

# PROCESSING-NEAR-MEMORY WITH CHIP LEVEL 3D-IC

MIAO LIU

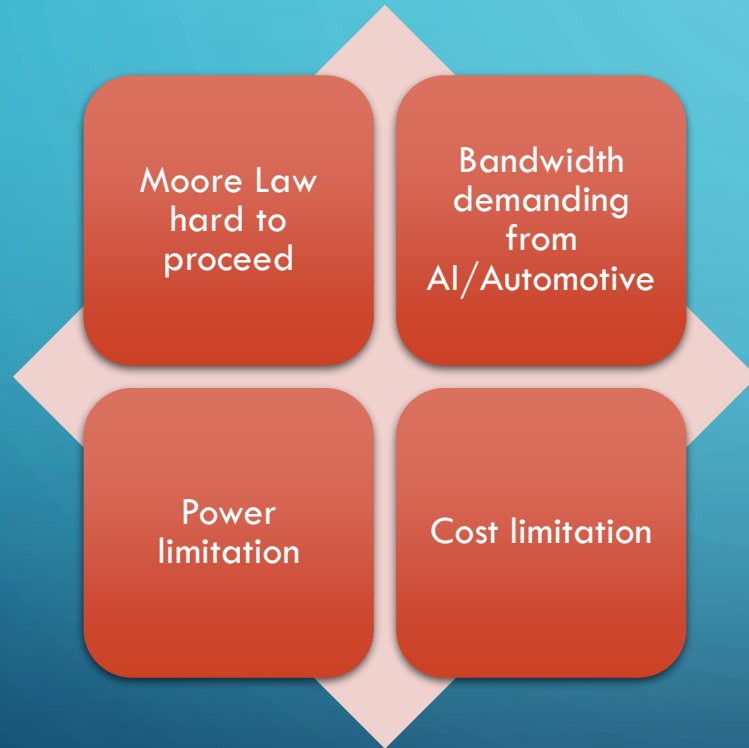
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# AGENDA

- Introduction
- 3DIC Roadmap
- SRAM-on-Logic Partitioning
- 2D vs 3D Area Benchmarking
- SRAM-on-Logic Implementation
- SRAM-on-Logic Advantage
- SRAM-on-Logic Challenge
- Conclusion

# INTRODUCTION

- Issues:



- Solution – Demo Case

## 3DIC

CA78

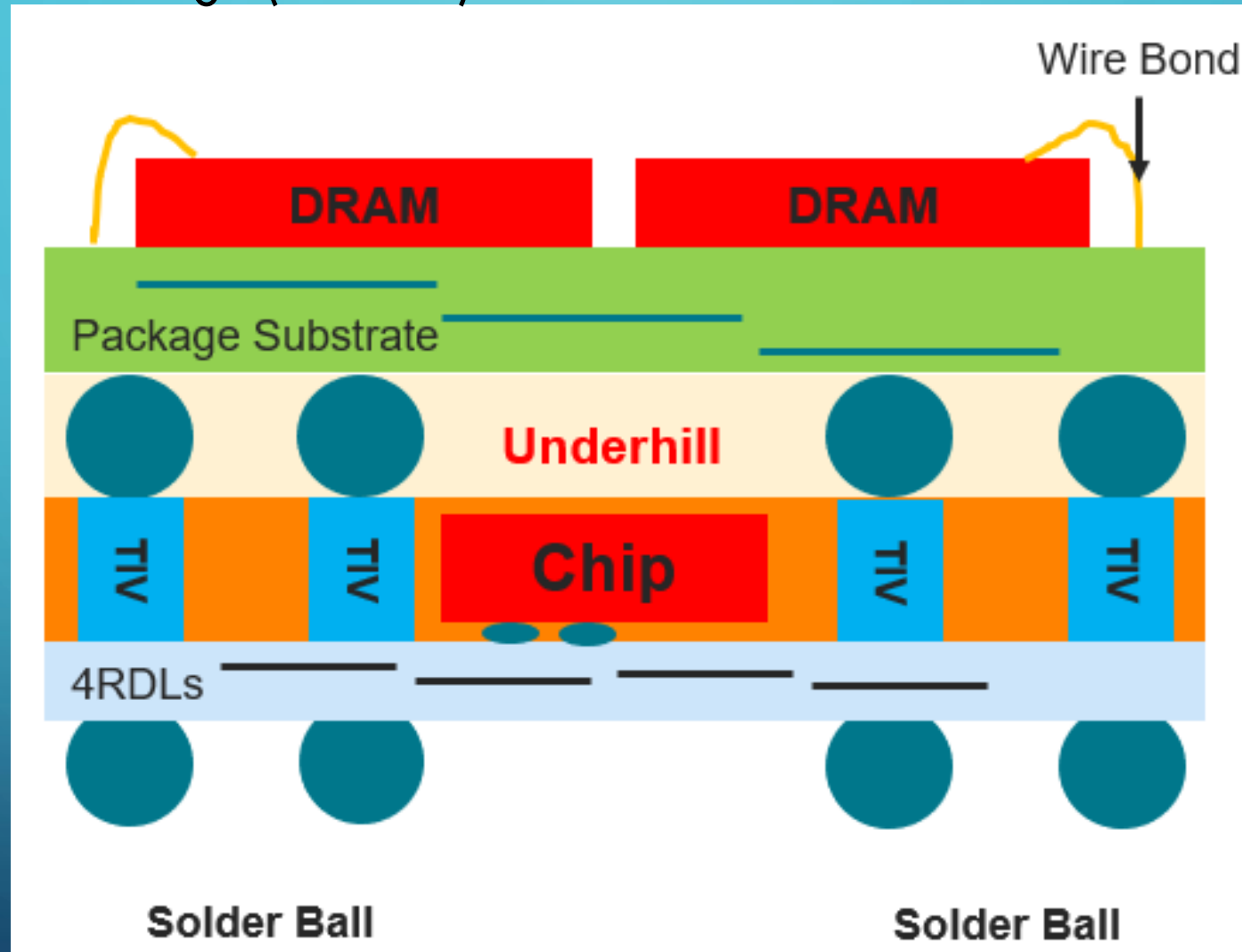
7nm

SRAM & Logic Separation

3D Implementation & SignOff

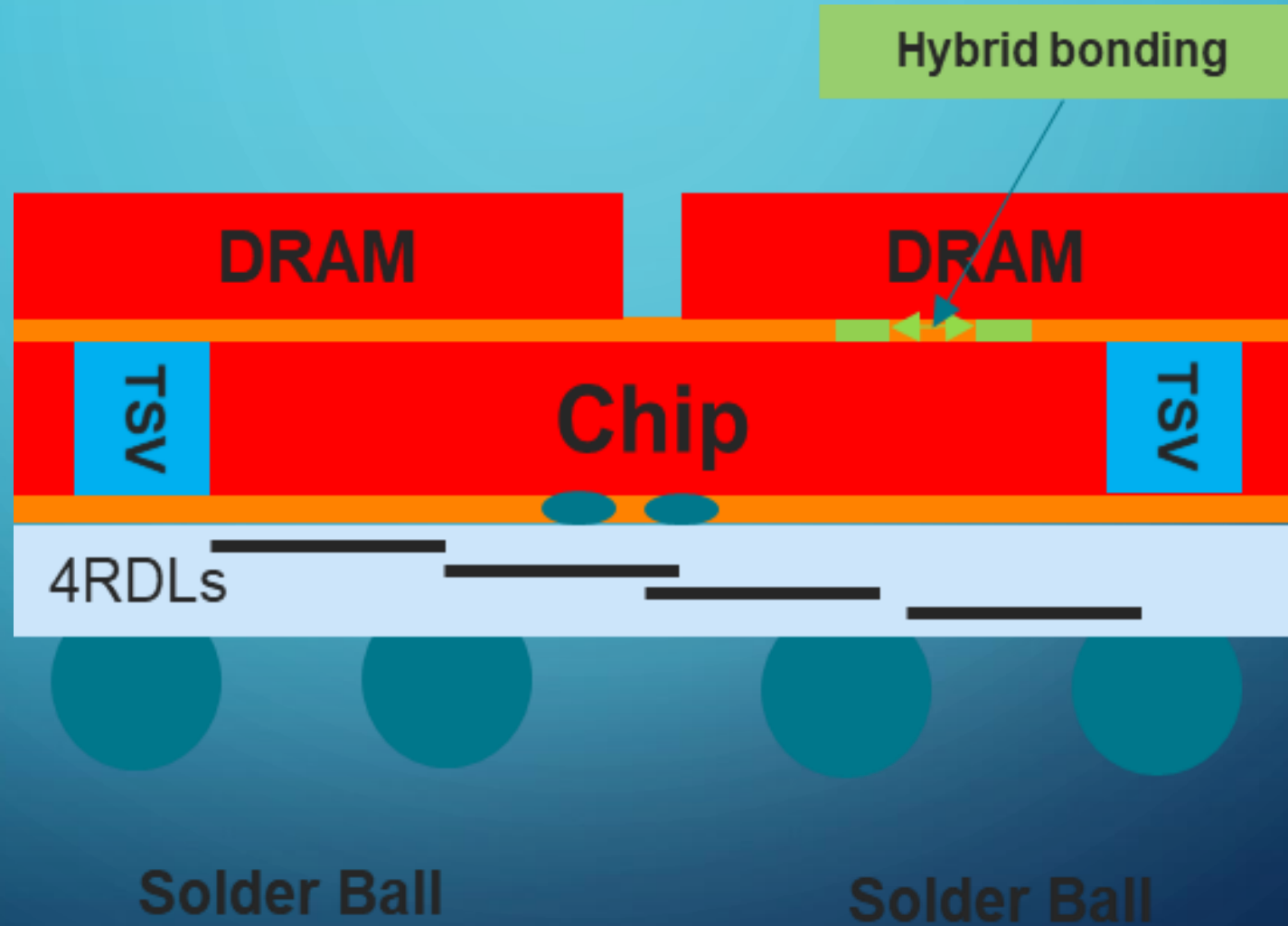
# 3DIC ROADMAP

## Fan-Out Wafer Level Package (FOWLP)



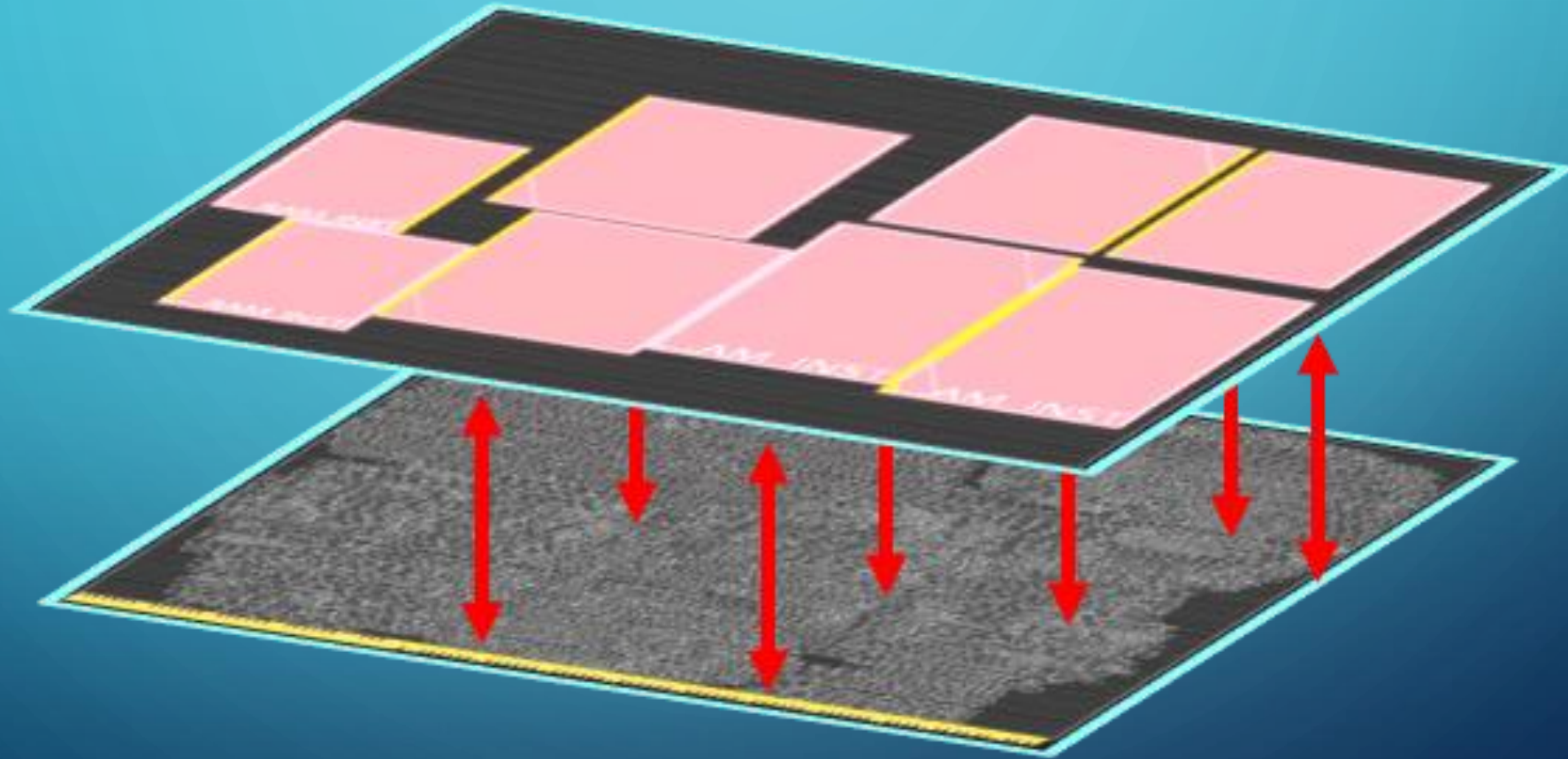
# 3DIC ROADMAP

Chip-Level 3D: DRAM-on-Logic



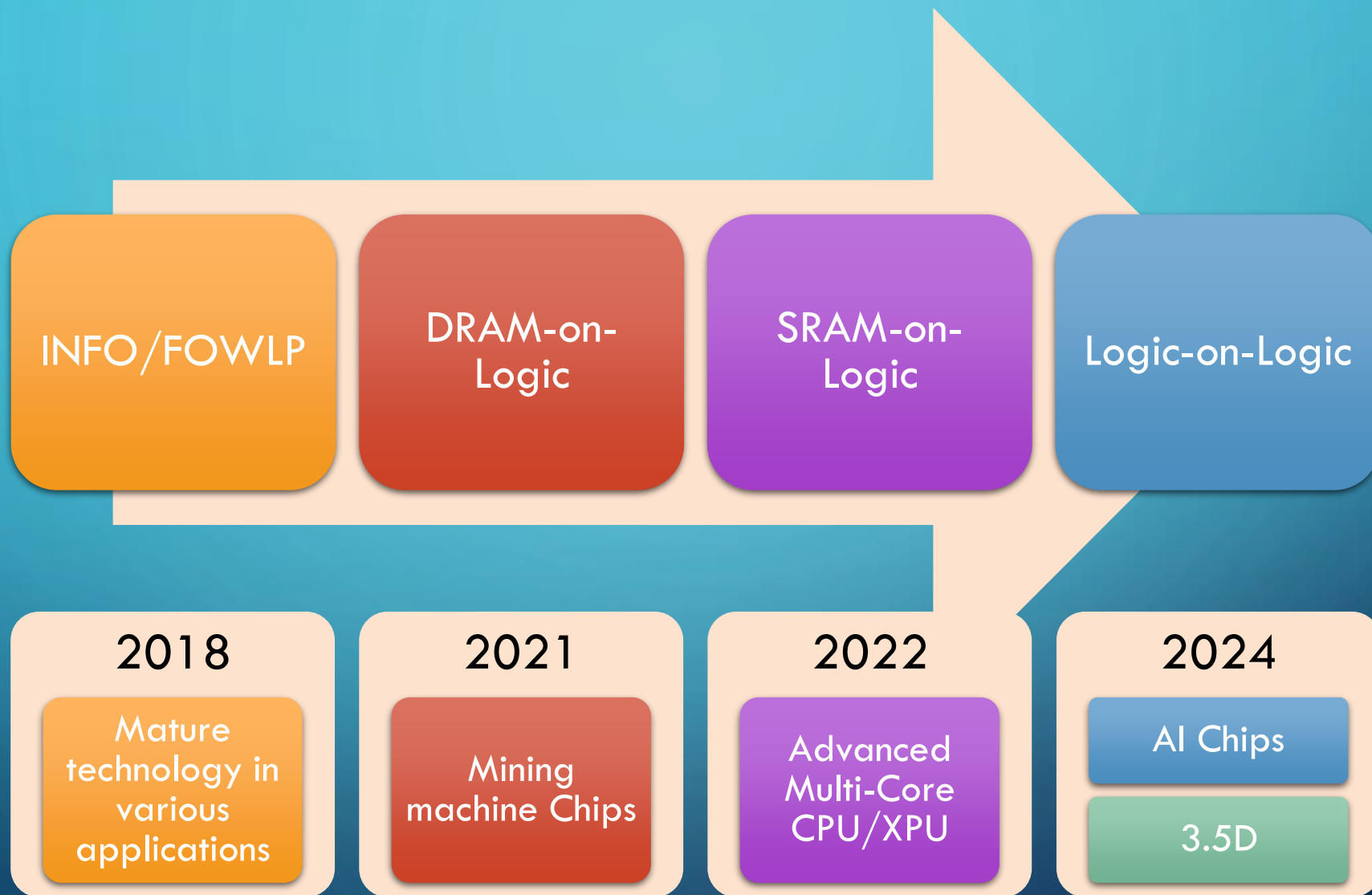
# 3DIC ROADMAP

Chip-Level 3D: SRAM-on-Logic



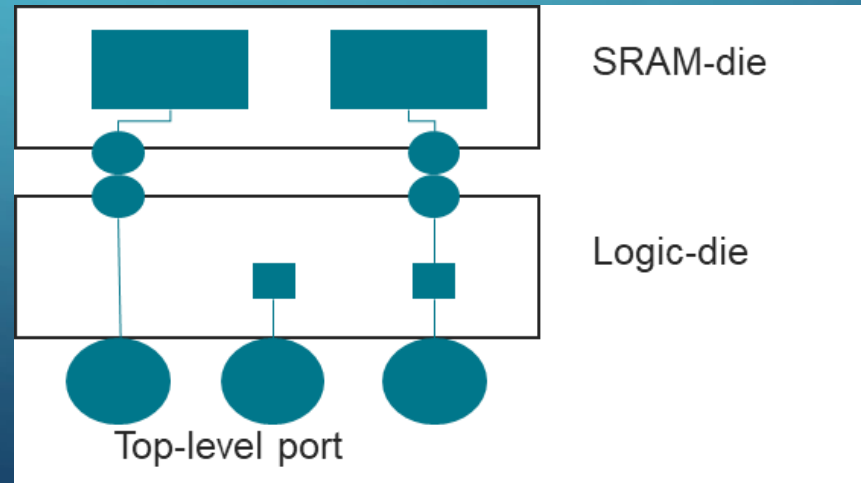
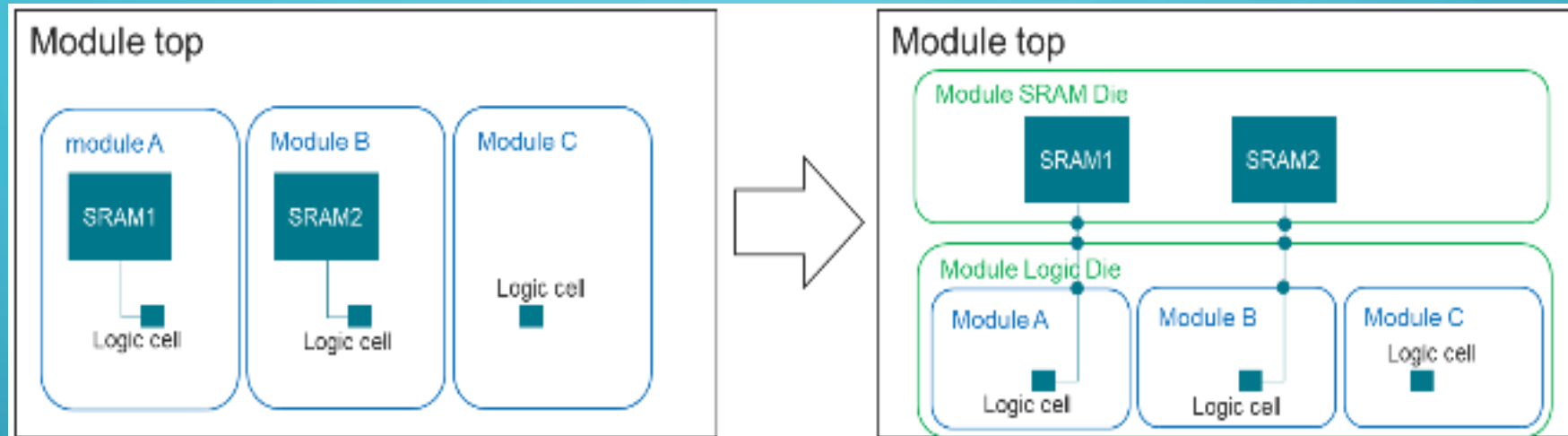
# 3DIC ROADMAP

Trend



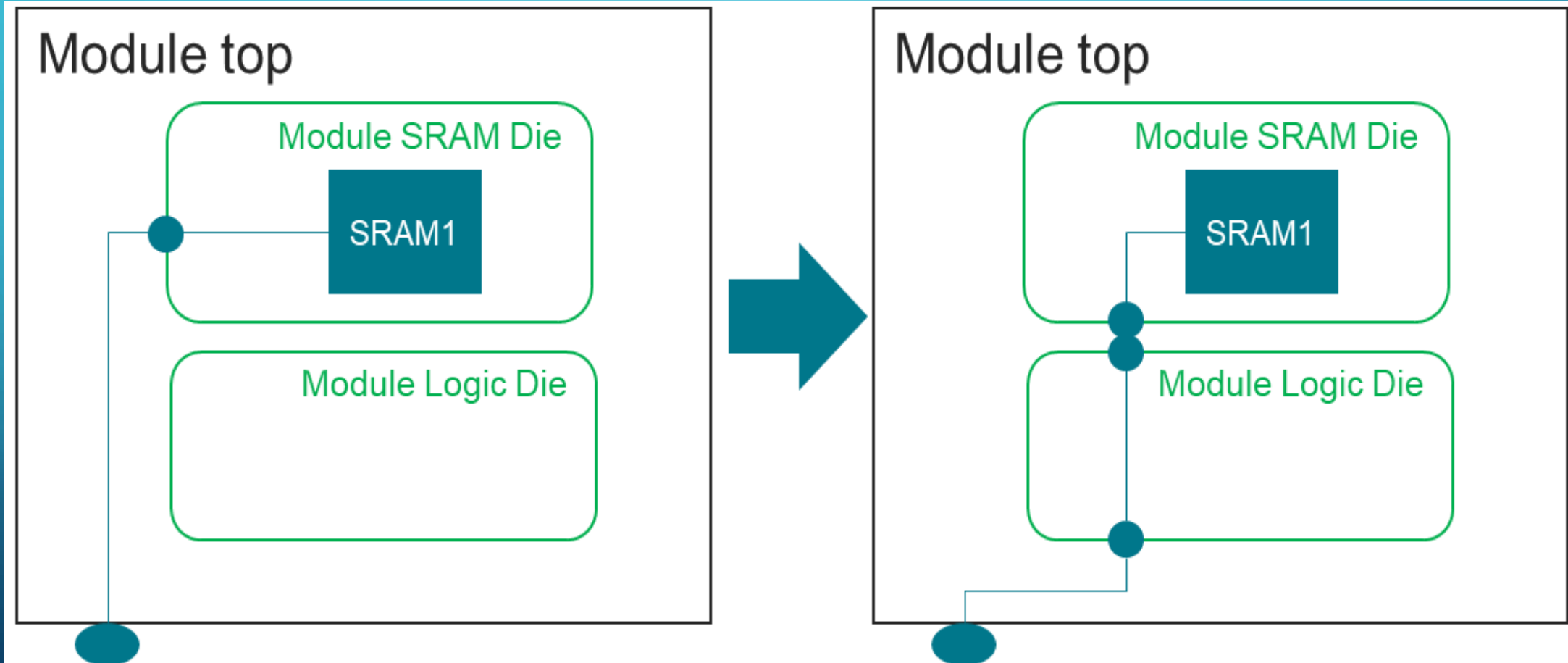
# SRAM-ON-LOGIC PARTITIONING

## Logical Partition



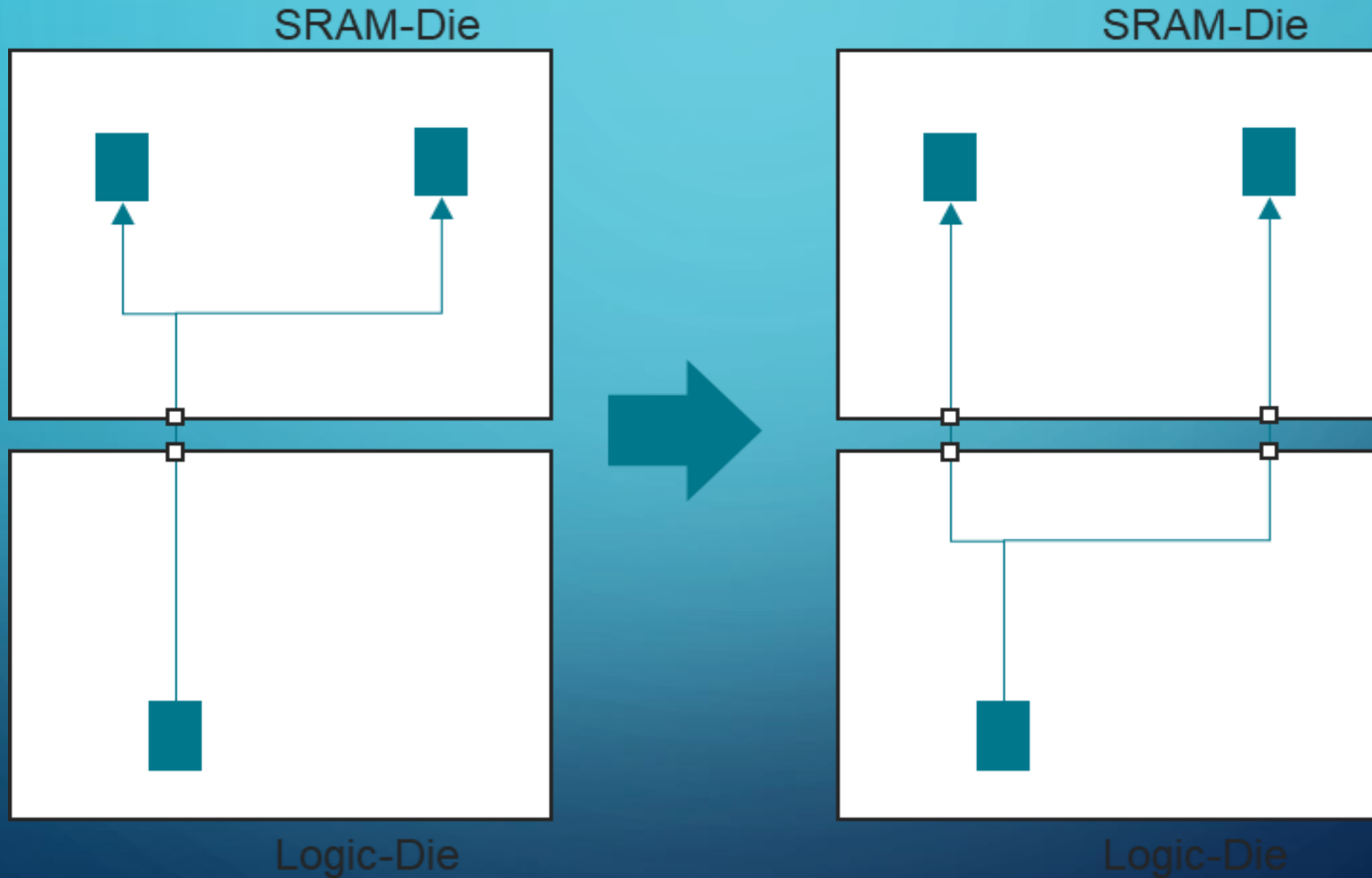
# SRAM-ON-LOGIC PARTITIONING

## Feedthrough Insertion



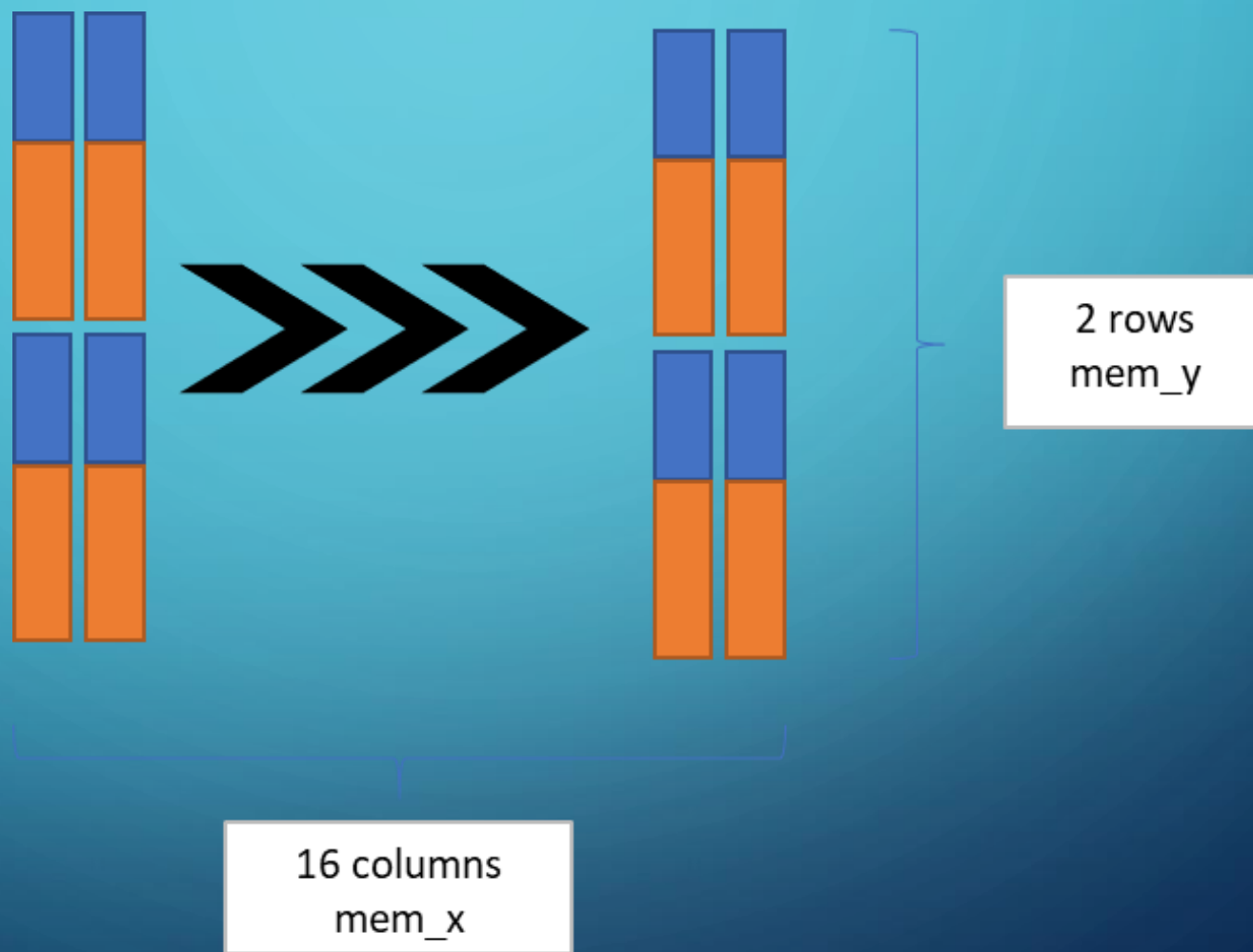
# SRAM-ON-LOGIC PARTITIONING

## Multi-fanout Port Cloning



# 2D VS. 3D AREA BENCHMARKING

## SRAM Die Layout



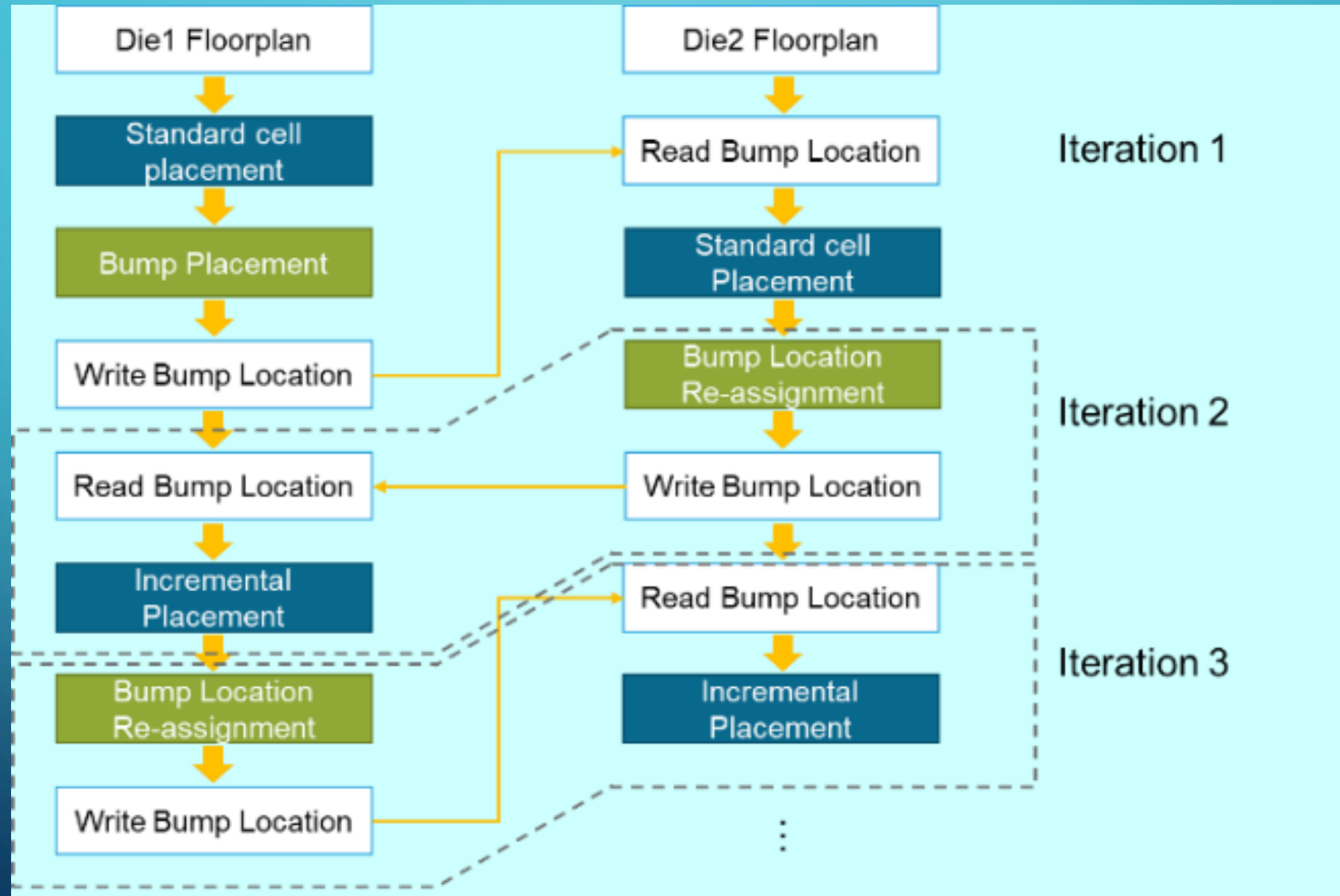
# 2D VS. 3D AREA BENCHMARKING

2D vs. 3D die edge length

| Logic Length | Logic area | array_x | array_space | mem_x  | mem_y  | mem_area   | total_use_area | 2D Length |
|--------------|------------|---------|-------------|--------|--------|------------|----------------|-----------|
| 1540         | 2371600    | 55.3    | 15          | 1109.8 | 872.09 | 967845.482 | 3339445.482    | 1827      |
| 1560         | 2433600    | 55.3    | 15          | 1109.8 | 872.09 | 967845.482 | 3401445.482    | 1844      |
| 1580         | 2496400    | 55.3    | 15          | 1109.8 | 872.09 | 967845.482 | 3464245.482    | 1861      |
| 1600         | 2560000    | 55.3    | 15          | 1109.8 | 872.09 | 967845.482 | 3527845.482    | 1878      |
| 1620         | 2624400    | 55.3    | 15          | 1109.8 | 872.09 | 967845.482 | 3592245.482    | 1895      |
| 1640         | 2689600    | 55.3    | 15          | 1109.8 | 872.09 | 967845.482 | 3657445.482    | 1912      |
| 1660         | 2755600    | 55.3    | 15          | 1109.8 | 872.09 | 967845.482 | 3723445.482    | 1930      |
| 1680         | 2822400    | 55.3    | 15          | 1109.8 | 872.09 | 967845.482 | 3790245.482    | 1947      |
| 1700         | 2890000    | 55.3    | 15          | 1109.8 | 872.09 | 967845.482 | 3857845.482    | 1964      |
| 1720         | 2958400    | 55.3    | 15          | 1109.8 | 872.09 | 967845.482 | 3926245.482    | 1981      |
| 1740         | 3027600    | 55.3    | 15          | 1109.8 | 872.09 | 967845.482 | 3995445.482    | 1999      |

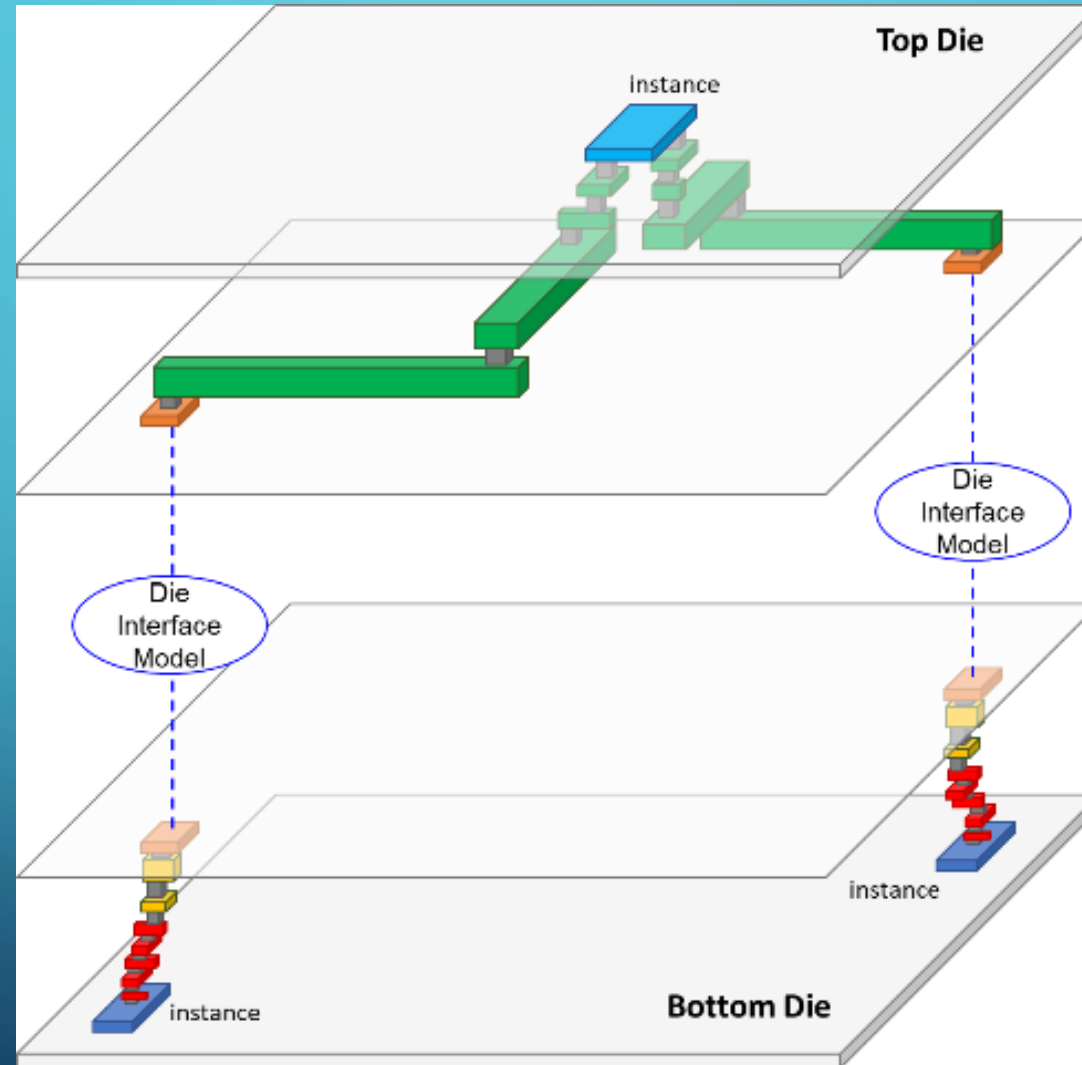
# SRAM-ON-LOGIC IMPLEMENTATION

## Die-by-Die Flow



# SRAM-ON-LOGIC IMPLEMENTATION

Concurrent Flow

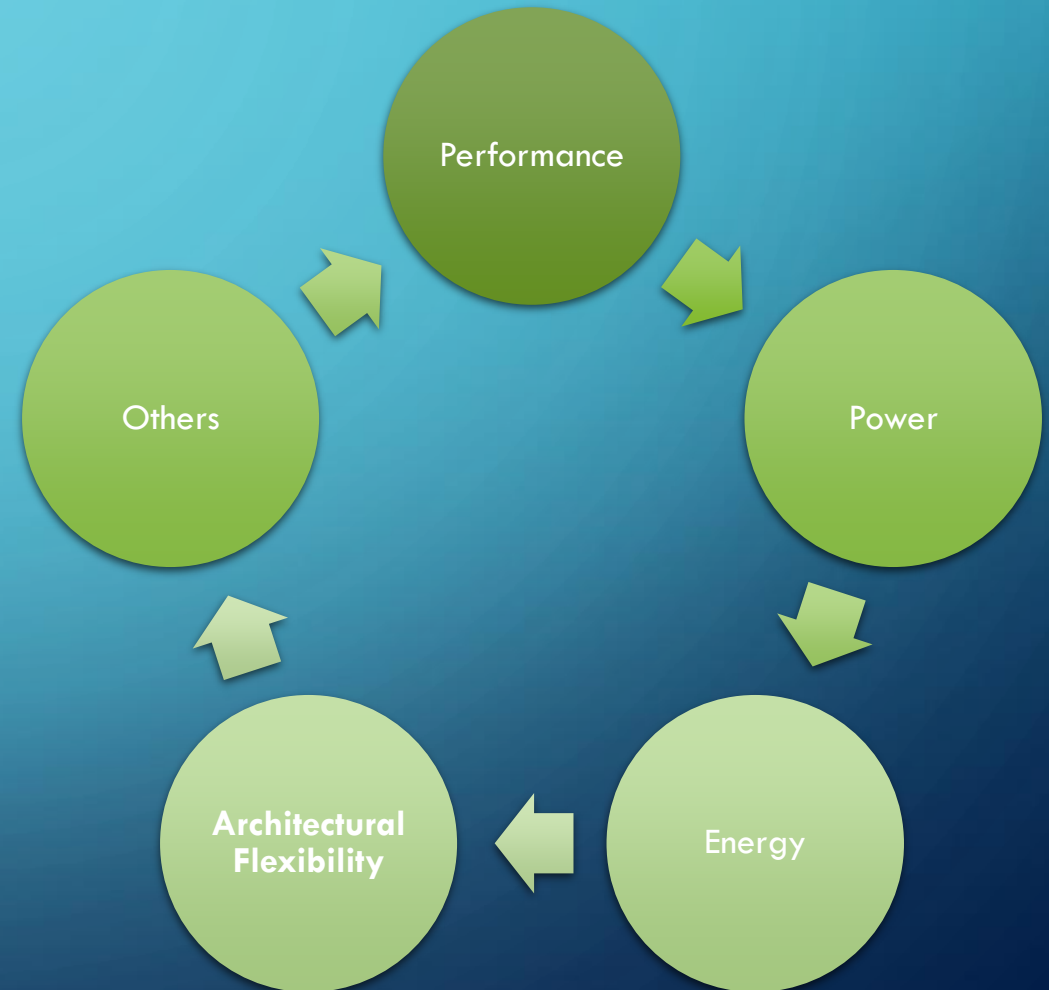
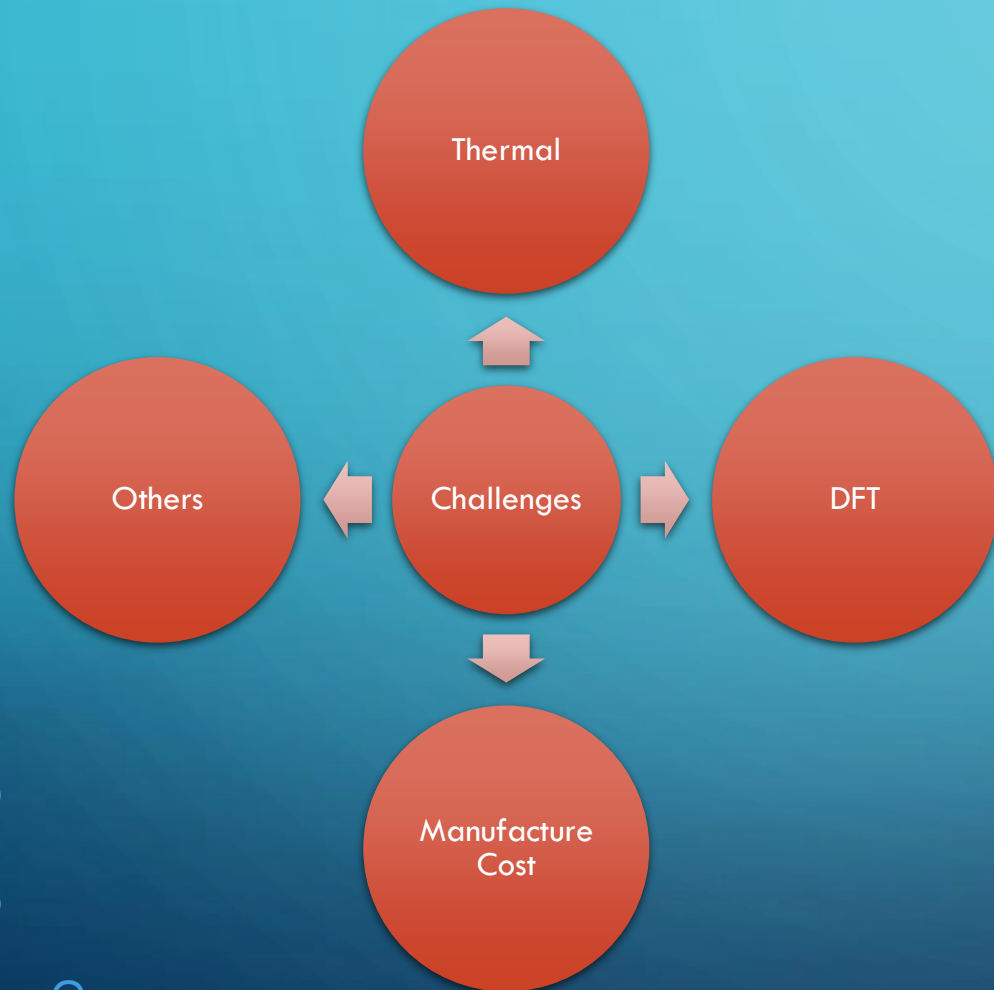


# SRAM-ON-LOGIC IMPLEMENTATION

3D vs. 2D PPA comparison

|        |              | Effect<br><u>Fre</u> | Power         | Energy        | Area                | Wire Length       |
|--------|--------------|----------------------|---------------|---------------|---------------------|-------------------|
| Target |              | [GHz]                | [ <u>mW</u> ] | [ <u>pJ</u> ] | [ $\mu\text{m}^2$ ] | [ $\mu\text{m}$ ] |
| 600ps  | 2D           | 1.17                 | 898.56        | 765.57        | 403946.65           | 10086629.38       |
|        | 3D           | 1.24                 | 874.81        | 704.22        | 417209.46           | 8322518.55        |
|        | $\Delta$ [%] | 6                    | -3            | -8            | 3                   | -17               |

# CHALLENGES & CONCLUSION



The background is a deep blue gradient. On the left side, there are white circuit-like lines and nodes. In the center and right, there are darker blue, wavy patterns resembling circuit traces, and numerous out-of-focus light blue circles (bokeh) scattered across the surface.

THANK YOU~