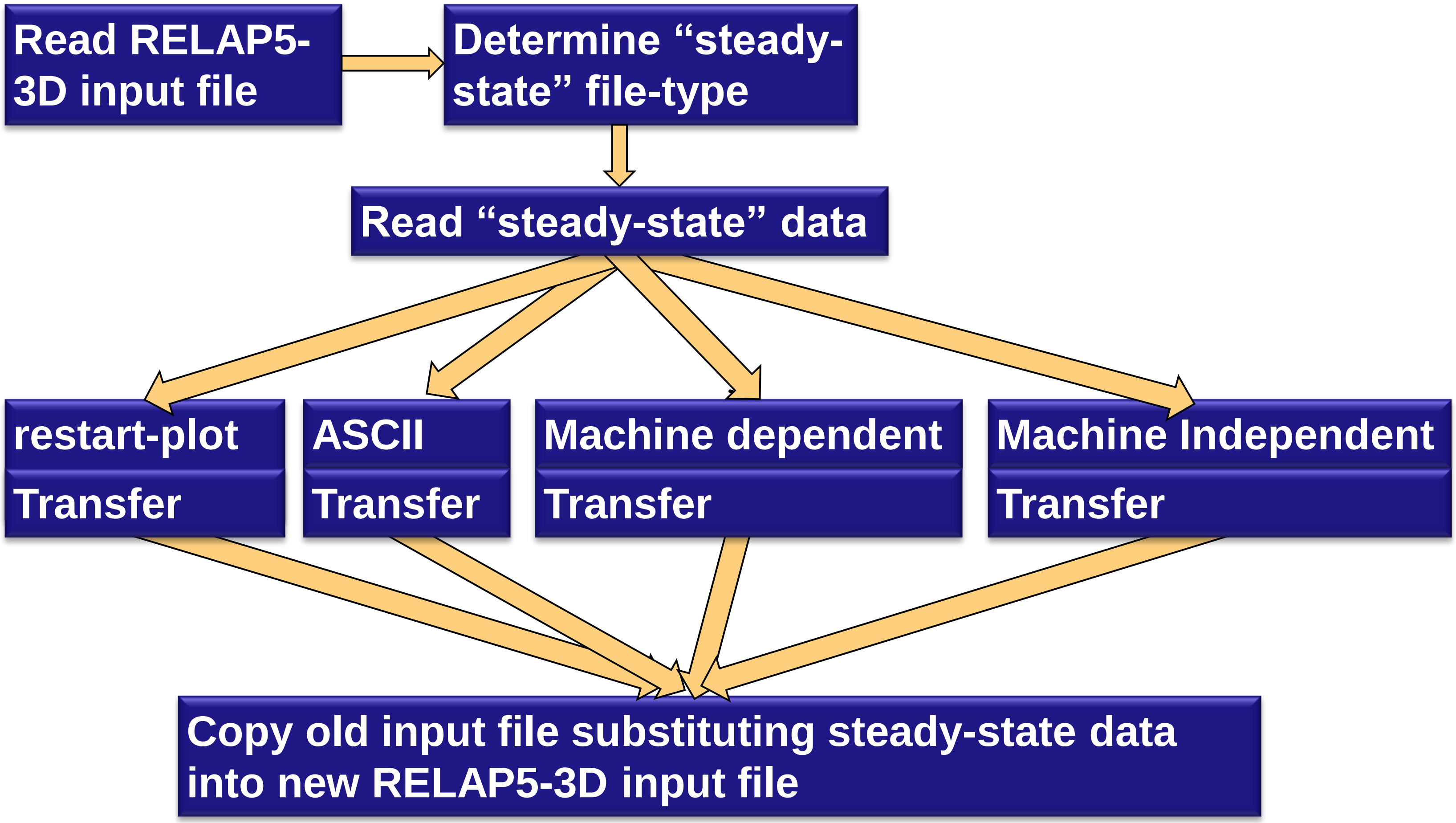
Necessity for Upgrade and Goals

- PYGI was designed to work with a combined restart-plot file
  - Works for versions up to RELAP5-3D/2.4
- Must be backward compatible to versions 2.4 and lower
  - Must still read old-style restart-plot file`
- PYGI does NOT work with RELAP5-3D products from 3.0 up
  - Conversion for Fortran 95 split restart-plot file into two separate files: restart file and plot file
  - The data PYGI needs resides in the plot file
- For RELAP5-3D/3.0+, PYGI must read the plot file
  - The plot file has 3 different formats:
    - ASCII
    - Machine-dependent Binary
    - Machine Independent Binary (XDR)

