Reducing Library Design Effort with Cadabra Layout Automation

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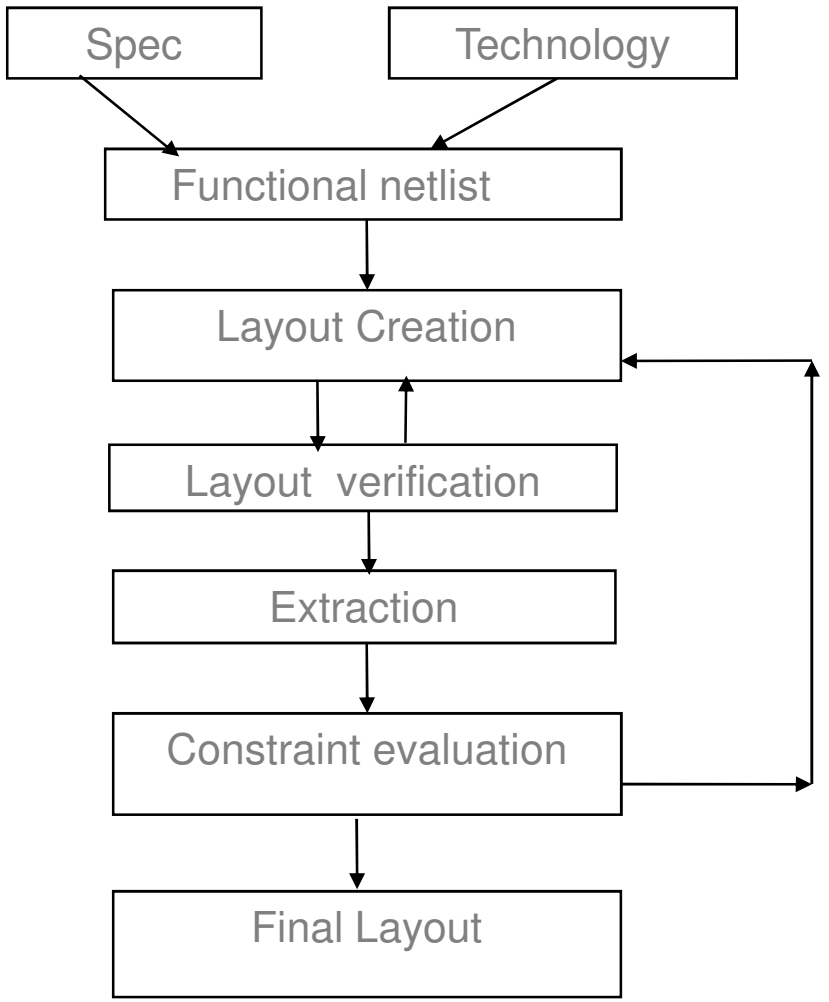
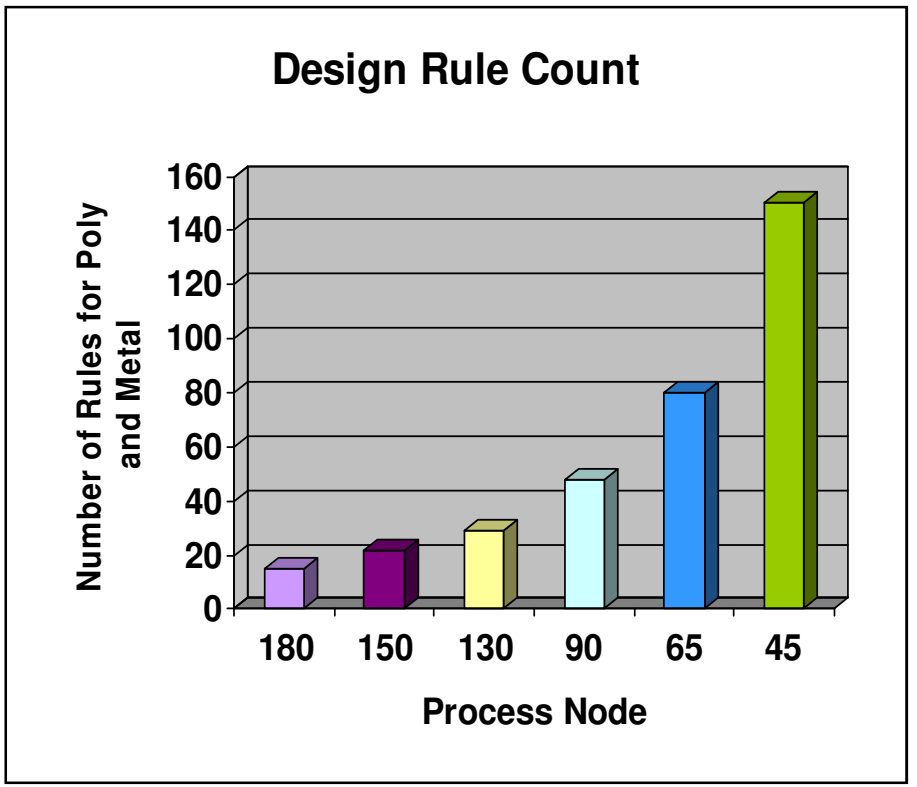
Standard Cell Design Flow



Why Automate Layout Creation?

- Time taken by Layout Creation
- Design Rule Complexity
  - Multiple complex design rules
  - Prioritized preferred rules
- Library Richness
  - Many more cell variants per library driven by performance needs
- Design Rule Changes
  - Frequent process rules changes

