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Applications of AI and Machine Learning in Interposer PCB Design

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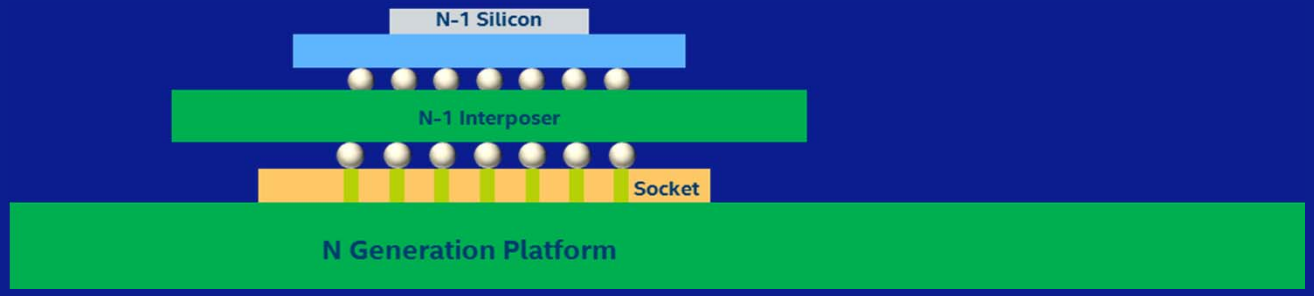
Agenda

- Interposer, design process, and bottlenecks
- Challenges of manual layout
- Limitations of legacy auto and interactive routers
- New AI-based smart router architecture and themes
- Case studies
- Summary
- Next steps

Interposer Usage Model



- Use of N-1 interposer with previous generation silicon to validate next generation platform
- Facilitate platform checkout and early deployment before new silicon arrival

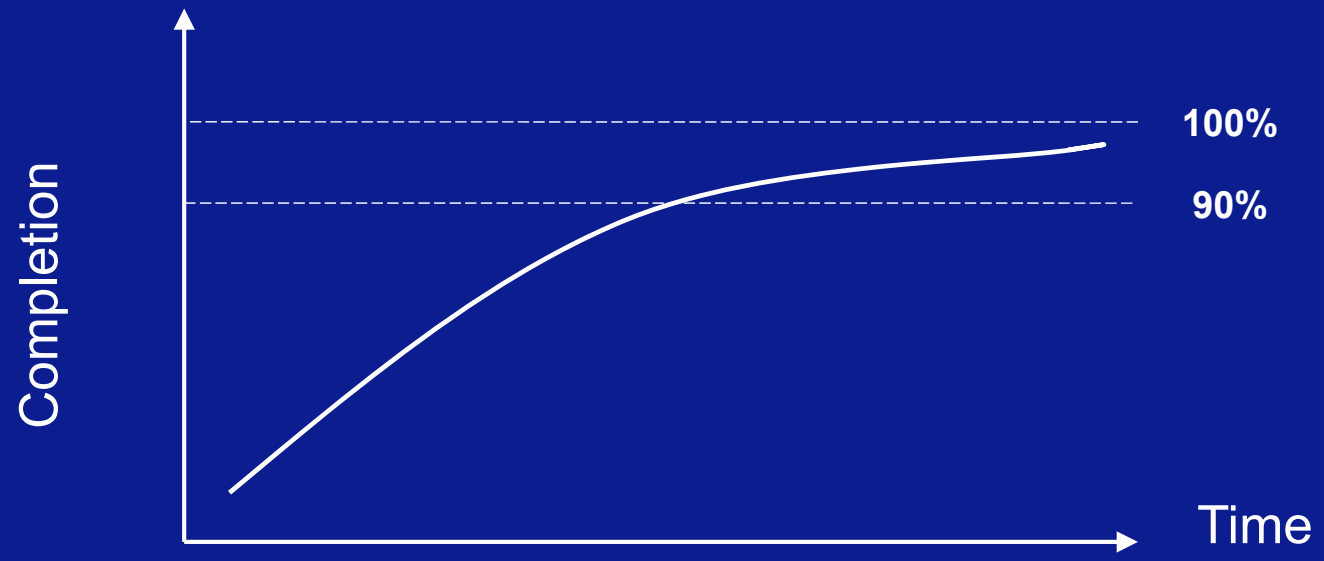
N-1 Interposer Design Process

- Collect customers' requirements
- Define the pin mappings between N and N-1 silicon chips
- Netlist generation using System Architecture or scripts
- PCB board stackup planning
- Layout constraints creations
- Board components placement and routings
- Layout review including Signal Integrity (SI) and Power Integrity (PI) optimizations

Technical Challenges

- High density and high pin count package
- Very small Interposer geometry and limited routing space
- Irregular routing patterns
- Complex and stringent constraints including SI/PI requirements
- Iterative process to get the optimal routing solution

