

Applications for Hierarchy Walker

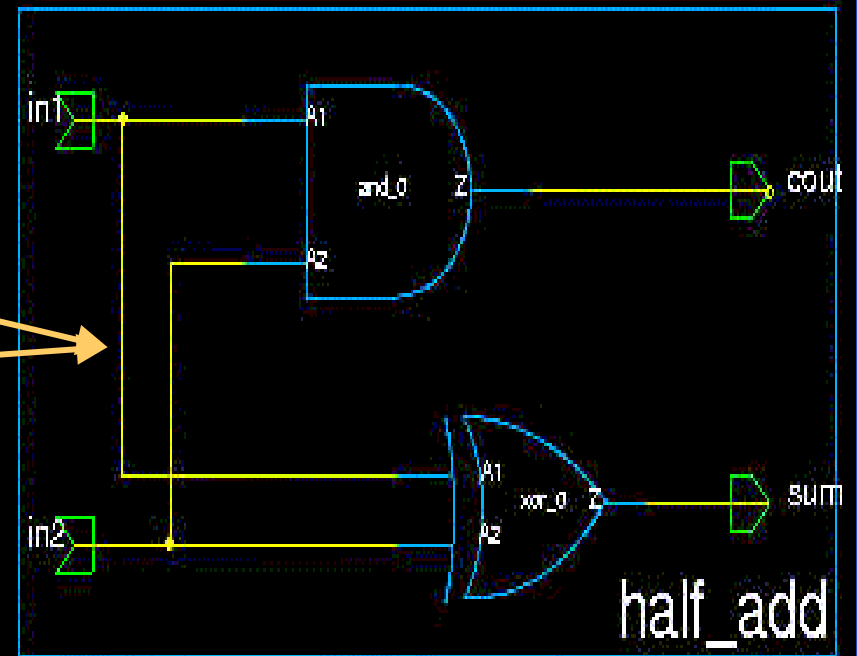
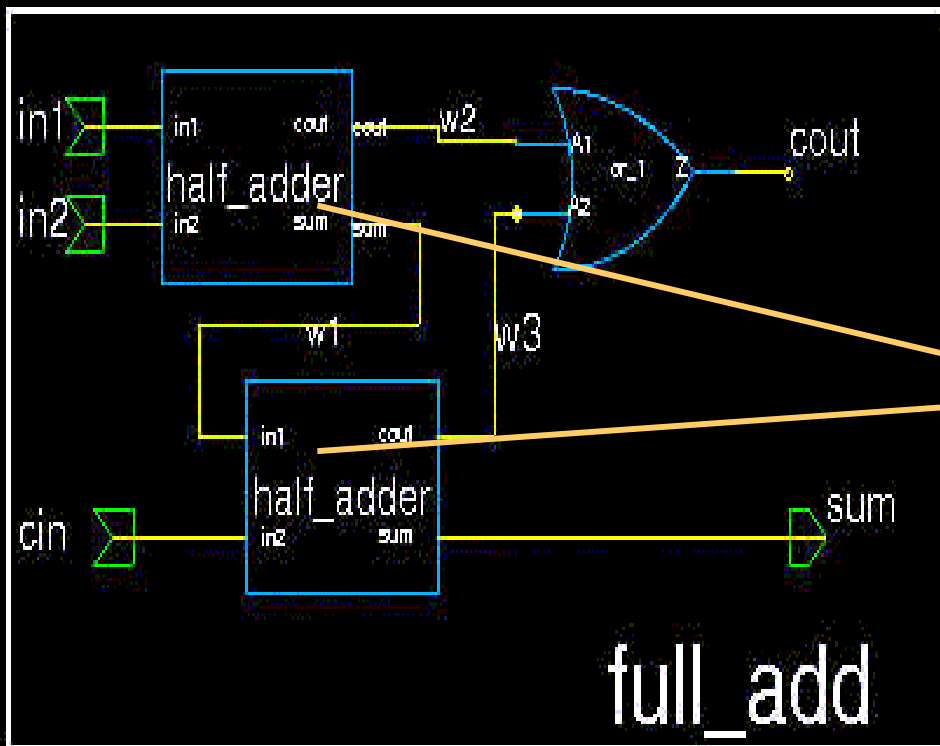
Tina Nguyen
Milkyway/Map-in CAE
Synopsys, Inc.



- Review Hierarchical Design Concepts
- Introduce Hierarchical Walker Program
- Discuss Application Topics
 - Data Management
 - Retrieving database information
 - Modification

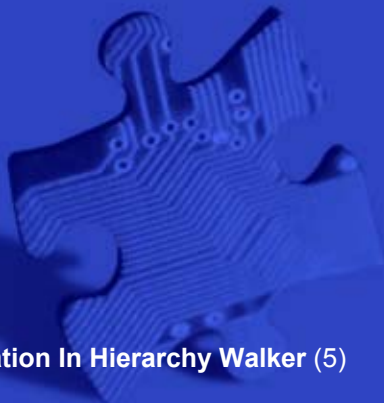
- Milkyway provides a Containment Hierarchy
 - Cells are inside other cells which are inside other...
- Milkyway Hierarchy is a Folded Hierarchy
 - Two instances are of the same cell, they use the exact same reference cell to define them
- The folded hierarchy can be flattened by tools
 - Create one cell with all leaf cells in it (i.e. those with no further cell instances)