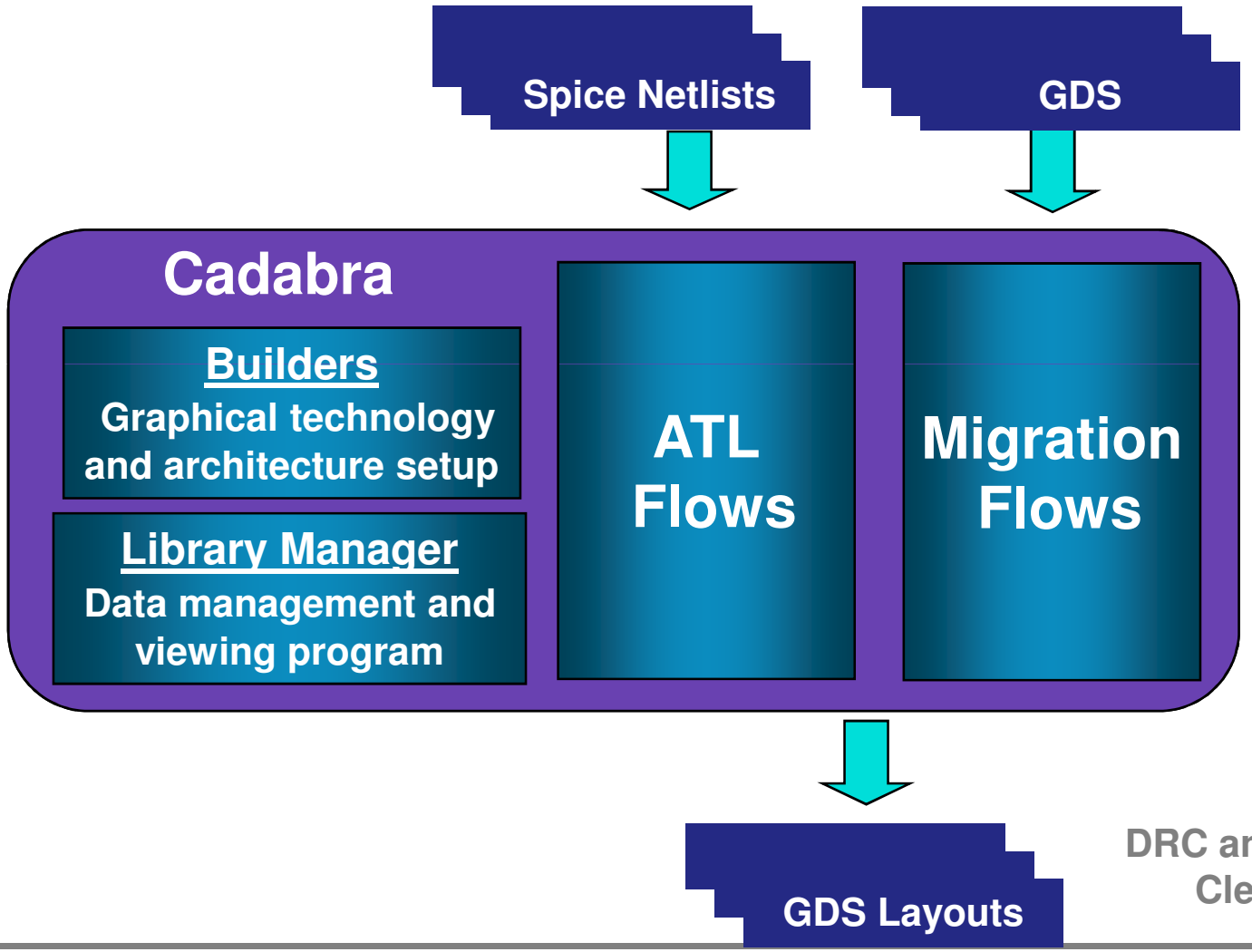


Automation is Essential!

Cadabra – Synopsys Solution for Automated Layout Generation

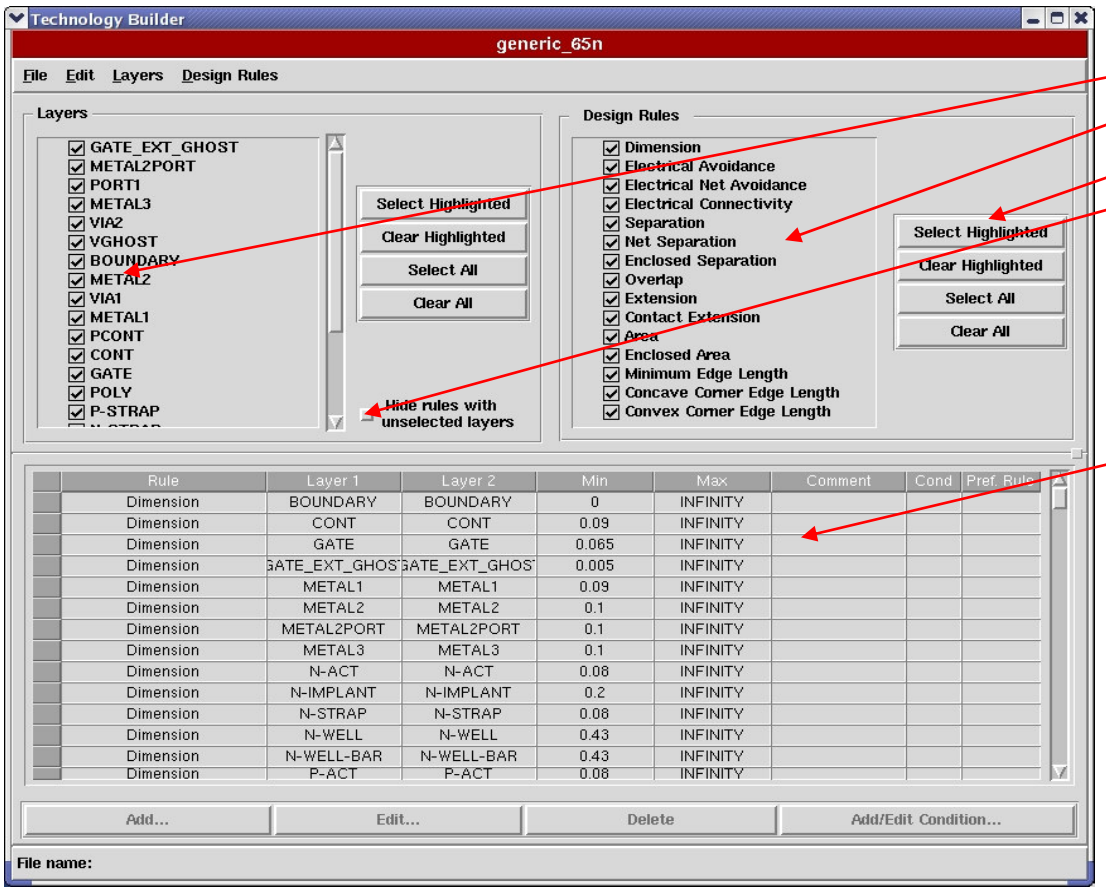
- Ease of Use (EoU) of Cadabra
- Layout Creation Flows
- LSI Adoption of Cadabra
- Future Enhancements Proposed