Layout Efficiency Bottlenecks



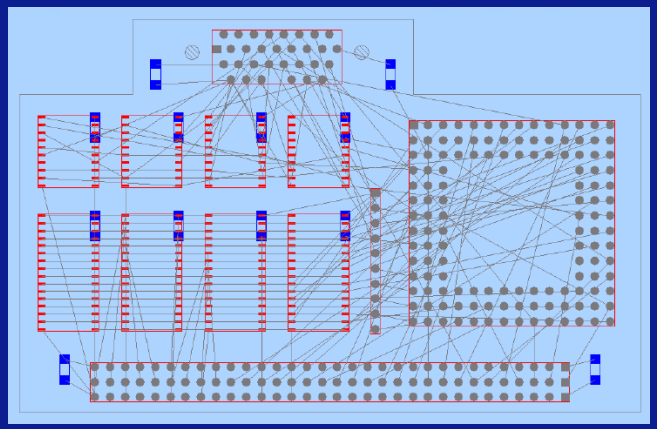
Manual Routing Challenges for Complex Design

- Most of the time is spent to route the remaining 10% nets
- If no satisfactory solution is found, most of previous routings have to be erased
- Have to explore new strategies and start over
- This manual trial and error process continues until all nets are routed

Manual Routing Inefficiency

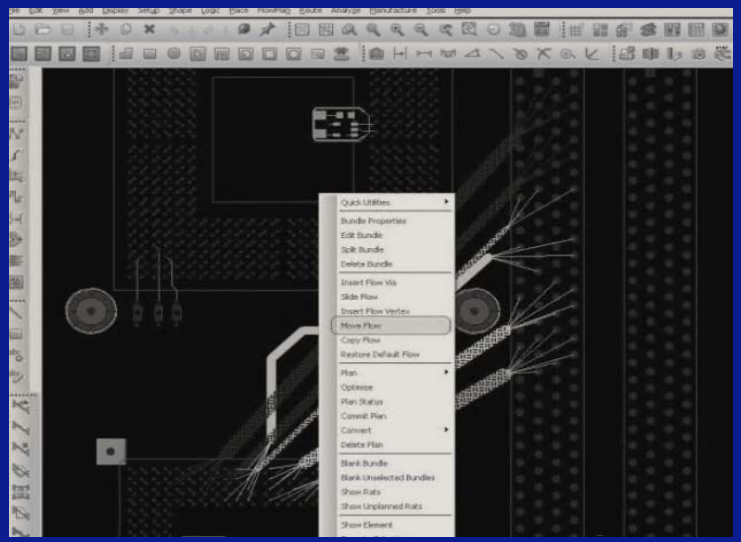
- Iterative process and needs user intervention
- Sequential process and only one strategy can be done at a time
- Very labor intensive
- Costly on time and layout resources
- Low return on investment

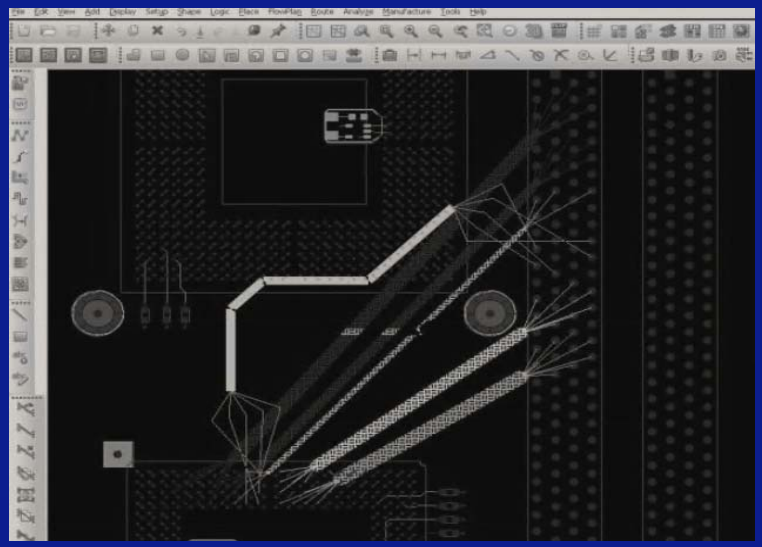
Legacy Auto Routing Process



- Use GUI and Do script files. Ok for very simple board
- Significant time has to be spent on debugging DO file and scripts
- Multiple steps process

Modern Interactive Routers (GRE)



