Exceeding Expectations Using Intel® Processors

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Today's talk

- Looking from a vendor's perspective using Intel processor PICs as an example

- Thinking about what customers need to do to maximize the performance of their applications

Intel embedded processor swim lanes

Intel® Xeon® Processors

Intel® Core™ Ultra Processors

Intel Atom® Processors

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Intel Xeon D Processors

- Designed for maximum CPU performance
- All cores are equal
- All cores run at the same base frequency
- Higher power consumption ~45W to 130W

- Biggest challenge is in extracting max performance at a high card edge temperature

- The laws of physics limit what is achievable with a conduction-cooled 3U VPX PIC

Real examples

- TR MAx (2022)
- 10-core Xeon D-1746TER @ 67W
- All cores running at 2.0GHz
- Max card edge +70ºC

- TR MDx (2024)
- 10-cores Xeon D-1848TER @ 57W
- All cores running at 1.9GHz
- Max card edge +85ºC

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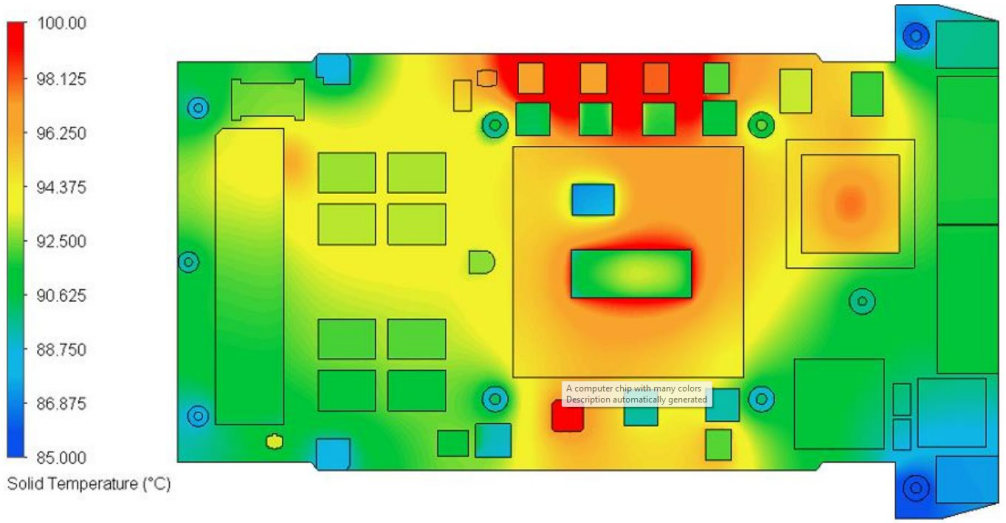
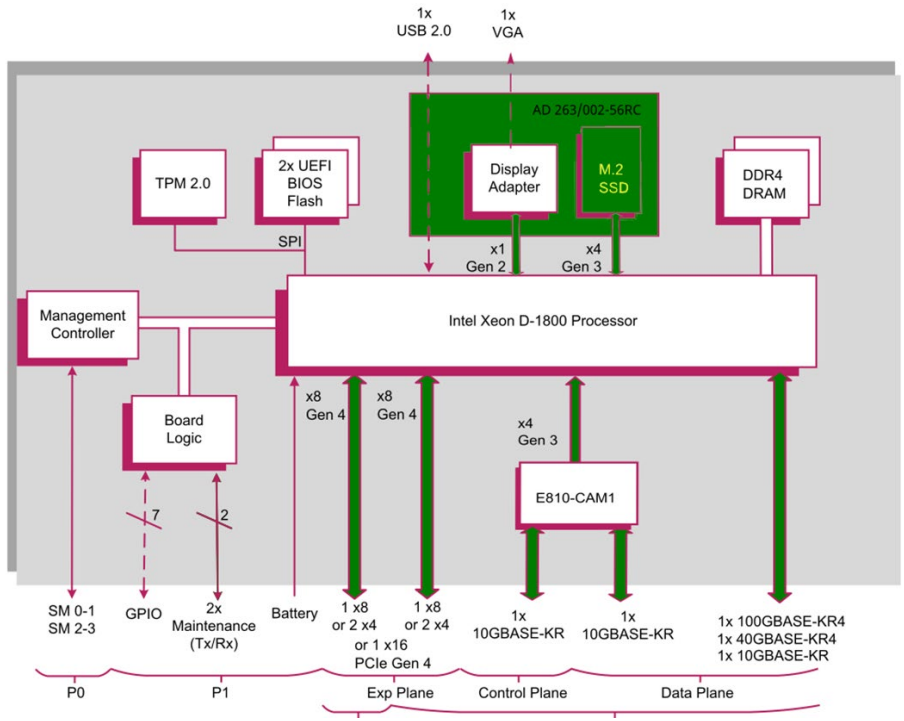
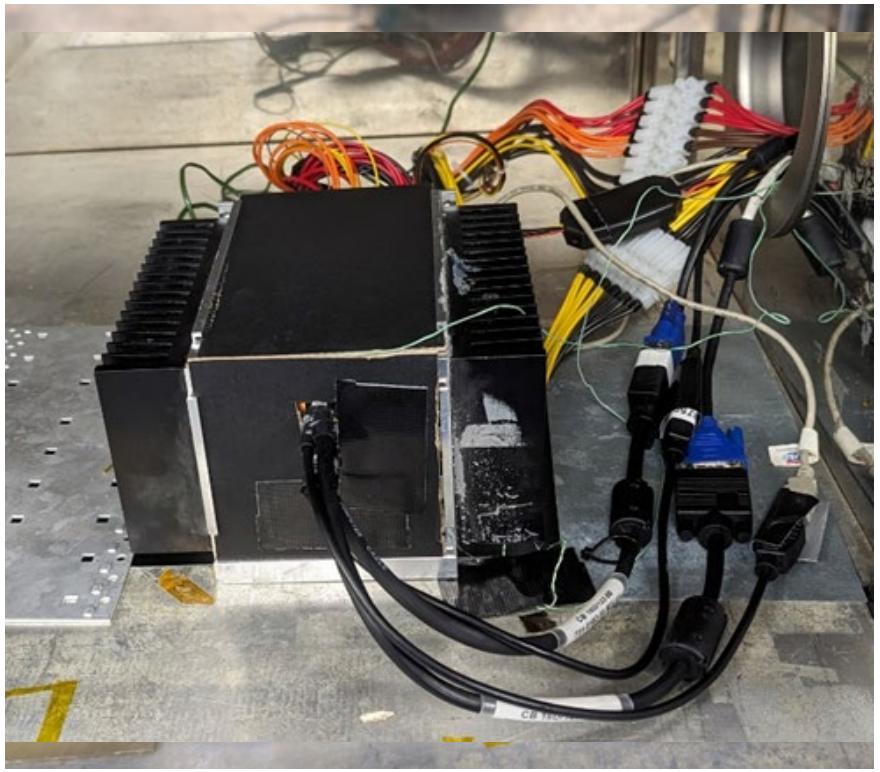
Xeon Thermal Testing

