Getting Started with SansGUI®

A Quick SansGUI Tutorial for Simulation Users and Developers

What is SansGUI ...

- **An Interactive Environment**
  - **for building models, entering parameters, running simulations, monitoring progress, and viewing results**
- **A Software Framework**
  - **for developing and deploying simulation programs *without* tedious *G*raphical *U*ser *I*nterface programming**

Who are the users ...

Anyone who is involved in developing and using computer simulation in scientific and engineering fields.

- **Simulation Users**
  - **Use SansGUI Run-Time Environment**
- **Simulation Developers**
  - **Use SansGUI Development Environment**

Simulation Users

Those who use building blocks to configure experimental models, perform simulation runs, study the effects from different sets of inputs in order to fine tune their designs.

- **Research Assistants**
- **Project Engineers**
- **Design Engineers**
- **Data Analysts**

Simulation Developers

Those who study the underlying logic and mathematics of target systems to define model building blocks and implement computer algorithms for simulation.

- **Research Scientists**
- **Research Engineers**
- **Software Developers**

SansGUI Architecture

- **SansGUI Development Environment**
  - **Define model building blocks in classes**
  - **Specify attributes involved in simulation model**
  - **Implement simulator logic and mathematics**
- **SansGUI Run-Time Environment**
  - **Configure model and prepare input data**
  - **Run simulation and monitor progress**
  - **Analyze simulation results to refine design**

Run-Time Features

- Interactive Model Building Tools
- Data Entry Assistance and Validation
- User Extensible Unit Conversion
- Model Data Version Synchronization
- Interactive Simulation Control
- Dynamic Charting & 3D Animation
- User Plug-In Routine Support

Development Features

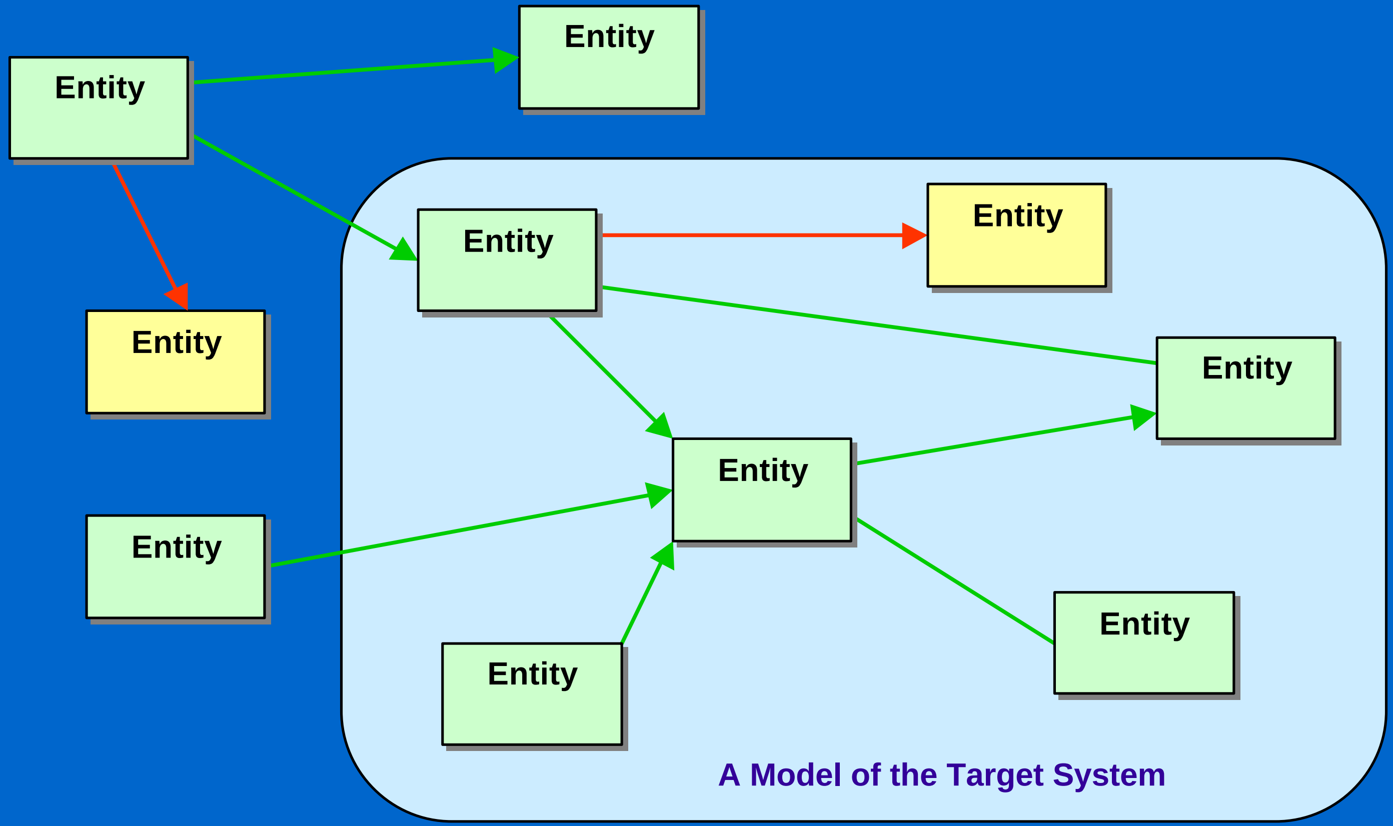
- Interactive Simulator Development
- Class Schema Definition & Update
- Programmable Data Validation
- Unit Object Creation & Maintenance
- SansGUI Source Code Framework
- Interactive Tracing and Debugging
- OpenGL® 3D Graphics Programming

Using SansGUI®

Modeling and Simulation

- **Working with SansGUI**
  - **System Abstraction - Entity / Relation**
  - **Model Configuration**
  - **Data Entry / GUI Control Types**
  - **User Extensible Unit Conversion**
  - **Simulation Run Controls**
  - **Simulation Result Logging and Plotting**
  - **Animated 3D Graphics Controls**

System Abstraction – E/R



denotes physical links with directionality; non-directional links are without arrows