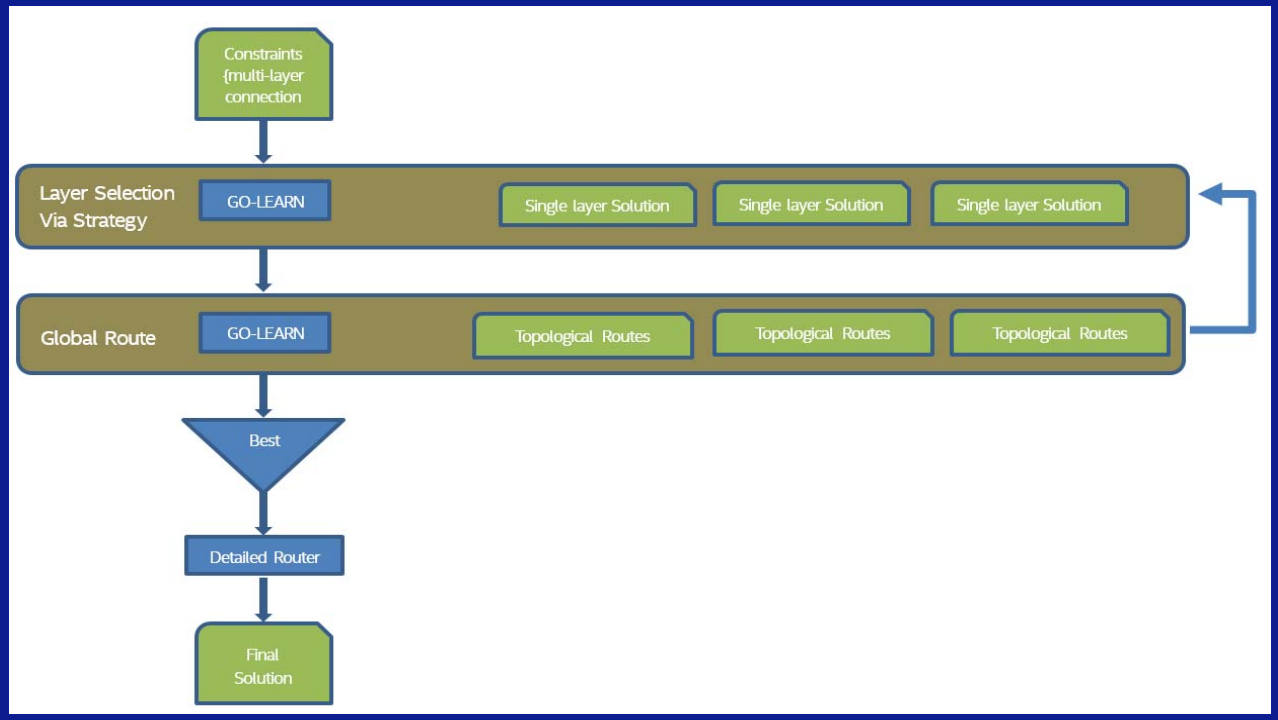


Use of bundles to pass design intent. Time consuming. Need user interventions.

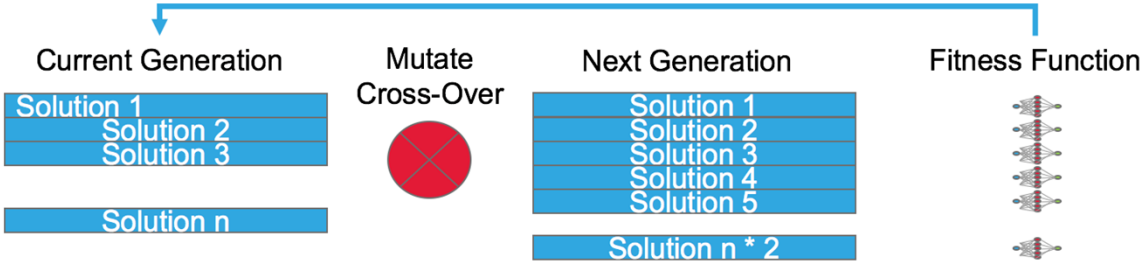
A New AI Smart Router

- Ultimate one click operation, smart and fully automatic
- No user involvement once setup is completed
- Can handle complex irregular PCB layout such as interposers
- AI smart router integrates multiple tools such as OrbitIO, package router, and PCB editor

AI Smart Router Flow



Machine Learning Based AI Router



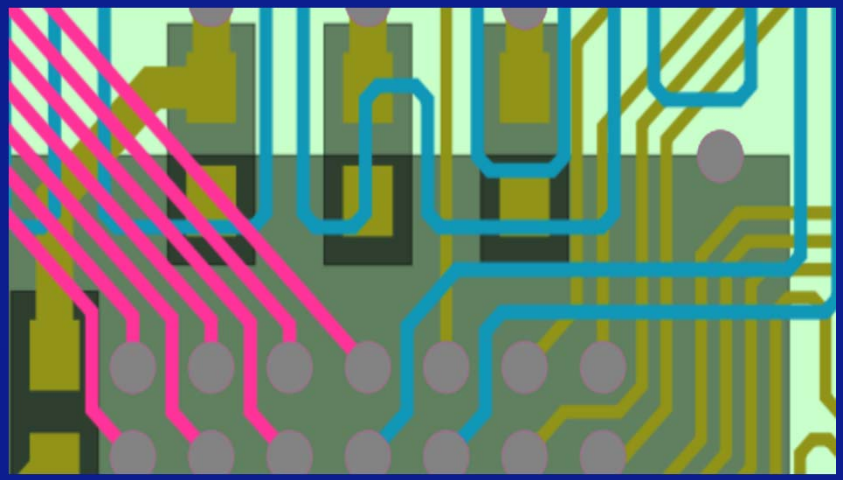
The fitness function for each solution is a trained neural net scoring each one concurrently based on previous design patterns deemed to produce good routing/placement solutions.