Milkyway Hierarchy Demonstrated in Cosmos Schematic View



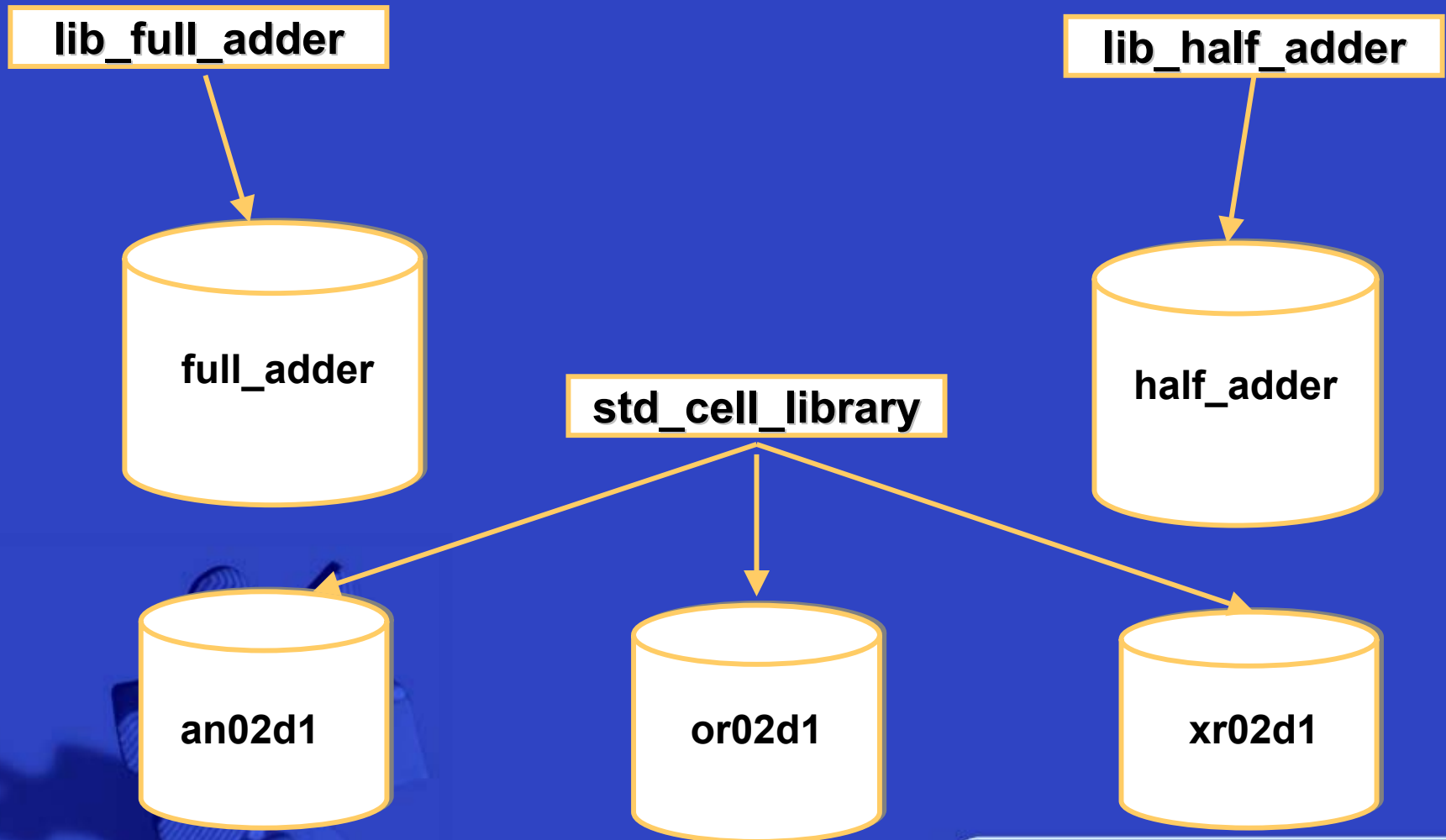
Included as a lab from the CAPI training

- On Oct 03, 2003 - Customer training...
- On Oct 16, 2003 - MAP-in training...



Application In Hierarchy Walker (5)

- Purpose:
 - Learn about hierarchy in the chip design.
 - Outer loop for working on the design hierarchically that can apply to retrieving and modifying the cell's information
- Help traverse cells using three different methods
 - Process every cell in a library
 - DoCellInLib
 - Output cellist file
 - Performs top cell hierarchical tree traversal
 - DoHierCell
 - Output cellist file
 - Performs cell traversal from the input cellist file. This will allow to work on the cells from different libraries
 - Create/modify cellist file from above methods
 - DoCellList



Cell Traversal In Library GUI

The screenshot displays the Synopsys Hierarchy Walker application. The main window title is "mde :lab5.b". The menu bar includes "Tools", "Library", "Cell", and "Options". The "Library" menu is open, showing options like "Tech File", "Netlist In", and "Cell Library". The "Hierarchy Walker" menu is also visible, with "Traverse In Library..." selected. An orange arrow points from this menu item to the "Traverse In Library" dialog box.

The "Traverse In Library" dialog box has a title bar "Hierarchy Walker Menu: Traverse In Library". It contains the following fields and options:

- Buttons: OK, Cancel, Help
- Library Name: Browse...
- Output File Name:
- Stop View Options: Not_Applicable, CEL, FRAM, NETL, PWR, TIM, ROUTE, EXP
- Applicable Functions: Not_Applicable, Fetch_Net, Dump_CellInstances