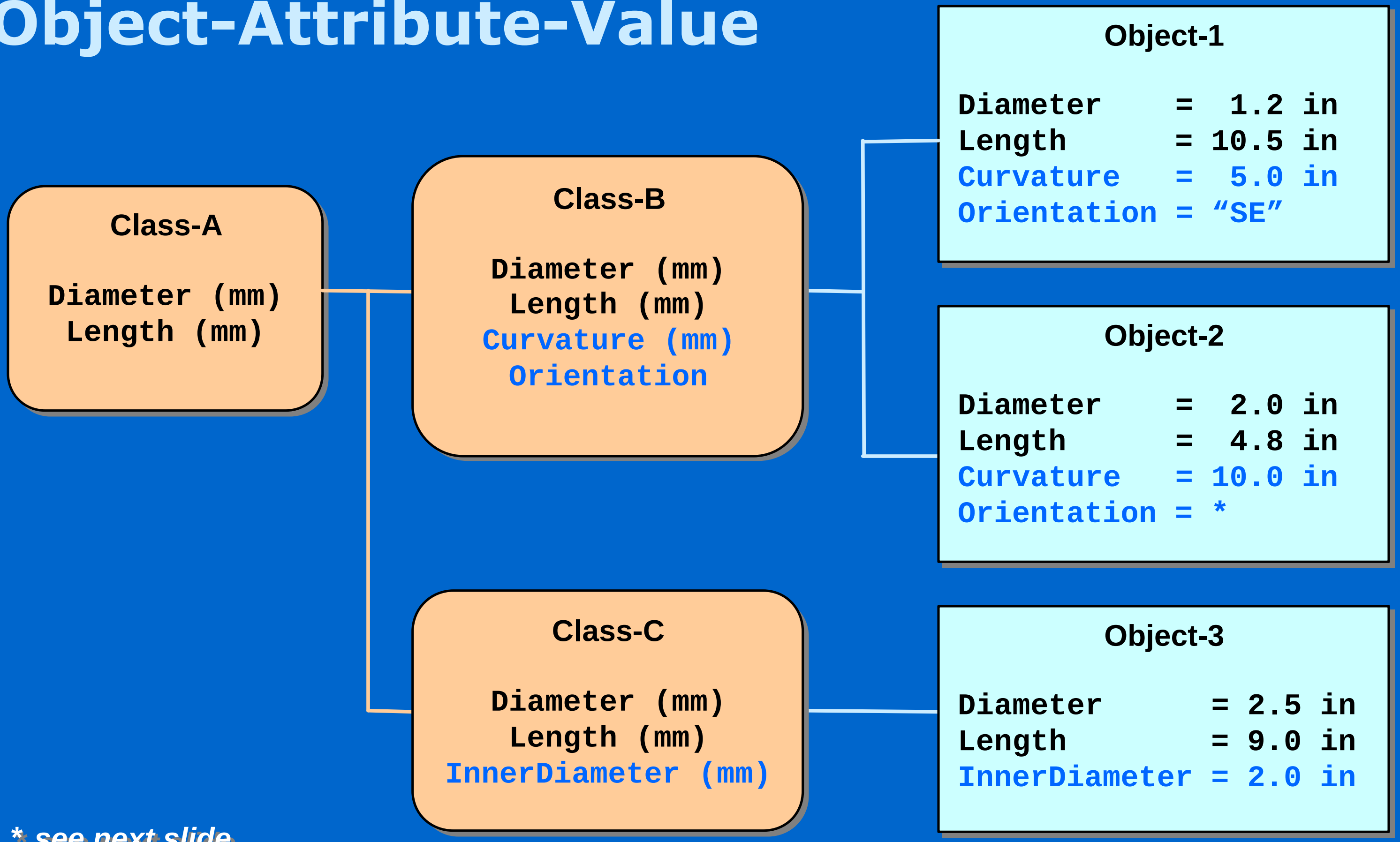
denotes referential links

Components and References

- **Component Objects**
  - Physical objects used to create parts
  - Links are special components that connect parts to form network models
- **Reference Objects**
  - Informational objects referred to by other objects, parts or links
  - Collection, Graphics, Matrix, Table, and more

Class Hierarchy

- **Object-Attribute-Value**



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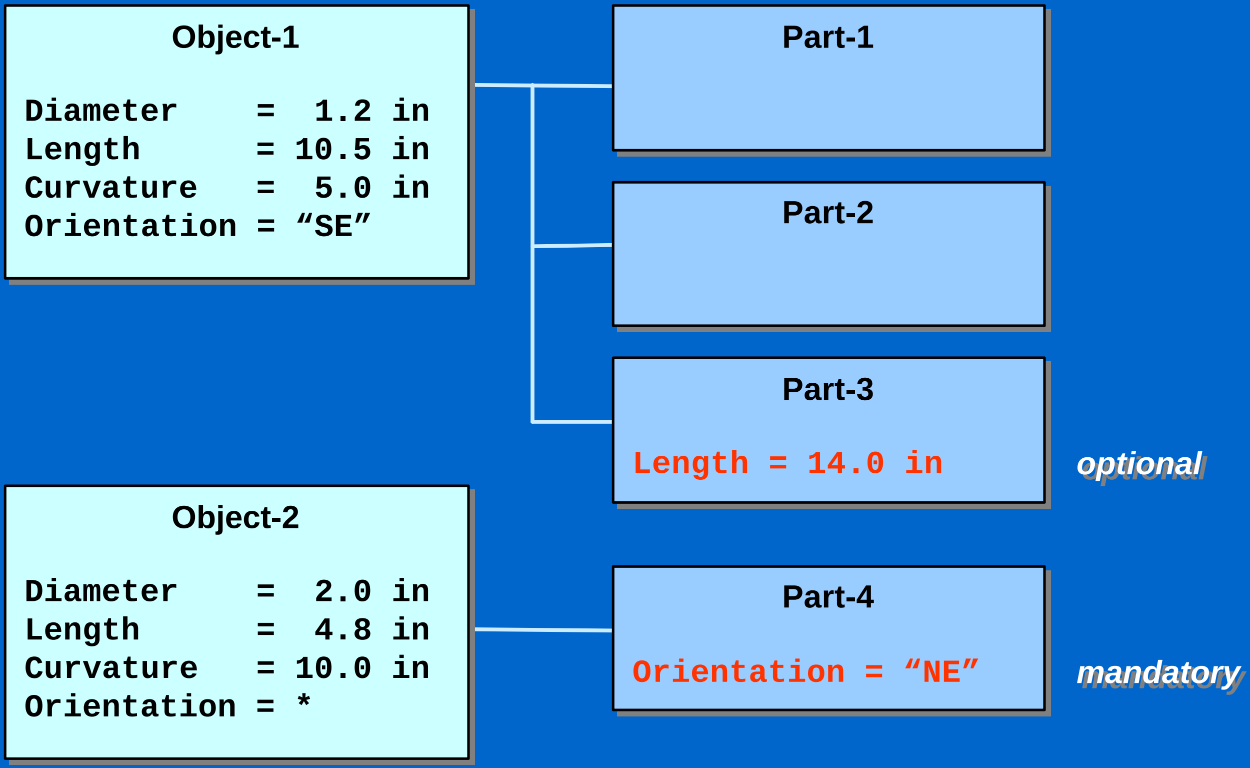
System Parts List

Overriding Values



```
Object-1

Diameter    =  1.2 in
Length      = 10.5 in
Curvature   =  5.0 in
Orientation = “SE”
```

```
Part-3

Length = 14.0 in
```

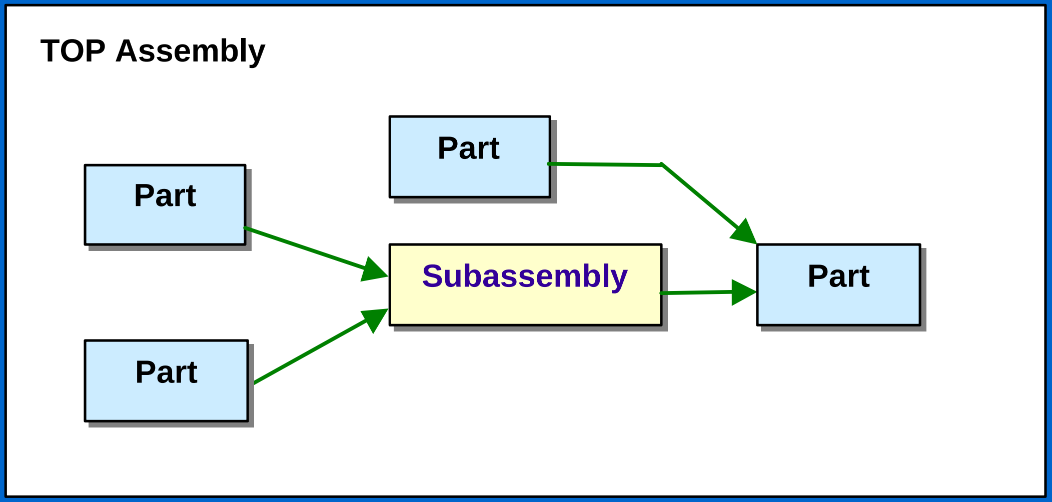
```
Object-2

Diameter    =  2.0 in
Length      =  4.8 in
Curvature   = 10.0 in
Orientation = *
```