AI Routing Process

- AI global router is used for topological routing
- Via patterns exploration and learning
- A detailed router transforms the topological routes into serpentine routes
- Delay and phase tuning
- Global and detailed routers co-optimization

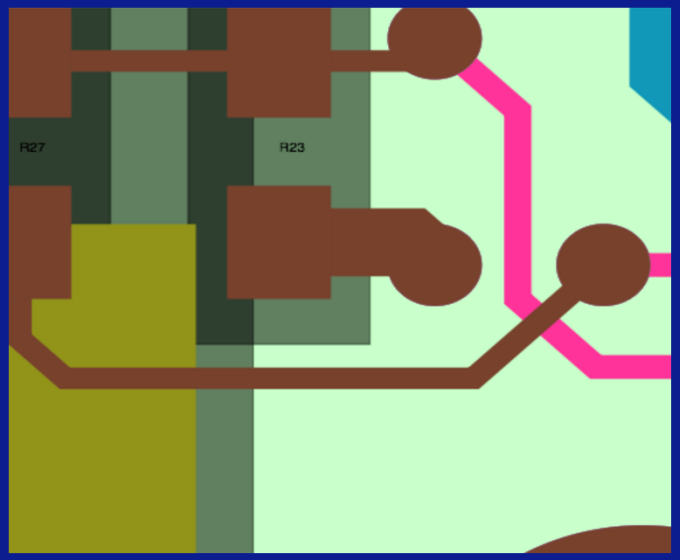
Via Patterns Learning

- **Dense BGA escape patterns, where concentric rings of pins must escape to different layers**

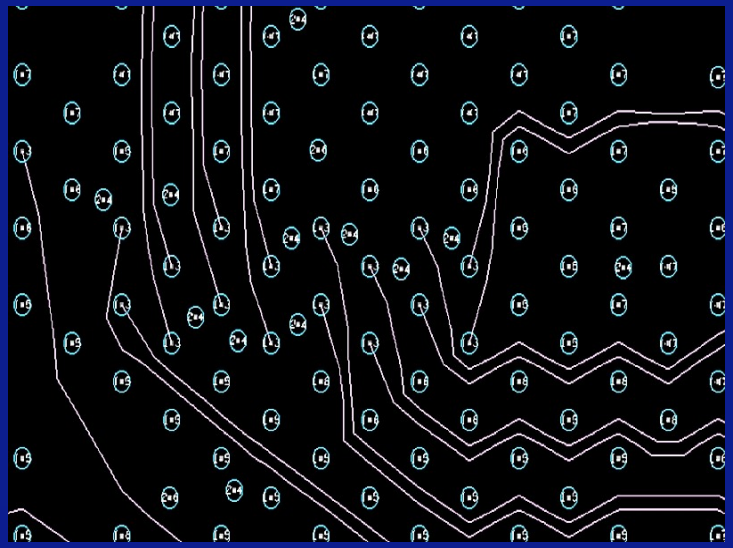


Via Patterns Learning

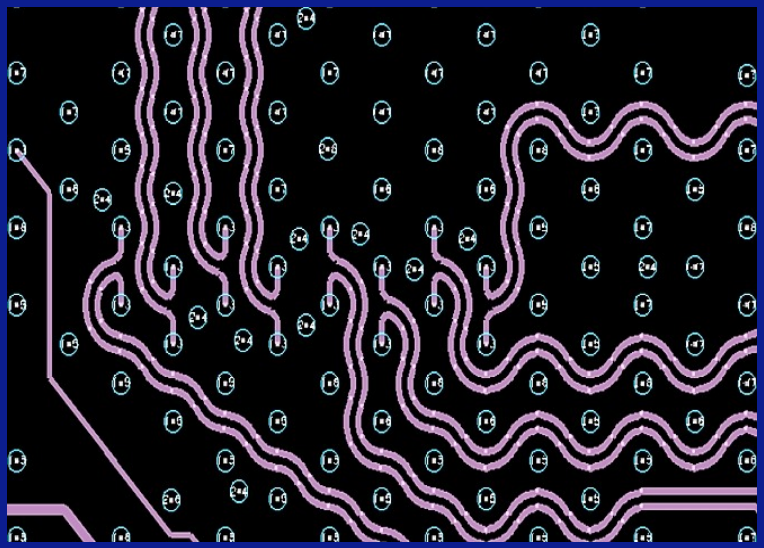
- **Via transitions to use layer directionality to relieve congestion**