- Hotspot analysis/measurement
- Low and High temperature storage and operating tests







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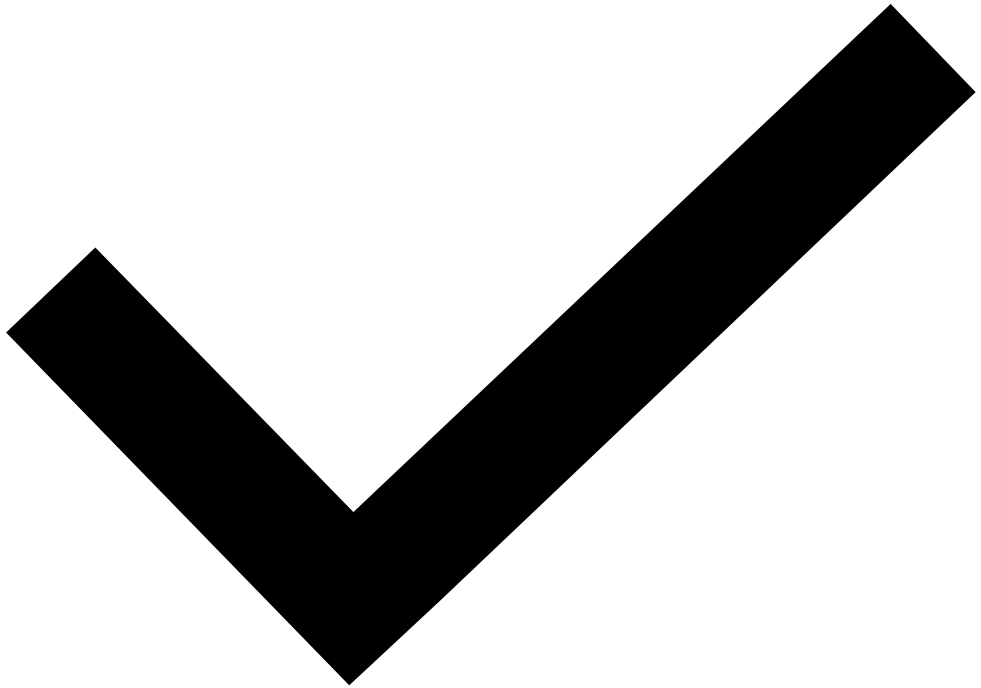
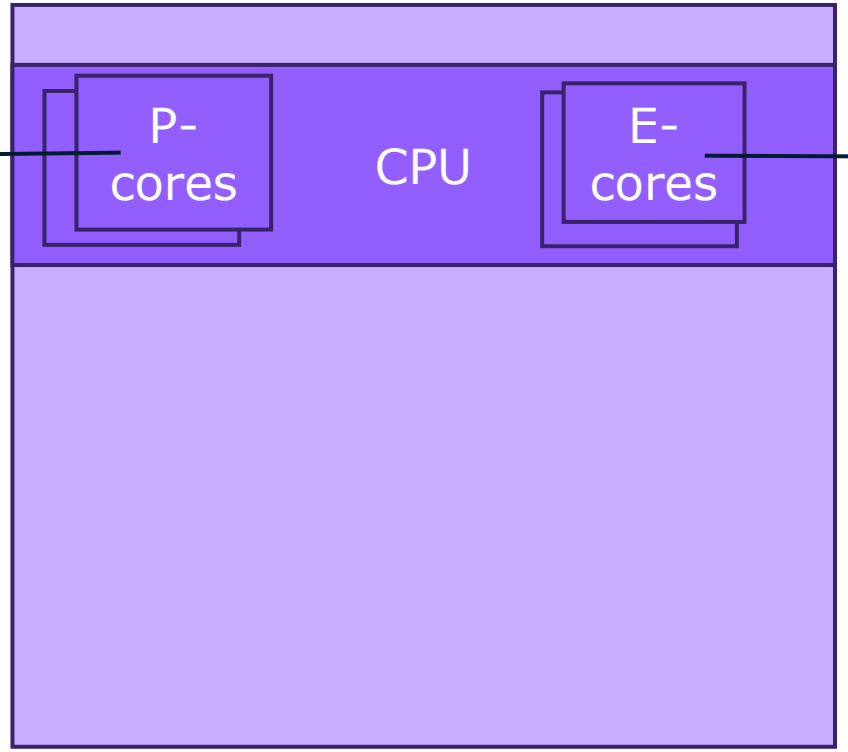
Intel Xeon based PIC Summary