Cadabra Functional Flow



Technology Builder

- GUI Interface to add Design Manual Rules

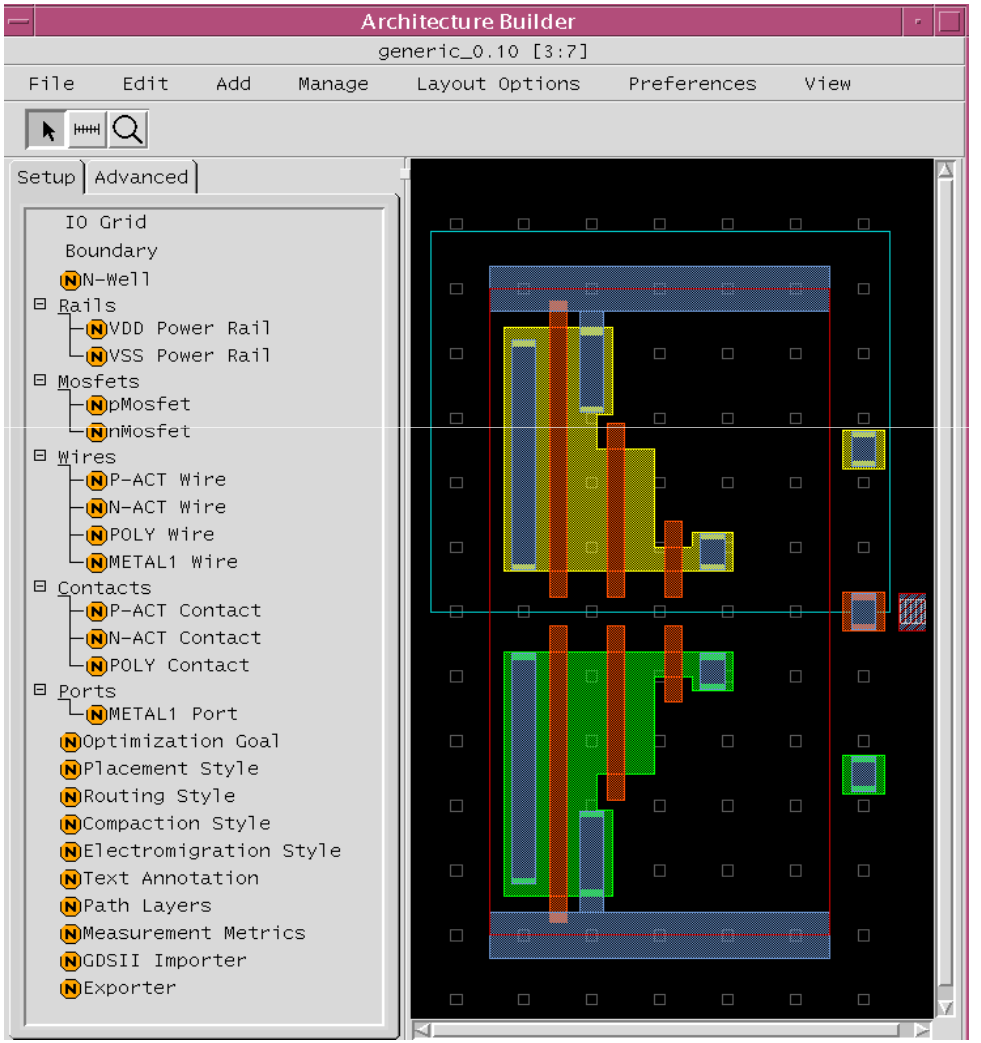


Layer Based, Rule Based View Filters

Spreadsheet view of design rules

Architecture Builder Interface

- GUI interface to define :
  - Cell template
  - Devices
  - Layout Preferences
  - Importers/Exporters

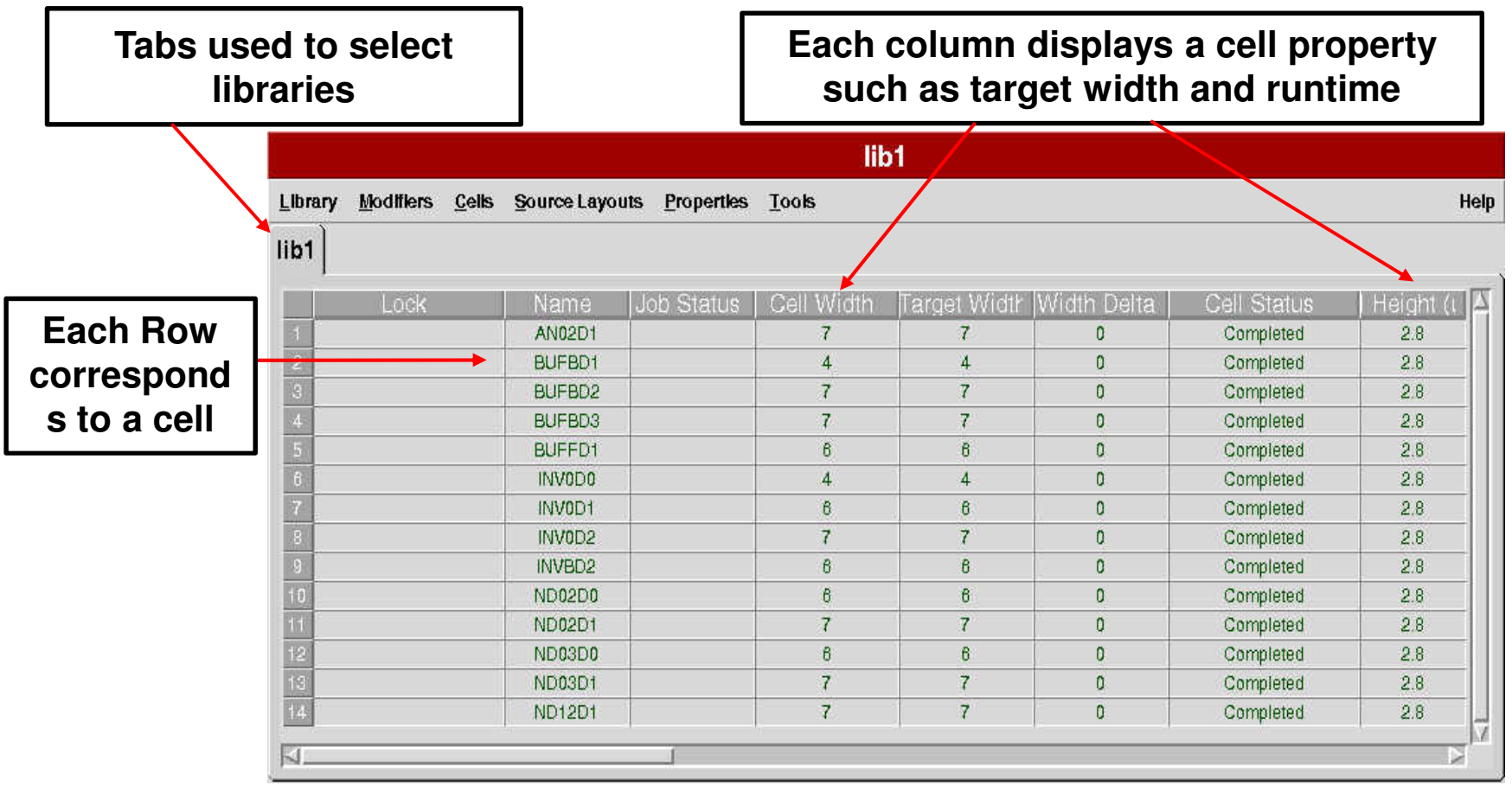


Rapid Start Kits (RSK)

- Can use the architecture and the technology builder ro create the setup from scratch OR use RSK
- RSK captures all the design rules for a particular process node.
- Synopsys has RSK for all common processes 250nm->45nm.