Routing Process Comparison

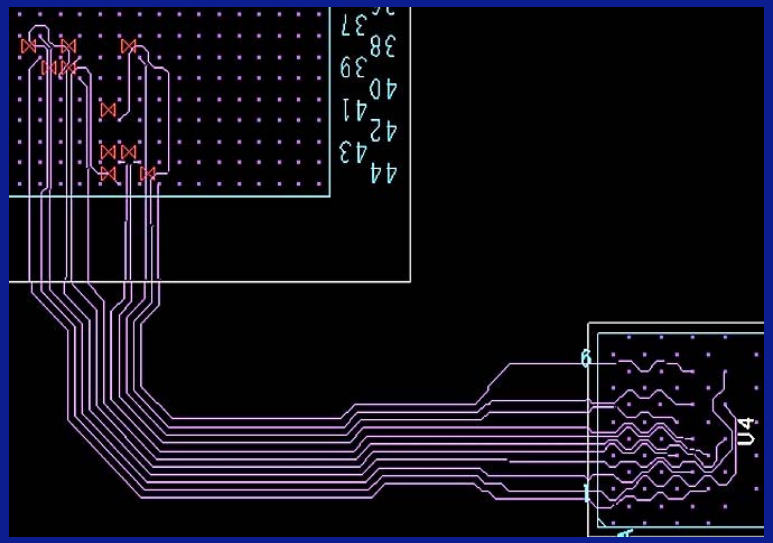


Topological routes as a result of the AI global router

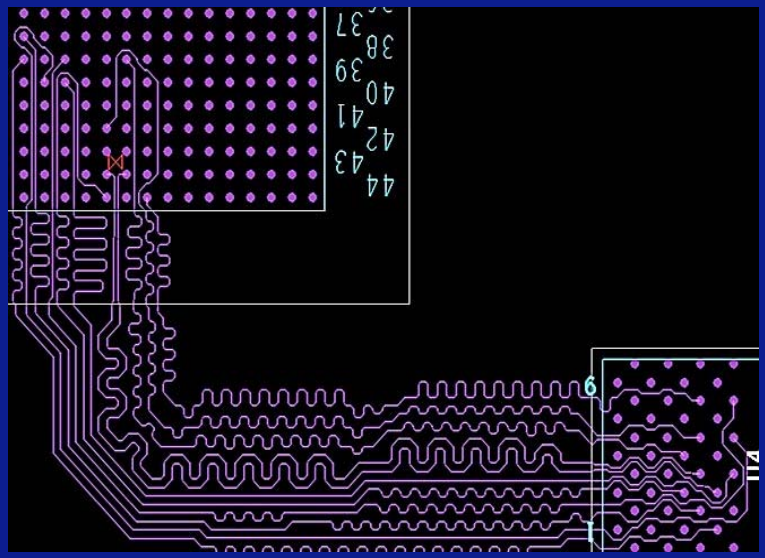


Transformed snake routes from the detailed router

Delay and Phase Tuning



Routings prior to delay and phase tuning

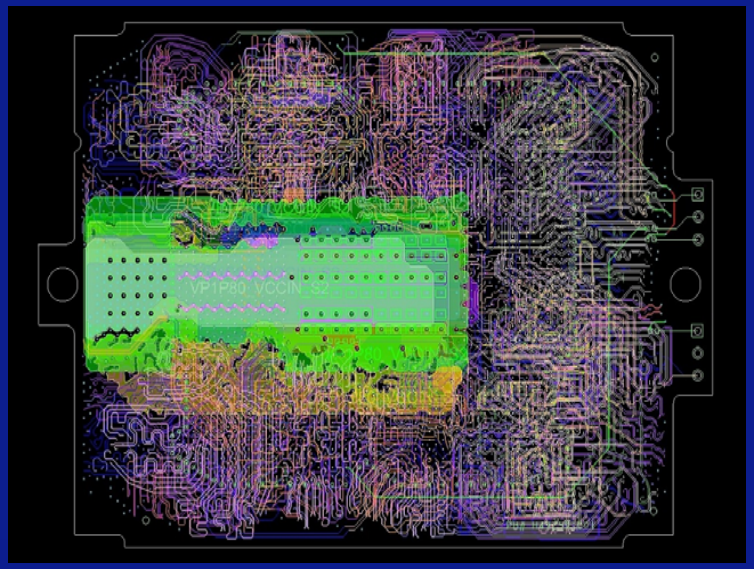


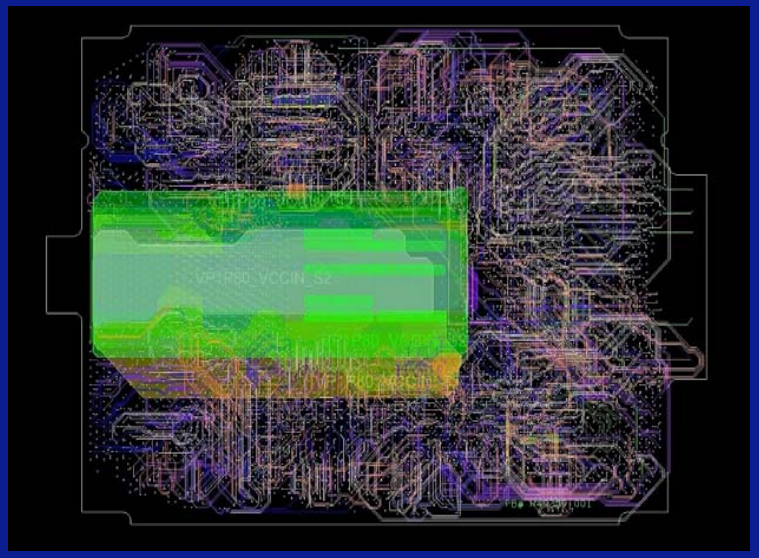
Routings after delay and phase tuning

Routing Methods Comparison

	Manual Routing	Legacy Auto Router	AI Smart Router