- Relatively straightforward to qualify
- Fully deterministic with no throttling
- Ideal for Compute Intensive tasks



Intel Core Ultra Processor

Performance Cores



Efficient Cores

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Hybrid CPU Architecture

Performance Cores:

- Physically larger, designed for highest frequencies
- Ideal for heavy single-threaded work
- Capable of hyper-threading

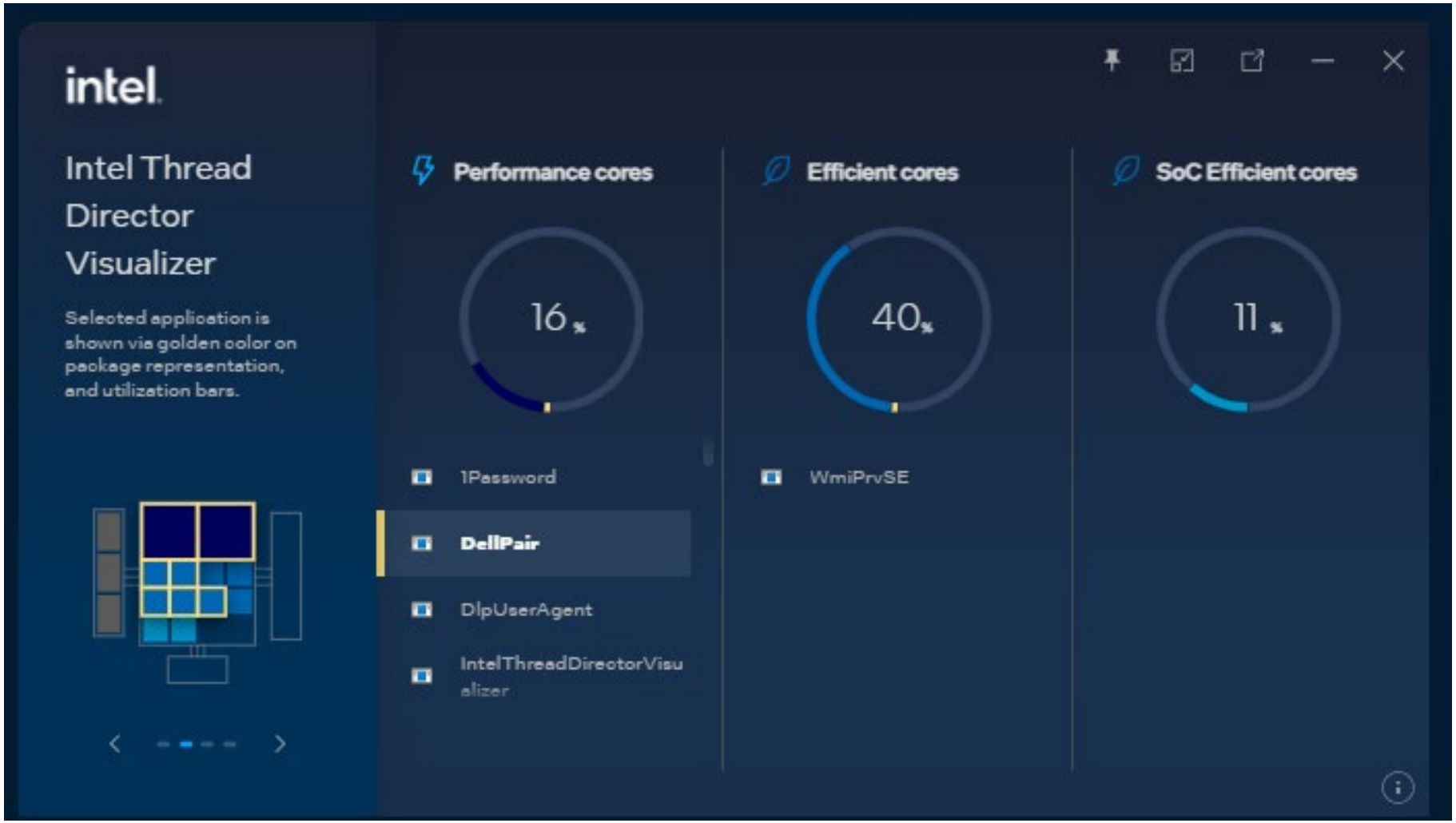
Efficient-cores:

- Physically smaller, maximize performance-per-watt efficiency
- Ideal for scalable, multi-threaded performance
- Optimized to run background tasks efficiently
- Capable of running a single software thread

Intel Thread Director

- Monitors the instruction mix of each thread and the state of each core with nanosecond precision
- Provides runtime feedback to the OS (Windows/Linux) to make the optimal decision for any workload
- Dynamically adapts its guidance according to the Thermal Design Point (TDP) of the system, operating conditions, and power settings