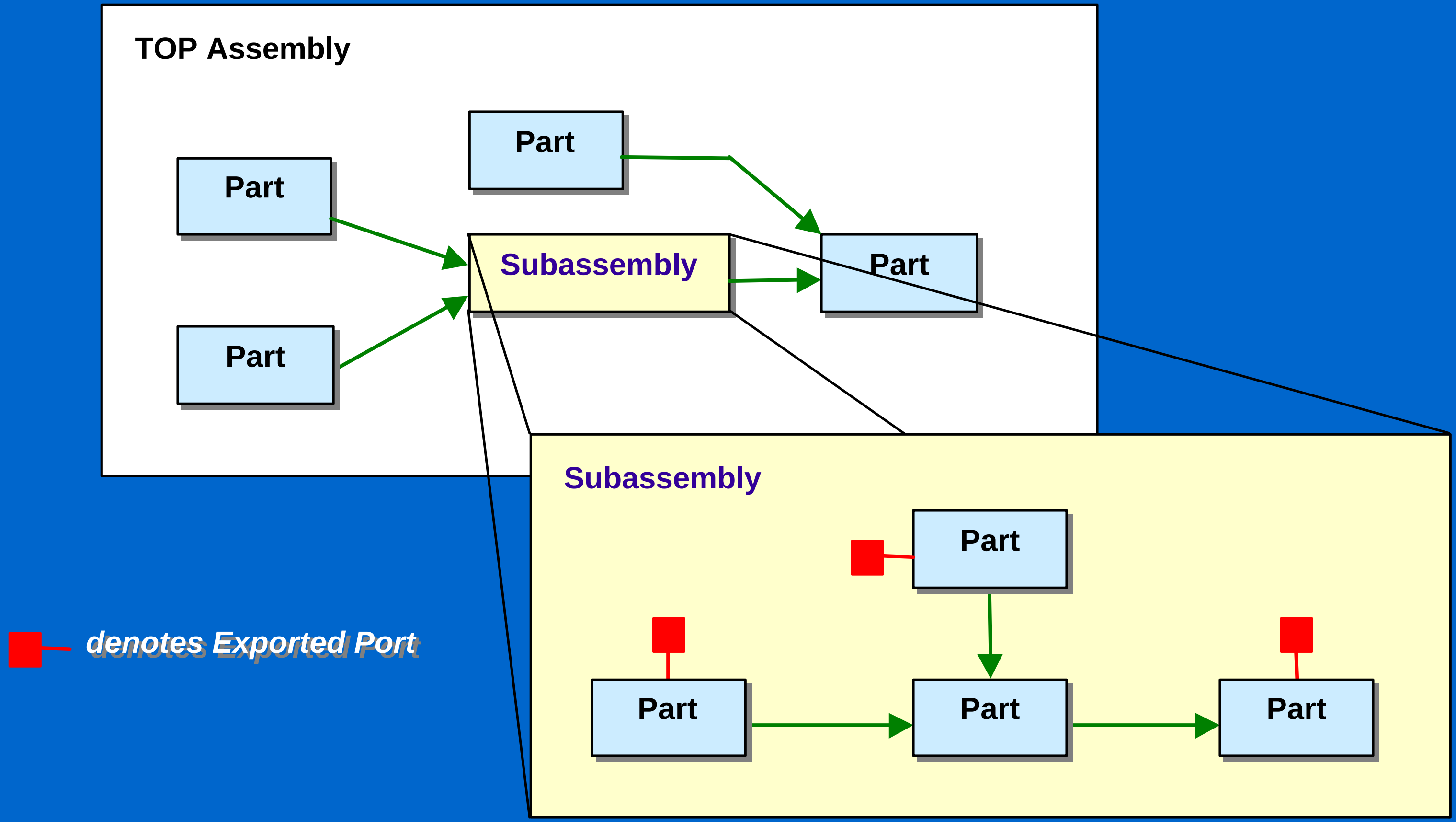
```
Part-4

Orientation = “NE”
```

Assembly Hierarchy

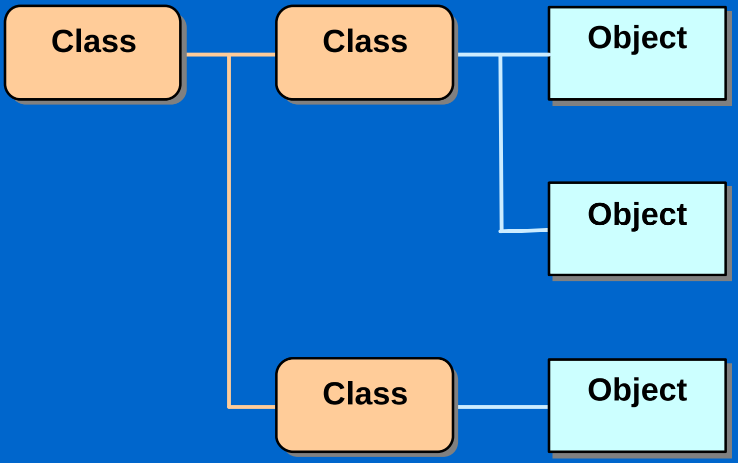


Assembly Hierarchy

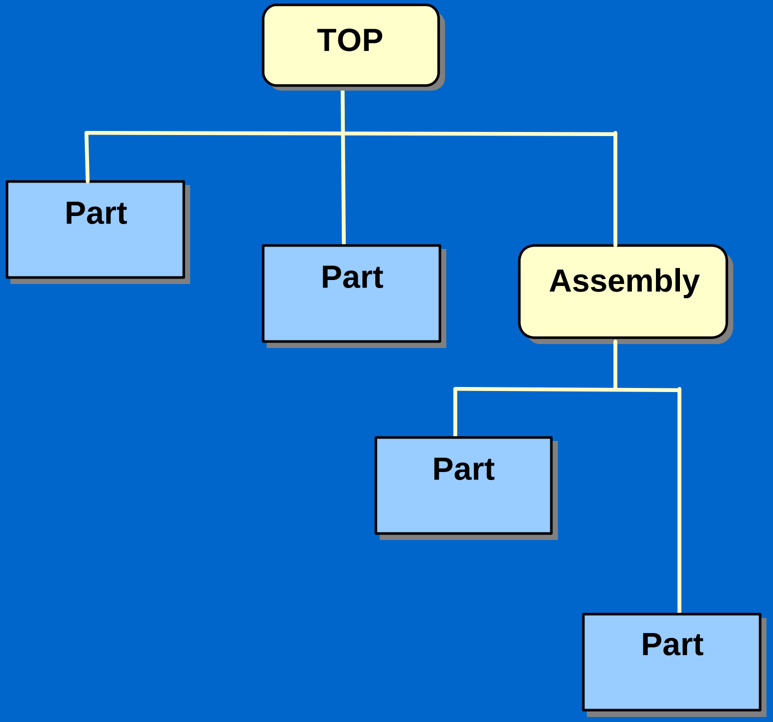


Project Models

- Class Hierarchy

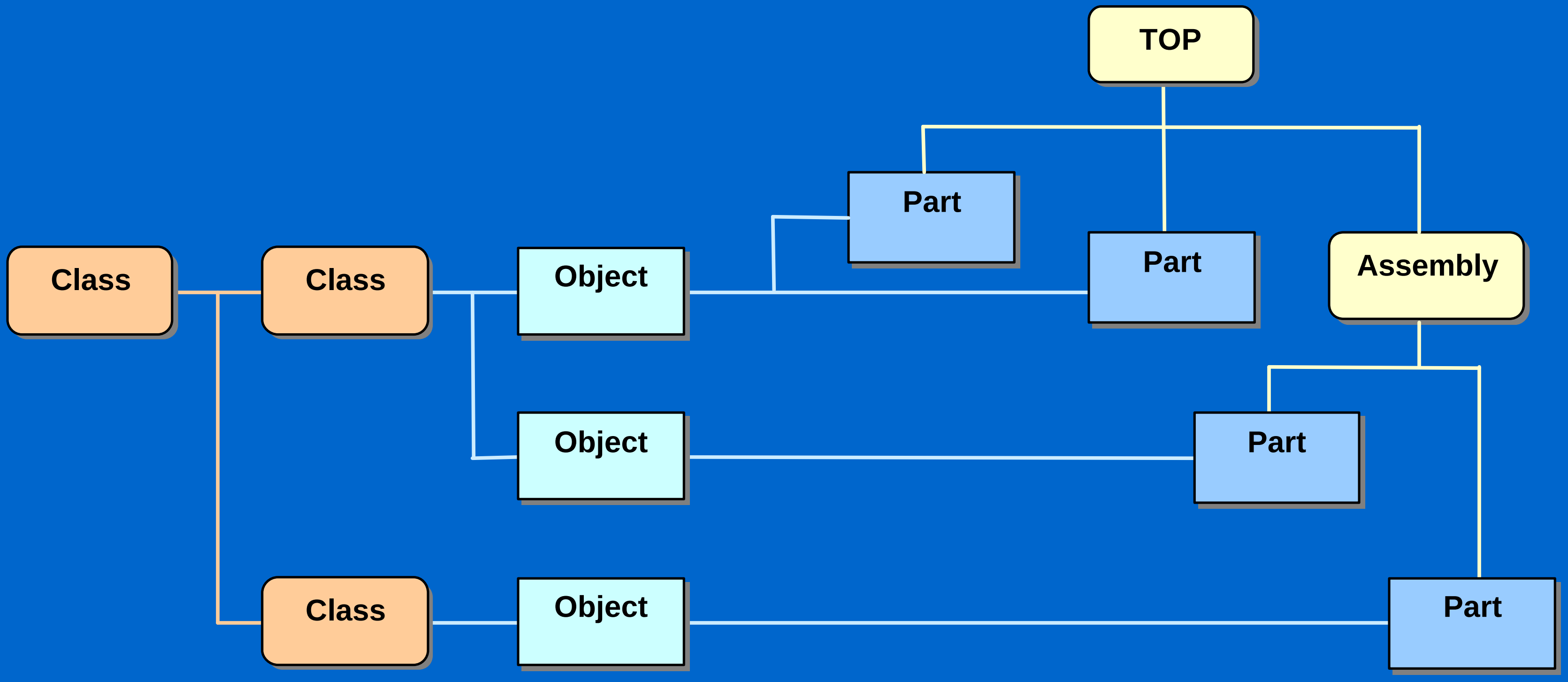


- Assembly Hierarchy



Project Models

- Class Hierarchy
- Assembly Hierarchy



Model Configuration

- Common Properties in Objects
  - Start from Simulator Object Libraries
- Hierarchical Assemblies of Parts
  - Create parts and links from objects
  - Form assemblies with parts and links
  - Export ports to parent assembly for linking
  - Replicate parts and all its subassemblies
  - Override object values in parts or links