Stackup planning	✓	✓	✓
Constraints creation	✓	✓	✓
Components placement	✓	✓	✓
Routing	Manual and interactive	Using DO files and need debugging	No any user involvements
Speed	Labor intensive. Very slow	Improved speed for some simple designs	Full automatic and very fast

Auto Router Comparisons- Test Case 1



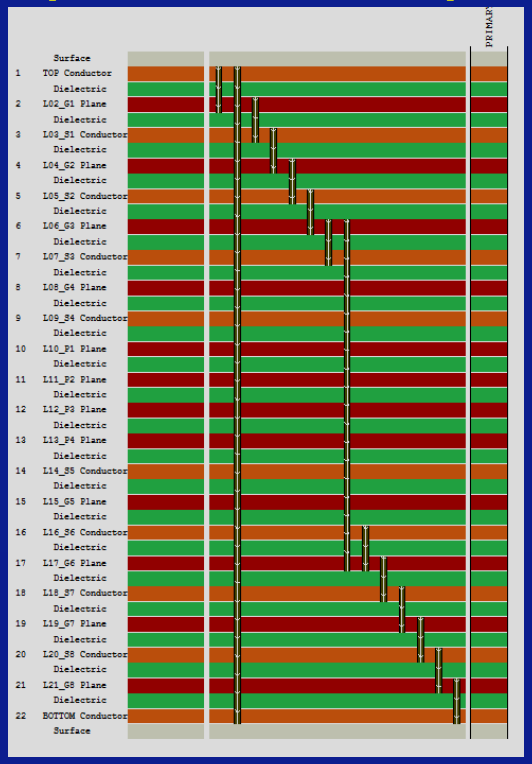


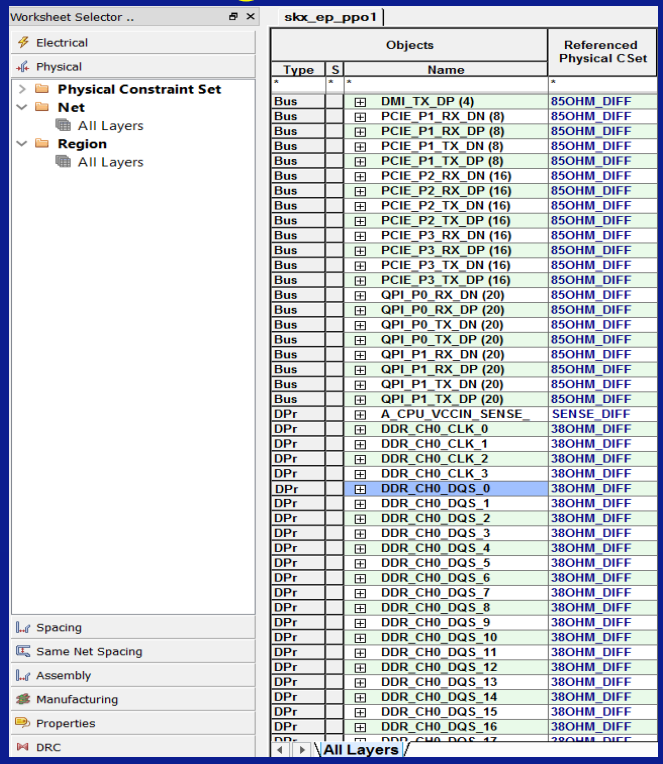
Manually routed and tuned N-1 CPU interposer
Routing time: ~120 hours