Intel Thread Visualization



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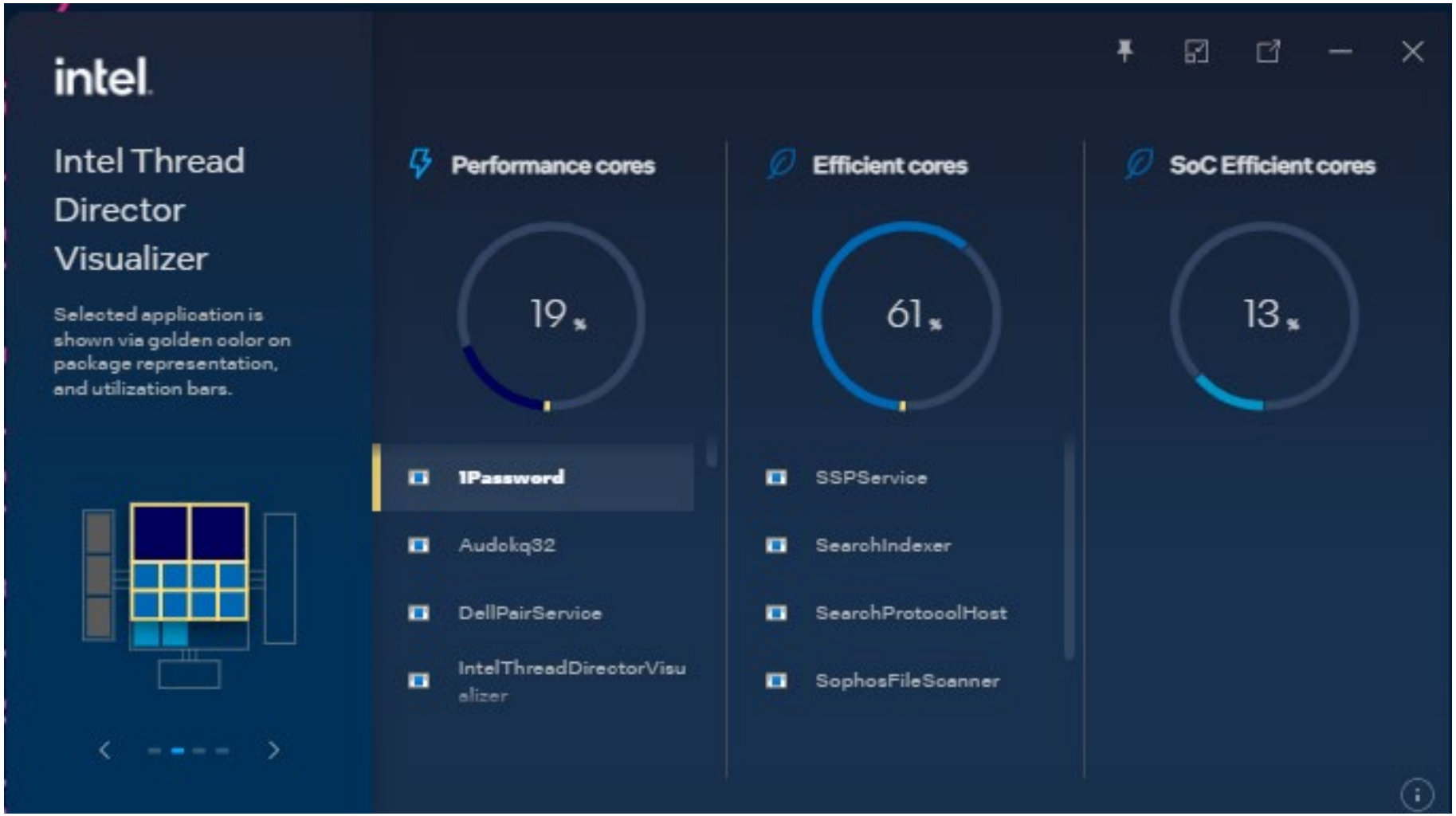
Intel Thread Visualization



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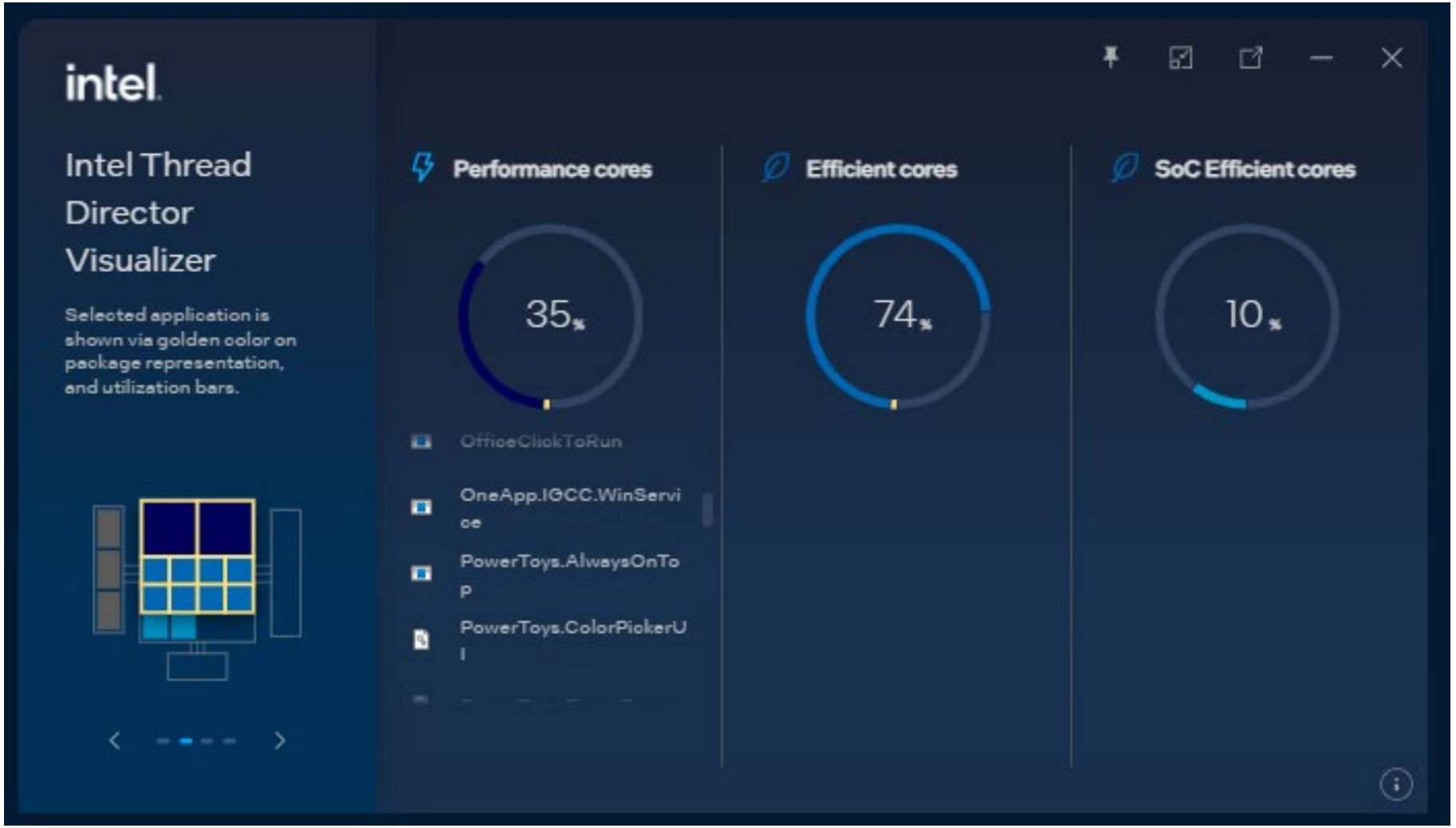
Intel Thread Visualization