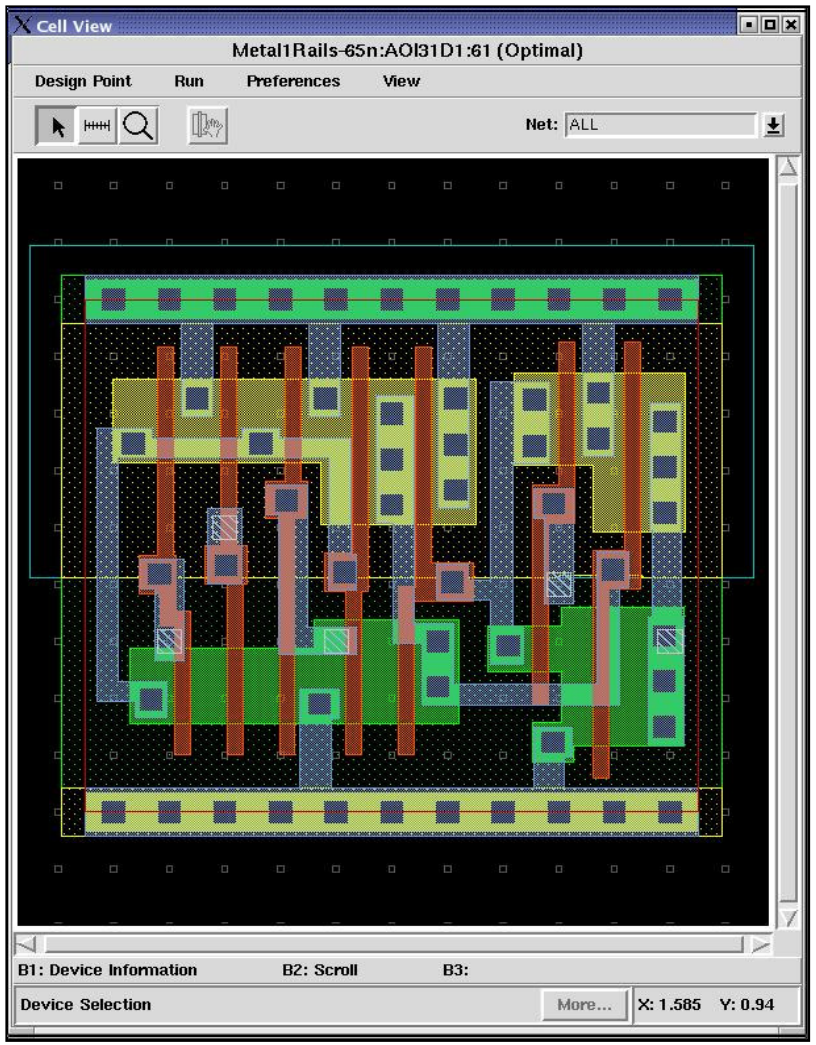
Library Manager

- Spreadsheet view of cells & status



	Lock	Name	Job Status	Cell Width	Target Width	Width Delta	Cell Status	Height (u
1		AN02D1		7	7	0	Completed	2.8
2		BUFBD1		4	4	0	Completed	2.8
3		BUFBD2		7	7	0	Completed	2.8
4		BUFBD3		7	7	0	Completed	2.8
5		BUFFD1		6	6	0	Completed	2.8
6		INV0D0		4	4	0	Completed	2.8
7		INV0D1		6	6	0	Completed	2.8
8		INV0D2		7	7	0	Completed	2.8
9		INVBD2		6	6	0	Completed	2.8
10		ND02D0		6	6	0	Completed	2.8
11		ND02D1		7	7	0	Completed	2.8
12		ND03D0		6	6	0	Completed	2.8
13		ND03D1		7	7	0	Completed	2.8
14		ND12D1		7	7	0	Completed	2.8