Automatic routings using the AI Global router.
Routing time: ~ 30 minutes

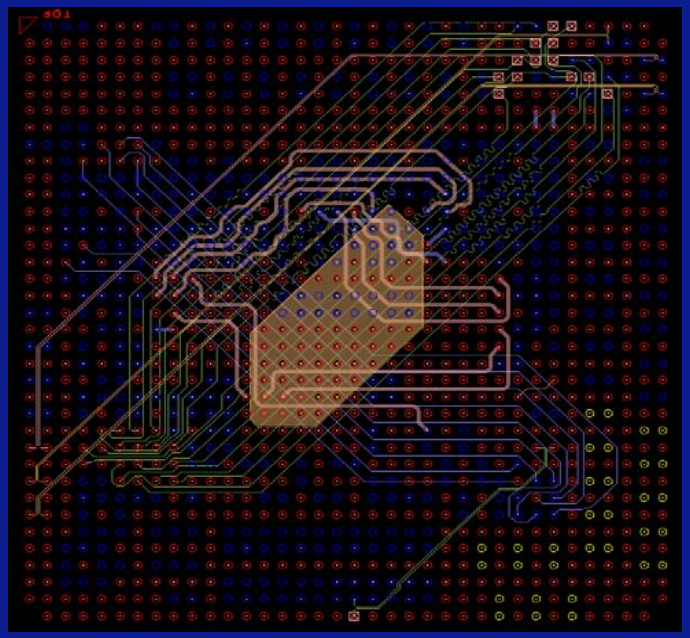
Total number of routed nets > 1000

Interposer Stackup and Routing Constraints

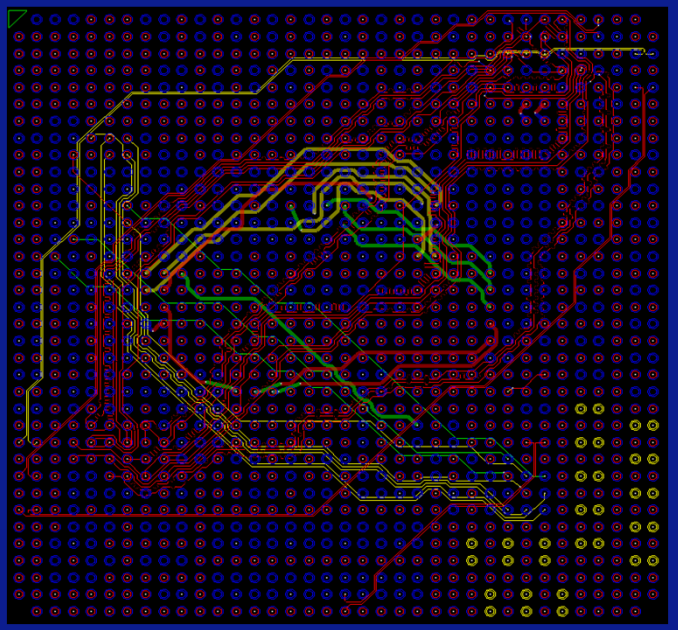




Auto Router Comparisons- Test Case 2

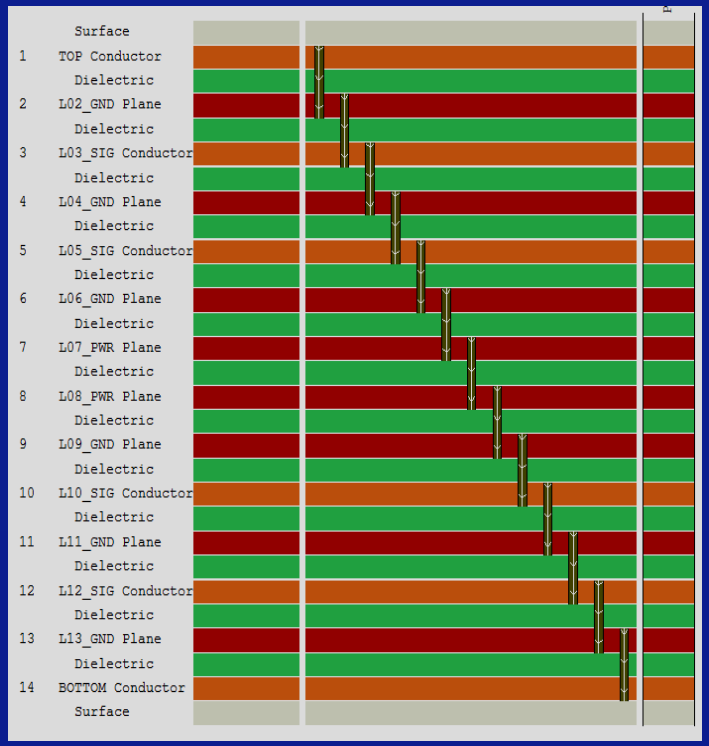


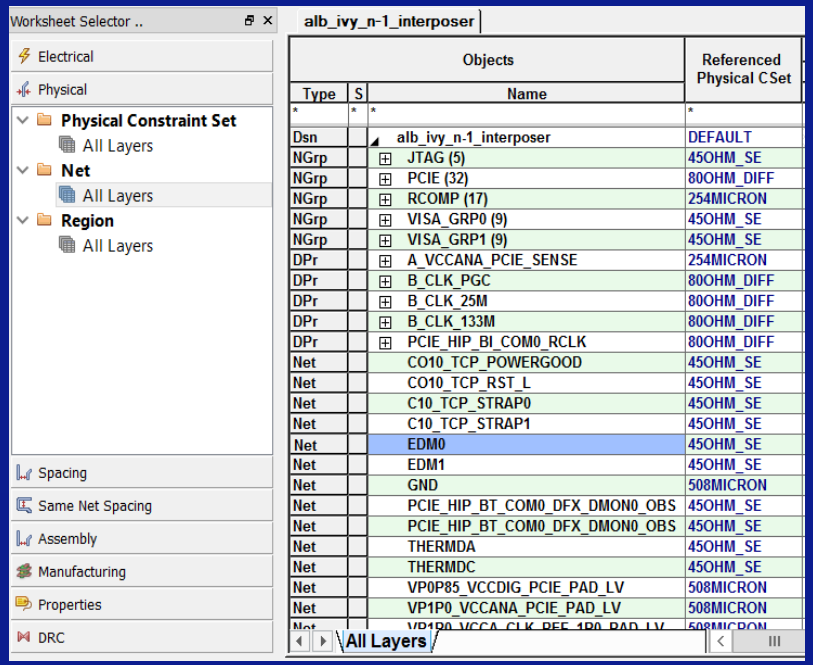
Manual layout time: ~16 hours



AI smart router routing time: ~5 minutes

Interposer Stackup and Routing Constraints





Summary

- Interposer PCB layout is a complex and time consuming process
- Manual and legacy routing methods are not efficient