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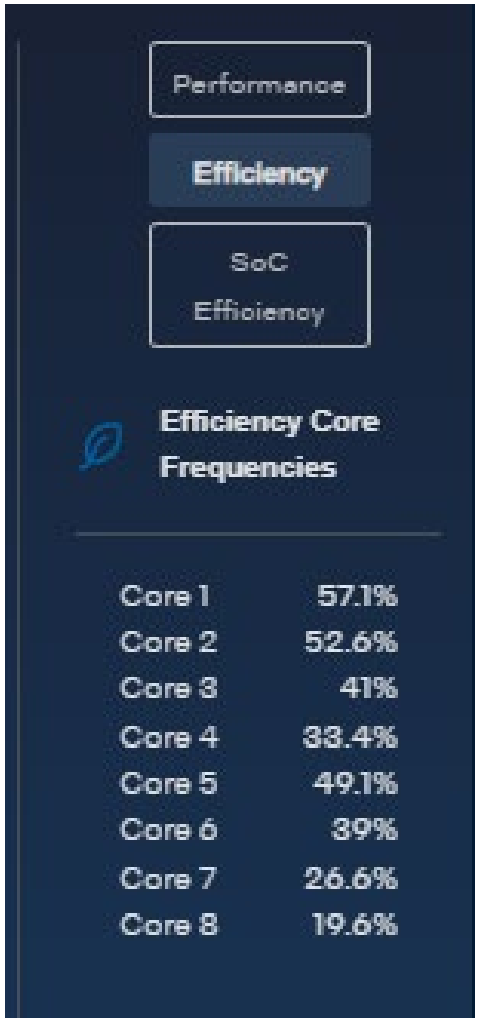
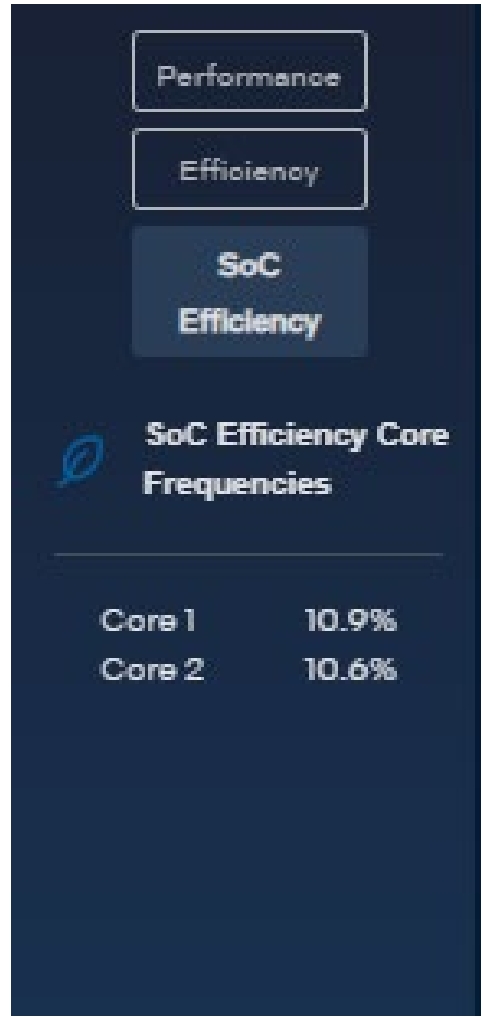
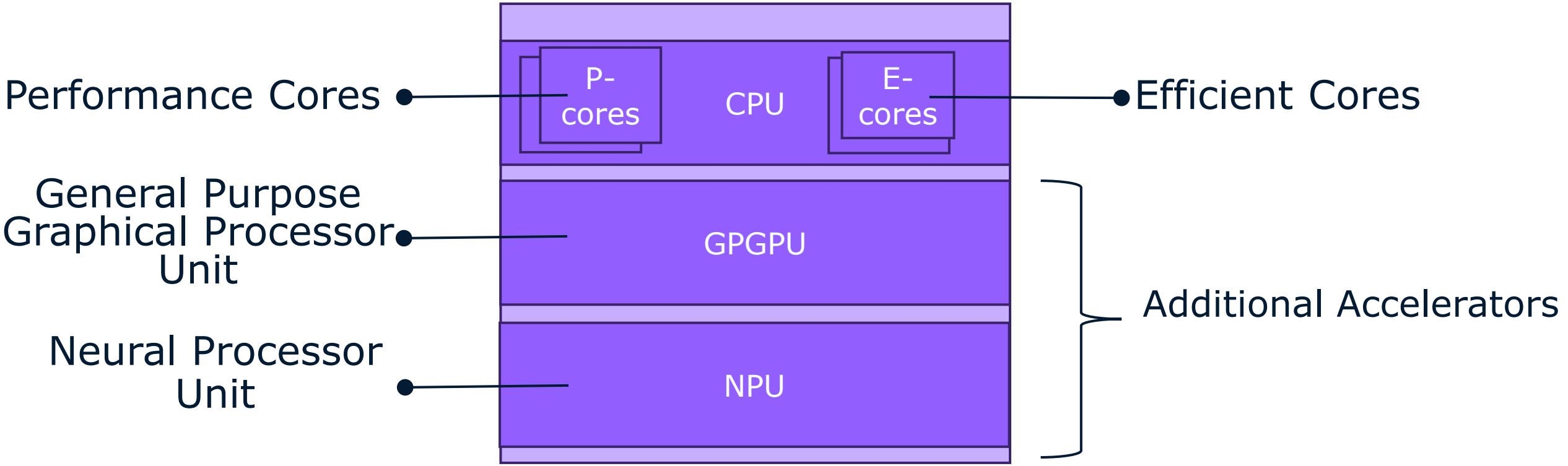
Intel Thread Visualization