Data Entry/GUI Control Types

- Numbers
  - Integer
  - Floating Point (single or double precision)
  - Currency Format
- String
  - Regular
  - Masked
  - Encrypted
- URL / File
- Date / Time
- On-Off Switch
- Tri-State Switch
- Enumerated Items
- Object Reference
- Quality
- Symbolic Parameter

Unit Conversion

- User Extensible Unit Objects
  - Specify units of measure for data input, output and presentation
  - Automatic conversion to units required by the simulators before simulation runs
  - Expand unit tables to add new units not covered by the simulator developer
  - Service Session - lock / unlock unit objects by simulation developers

Simulation Run Controls

- In-Process Simulation Controls
  - Run, pause / resume, step, fast forward, stop
  - Monitor and change data values on the fly
  - Simulation runs in a thread within SansGUI
- External Process Controls
  - Run and stop a simulation
  - Customize invocation script
  - Simulation runs in a separate process

Simulation Control Objects

- **In-Process Cycle Simulation Control**
  - **Continuous, cycle-driven simulation control**
    - Program location, log file name, start / pause / end cycle number, current cycle number, screen refresh interval, part evaluation order
- **External Process Simulation Control**
  - **Stand-alone or legacy code integration**
    - Program location, invocation script, model file name and type, working directory, command parameters

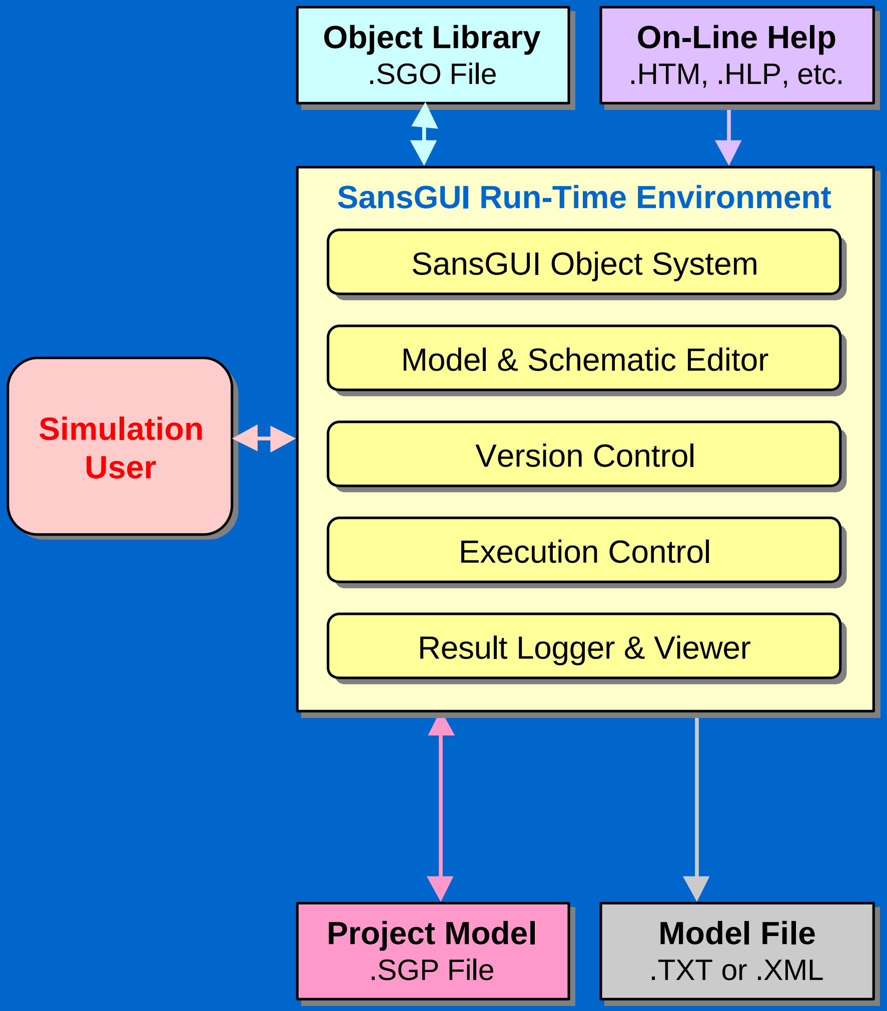
Results Logging and Plotting

- **Logging**
  - **Select logged values in objects, parts or links**
  - **Logged results can be viewed in a data grid**
  - **Change output units as desired**
- **Plotting**
  - **Plot selected set of logged data when running**
  - **Change plot specifications when paused**
  - **Customize plotting features**

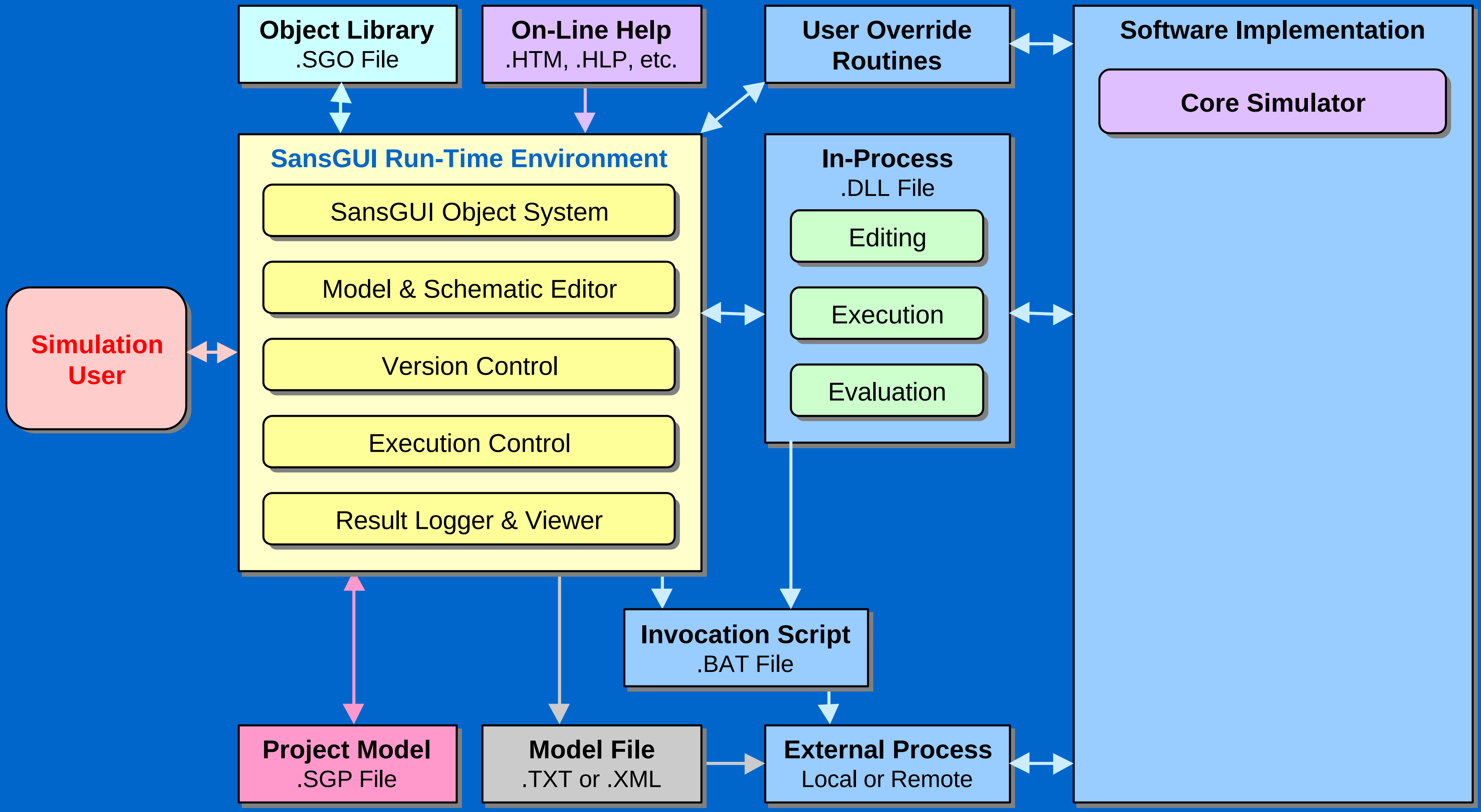
SansGUI Object Library

- **Simulator Dependent**
- **Class Schema Version Control**
- **Convenient & Custom Objects**
  - **Mandatory Objects: required by simulators**
  - **Default Objects: with default values**
  - **Common Objects: frequently used values**
  - **Special Objects: with hard to enter or remember values**