To traverse the cells in the library, using group of three C-API functions

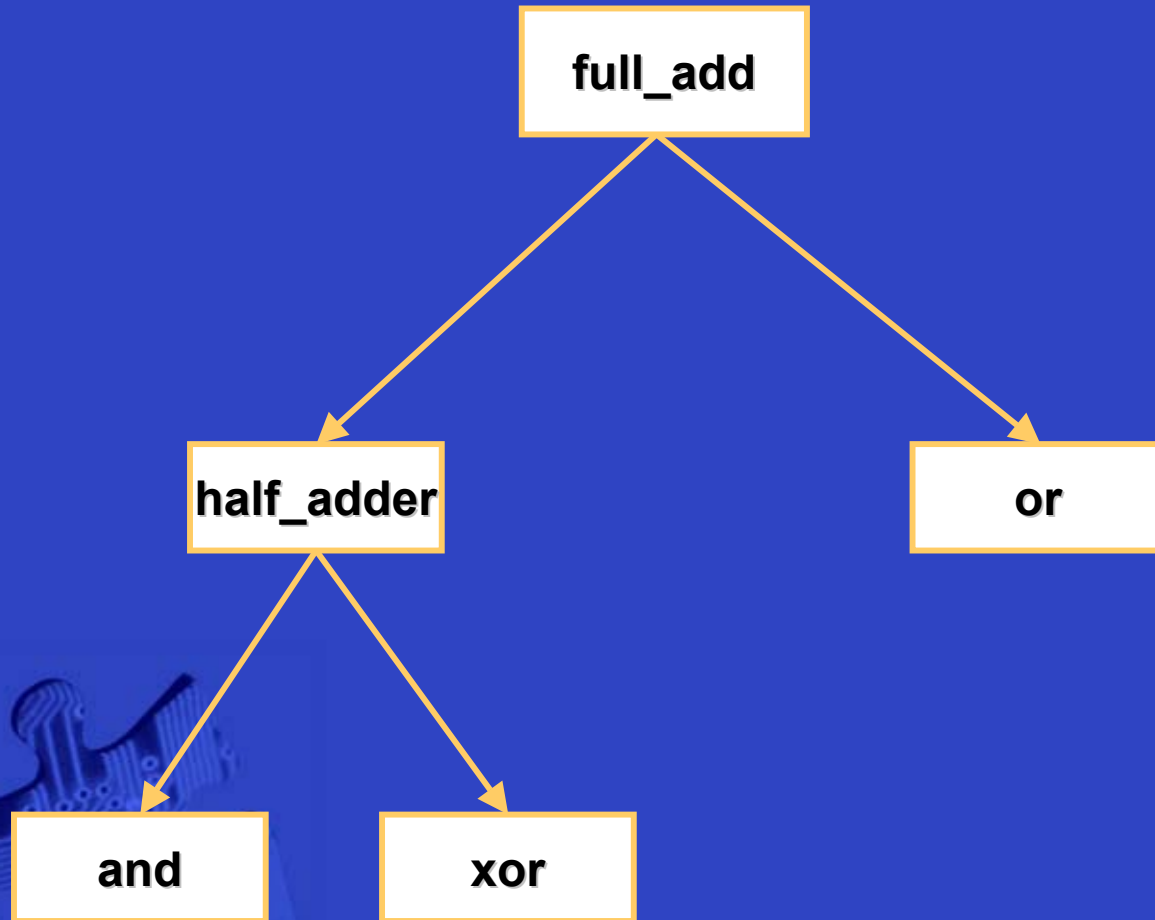
- Start with function to iterate cell view pairs in library
 - `MWXDb_Iter_LibCellViewPair` (MWXLibId_t libId, int32 mode, MWXIteratorId_t *iterId)
- This function returns either the next cell view pair or MWXIterDone when there are no more cells to retrieve.
 - `MWXDb_Iter_Next_LibCellViewPair` (MWXIteratorId_t *iterId, char **cellName, char **viewName)
- This function completes the iteration process.
 - `MWXDb_Iter_Quit_LibCellViewPair` (MWXIteratorId_t iterId)

Keep all traversed cells in the memory structure and dump out to the cellist file for later use.

Cell_List File

LibraryName	CellName	ViewName	CellType	AccessMode
design	top_design	CEL	Other	w
/home/test/stdlib	bufbd3	FRAM	Standard	r
/home/test/mcrlib	nand	FRAM	Macro	r
.....				
.....				

Cell Traversal In Hierarchy Tree



Cell Traversal In Hierarchy Tree GUI



Tools Library Cell Opti
Tech File Netlist In Cell Li
HierarchyWalker
Traverse Options
Traverse In Library...
Traverse From Hierarchy...
Traverse From File...
Protected by U.S. Patent No.
TIX library invoked is Copyr:

Library Name: /remote/cae826/mwcae/CAPI-Training/Intel_Training/Lab/CAPI_Class_Lab/lab/lab5/lab5.a/top_d
View Name: CEL
Cell Name:
Output File Name:
Browse...
Select...
Browse...
OK Cancel Help

Stop View Options:
Not_Applicable CEL FRAM NETL PWR TIM ROUTE EXP
Applicable Functions:
Not_Applicable Fetch_Net Dump_CellInstances

select cell
Directory: /remote/cae826/mwcae/CAPI-Training/Intel_Training/Lab/CAPI_Class_Lab/lab/lab5/lab5.a/top_design_library/CEL
top_design:1 top_design:2_2 top_design_CTS:1_3 top_design_route:1
top_design:1_1 top_design:2_3 top_design_floorplan:1 top_design_route:1_1
top_design:1_2 top_design:2_5 top_design_floorplan:1_1 top_design_route:1_2
top_design:1_3 top_design_bind:1 top_design_place:1 top_design_route:1_3
top_design:1_5 top_design_CTS:1 top_design_place:1_1 top_design_route:1_5
top_design:2 top_design_CTS:1_1 top_design_place:1_2
top_design:2_1 top_design_CTS:1_2 top_design_place:1_3
File name: top_design_route:1_5
Files of type:
Open Cancel

select library
Directory: /remote/cae826/mwcae/CAPI-Training/Intel_Training/Lab/C
answer
bin
macro_cell_library
std_cell_library
top_design_library
Select
Hide
CEL
EXP
NETL
ROUTE

Application In Hierarchy Walker (12)

Traverse Cells From Hierarchy Tree

- To perform this traversal you need to go through few lengthy steps:
 - Apply the hierarchical walker fundamental.
 - Cell to cell Instance to defining cell.
 - Walk through the hierarchy from the top cell down to the leaf cell recursively.
 - Write all information to cellList dump file.
 - Use cell traversal from input file methods to insert all the cell information into memory records, which later can be used with any application.

Traverse Cells From Hierarchy Tree Algorithms



- Apply the hierarchical walker fundamental
 - Cell to cell Instance to defining cell
- Open design library
 - Note that when a design library is opened, all referenced library are automatically opened.
- Cell to Cell Instances - **C-API**
 - `MWXdB_Get_Objects_ByType(cellId, MWX_CELLINST, &numberOfInsts, &instIdArrayPointer)`

Traverse Cells From Hierarchy Tree Algorithms (*cont*)



- Cell Instance to define cell – C-API
 - `MWXDb_Get_CellInst_CellInstMasterId`(cellId, cellInstId, &cellInstMasterId);
 - `MWXDb_Get_CellInstMaster_CellName`(cellId, cellInstMasterId, &cellNameString);
 - `MWXDb_Open_Cell`(cellNameString, accessMode, &childCellId);



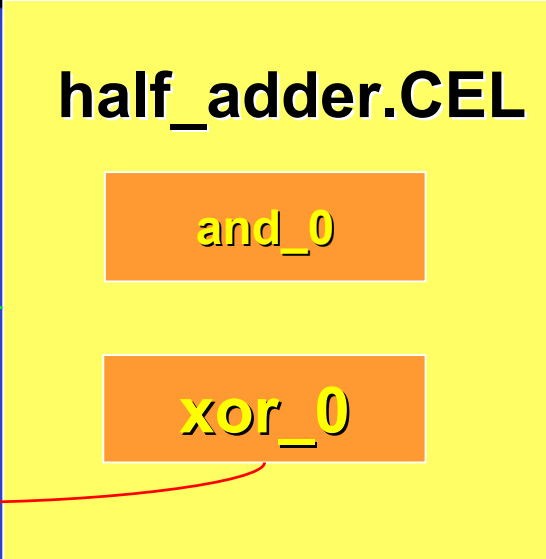
Milkyway Physical Cell Hierarchy



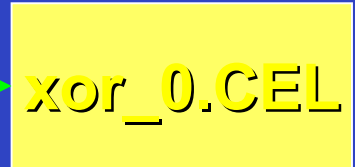
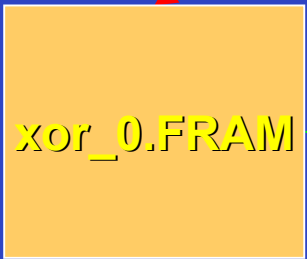
The Cell Instances in the top cell reference the FRAM view of the defining Cell.



