Symbolic Nuclear Analysis Package (SNAP)

Glenn Roth
KAPL, Inc.
Outline

- Brief Overview of System Architecture
- Extensibility
- GUI Features
- SNAP Demo
SNAP System Architecture

Clients

GUI Client Application

- CAFEAN Plugin API
  - CRUD/PostCRUD
  - TRACE
  - MELCOR
  - RELAP5
  - Animation

  - Pipe Component Beans
  - MELCOR DCH Component Beans
  - Pipe Strip Chart Dial
  - Display Beans

CORBA (JacORB)

- Configuration Tool

Servers

Calculation Server

- CAFEAN Plugin API
  - PARCS
  - TRACE
  - RELAP5
  - MELCOR
  - EXTDATA

  - PARCS
  - TRACE
  - RELAP5
  - MELCOR
  - DATA

Analysis Codes

NRC Databank Server

- NRCDB

- Job Status
  - jEdit Plug-in
  - Batch Submit
  - AptPlot (Plotting)

Experimental Data

Runtime & Replay Data
Design Features

• Platform Independent
  – Java 1.5 or newer
  – Supported on: Windows, MAC OS X, Linux, Solaris, HP-UX, etc...

• Common Environment for Performing Engineering Analysis
  – An Interface for constructing and editing input models
  – A Tool for visualization of code outputs and data
  – Runtime Job Control
  – Job organization features; keeps track of your input and output files
  – Easy access to analytical code documentation

• Highly Extensible and Flexible
  – Framework provides a support for many different types of analytical codes
  – Plug-in based architecture allows for extensibility to new/other analytic codes
  – No Modification of the Base Code Required
  – Python Scripting:
    • User Defined Functions – Calculate Model Input
    • Python Data Channels – Post-Processing Calculations, Animations
Plug-ins

- A SNAP “code” plug-in is a program unit that encapsulates all user interface, input, output, and run-time features for a particular analytic code.

- SNAP Code Plug-ins (Partial List)
  - TRACE
  - RELAP5 (MOD 3.3 & RELAP5-3D©)
  - CONTAIN
  - MELCOR 1.8.6
  - PARCS
  - COBRA

- A SNAP plug-in can also implement a “feature” or extended capability that may or may-not be related to a specific analytic code.
  - Animation Model Plug-in
  - RELAP5 to TRACE Model Conversion Plug-in
  - Model Documentation Plug-in

- Plug-in API for Adding New Analysis Codes & New Features
  - available at: http://www.nrcsnap.com/snap
Component Data Model

- All Component Data is Declared Private
- Views Implement a ComponentListener Interface
- Changes to Component Data are Automatically Reflected in all Views.

### Data Model

**Pipe 101 Data**

### Drawn Components
Multiple-Window Mode

- **Message Window**
- **Component Navigator**
- **Property View**
- **2D Views**
- **ASCII Views**
Single-Window Mode
Component Navigator

- Logical Representation of Model
- All Model Data / Views
- Create, Edit, Delete Components
- Create 2D&3D Views

Main Categories
- Components
- Connections: Hydraulic, Heat Structures, etc.

Sub-Categories
- Plug-in Nodes
- Model Node

User Defined Constants & Equations

Views

Model Node

Component Navigator

Model Data / Views
Create, Edit, Delete Components
Create 2D&3D Views

Connections:
- Hydraulic
- Heat Structures, etc.
Properties View

The Main Property View
- Reflects the Current Selection
- Supports Multi-Selection-Edit
Custom Editors

- Used to provide intuitive interface for editing complex data
- Table data can be copied to/from spreadsheet apps
2D Model Views

- Create/Edit/Delete Components and Connections.
- Any component can be displayed in multiple views.
- Embed a View into another View to Link Views.
- Export to Raster or Vector Image Formats.
- Add Text, Line, Shape and Image Annotations.
- Model Views Can be Copied into Animation Views
- Layouts can be saved as Templates
3D Visualization

- Supported by RELAP5 & TRACE Plugins
- Generate 3D Coordinates
- Rotate Pan & Zoom View
- Pivot & Shift used to Move Components about Vertical Axis
- Export Display for 3D Animation
### ASCII Views

- Component “Show ASCII” Menu Item
- Automatically Updates When Component Data Changes
- Syntax Highlighting

```
<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>name</td>
<td>type</td>
</tr>
<tr>
<td>1130000</td>
<td>&quot;ipump&quot;</td>
</tr>
<tr>
<td>area</td>
<td>length</td>
</tr>
<tr>
<td>1130101</td>
<td>15.723</td>
</tr>
<tr>
<td>az-angle</td>
<td>inc-angle</td>
</tr>
<tr>
<td>1130103</td>
<td>0.0</td>
</tr>
<tr>
<td>flags</td>
<td>0</td>
</tr>
<tr>
<td>ebt</td>
<td>press</td>
</tr>
<tr>
<td>1130200</td>
<td>003</td>
</tr>
<tr>
<td>to</td>
<td>area</td>
</tr>
<tr>
<td>1130108</td>
<td>112050002</td>
</tr>
<tr>
<td>flow</td>
<td>nfl</td>
</tr>
<tr>
<td>1130201</td>
<td>1</td>
</tr>
<tr>
<td>to</td>
<td>area</td>
</tr>
<tr>
<td>1130109</td>
<td>114010001</td>
</tr>
<tr>
<td>flow</td>
<td>nfl</td>
</tr>
<tr>
<td>1130202</td>
<td>1</td>
</tr>
<tr>
<td>phase</td>
<td>twophase</td>
</tr>
<tr>
<td>1130301</td>
<td>-2</td>
</tr>
<tr>
<td>pvel</td>
<td>pratil</td>
</tr>
<tr>
<td>1130302</td>
<td>1189.0</td>
</tr>
<tr>
<td>rtq</td>
<td>imoment</td>
</tr>
<tr>
<td>1130303</td>
<td>9.48e4</td>
</tr>
</tbody>
</table>
```