Automated Transistor Layout (ATL) flow



SPICE Netlist

↓

Placed Symbolic Layout

↓

Routed Symbolic Layout

↓

Compacted Symbolic Layout

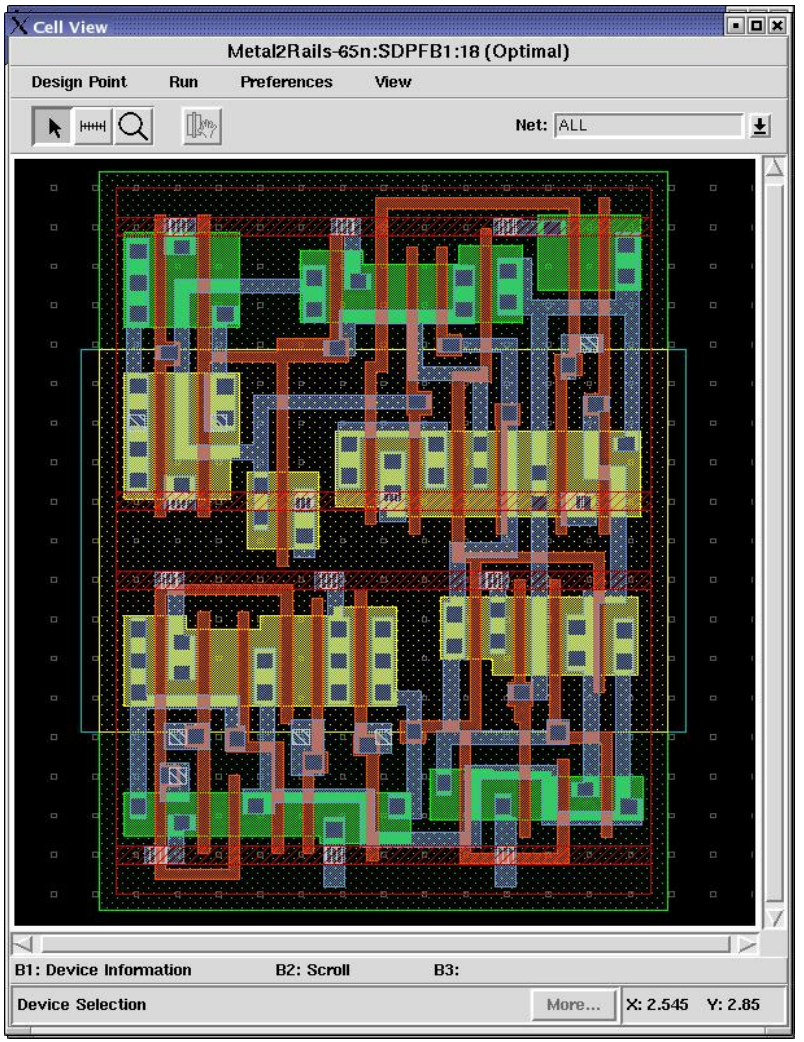
↓

Layout

↓

GDS

Migrate GDS flow



Source Layout + Netlist

↓

Imported Symbolic Layout

↓

Compacted Symbolic Layout

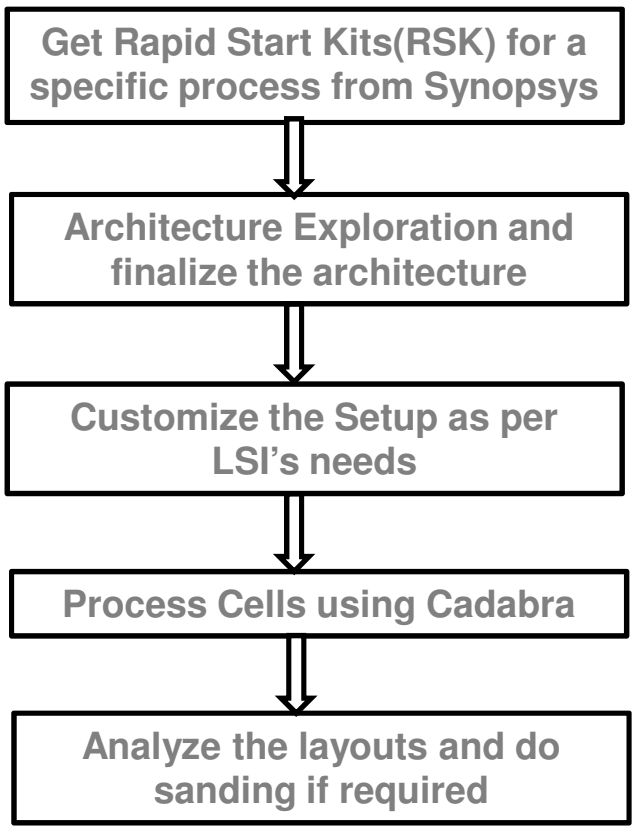
↓

Layout

↓

GDS

LSI Adoption of Cadabra

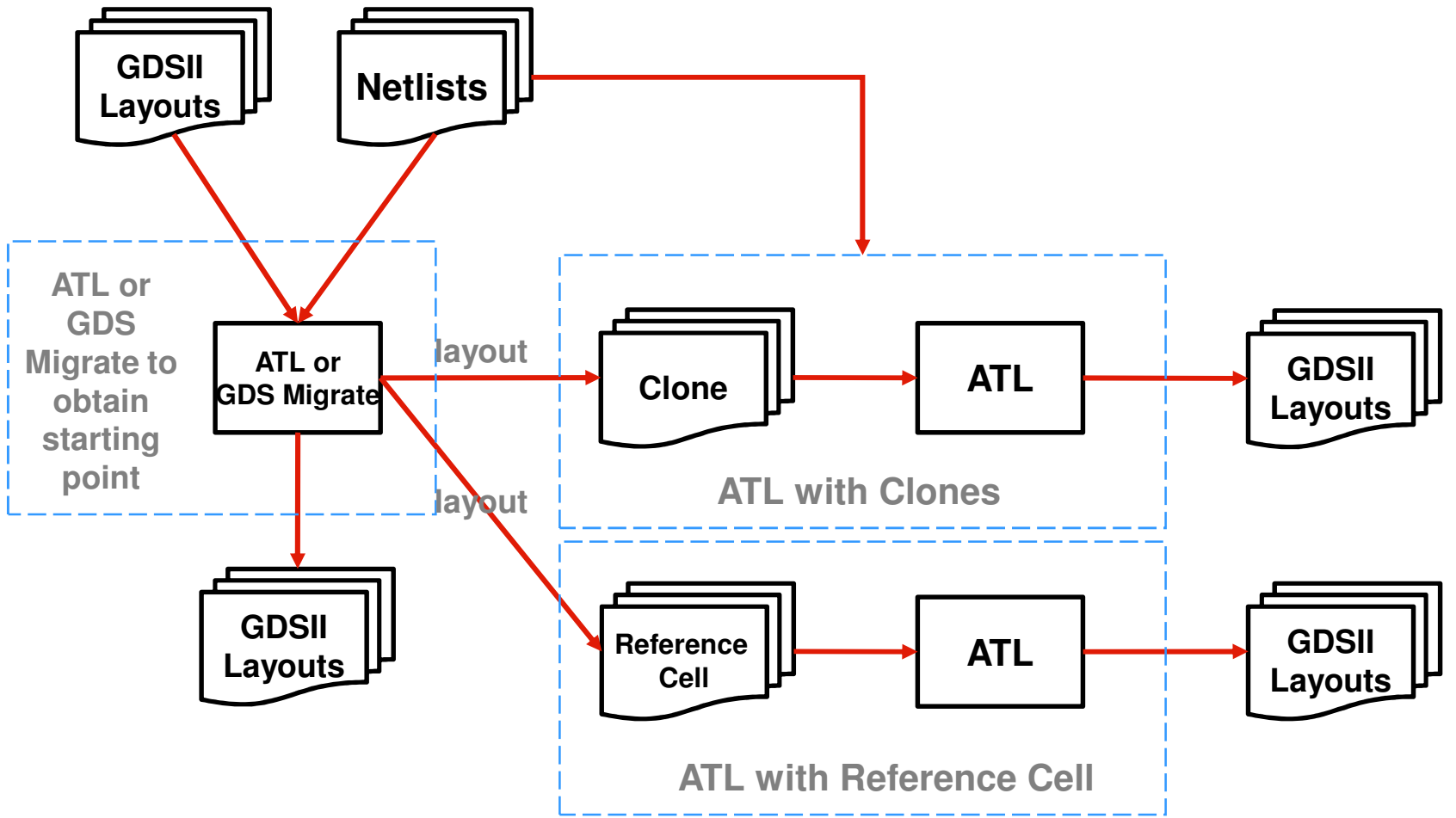


LSI Adoption of Cadabra

- Some advanced flows used by LSI
  - Reference Cell and Cloning Flow
  - ECO Migration
  - Manual Assisted Flow
- Reference Cell and Cloning Flow
  - Design Reuse Concept
  - Based on other cells layout
  - More consistency between the layouts
  - Pre-requisite for Reference Cell Flow