FRAM view represents only blockage, pins, and vias. Cell Instances can not be seen from this view



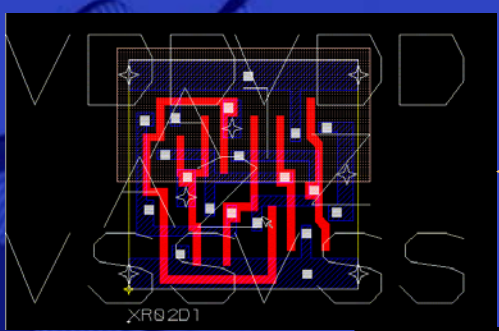
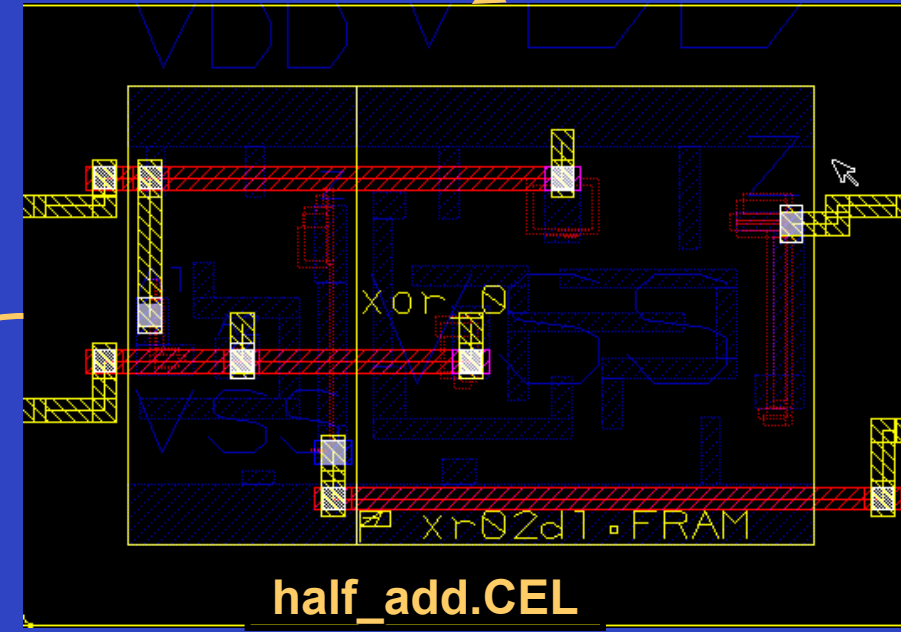
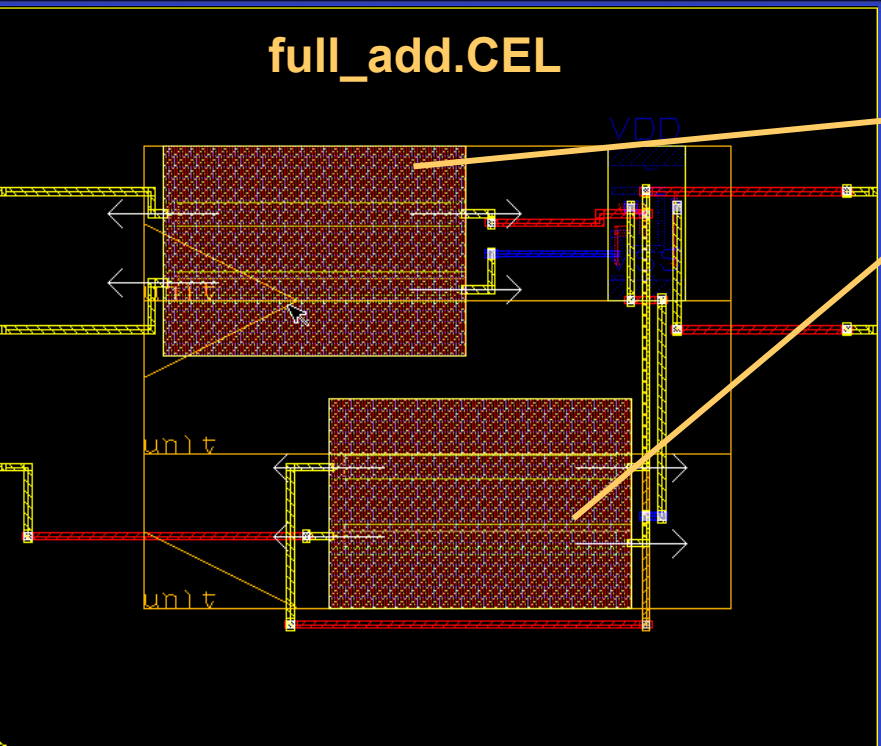
Only CEL views show the lower level Cell Instances



At the bottom of the hierarchy the cells have no cell Instances in the CEL view.



Milkyway Physical Cell Hierarchy example design



Application In Hierarchy Walker (17)

xr02d1.CEL

Your Interoperability Partner

Cell Traversal From Input File **SYNOPSYS**[®]

Cell_List File

LibraryName	CellName	ViewName	CellType	AccessMode
design	top_design	CEL	Other	w
/home/test/stdlib	bufbd3	FRAM	Standard	r
/home/test/mcrlib	nand	FRAM	Macro	r
.....				
.....				