Intel Core Ultra Processor



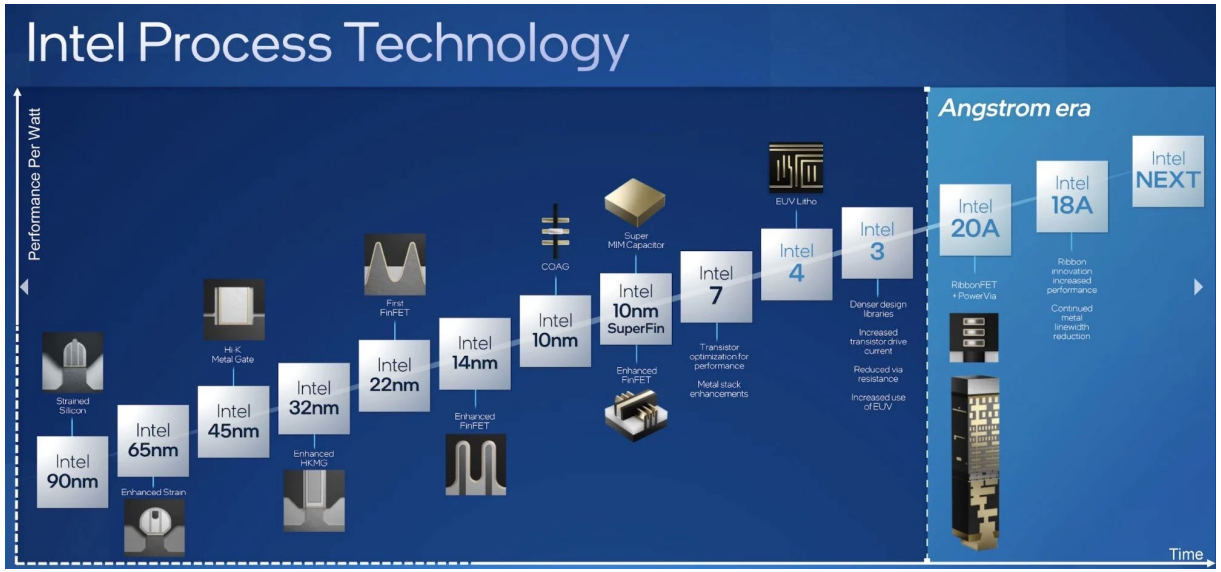
AI Inferencing Applications

Heterogeneous Computing Applications

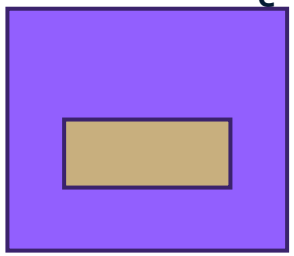
- Write once in DPC++, deploy using any/all available compute resources

Core Processor Thermal Challenges

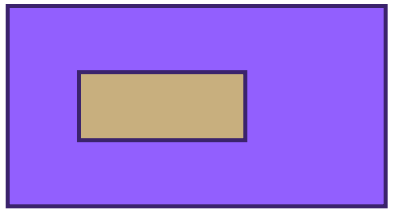
- Power density
  - Similar overall power
  - More CPU cores concentrated into a much smaller area of the overall die