Close  Refresh
**User Defined Functions**

- **Constants/Variables:**
  - Can be used to define values in editing dialogs
  - Include Engineering Units
  - Can be displayed and edited in 2D Views
  - Parametric Constants generate a set of Calculations

- **Functions:**
  - Python Interpreter
  - Calculate Variables based on Constants and Variables

---

**Source Editor - Function: Fuel Element Calculations**

```python
# Define some constants
PI = 3.1415926
r = GetConstant("CHAN_CORNER_RADIUS")
w = GetConstant("CHAN_INSIDE_WIDTH")

# Calculate the Channel Inside Perimeter
p = 4 * (w - 2*r) + (2*PI*r)
# Set the Result
SetVariable("CHAN_INSIDE_PERIM", p)

# Now calculate the flow area
chanarea = w*w - (r*r - (2 * PI * r*r))
rodsPerRow = GetConstant("RODS_PER_ROW")
umFuelRods = rodsPerRow*rodsPerRow*GetConstant("FUEL_ROW_LENGTH")

fuelRodArea = PI*GetConstant("CLAD_OUTSIDE_RADIUS")
waterRodArea = PI*GetConstant("CLAD_OUTSIDE_RADIUS")

# chanFlowArea = chanarea - numFuelRods
# Set the Result
SetVariable("CHAN_FLOW_AREA", chanFlowArea)
```

**Calculated Variables**

- `CHAN_INSIDE_PERIM: 0.490505 m`
- `CHAN_FLOW_AREA: 4.985552E-3 m^2`

---

**Water Rod Detail**

- `R_{inner}`: 7.71440E-3 m
- `R_{outer}`: 7.74492E-3 m

---

**Water Rod Perimeter**

- `RODS_PER_ROW: 8.000000`
- `PELLET_RADIUS: 7.620000E-3 m`
- `CLAD_INSIDE_RADIUS: 7.650000E-3 m`
- `CLAD_OUTSIDE_RADIUS: 7.802000E-3 m`

---

**Sheet 8x8 Fuel Element Calculations**

- `CHAN_INSIDE_WIDTH: 0.128016 m`
- `CHAN_CORNER_RADIUS: 0.012558 m`
Runtime & Post-processing

- Support for Interactive and Batch Modes as well as Importing Completed Runs
- Provides Access to Plot Data for Client Applications (Animation & Plotting)

Job Status Tool:
- View Status of All Runs
- Interactive Commands
- View ASCII Output
- Delete Runs
Animation Models

- Can be Created Directly from Model Views
- Multiple Simultaneous Data Sources
  - Analysis Code Calculations
  - Experimental Data
  - Python Calculations
- 2D & 3D Animation
- Dynamic T/H Property Range Selection
- Interactive Capability
- JavaBean Display Elements
  - Easy to Add New User Defined Beans
Recent UI Improvements

• Improved Table Editors
  – More Intuitive Multi-Cell Editing
  – Copy/Paste between Editors and Spreadsheets
  – Plot Selected Data Directly to AptPlot

• New Modes for Drawn Connections
  – Single Line - A single segmented line to represent a connection between two components.
  – Source Marker - A "marker" connected to the source component that displays a short description of the target side.
  – Target Marker - A "marker" connected to the target component that displays a short description of the source side.
  – Source & Target - Both source and target markers.

• Component Grouping added to 2D Views.
• Horizontally and vertically constrained dragging in 2D Views
• "Open Recent" file menu was updated to include sub-menus for each of the available plug-ins.
• "View Files" button was added to the Run Console to allow the Output Viewer to be launched directly from the console.
Model Documents (MDOCS) Feature Plug-in

- Add a note to one or more components.
- HTML formatting can include hyperlinks to external documents.
- Flexible note types: TODO, Comment, User-specified.
- Sort by type or component.
- Works for all new and existing plug-ins automatically Saved with the model.
- Notes can be added programmatically by other plug-ins.
AptPlot Plotting Package

- Pure-Java replacement for Xmgr5 & AcGrace
- Extensive batch capability.
- Produces publication quality output (postscript, PDF, SVG, etc…)
- Java based plot files demultiplexers for RELAP5, TRACE, MELCOR, etc...
- AptPlot can be integrated with SNAP
Test Suite Analyzer (TSA)

- Collect and Analyze Model Metrics
- Identify Holes in the Test Suite
- Generate summary and detailed reports.
- Embedded SQL Database (DERBY)
- Custom and free-form queries may be used to explore the data.
Contacts

Websites:

- http://www.nrcsnap.com (SNAP)
- http://www.aptplot.org (AptPlot)

USNRC Project Manager:
Chester Gingrich
Safety Margins and Systems Analysis Branch
Division of Systems Analysis and Regulatory Effectiveness
Office of Nuclear Regulatory Research
email: cgg@nrc.gov
voice: (301)415-6780

APT Project Manager:
Ken Jones
Applied Programming Technology, Inc.
240 Market St., Suite 208
Bloomsburg, PA 17815
email: krjones@appliedprog.com
voice: (570)204-4052