Cell Traversal From Cellist GUI



The screenshot displays the Cellist GUI interface. The main window title is "mde :lab5.b". The menu bar includes "Tools", "Library", "Cell", and "Options". Below the menu bar, there are options for "Tech File", "Netlist In", and "Cell Library". The "HierarchyWalker" menu is open, showing options: "Traverse In Library...", "Traverse From Hierarchy...", and "Traverse From File...". An orange arrow points from the "Traverse From File..." option to the "Hierarchy Walker Menu: Traverse From File" dialog box.

The dialog box "Hierarchy Walker Menu: Traverse From File" contains the following elements:

- Buttons: "OK", "Cancel", and "Help".
- Text field: "Output File Name" with an empty input box.
- Section: "Stop View Options:" with a row of dropdown menus: "Not_Applicable", "CEL", "FRAM", "NETL", "PWR", "TIM", "ROUTE", and "EXP".
- Section: "Applicable Functions:" with a row of dropdown menus: "Not_Applicable", "Fetch_Net", and "Dump_CellInstances".

Cell Traversal from Input File **SYNOPSYS**[®]

- This feature...
 - Gets the data from the input file
 - Input file is the cellList output file from other two cell traversal methods.
 - User can also create or modify the cellList file.
 - Stores the information in a cellList linked list element.

LibraryName	CellName	ViewName	CellType	AccessMode
design	top_design	CEL	Other	w
/home/test/stdlib	bufbd3	FRAM	Standard	r
/home/test/mcrlib	nand	FRAM	Macro	r
.....				

- Data Management
- Retrieving database information
- Modification



Application In Hierarchy Walker (21)

Walk through hierarchy tree of the design and dump out cell information to output file to

– **Maintain design record**

- Find tree record from library
- Find cells from library
- Rearrange cell data between libraries

– **Keep record of referenced libraries' order**

– **Keep the record clean**

- Clean up duplicated cells to reduce unnecessary disk space used
- Archive only needed cell to new library for shipping or testing purpose
- Avoid unnecessary duplicated cell header

– **Modification**

- Combine all small blocks from different libraries to one library
- Reorganize blocks from one library to different libraries.
- Add prefix name of cells in new library

Outer loop to traverse hierarchy design or library to process every cell in one design into another design

- Translate from Milkyway Database to your database
- Fetch Nets/Instances information hierarchically
- Convert our pin/CellInstance/Macro information (I.e. location..) into your own floor plan input file
- Dump out layer information used in each cell

—

- Retrieve pins/ports in the nets
 - List pins & pin instances information that are associated with the net
 - List pins from port
 - List ports port instances information that are associated with the net
- Dump out I/O information
 - I/O pins name and locations
 - I/O pins direction
- Dump out objects associate with Net
 - Horizontal & vertical wires
 - Total wire length for each net

- Dump out cell Instances information in one cell
 - List of cell Instances and their parent cell
 - Cell instance Master
 - Total count of cell instance Master in one cell
- Dump out statistic of cell Instance
 - List of cells instantiated per cell instance master
 - Number of inserted buffers
- Dump out information for
 - VIAS & Contact Array

- Calculate total number of wire lengths used in different layers
- Dump out layer area for density
- Dump out objects in each layer
 - Vertical/horizontal wire objects
 - List of paths, rectangles, polygon
 - List of texts and the location
 - Pins on each metal layer

- Add extra text information into the design
- Find invalid objects with Null Net ObjectId
 - Output invalid object for investigation
 - Delete invalid object
- Modification guidelines
 - Users can only **create** new geometry objects or **delete** objects that are not associated with connectivity
 - Do not use CAPI function to modify the techfile information. Use loading techfile instead.
 - Users will not be allowed to modify data of the existing objects in the design.
 - Delete the original object first
 - Create new object to replace old deleted object

Description:

- Use all three cell traversal methods to dump out the list of cell information to the output file.
- Demonstrate an Add Text Application
 - Add cellName to all cells from a input cell list

Do Cell Traversal In One Library



Hierarchy Walker Menu: Traverse In Library

OK Cancel Help

Library Name Browse...

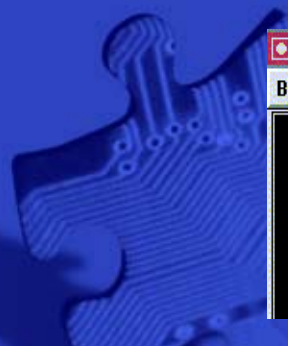
Output File Name

Stop View Options:

Not_Applicable CEL FRAM NETL PWR TIM ROUTE EXP

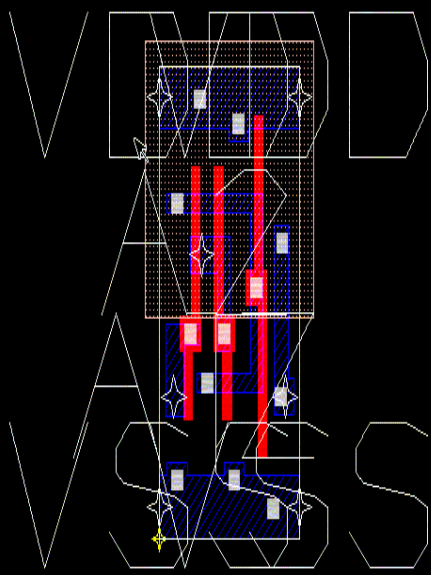
Applicable Functions:

Not_Applicable Fetch_Net Dump_CellInstances Add_Text



```
emacs@elfowl
Buffers Files Tools Edit Search Mule Help
/remote/cae826/mwcae/lab5/lab5.b/std_cell_library an02d1 CEL Standard r
/remote/cae826/mwcae/lab5/lab5.b/std_cell_library xr02d1 CEL Standard r
/remote/cae826/mwcae/lab5/lab5.b/std_cell_library or02d1 CEL Standard r
/remote/cae826/mwcae/lab5/lab5.b/std_cell_library unitile CEL Other r
```

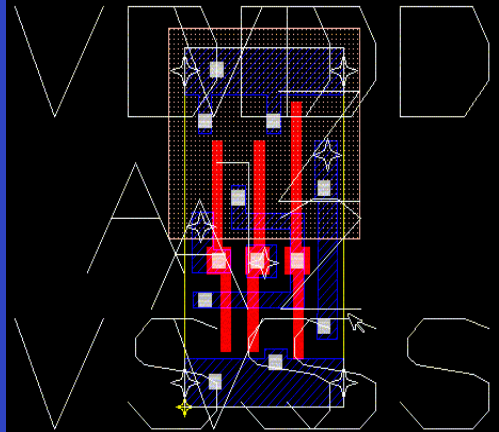
Layout of Cells In Library



OR02D1
2-INPUT OR, 1X DRIVE
Rev. main.4
14-Jul-99 16:23
(C) Copyright 1999 Avant! Inc.