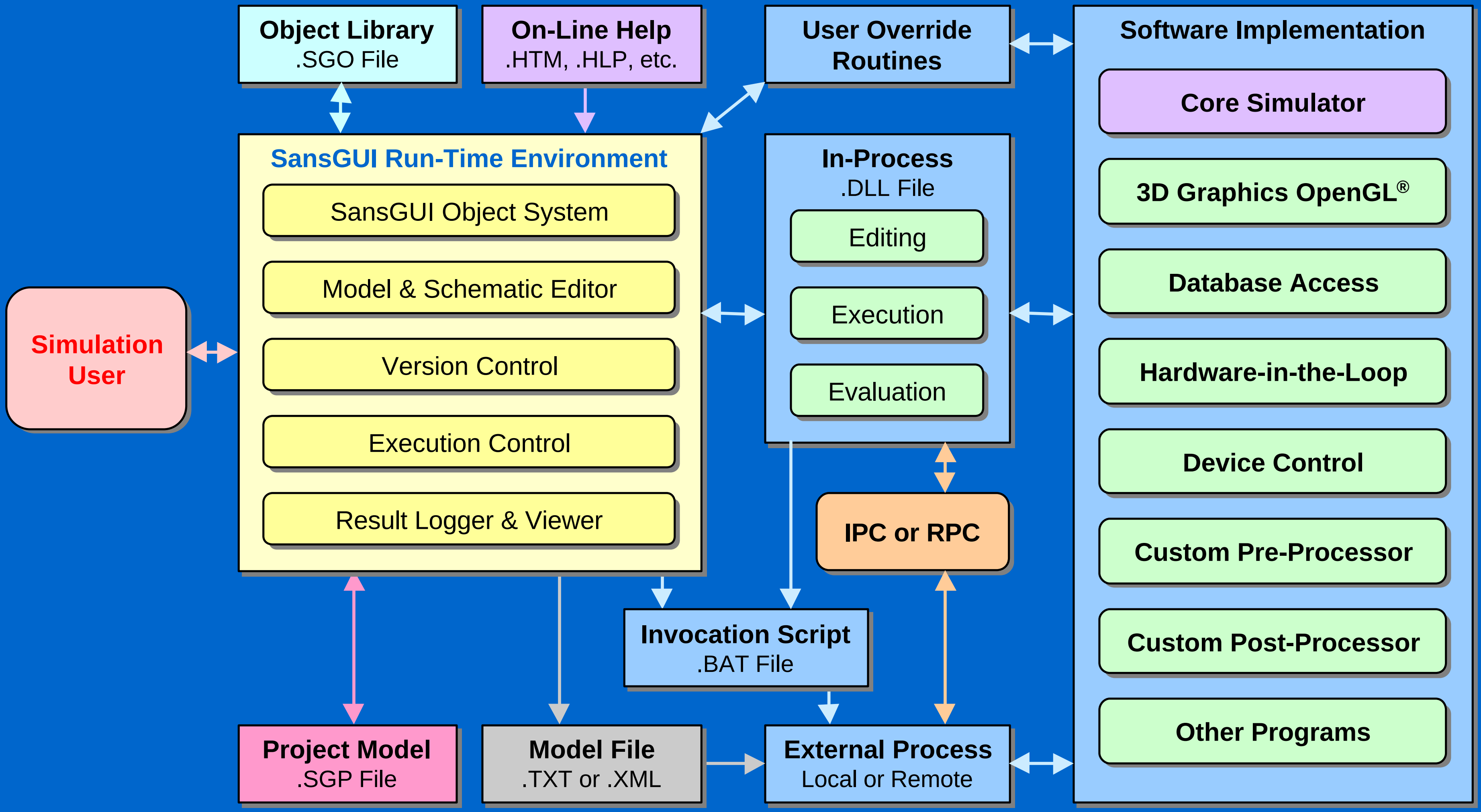
Run–Time Environment



Run–Time Environment



Run–Time Environment



Advanced Simulation Users

- **Managing Common Objects**
  - **Customizing Object Libraries**
  - **Importing Objects and Classes**
- **Overriding Simulator Routines**
- **Customizing SansGUI Environment**
  - **Managing User Workspaces**
  - **Tuning Environment Parameters**
  - **Using Different Directories**

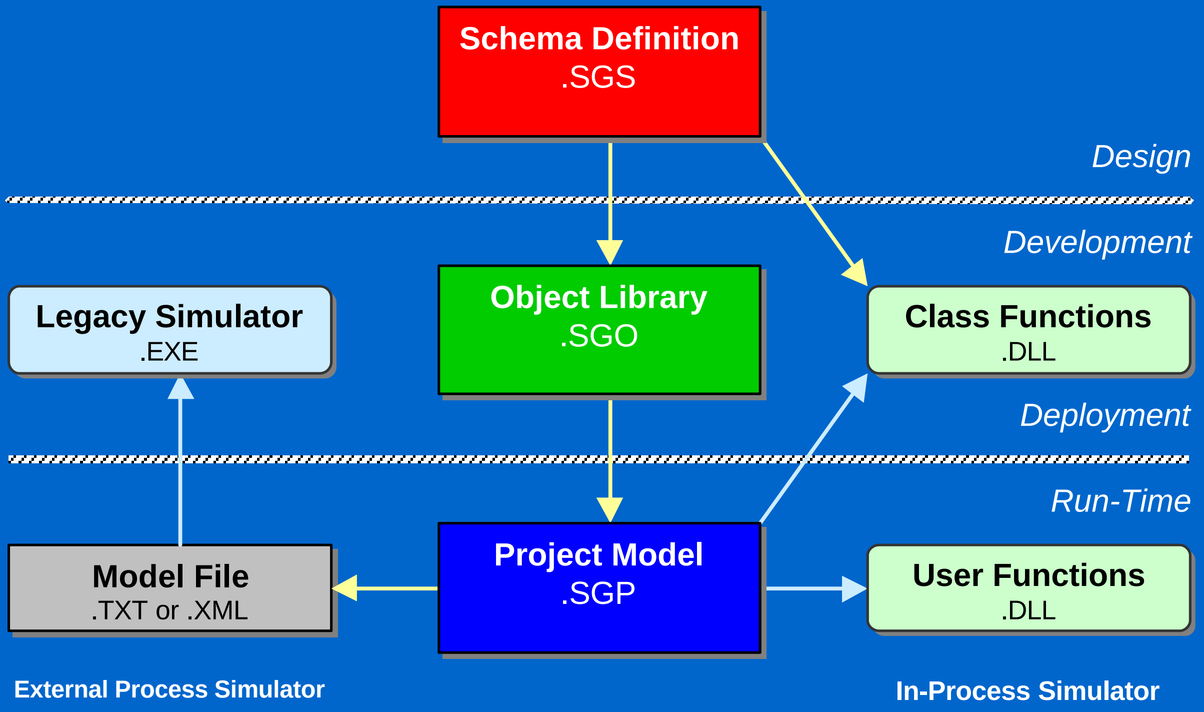
Developing with SansGUI®

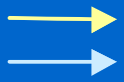
Simulator Development

- SansGUI File Types and Architecture
- Simulator Schema Definition
- Input Data Specification / Validation
- Internal Data Structures
- Core Simulator Programming
- Pre-processors / Post-processors
- On-Line Help Development