LSI Adoption of Cadabra

- Reference Cell and Cloning Flow

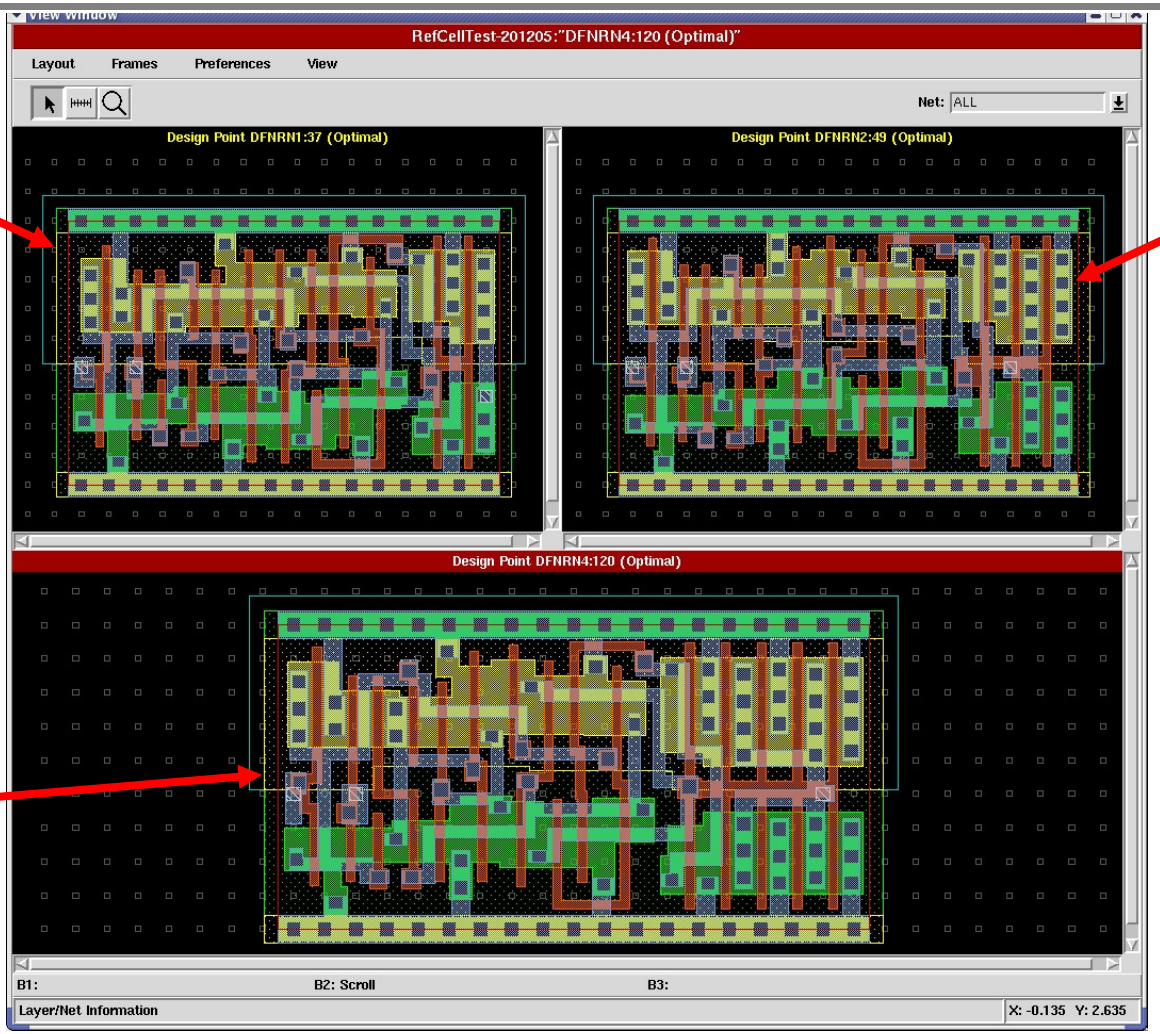


Reference Cell Flow

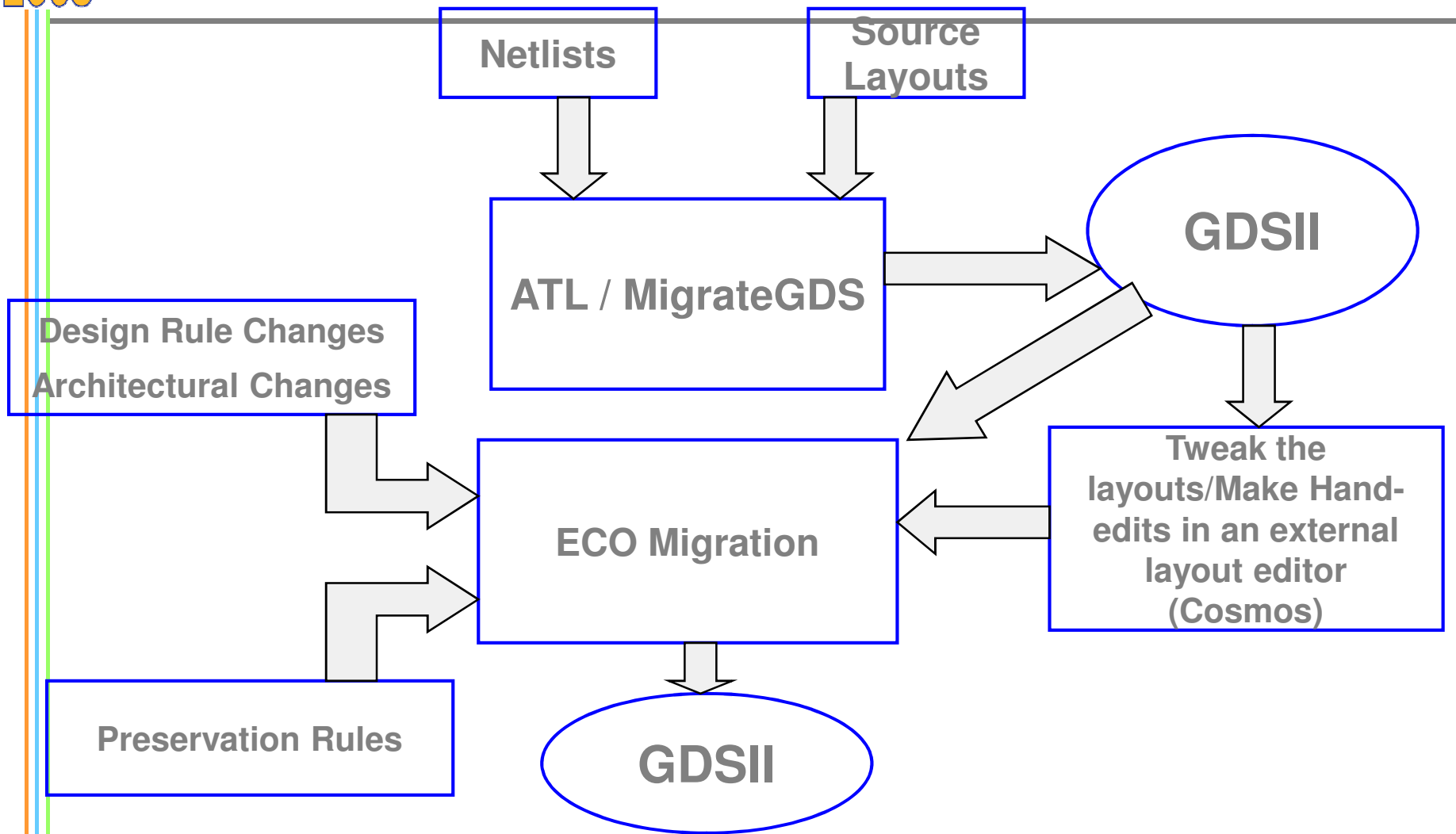
Child Cell

Child Cell

Reference Cell



LSI Adoption of Cadabra

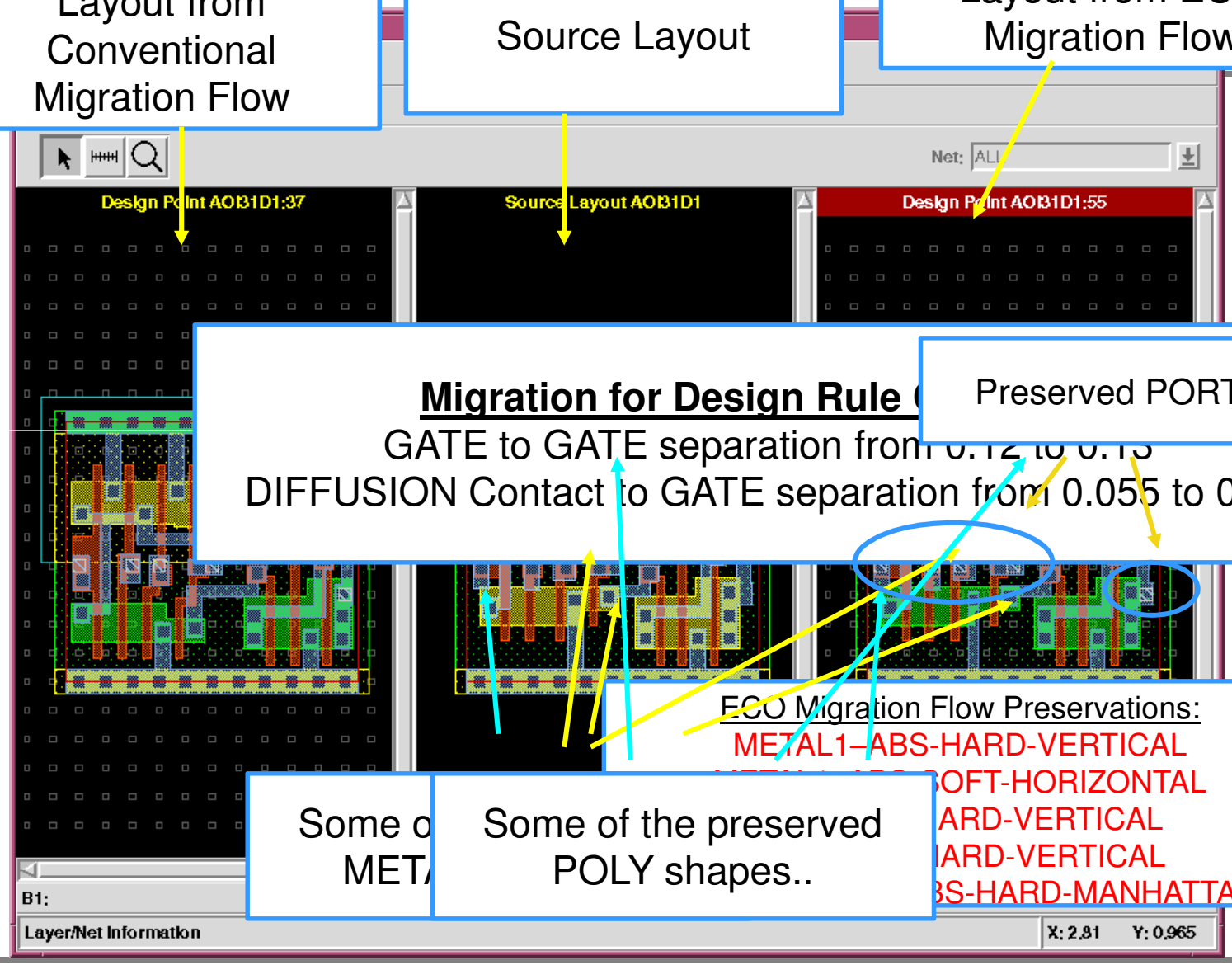


ECO Migration Flow

Layout from Conventional Migration Flow

Source Layout

Layout from ECO Migration Flow



Migration for Design Rule (

GATE to GATE separation from 0.12 to 0.13

DIFFUSION Contact to GATE separation from 0.055 to 0.06

Preserved PORTs..

ECO Migration Flow Preservations:

METAL1–ABS-HARD-VERTICAL

SOFT-HORIZONTAL

ARD-VERTICAL

IARD-VERTICAL

3S-HARD-MANHATTAN

Some o

MET

Some of the preserved POLY shapes..