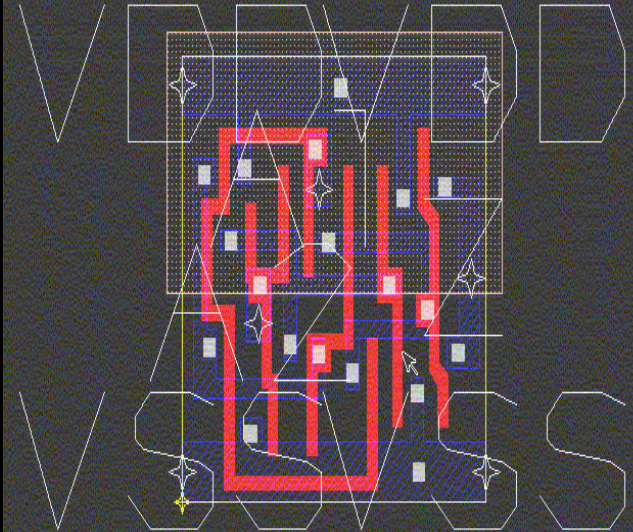
OR02D1.CEL

Application In Hierarchy Walker (30)



AN02D1
2-INPUT AND, 1X DRIVE
Rev. main.1
17-Jun-99 18:00
(C) Copyright 1999 Avant! Inc.

AN02D1.CEL



XR02D1
2-INPUT EXCLUSIVE OR, 1X DRIVE
Rev. main.4
14-Jul-99 14:21
(C) Copyright 1999 Avant! Inc.

XR02D1.CEL



Do Cell Traversal In Hierarchy Tree



Hierarchy Walker Menu: Traverse From Hierarchy

OK Cancel Help

Library Name Browse...

View Name Select...

Cell Name Browse...

Output File Name

Stop View Options:

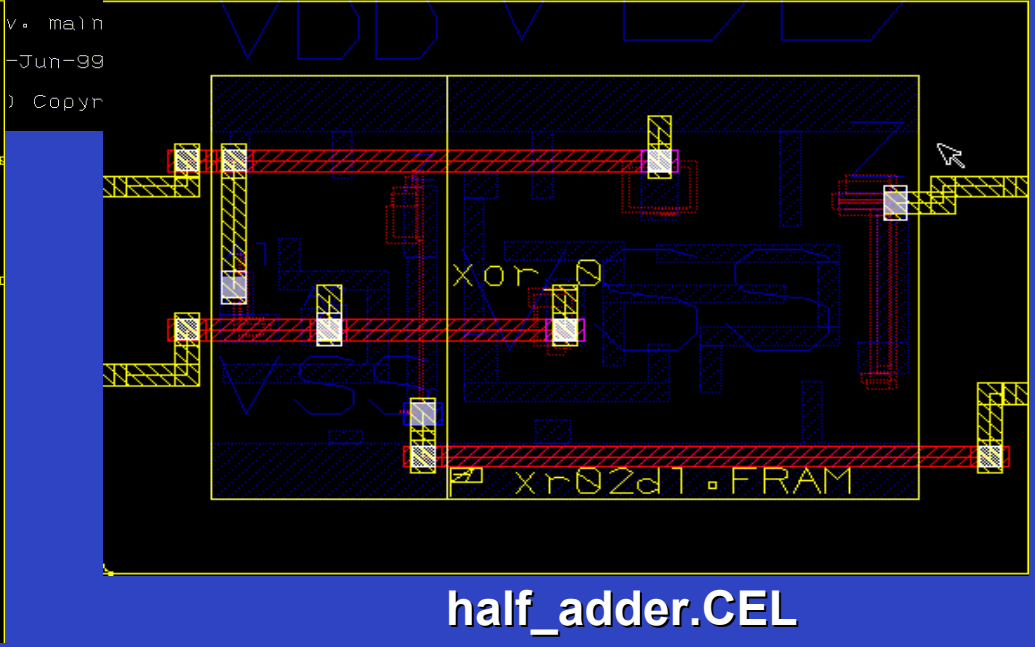
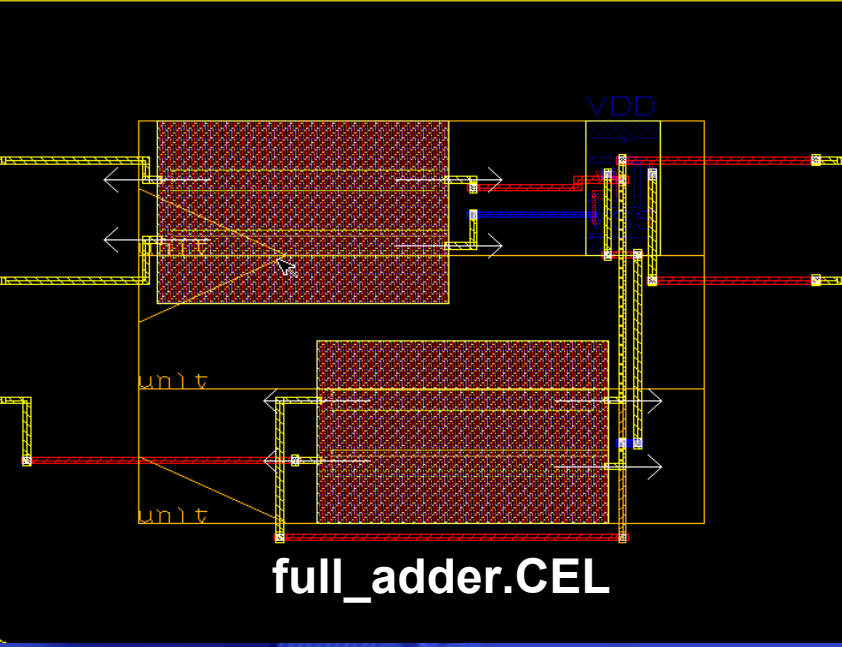
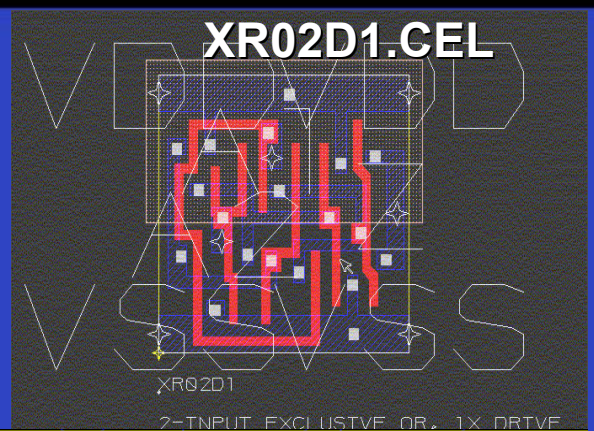
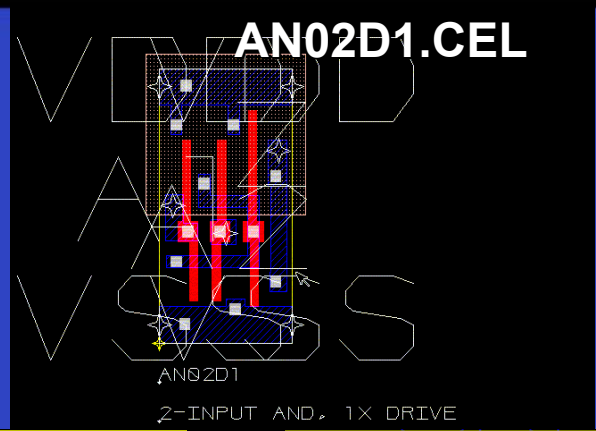
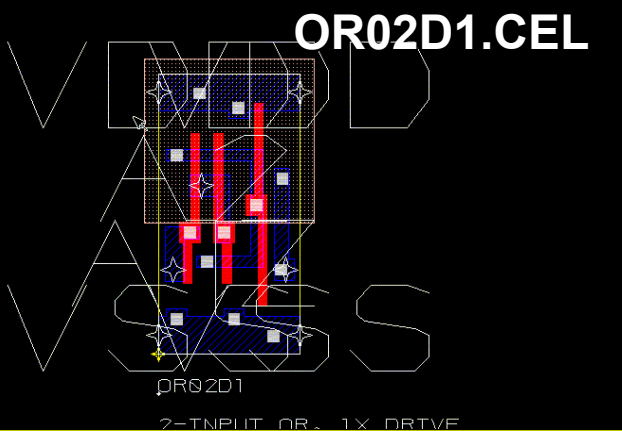
Not_Applicable CEL FRAM NETL PWR TIM ROUTE EXP