SansGUI File Types

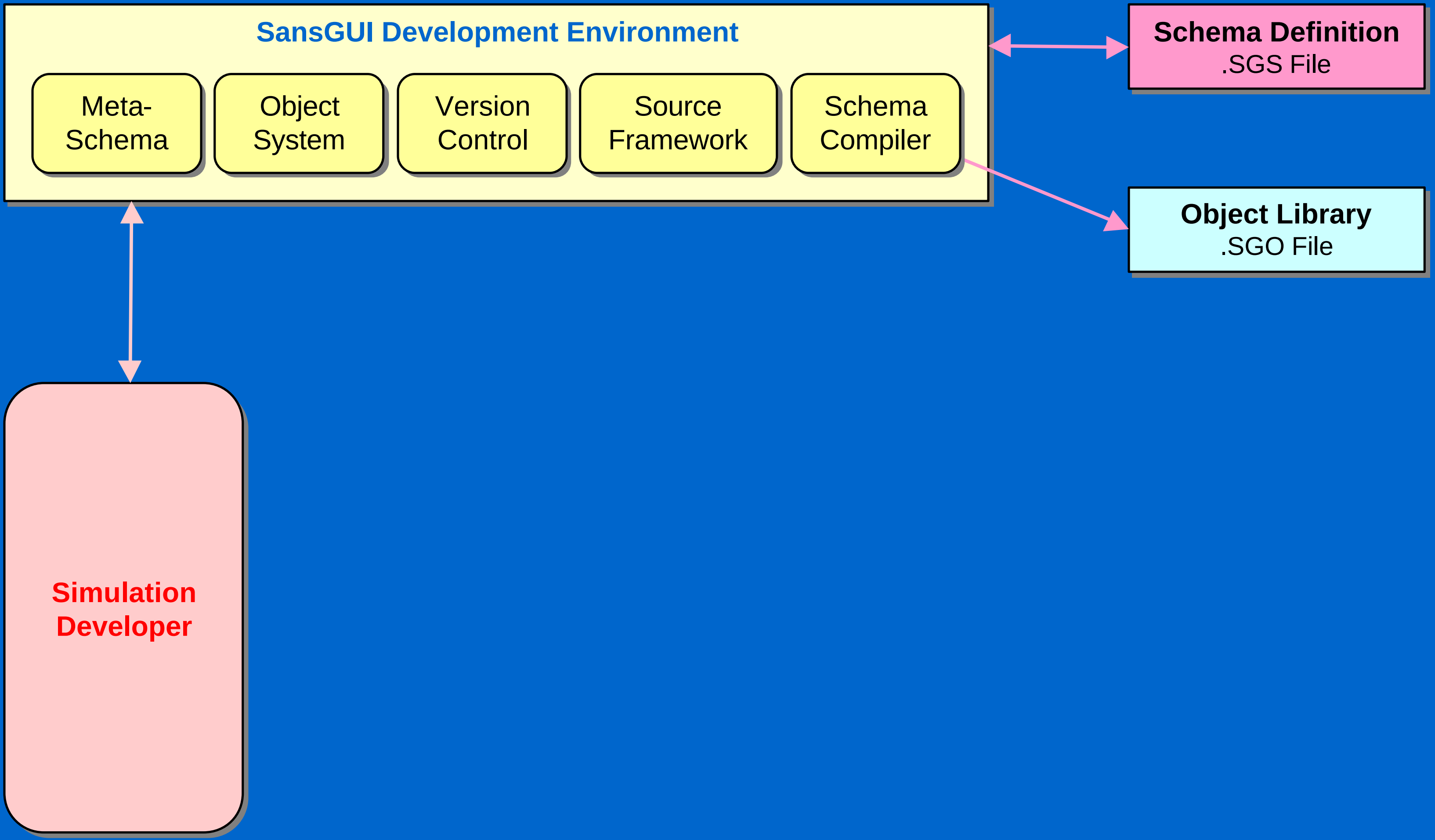
Primary Extensions



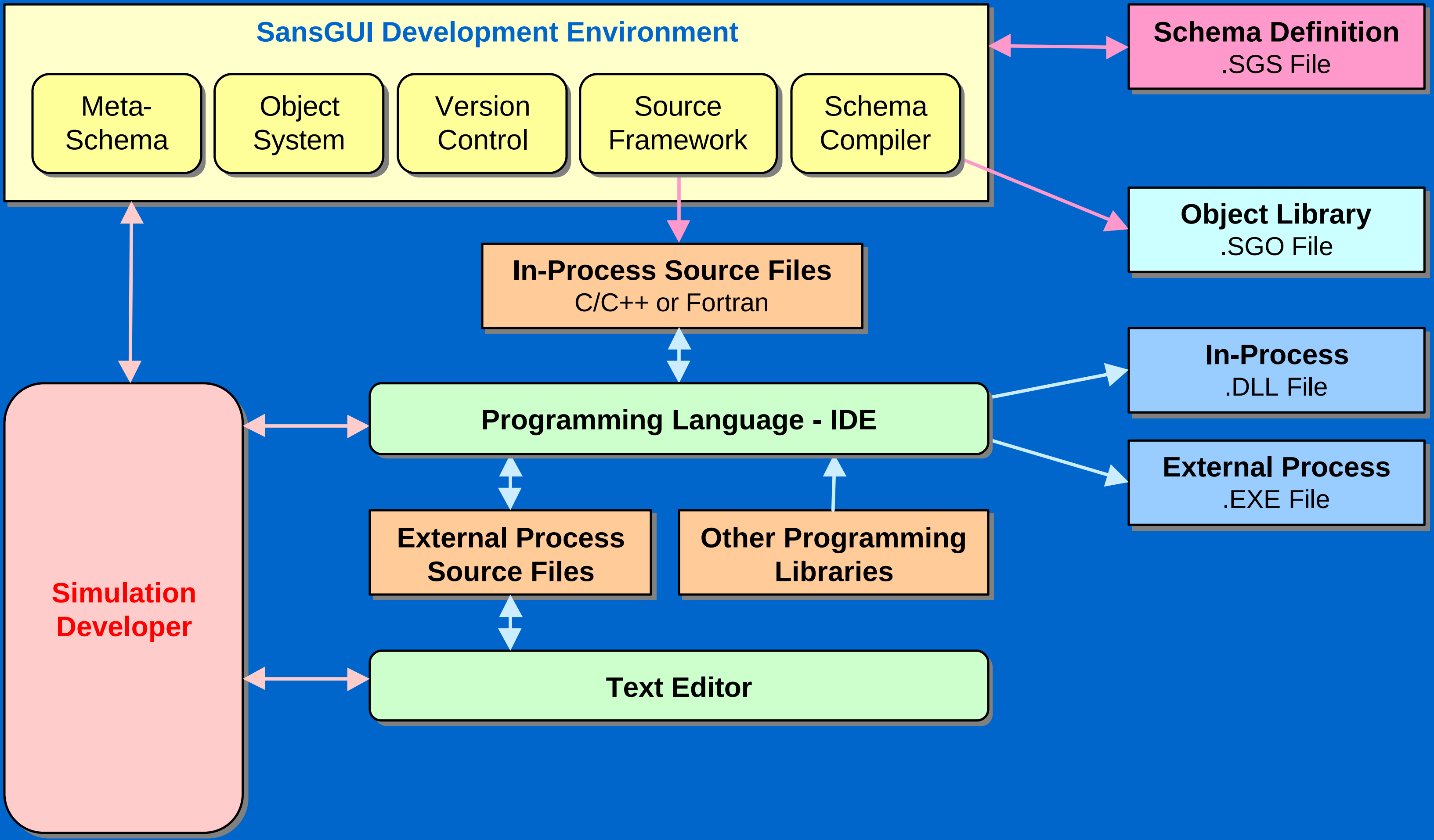

denotes the source information is used to generate the target file or code framework