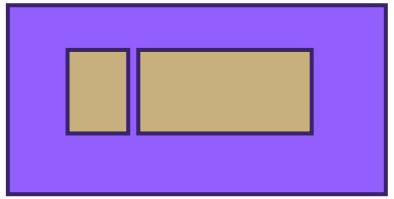
2013
22nm
4-core
i7-4700EQ



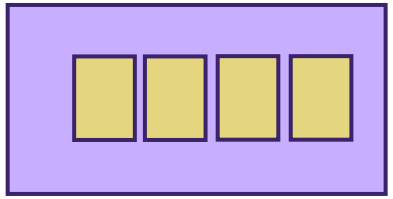
2021
10nm
8-core
i7-11850HE



2023
Intel 7
14-core
i7-13800HE



Future Intel
18A



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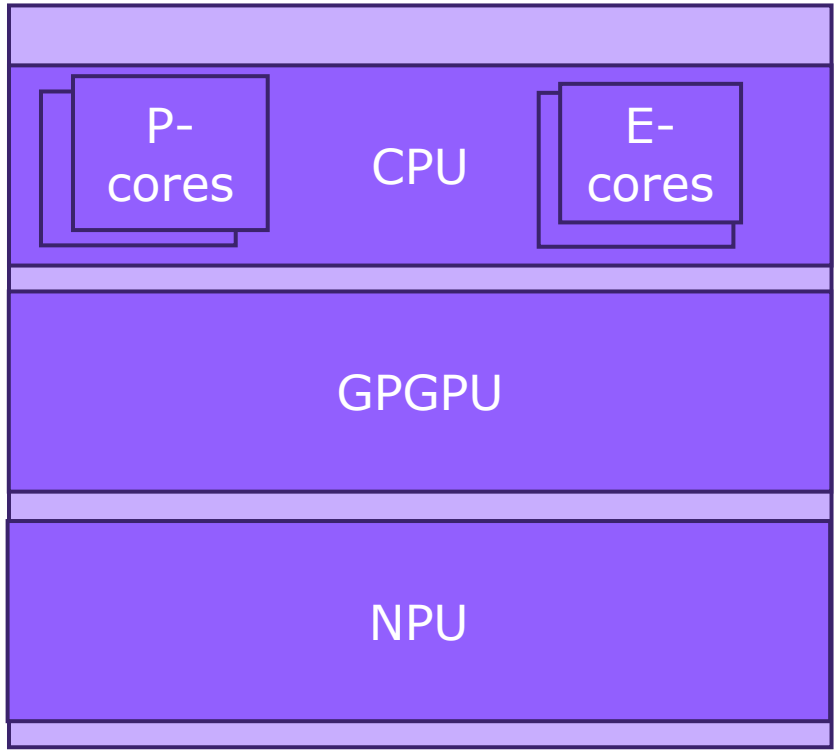
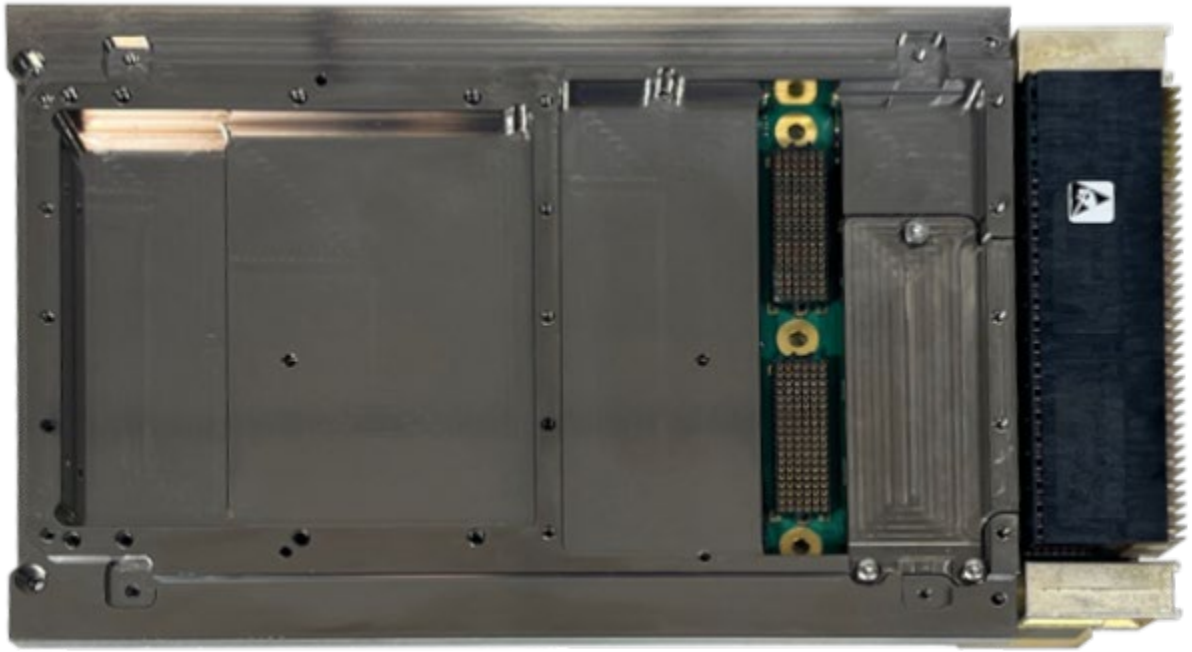
Core Processor Thermal Challenges cont.

