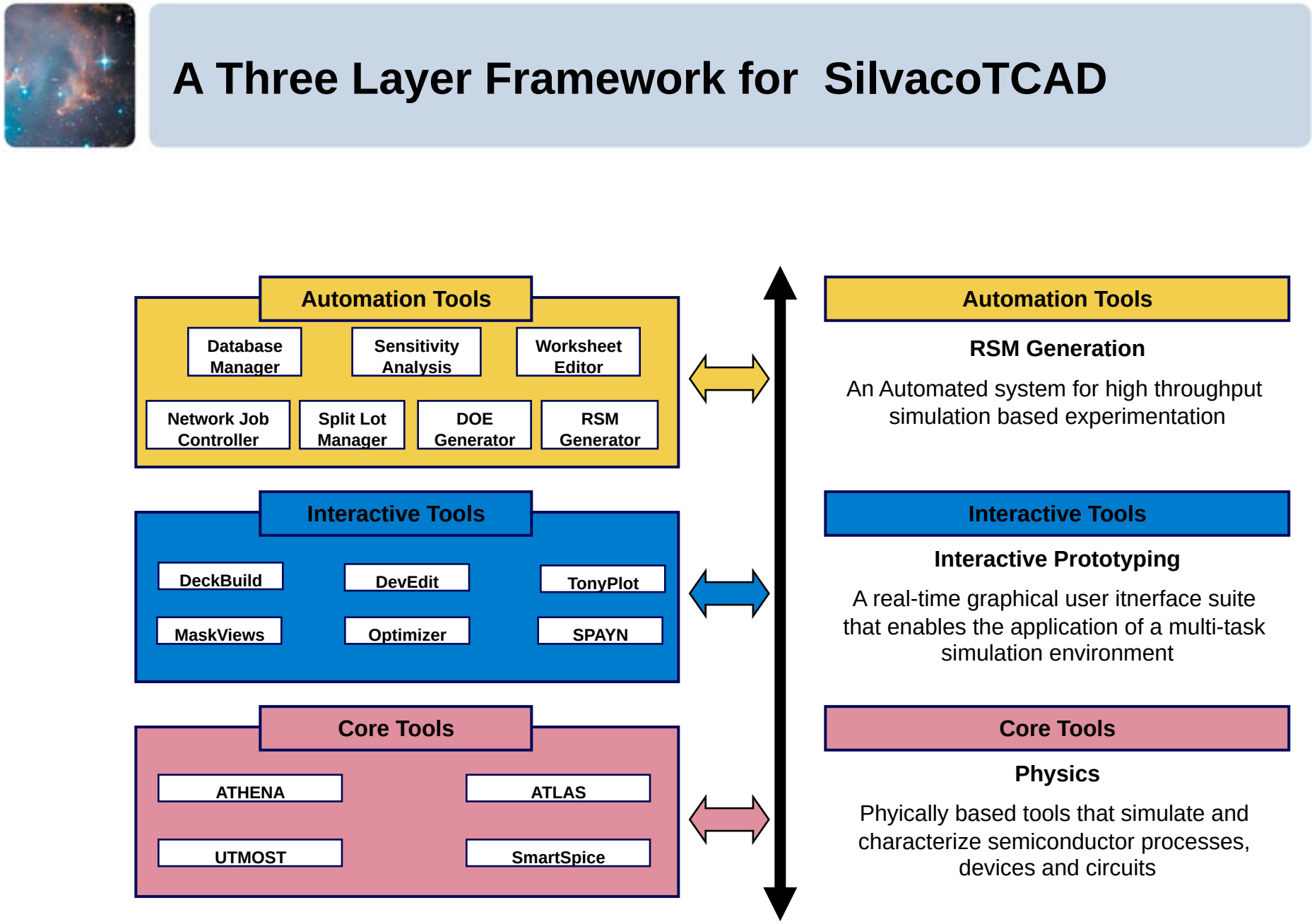
Introduction to Interactive Tools

MULTI CORE TOKEN WORLD LICENSE

SILVACO

A Three Layer Framework for SilvacoTCAD



Purpose of the Interactive Tools

- A tool set which facilitates the use of simulators to perform engineering tasks
  - Ease of Use
  - Easier access to simulation results
  - Common look and feel between simulators
  - High Level functionality built into user interface rather than each separate simulator

The Interactive Tools

- DeckBuild — Front end GUI for Input File Development and an Interactive Run Time Environment
- TonyPlot — Interactive Graphics Tool
- DevEdit — Structure Editing and Meshing
- MaskViews — IC Layout Interface
- Optimizer — General Purpose Optimizer Tool (requires DeckBuild)

Training Pre-Requisites

- Fundamental Features of Silvaco's GUI
  - DeckBuild
    - Input deck building from menus
    - Run-time control
    - Accessing TonyPlot
    - Parameter extraction
  - TonyPlot
    - 2D contour control
    - Cutlines and 1D plots
    - XY graphs for terminal characteristics
    - Multiple plots and overlays

DeckBuild Key Features

- Interactive Input File Development
- Interactive Runtime Control
- Menu Access to Standard Example Set
- Auto-Interfacing Between Simulators (GO statement)
- Access to TonyPlot (TonyPlot statement)
- IC Layout Interface with MaskViews (MASK statement)
- Parameter Extraction (EXTRACT statement)
- Variable Substitution (SET Statement)