denotes the source information is sent to the target for execution

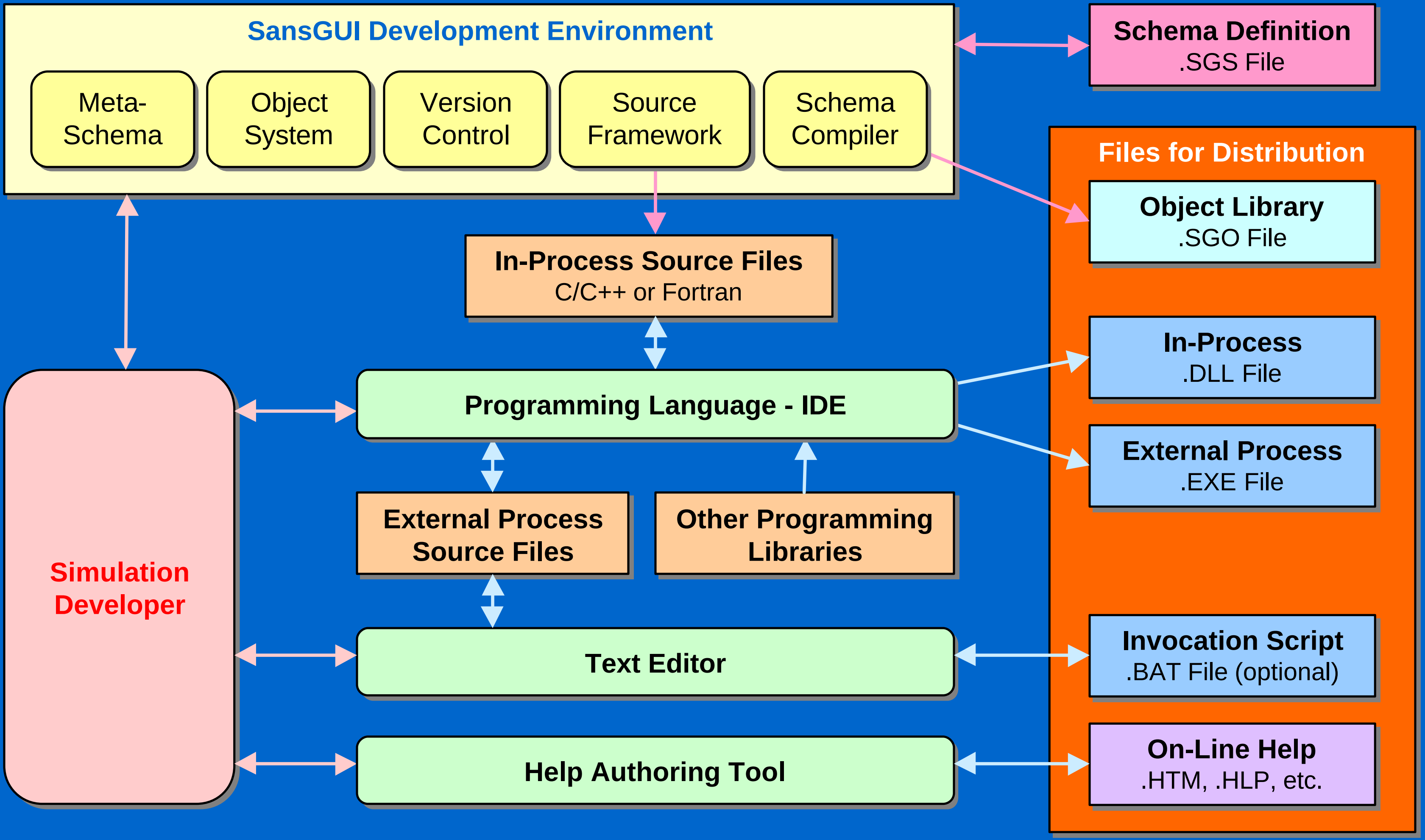
Development Environment



Development Environment



Development Environment



SansGUI Development Environment
Meta-Schema
Object System
Version Control
Source Framework
Schema Compiler
Schema Definition .SGS File
Files for Distribution
Object Library .SGO File
In-Process Source Files C/C++ or Fortran
In-Process .DLL File
Simulation Developer
Programming Language - IDE
External Process .EXE File
External Process Source Files
Other Programming Libraries
Text Editor
Invocation Script .BAT File (optional)
Help Authoring Tool
On-Line Help .HTM, .HLP, etc.

SansGUI Schema Definition

- Simulator Identification
- Class Properties and Attributes
- Class Sharing Options
- DLL Function Specifications
- Port Specifications in Components
- Connectivity Specifications
- Unit Objects

SansGUI Intrinsic Classes

- **Component Classes**
  - **Base, Assembly, and Link**
- **Reference Classes**
  - **Collection, Graphics, Matrix, and Table**
- **Simulation Control Classes**
  - **Cycle and XProc**
- **Unit Class**

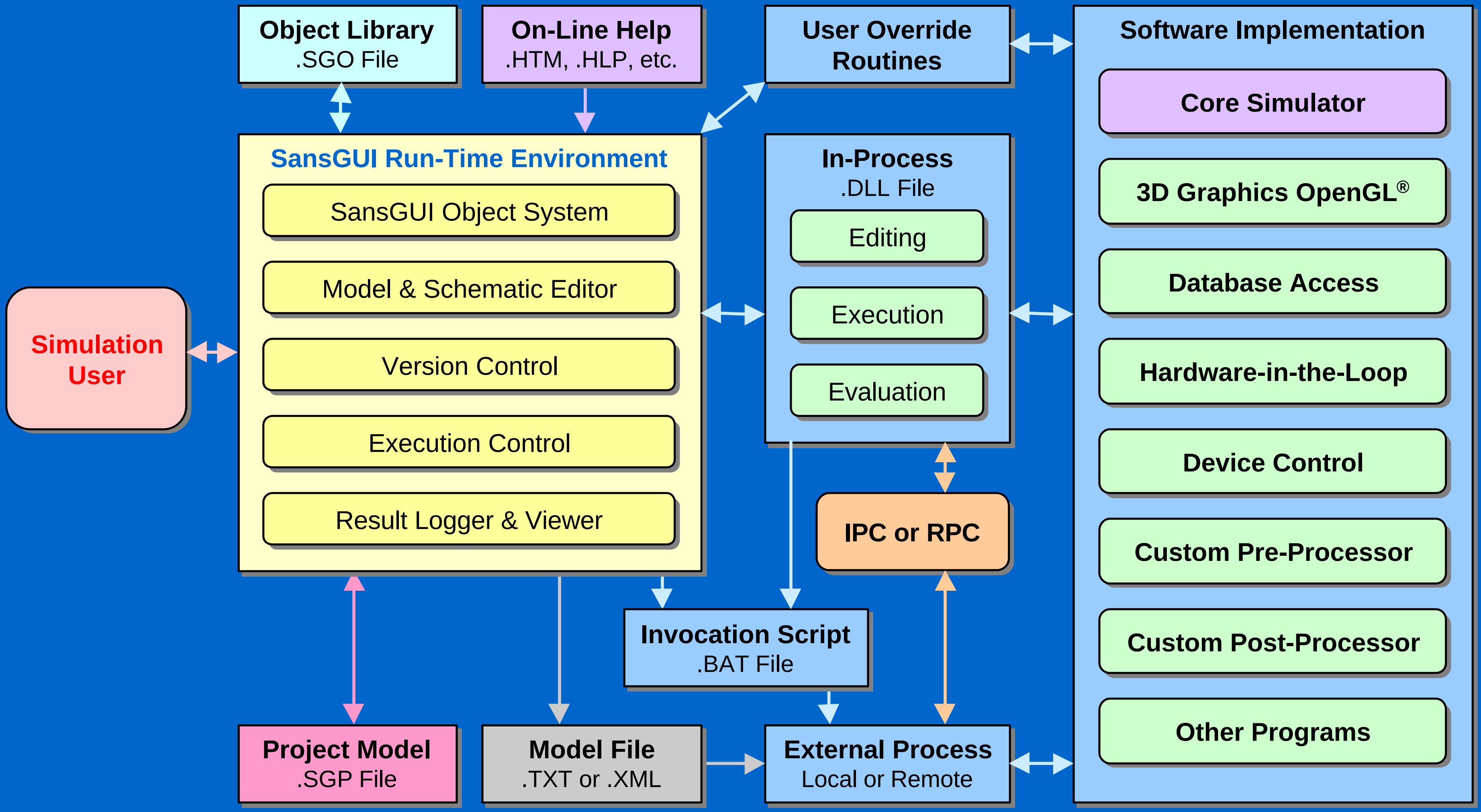
External Process Simulator

- **Model File Format**
  - **Tabular Data Blocks**
  - **XML Model Data**
- **Invocation Script Customization**
  - **Input Filter - convert SansGUI file format**
  - **Pre & Post Processor - integrate execution**
  - **Job Control - submit long running job**
  - **Remote Execution - run simulation remotely**

In-Process Simulator

- **Checking DLL Function Entry Points**
  - **Define DLL entry points in Class Properties**
- **Using Source Code Framework**
  - **Generate skeleton code in C/C++ & Fortran**
- **Working with MS Visual Studio**
  - **Create DLL projects and insert source files**
  - **Implement simulator logic and mathematics**
  - **Compile, debug, and trace through code**

Run-Time System Review



SansGUI Object System

- **SansGUI Data Object Format**
  - **SG_OBJ Data Structure**
  - **SG_VALU Data Structure**
  - **GUI Control Type Funneling**
- **SansGUI API**
  - **DLL Function Prototype**
  - **DLL Function Entry Points**
  - **Cycle Simulation Calling Sequence**

SG_OBJ Data Structure

- **SansGUI Schema Version**
- **Object Status and User Data**
- **Class Information**
  - **Class Name, Path, Version, and Attributes**
- **Object Information**
  - **Component Path and Serial Number**
- **SG_VALU Data Array**

SG_OBJ in C/C++

```
typedef struct SG_OBJ_tag {
    SG_CONST UINT nSGobjSchema;
    INT iStatus, iUserData;
    SG_CONST INT iNumVars;
    SG_VALU *SG_CONST zValues;
    SG_CONST INT iVerMajor,iVerMinor,iVerPatch, iVerBuild;
    SG_CONST UINT nCmpnNo;
    const TCHAR *SG_CONST cObjName, cCmpnName;
    SG_CONST TCHAR *SG_CONST cClassPath, cCmpnPath;
    const TCHAR *SG_CONST *SG_CONST sVarNames;
} SG_OBJ;
```

SG_VALU Data Structure

- Data Type
- Dimension
  - Size, columns, and rows
- Data Array
  - All values are in arrays
  - INT*, FLOAT*, DOUBLE*
  - TCHAR* (Dynamic TCHAR Array)
  - TCHAR** (String Array)