LSI Adoption of Cadabra – Manual Assist Flows

- Incompletion of cells through Cadabra
  - Unrouted cells
  - Infeasibilities
- Solution
  - Manual layout completion
  - Edit in Cadabra cell editor & complete the flow
- Manual Assist Flow in Cadabra
  - In case of unrouted cells
    - Use cell editor to complete the route
    - Pass it on to compactor
  - In case of infeasibilities
    - Use compaction browser to understand the infeasibilities
    - Use the cell editor to solve those infeasibilities

LSI Adoption of Cadabra

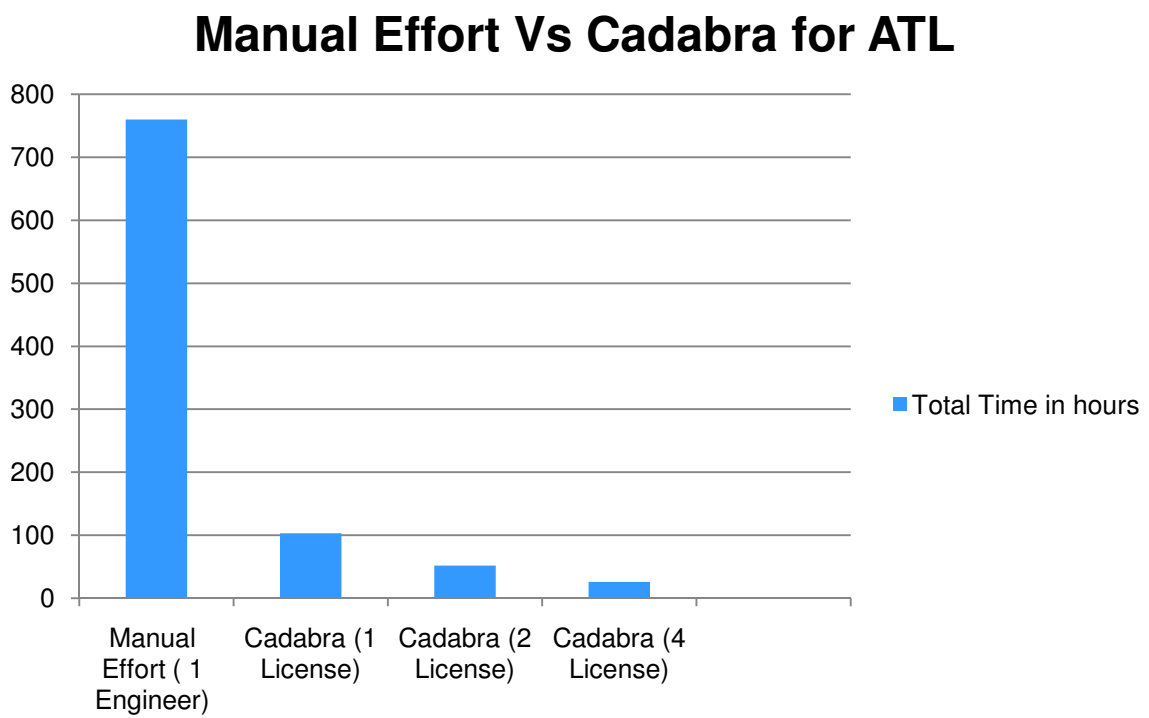
- Double Height Cell (DHC) Creation
  - Created using both ATL and Migrate-GDS Flows
  - 3 different row styles
  - Same architecture to create both Single and double height cells.
- Distributed Processing
  - Least time for a cell through parallel processing
  - Best choice between multiple layouts for the same cell

LSI Adoption of Cadabra - Statistics

- Library Size – 100 Cells
- 40 simple cells(4-10 mos), 40 complex combinationals(20-25 mos) and 20 complex flops (50-60 mos)
- Flow run – ATL

Cell Type	Time taken to create layouts manually (1 Engineer)	Time taken to generate layouts from Cadabra (1 license)
Simple	40 * 1.5hr = 60 hrs	40 * 5 min = 3.33 hrs
Complex Combinationals	40 * 8hr = 320 hrs	40 * 1hr = 40 hrs
Complex flops	20 * 19hr = 380 hrs	20 * 3hr = 60 hrs
Total Time (100 cell library)	**760hrs**	**103.3 hrs**

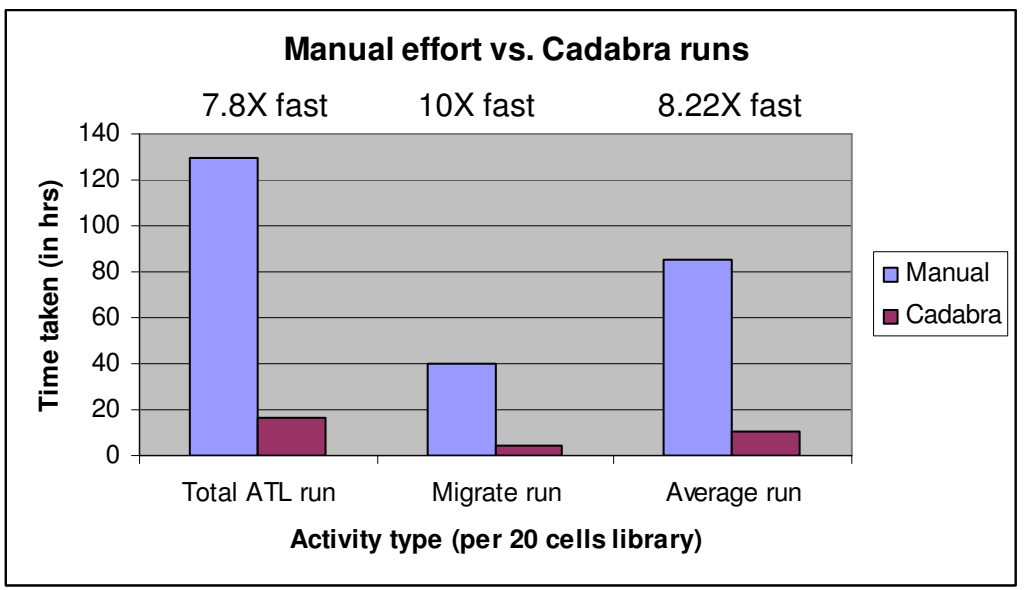
LSI Adoption of Cadabra



LSI Adoption of Cadabra – Statistics

- Time taken by manual effort Vs Cadabra for ECO Migration

Library Information	Time taken to create Layouts Manually (1 Engineer)	Time taken to create Layouts using Cadabra (with 1 License)
20 cells	1 week (40 hours)	4 hours (including sanding)



Future Expectations

- Incorporate Parasitic aware extractions
  - Should be able to limit the parasitics on the important nets
- Work on non-grid based libraries
  - Memory cells
  - Migrate flow for Analog libraries

Conclusion

- Automation of Layout is “a must” as the process nodes shrink
- Cadabra has been successful at LSI. The advantages of using Cadabra are
  - Faster Time To Market
  - IP re-use
  - Optimized Libraries
  - Better Yield

Q/A ?

Thank You