Under the Hood

- Read method for RELAP5-3D input file remains same
- Four read methods for “steady-state” plot data
  - Original combined <u>restart-plot</u> file (BACKWARD COMPATIBLE)
  - ASCII <u>plot</u> file
  - Machine-dependent plot file
  - Machine Independent plot file
    - Machine Independent plot files, PYGI uses the PIB modules from RELAP5-3D distribution
    - PIB library is RELAP5-3D specific interface to industry standard machine independent XDR library
- Steady-state data from each read method is transferred into a single common set of arrays
  - This unifies the real and integer “kind parameter”
  - The output file is written from these arrays

PYGMALION Flowchart



Read RELAP5-3D input file

Determine “steady-state” file-type

Read “steady-state” data

restart-plot Transfer

ASCII Transfer

Machine dependent Transfer

Machine Independent Transfer

Copy old input file substituting steady-state data into new RELAP5-3D input file

Invoke PYGI from the Command Line Prompt

- Example PYGMALION command line (for RELAP5-3D version 2.4).

```
prompt:> PYGI  -r restartPlot.plt  -t time < origInput.i > newInput.i
```

Command line options		
Flag	**Input Values**	**Description**
<	origInput.i	original input file used to create “steady-state”
>	newInput.i	new input file with “steady-state” data
-r	file	“steady-stated” (restart-)plot file
-t	val	floating point time of data for creating new input file
-e	frac	fraction of maximum normalized truncation error
-F	fmt = a, m, or b	a for ASCII m for machine dependent b for machine independent (XDR)

PYGI Command Line Prompt (continued)

- Example PYGMALION command line (for RELAP5-3D version 4.0)

```
prompt:> PYGI -r restartPlot.r  -t time  -B  -C  -F a < origInput.i > newInput.i
```

More command line options

Flag	Description
-B	Forces PYGI to examine records that begin with a blank
-C	Prevents control variable initial conditions from changing
-m	PYGI usage

Obsolete options

Flag	Description
-I	Indicates the original input deck is from RELAP5/MOD1
-O	Output (new input file) formatted for RELAP5/MOD1

PYGMALION Output

```
prompt:> PYGI -r cstest1.plt -t 1.0 -F m < cstest1.i > cstest1m.i
             scanning old deck
             attempting to find i c data for:
               26 control volumes
               30 junctions
                1 pumps
                0 compressors
                0 turbines
                0 motor valves
               13 control variables

             the rstplt file provides data for:
               30 control volumes
               31 junctions
                1 pumps
                0 compressors
                0 turbines
                2 valves
               16 control variables
                1395 time                1

             processing data from plot record
               at   1.00     seconds

             80 card replacements attempted

             80 card replacements completed

             0 $pygmsg messages written into newdk
            Thank You!
```

Testing and Comparison

- Pygmalion input files must pass RELAP5-3D Input Processing inspection and run
- Successfully tested with several sample input problems including:
  - Edward's Pipe
  - Typical PWR
  - cstest1
- Effect of plot-file format
  - Some values are rounded in ASCII format and truncated in machine Independent XDR format
  - Resulting new input files differ in some of the last significant digits
    - This is to be expected
  - Neither format is clearly better

Conclusions

- RELAP5-3D/4.0.3 builds and runs on Windows 7 Environments
- The build procedure employs MS Visual Studio and Intel Fortran 12
- Issue with XDR formatted tpf fluid files

- PYGMALION has been upgraded to handle:
  - Original combined restart-plot file (BACKWARD COMPATIBLE)
  - ASCII plot file
  - Machine-dependent plot file
  - Machine Independent plot file
- It successfully builds correct RELAP5-3D input files
- The format of the plot file affects the last significant digit of the data placed into the new input file
- It runs on Linux Operating Systems