SG_VALU in C/C++

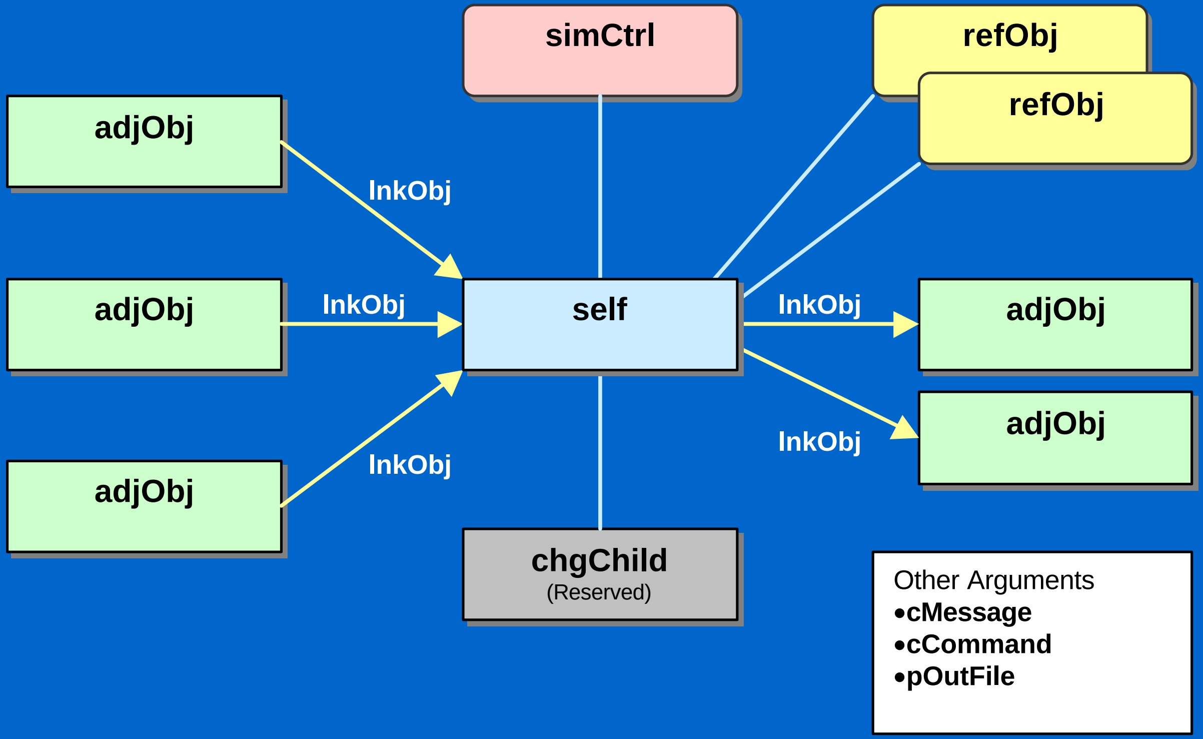
```
typedef struct SG_VALU_tag {
    SG_CONST UINT nType;
    SG_CONST INT iSize, iCols;
    INT iRows;
    union {
        void *SG_CONST vData;
        INT *SG_CONST iData;
        FLOAT *SG_CONST fData;
        DOUBLE *SG_CONST dData;
        TCHAR *SG_CONST cData;
        TCHAR *SG_CONST *SG_CONST sData;
    };
} SG_VALU;
```

GUI Control Type Funneling

- **SG_VALU Data Storage**
  - **Number → INT, FLOAT, DOUBLE Array**
  - **String → String Array**
    - Regular string in a cell ® Dynamic TCHAR Array
  - **URL / File / Reference → String Array**
  - **Date / Time → INT Array**
  - **On-Off and Tri-State Switch → INT Array**
  - **Enumerated Items → INT Array**

DLL Function Prototype

- **SG_SIM_FUNC Arguments**



Other Arguments
•**cMessage**
•**cCommand**
•**pOutFile**

SG_SIM_FUNC in C/C++

```
typedef SG_RET_CODE (SG_SIM_FUNC)(
    SG_OBJ *const self,
    SG_OBJ *const simCtrl,
    SG_OBJ *const chgChild,
    SG_OBJ *const refObjs[], const INT *const piRefObjs,
    SG_OBJ *const adjObjs[], const INT *const piAdjObjs,
    SG_OBJ *const lnkObjs[], const INT *const piLnkObjs,
    TCHAR *const cMessage, const INT iMsgLen,
    TCHAR *const cCommand, const INT iCmdLen,
    SG_FILE *const pOutFile
);
```

DLL Function Return Value

- **SG_R_OK** - success, continue simulation
- **SG_R_LMSG** - display a message to user
- **SG_R_PAUS** - pause and inquire user
- **SG_R_STOP** - error detected by simulator
- **SG_R_VERS / SG_R_SCHM** - version
- **SG_R_ERR** - error detected by SansGUI
- **SG_R_*** | 24 Bit Simulator Error Number

DLL Function Entry Points

- Data Editing Functions
  - End Edit Check
  - Resize/Load Data
- Execution Functions
  - Resize/Initialize Data
  - Begin/End Run and Case
- Evaluation Functions
  - Pre Evaluation/Evaluation/Post Evaluation

Cycle Simulation Sequence

(1) All Reference Objects and then all Parts

(2) All Parts and then all Reference Objects

- **Init-Size (2) / Initialization (1)**
- **Begin Run / Case (1)**
- **Pre Evaluation (1)**
- **Evaluation and Post Evaluation (2)**
- **End Run / Case (2)**

Evaluation Cycles

- Reference Objects
  - By Name
- Parts in Assembly Tree - Depth First
  - By Name
  - By Z-Order
  - By Horizontal Scan Lines
  - By Vertical Scan Lines
  - Random

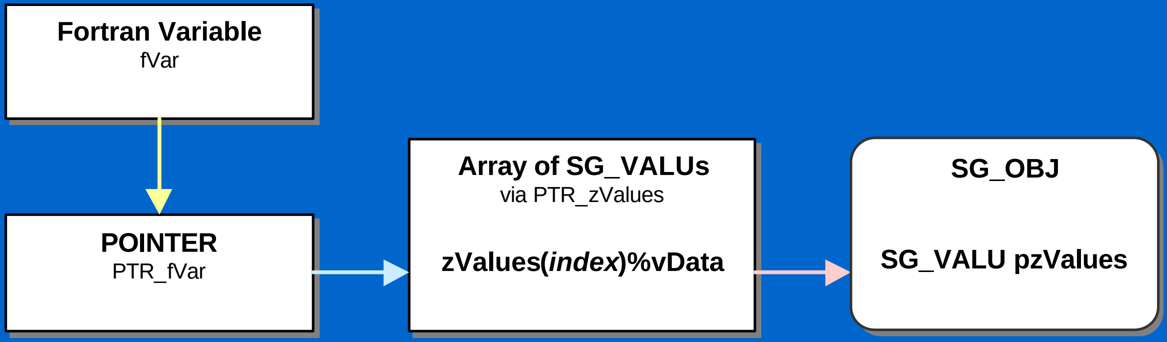
Using Class Graphics

- **Support OpenGL® 3D Graphics**
  - **Initialize - mapped to Begin Run function**
  - **Reshape - mapped to Pre Evaluation function**
  - **Display - mapped to Post Evaluation function**
  - **Select - mapped to Evaluation function**
- **Simplify 3D Graphics Operations**
  - **Rotate, Pan, Zoom, and Reset**
  - **Print, Copy to clipboard, Save to image files**

Visual Fortran Support

- Select Column-Major Data Storage
- Use Generated Framework
  - Source files are generated as in C/C++
  - Choose Fortran or C/C++ implementation on a class-by-class basis
- Use Supplied Header File - SGdllf.h
- Dump SG_OBJ in Visual Fortran
  - Use the distributed SGdump.f code

Data Access in Fortran



```
real*4, dimension(*) :: fVar
POINTER(PTR_fVar, fVar)
PTR_zValues = self%pzValues
PTR_fVar = zValues(index)%vData
```

Development Environment

- Microsoft Visual Studio®
  - Microsoft Visual C++ 6.0 (SP3+)
  - Compaq Visual Fortran 6.1+
  - Simulator code debugging and tracing
  - Multi-Threaded Execution Support
- OpenGL® 3D Graphics Programming
- XML Model Data Support
- Existing Code/Library Integration

Other Language Support

- **In-Process Simulation - PC**
  - **Can create Win32 DLLs**
  - **Can be called from Microsoft Visual C++**
    - Function names (length and case sensitivity)
    - Compatible function argument list
  - **Can access C data structures with pointers**
- **External Process Simulation**
  - **Can create stand-alone programs**
    - Batch command / Shell script invocation

Experiencing with SansGUI®

Hands-On Sessions

- **Visual Calculator for SansGUI**
  - **Creating a simple graphical calculator with step-by-step instructions**
- **MIDI Player for SansGUI**
  - **Showing a legacy program and an in-process layer work in concert for dynamic charting**
- **Mixer Example for SansGUI**
  - **Building, loading and solving a system of linear equations**

Thank you !

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