- Determining a realistic load
- Minimize CPU Throttling



An example

- TR LBE (2024)
- 14-cores i7-13800HE @ 35W
- Cores running around 1.6GHz
- Max card edge +85ºC



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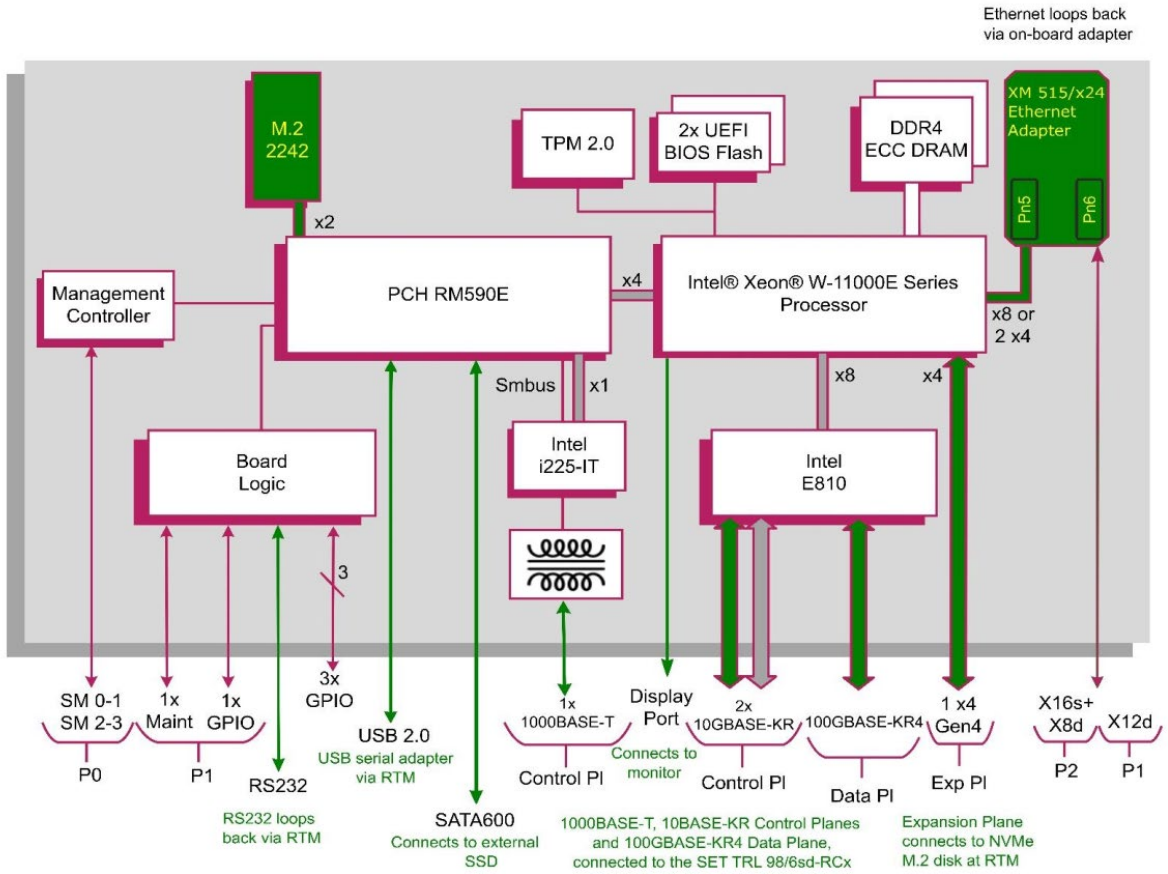
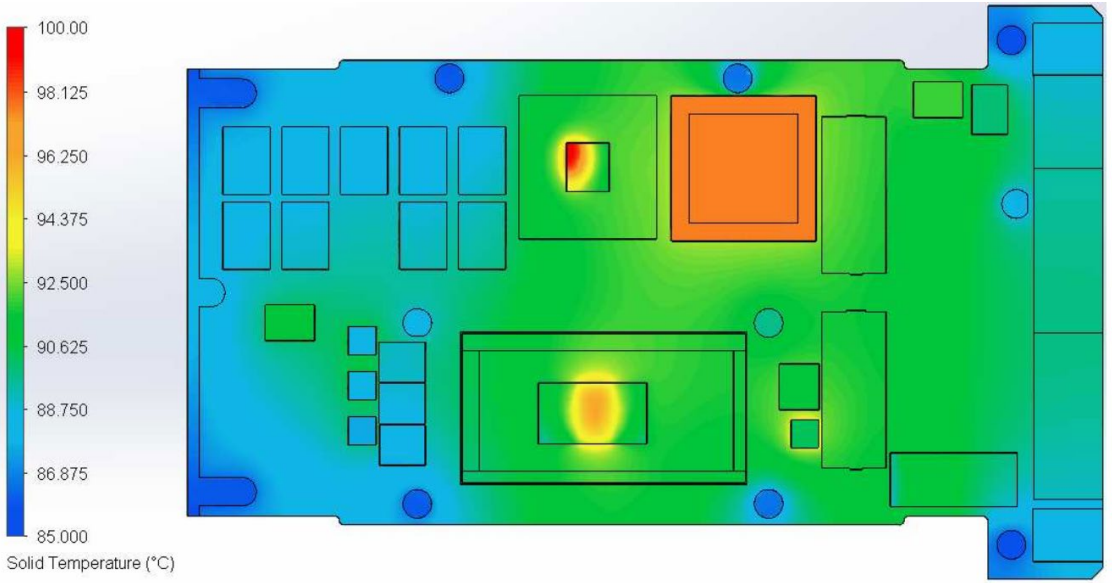
Core testing





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Intel Core Ultra based PIC Summary

- More challenging to qualify thermally
- Difficult to avoid throttling
- New process nodes significantly increase power density
- Not easy to compare performance between vendors

Questions?