Starting DeckBuild

- Interactive Mode

```
DECKBUILD <input file>
```

- Batch Mode

```
DECKBUILD -RUN <input file> -OUTFILE <output file>
```

- Non-Graphical Mode for Batch Operations

```
DECKBUILD -ASCII -RUN <input file> -OUTFILE <output file>
```

- Command line arguments for simulator and version

```
DECKBUILD -ATHENA -SIMVER 3.0.0.R
```

- Within DECKBUILD the GO command allows version choice

```
GO ATHENA SIMFLAGS="-V 3.0.0.R"
```

History and Plotting within DeckBuild

- In process simulation a HISTORY file is automatically saved after each process step
- To re-initialize at any process step:
  - place mouse pointer at the start of that line
  - press the INIT button on the DECKBUILD control bar
- To plot history files:
  - highlight the name of the history file in the run-time output
  - select the menu option TOOLS/PLOT/PLOT_STRUCTURE
  - This technique can be used to plot any file
- To plot the current structure:
  - make sure no text is highlighted
  - select the menu option TOOLS/PLOT/PLOT_STRUCTURE

Parameter Extraction in DeckBuild

- The Extract statement used to derive specific measurements from both structures and terminal characteristics
  - menu support exists for extraction from structures
  - the EXTRACT syntax operates on the latest structure file in process simulators
  - the EXTRACT syntax operates on the latest log file in device simulators
  - to override this default use:

```
EXTRACT INIT INF="<filename>"
```

Parameter Extraction in DeckBuild

- The results of EXTRACT are:
  - printed to the run-time output
  - saved to an external file

    `EXTRACT . . . . . DATAFILE="<filename>"`
  - used in the OPTIMIZER as optimization targets
  - logged to the worksheet in the VWF AUTOMATION TOOLS

Parameter Extraction Targets

- Single Process Parameters:
  - Xj, Tox, Surface Doping, Peak Doping, etc...
- Process Simulation Curve Targets:
  - SIMS, SRP, CV, Doping profiles, etc ...
- Device Simulation Parameters:
  - Vt, Beta, Gamma, Theta, Rb, bf, fT, etc ...
- Device Simulation Curve Targets:
  - IV Curves, It Curves, fT Curves, CV Curves, etc ...
- Device Simulation Structural Targets:
  - Max E Field, Integrated Electron Conc., etc ...

Optimizer Key Features

- Allows optimization loops within any simulator or across simulators
- Used primarily for calibration and automatic searching for simple targets
- Simple worksheet based control
- Optimization is NOT controlled via the input syntax
- Targets are any EXTRACT statement (single parameter or curve)
- Variables are any numerical input to the simulator (process inputs or model parameters)
- Multi-variable, multi-target optimization allowed

TonyPlot Key Features

- Can be called from UNIX or DeckBuild
- Supports all file types automatically
  - 2D structure
  - 1D structure
  - terminal characteristics
  - user supplied XY datafiles
- 3D structures plotted using separate package: TonyPlot3D
- Select what to plot from PLOT/DISPLAY menu

Tonyplot Key Features

- 1D slices though 2D structures
  - choose the TOOLS/CUTLINE menu
  - select type of cut (vertical, horizontal, free, etc)
  - click left button and hold down to draw a cut
  - release button
- Select one of multiple graphs using left button
- Select more that one of multiple graphs using middle button
- To overlay plots:
  - select more that one plot as above
  - select VIEW/OVERLAY
- Use FUNCTIONS menu to plot functions of the available data (e.g. to get bipolar gain use collector current/base current)

MaskViews

- IC Layout Editor for the TCAD Engineer
- MaskViews brings design rules into the Optimization Loop
- IC Layout Issues should be treated side by side with Process Flow Technology: Time, Temp, Dose, Energy, etc

MaskViews Key Features

- Layout can be drawn by the user or imported from GDS-II format files (NB: GDS-II format does not contain layer names)
- Often mask dimensions from CAD packages do not correspond to mask sizes on the wafer. CD variations and misalignment can be edited layer by layer on DEFINE/LAYER menu
- User defines a 1D, 2D, or 3D area of interest on the layout using `WRITE_FILE`. This creates a cross-section file (*.SEC)
- Cross section files are loaded into DeckBuild using the TOOLS/MASKVIEWS/CUT_FILES menu
- Control of masking information in DeckBuild is controlled by:
  - `MASK` command in ATHENA and SSuprem3
  - `LAYER` command in INTERCONNECT3D
- The layer/mask names in the input syntax must correspond exactly with those in the layer

TonyPlot Interactive Graphics

- Driven interactively, NOT via the input syntax
- Versatile set of visualization tools
- Common to all simulators
- Easy to learn and to use
- Faster report generation

Conclusion

- Interactive Tools are a powerful set of tools to simplify and streamline TCAD simulation
  - **DeckBuild** – Interactive Input and Runtime Environment with optimization
  - **TonyPlot2D/3D** – Powerful Graphical Display and Analysis
  - **DevEdit2D/3D** – Powerful Structure Editing and Remeshing
  - **MaskViews** – IC Layout Customized to TCAD