Applicable Functions:

Not_Applicable Fetch_Net Dump_CellInstances Add_Text

```
emacs@elfowl
Buffers Files Tools Edit Search Mule Help
/remote/cae826/mwcae/lab5/lab5.b/lib_full_adder full_adder CEL Other r
/remote/cae826/mwcae/lab5/lab5.a/lib_half_adder half_adder CEL Macro r
/remote/cae826/mwcae/lab5/lab5.a/std_cell_library an02d1 CEL Standard r
/remote/cae826/mwcae/lab5/lab5.a/std_cell_library xr02d1 CEL Standard r
/remote/cae826/mwcae/lab5/lab5.a/std_cell_library or02d1 CEL Standard r
```

Layout of Cells In Hierarchy Tree



Generating cellList.txt file

```

emacs@elfowl
Buffers Files Tools Edit Search Mule Help
/remote/cae826/mwcae/lab5/lab5.b/std_cell_library an02d1 CEL Standard r
/remote/cae826/mwcae/lab5/lab5.b/std_cell_library xr02d1 CEL Standard r
/remote/cae826/mwcae/lab5/lab5.b/std_cell_library or02d1 CEL Standard r
/remote/cae826/mwcae/lab5/lab5.b/std_cell_library unitTile CEL Other r
/remote/cae826/mwcae/lab5/lab5.b/lib_full_adder full_adder CEL Other r
/remote/cae826/mwcae/lab5/lab5.a/lib_half_adder half_adder CEL Macro r
/remote/cae826/mwcae/lab5/lab5.a/std_cell_library an02d1 CEL Standard r
/remote/cae826/mwcae/lab5/lab5.a/std_cell_library xr02d1 CEL Standard r
/remote/cae826/mwcae/lab5/lab5.a/std_cell_library or02d1 CEL Standard r

```

Remove this non-standard cell

Remove these repeated cells

cellList.txt

```

emacs@elfowl
Buffers Files Tools Edit Search Mule Help
/remote/cae826/mwcae/lab5/lab5.a/lib_full_adder full_adder CEL Other r
/remote/cae826/mwcae/lab5/lab5.a/lib_half_adder half_adder CEL Macro r
/remote/cae826/mwcae/lab5/lab5.a/std_cell_library an02d1 CEL Standard r
/remote/cae826/mwcae/lab5/lab5.a/std_cell_library xr02d1 CEL Standard r
/remote/cae826/mwcae/lab5/lab5.a/std_cell_library or02d1 CEL Standard r

```

Do Cell Traversal From File



```
emacs@ellowl  
Buffers Files Tools Edit Search Mule Help  
/remote/cae826/mwcae/lab5/lab5.b/std_cell_library an02d1 CEL Standard r  
/remote/cae826/mwcae/lab5/lab5.b/std_cell_library xr02d1 CEL Standard r  
/remote/cae826/mwcae/lab5/lab5.b/std_cell_library or02d1 CEL Standard r  
/remote/cae826/mwcae/lab5/lab5.b/std_cell_library unitFile CEL Other r  
/remote/cae826/mwcae/lab5/lab5.b/lib_full_adder full_adder CEL Other r  
/remote/cae826/mwcae/lab5/lab5.a/lib_half_adder half_adder CEL Macro r
```

cellList.txt

Hierarchy Walker Menu: Traverse From File

OK Cancel Help

Output File Name

Stop View Options:

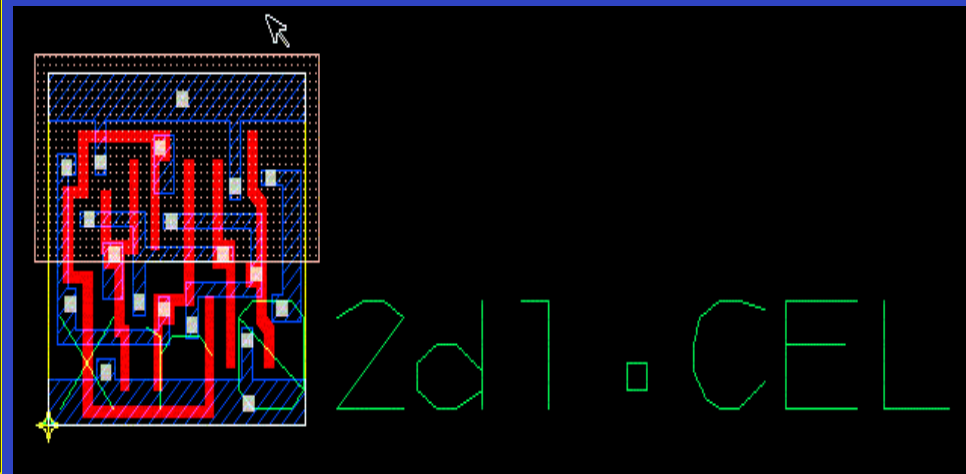
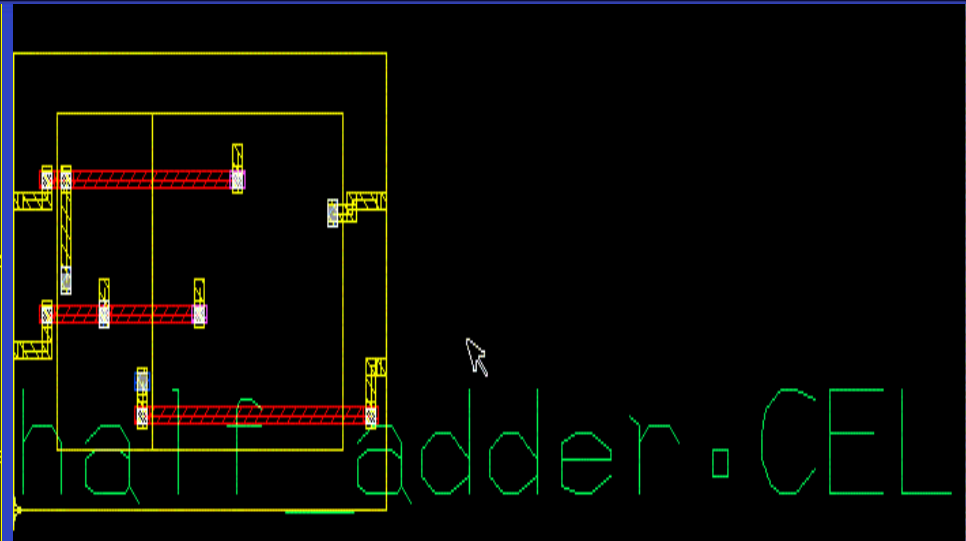
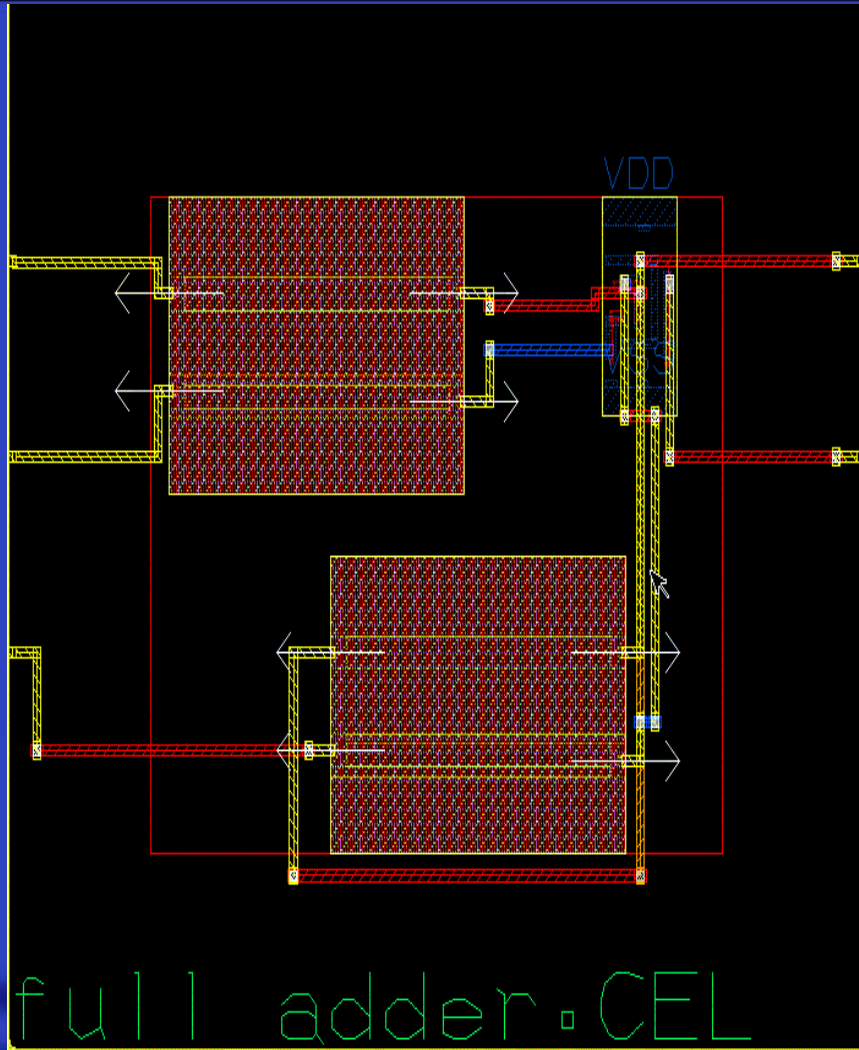
◆ Not_Applicable ◆ CEL ◆ FRAM ◆ NETL ◆ PWR ◆ TIM ◆ ROUTE ◆ EXP

Applicable Functions:

◆ Not_Applicable ◆ Fetch_Net ◆ Dump_CellInstances ◆ Add_Text

Cells layout after applying Add Text Application

SYNOPSYS®



- Hierarchy Walker program provides a way as outer loop to process the whole design hierarchically.
- Help to assess Milkyway database easier.
- Example of Hierarchy Walker program can be found at MAP-in website

```
exit(MWXSuccess);
```