- AI smart router revolutionizes this process and achieves significant time and resource savings

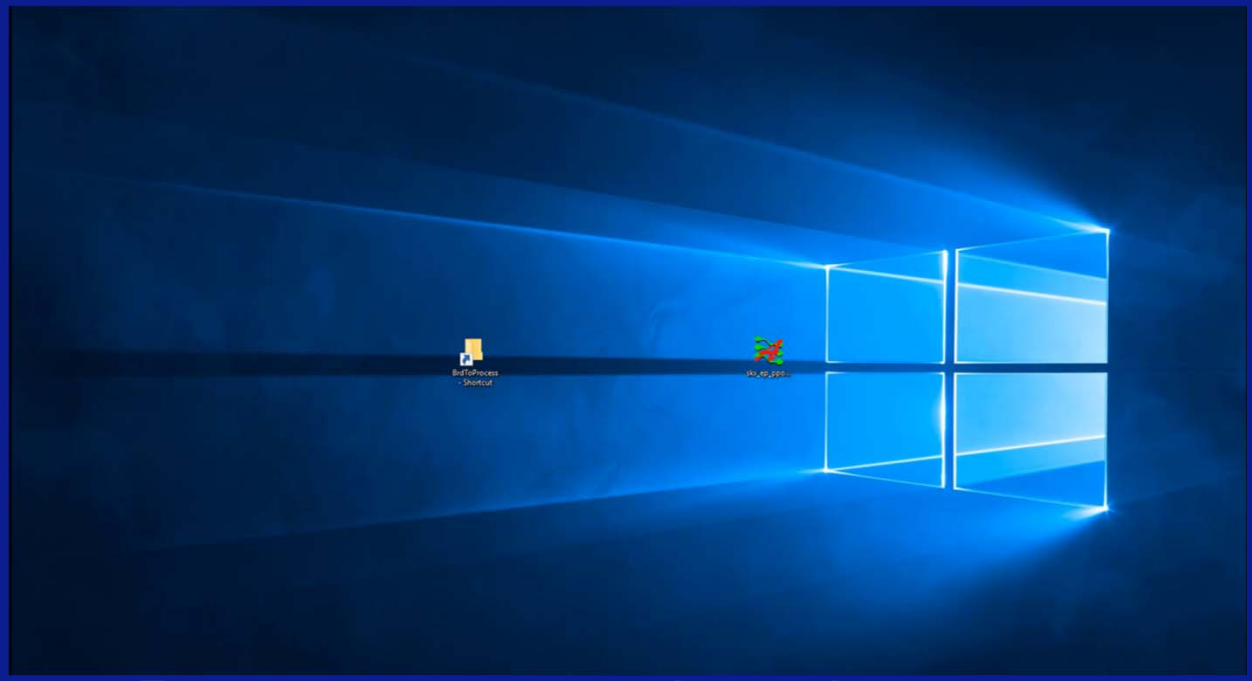
Next Steps

- Extend AI routing capability to generic PCB board layout
- Components placement optimization
- Provide flexible routing control options such as routing by interfaces or regions

Acknowledgements

The authors would like to thank Leo Tang, Jeff Morehouse, Mike McGuire for their technical support. Thanks also go to John Kelbert and Ila Pal for the reviews and feedbacks.

AI Smart Router Server Demo



Please see online demo at: