Thermal Challenges in 3D Stacks

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Agenda

- The Evolution of the Network
- The Information Explosion
- Increasing ASIC Power
- Need for 3D Stacks in Networking
- Case Study with a single 3D Stack
- Case Study with Multiple 3D Stacks in a networking application
- Conclusions

The Evolution of The Network

Explosion in the Amount of Information…

2007
5 Exabytes per month
1 Billion DVDs crossing the network

2010
21 Exabytes per month
4.4 Billion DVDs crossing the network

2013
56 Exabytes per month
12 Billion DVDs crossing the network

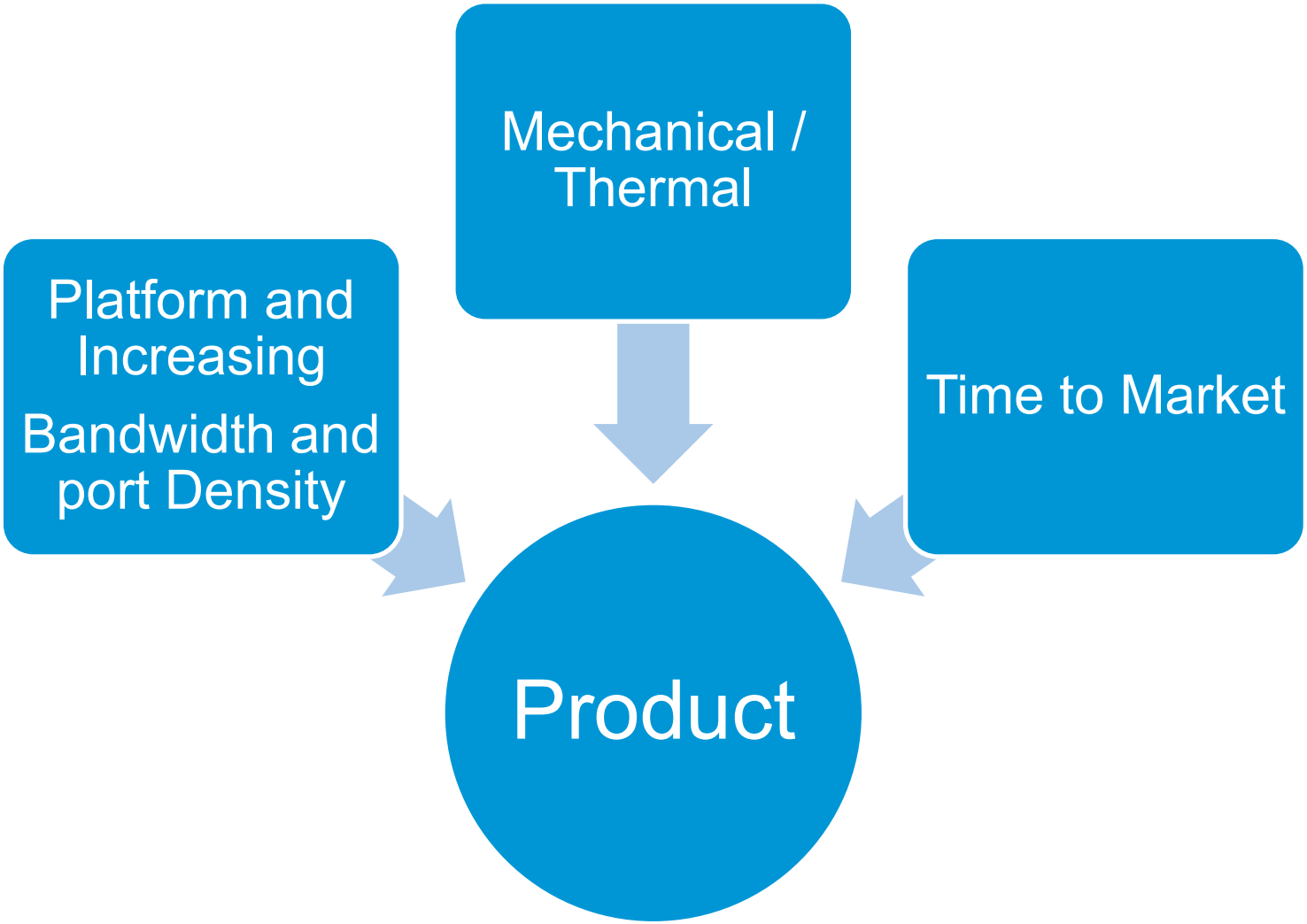
and devices

50 Billion
Connected Devices

1 Million
Applications

1 Zettabyte
Content

Challenges on the Product Scene

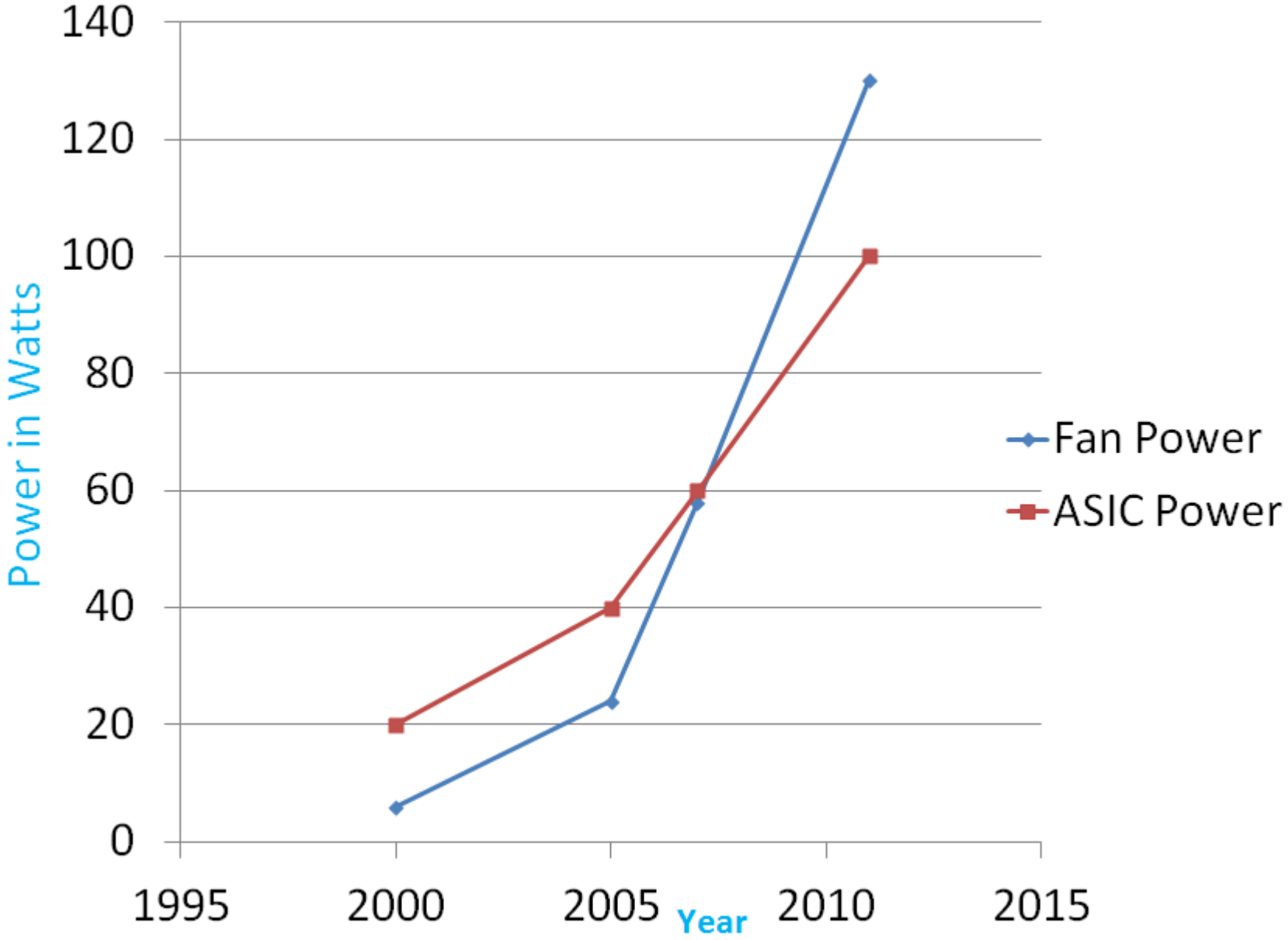


Thermal Challenges in Networking Products

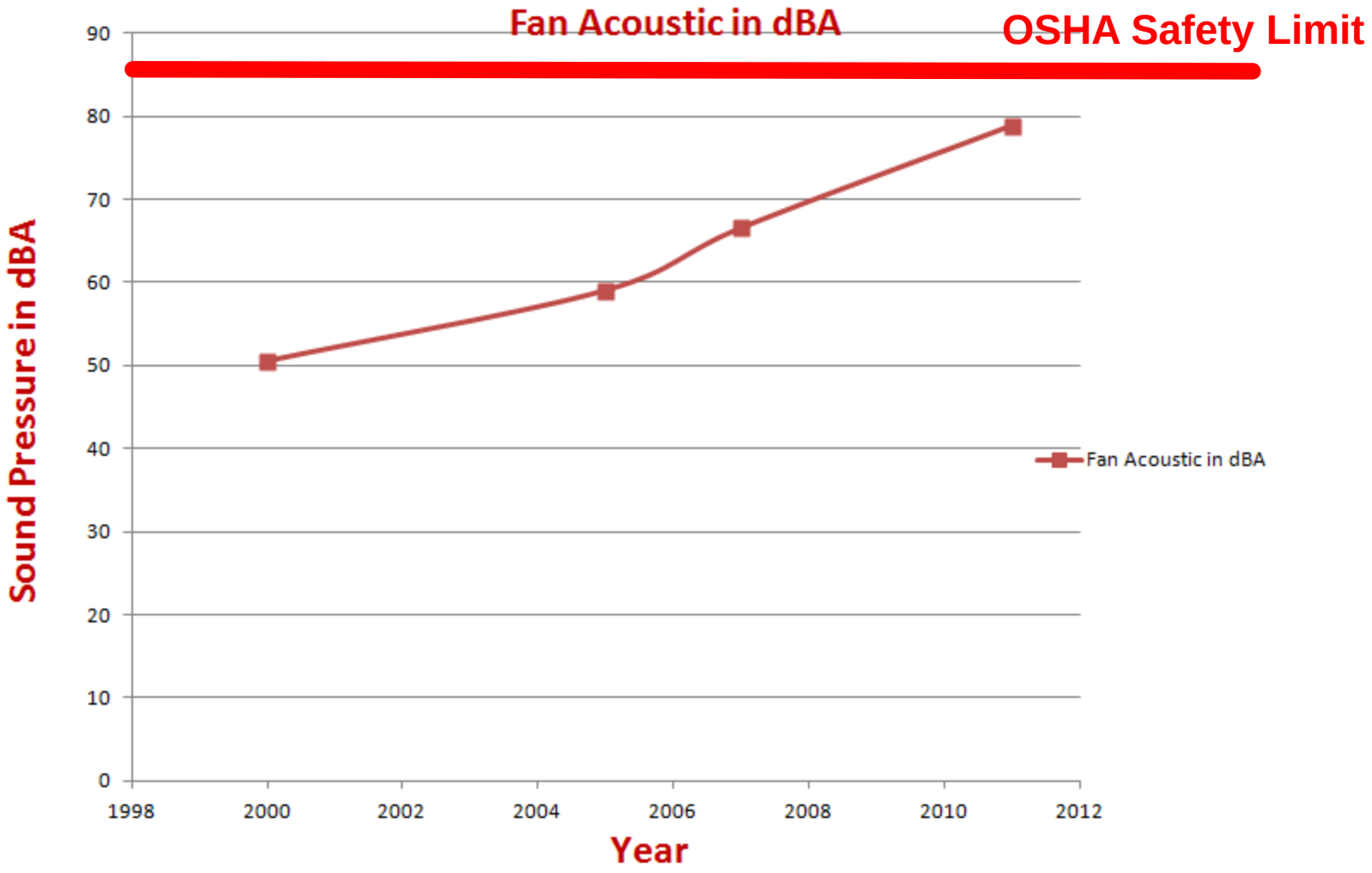
- ASIC power has burgeoned in the last decade and so also has fan power and acoustics.
- There is an acute need to

1. Reduce ASIC Power
2. Reduce Fan Power
3. Reduce Fan Noise

Fan Power Versus ASIC Power over the Last Decade



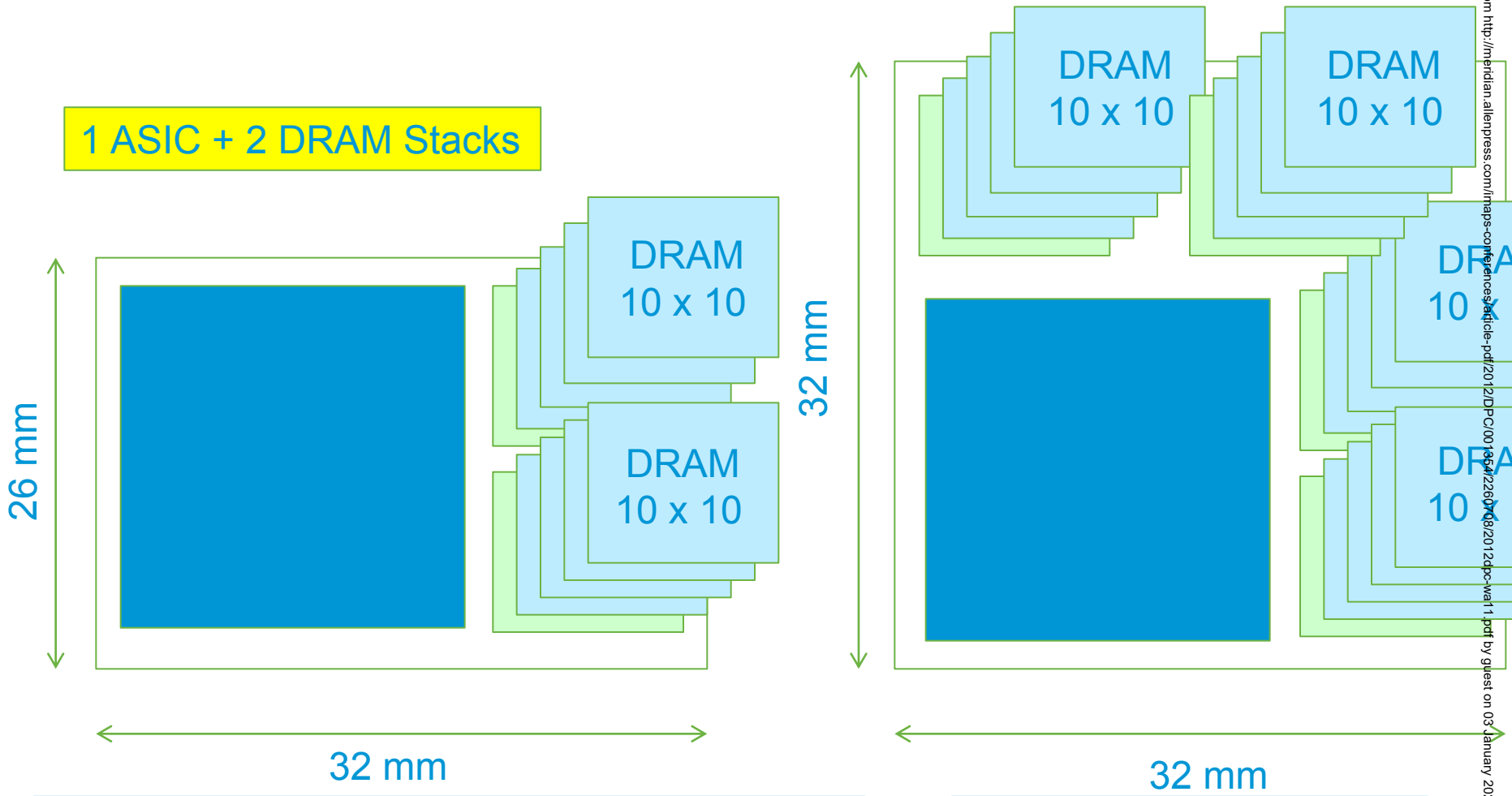
Fan Acoustic Noise Over the Past Decade



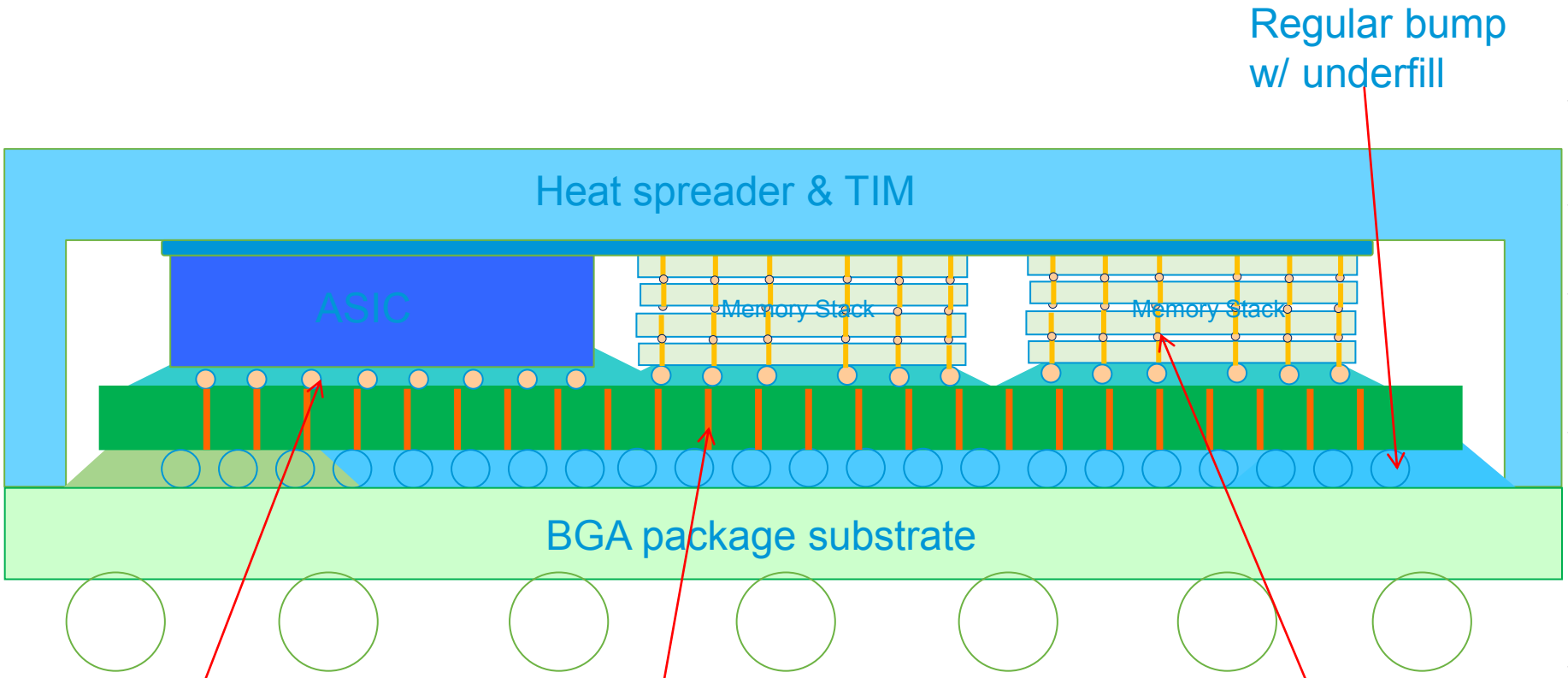
3D Stacks

- Increasing need for bandwidth has put forward the need for packing more silicon and memories within an available Board Space.
- 3D Stacks of silicon and memories offer a viable solution to this challenge in terms of real estate
- But 3D Stacks offer their own challenges in terms of thermal density, cooling and packaging
- This study features one such a 3D package with One ASIC and four Stack of Memories

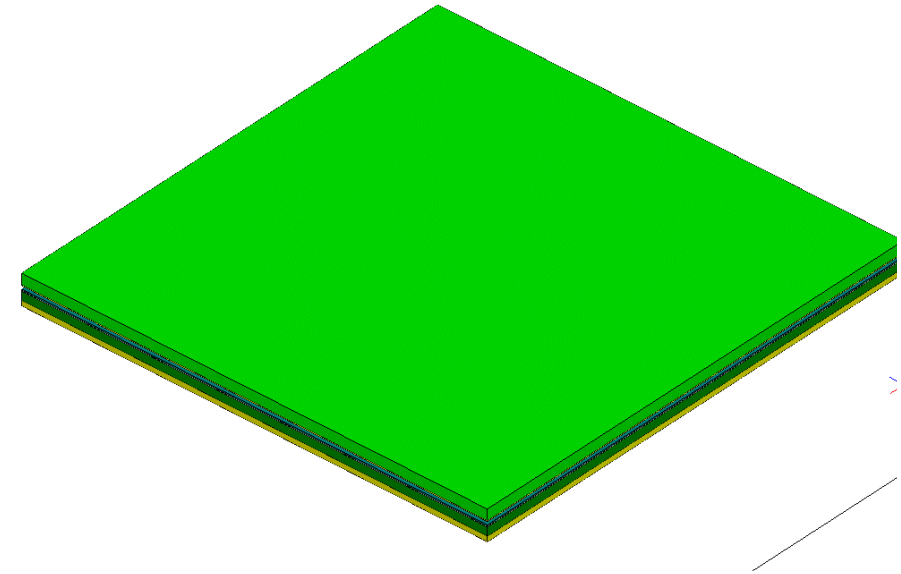
ASIC & DRAM Integration on Si Interposer

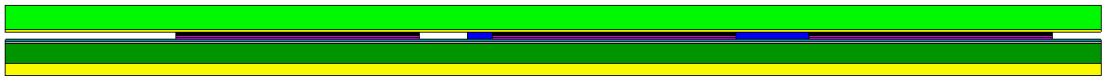


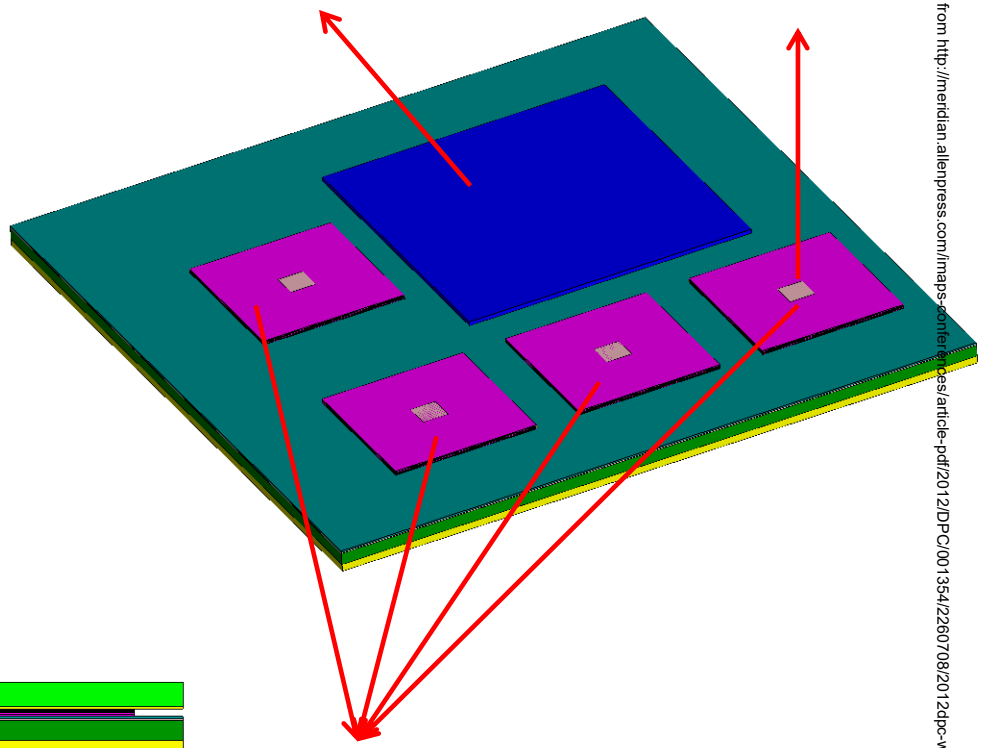
Stack up of a 3D Stack with SI Interposer



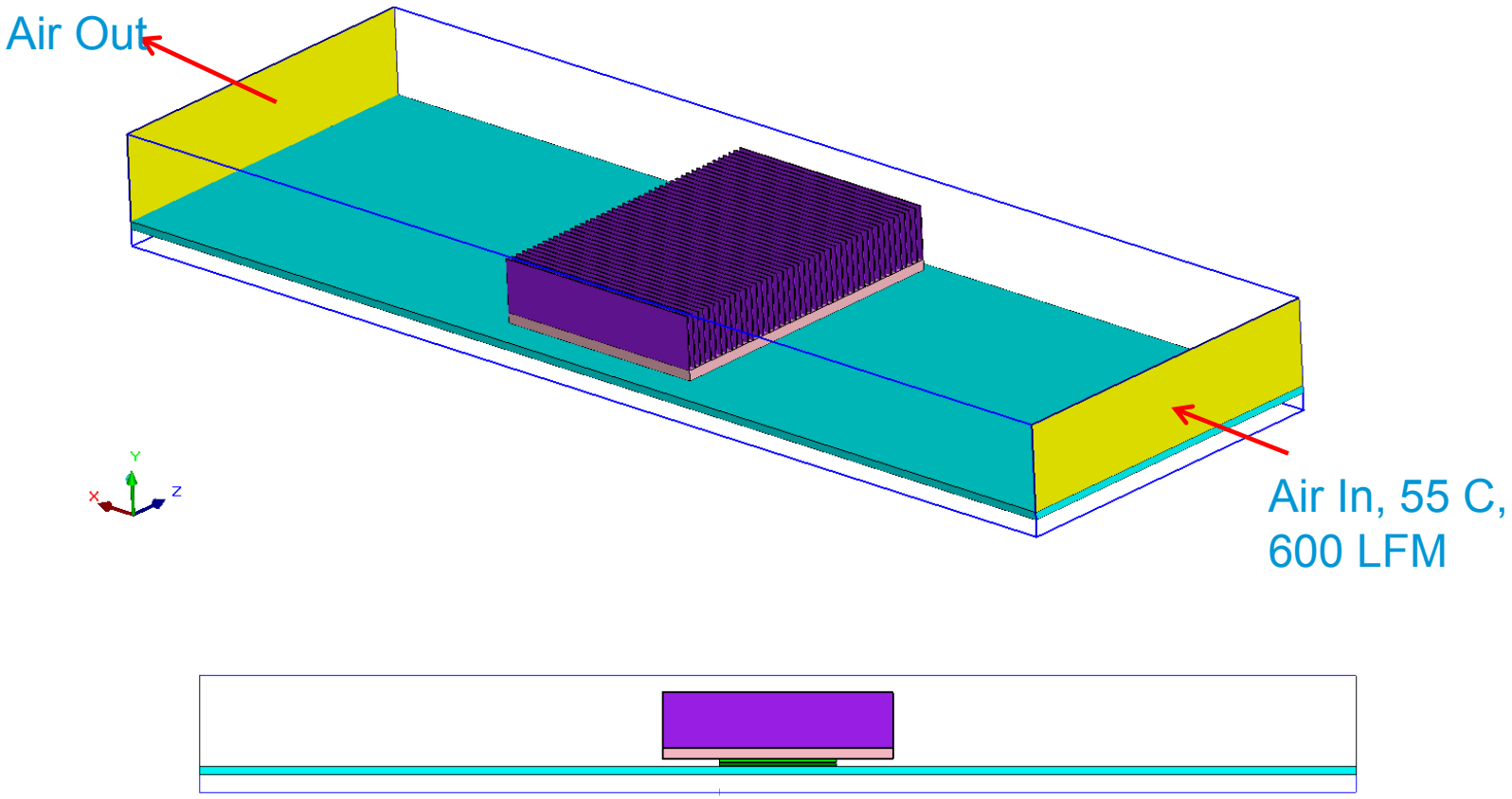
A typical 3D Package in thermal Simulation



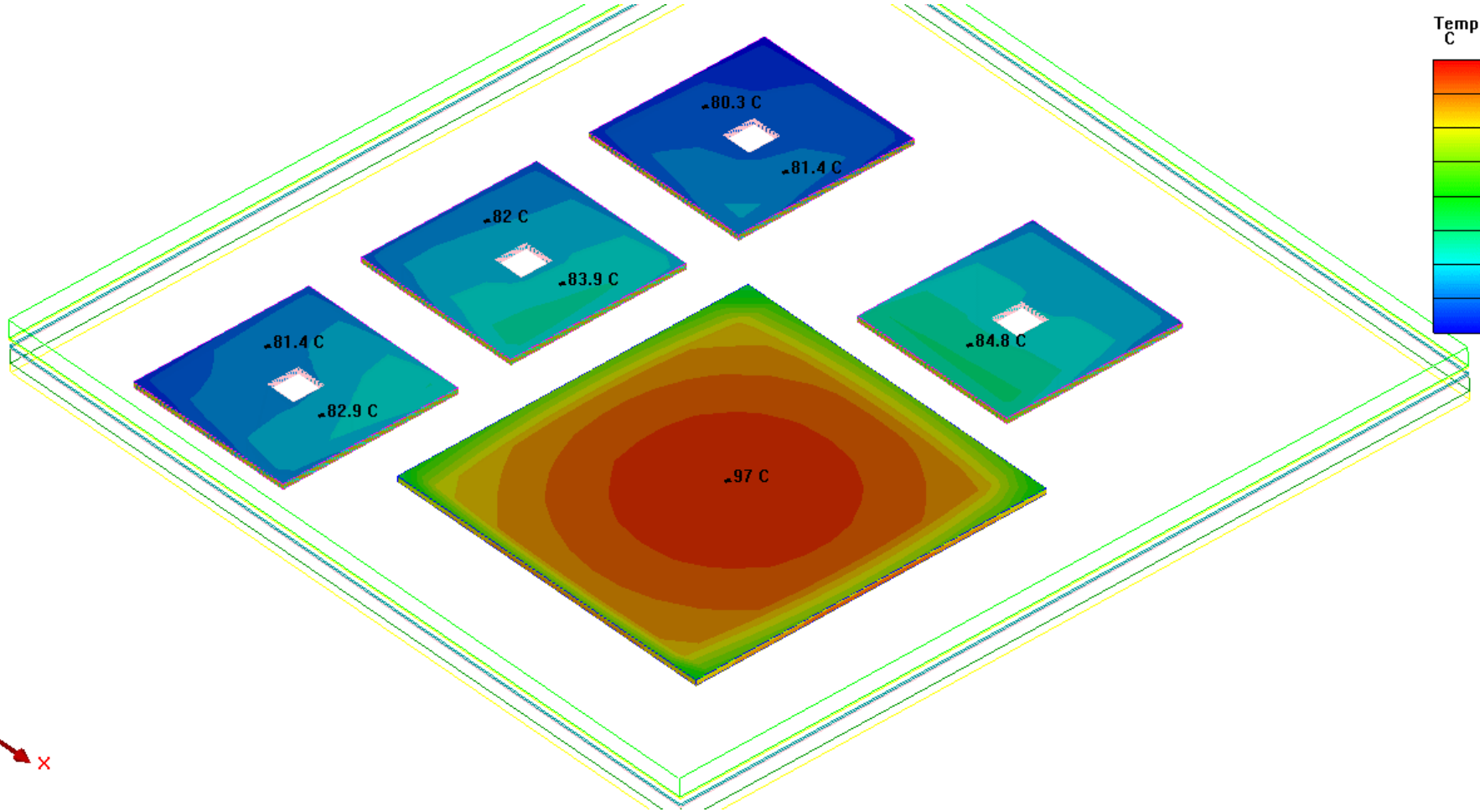




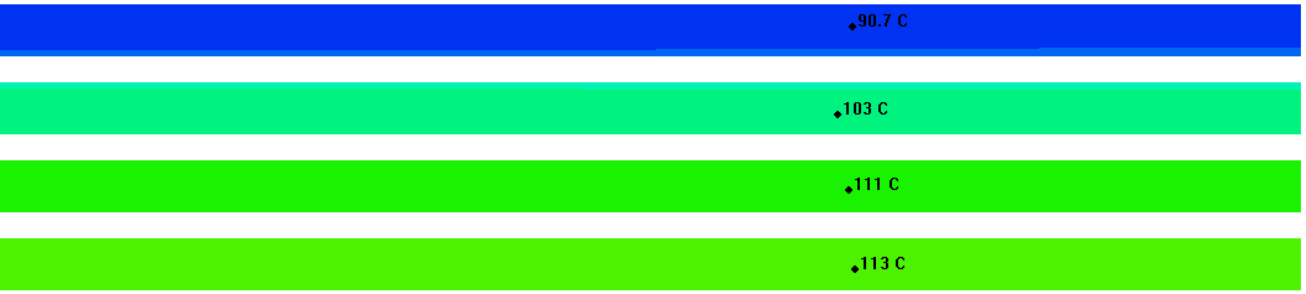
Single 3D Stack with a heatsink



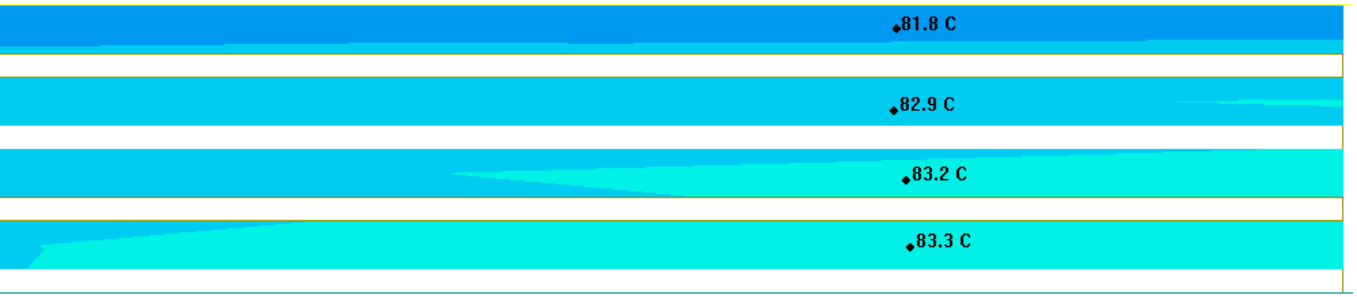
Temperatures on Silicon Stack



Temperatures in Memory Stack in two diff Scenarios

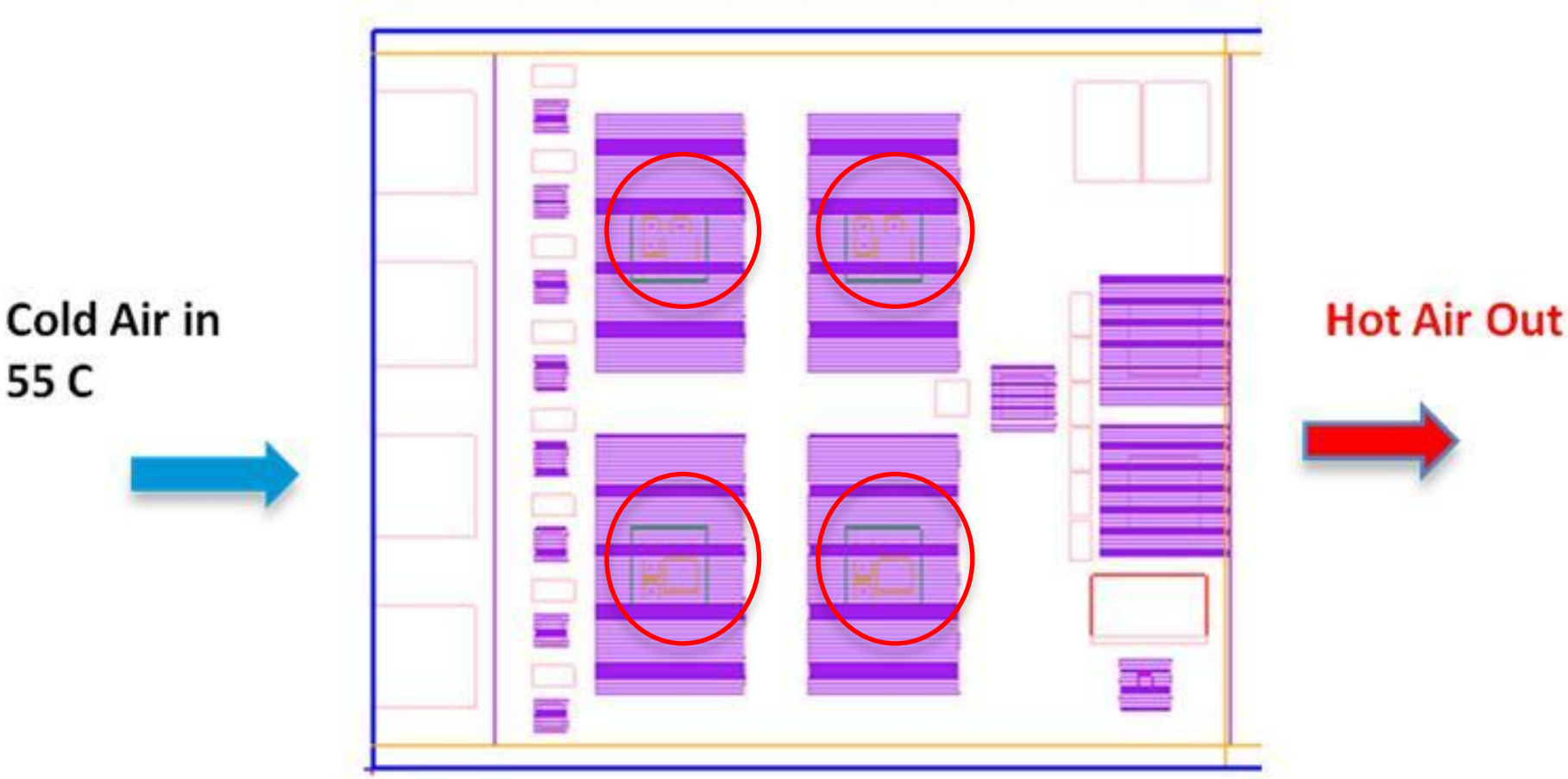


Scenario 1,
No Microbumps around TSV in underfill layer

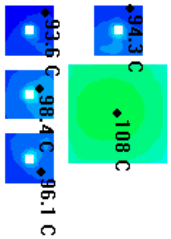


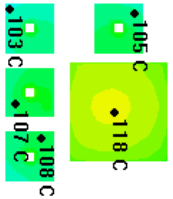
Scenario 2,
Microbumps around TSV in underfill layer

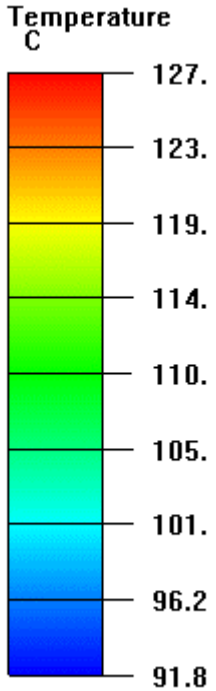
Same 3D Stack Package in a networking environment

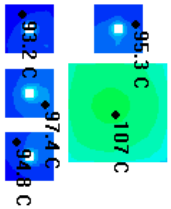


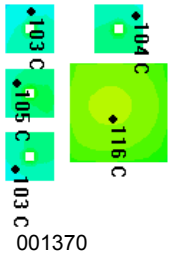
3D Stack Chip Temperatures in a System











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Conclusions

- 3D Stacks when handled properly with TSV's and micro-bumps in Underfill layers between silicon layers can help to keep memories to uniform temperature.
- 3D Stacks in next generation Telecom application could be handled if we maximize and optimize cooling by the use of

1. Vias below 3D Stacks and using PCB layers as an effective way to dissipate the heat
2. The sheet-metal tray below the board could be used a big heat-spreader and heatsink as well.
3. Overall, 3D Stacks hold a good promise in next generation high density packages, high density switches etc.

Thank you.