Embedded TechTrends

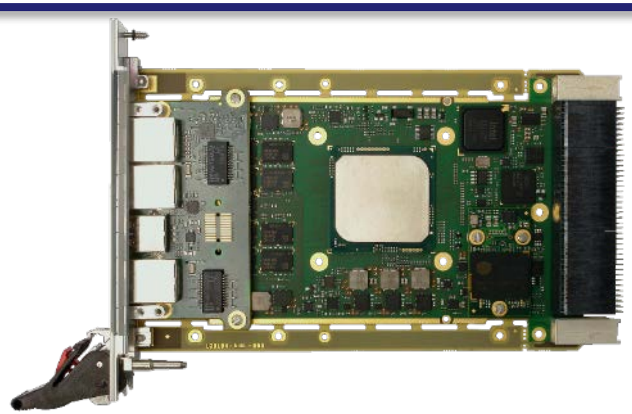
CONCURRENT TECHNOLOGIES

The dark powers on Intel® processor boards

Processing Resources (3U VPX)

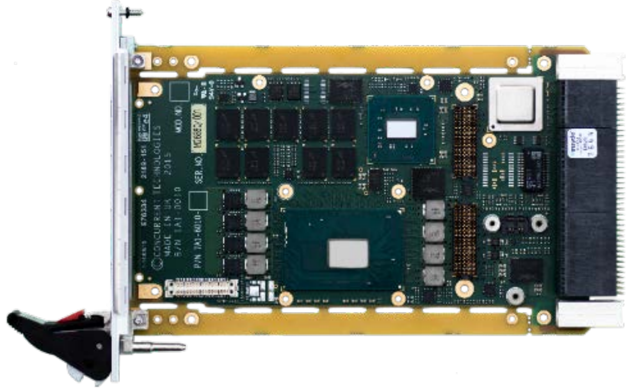
Boards with Multicore CPUs:

- Up to 16 cores using Intel® Xeon® D-1577 on TR C4x/msd



Boards with 4-Core CPUs and Multiple Graphical Execution Units:

- Up to 72 cores using Intel® Xeon® E3-1515M v5 on TR E5x/msd



Board types need radically different solutions:

- There isn't just an Intel SBC anymore

Intel marketing is very inventive

- **There is a bewildering range of Technologies and kits**
  - Intel Turbo Boost Technology
  - Intel Hyper Threading Technology
  - Intel Virtualization Technology (VT-x)
  - Intel Virtualization Technology for Directed I/O (VT-d)
  - Intel VT-x with Extended Page Tables (EPT)
  - Intel TSX-NI
  - Enhanced Intel SpeedStep® Technology
  - Trusted Execution Technologies
  - Intel vPro Technology
  - Intel Data Plane Development Kit (DPDK)
  - Intel Media Server Studio SDK.........etc

?

What does this mean for our typical users?

Three dark powers considered

- **TSX-NI**
- **Resource and Cache Allocation**
- **Intel Media Server Studio 2016**

TSX-NI

- **Transactional Synchronization Extensions – New Instruction**
- **Designed to improve high-performance computing (HPC) workloads**
- **Enables optimistic execution of transactional code regions with hardware ‘roll-back’ when multiple threads access a conflicting memory section**
- **Easy to implement**
- **Can provide significant performance benefits:**
  - Up to 40% on real world HPC workloads

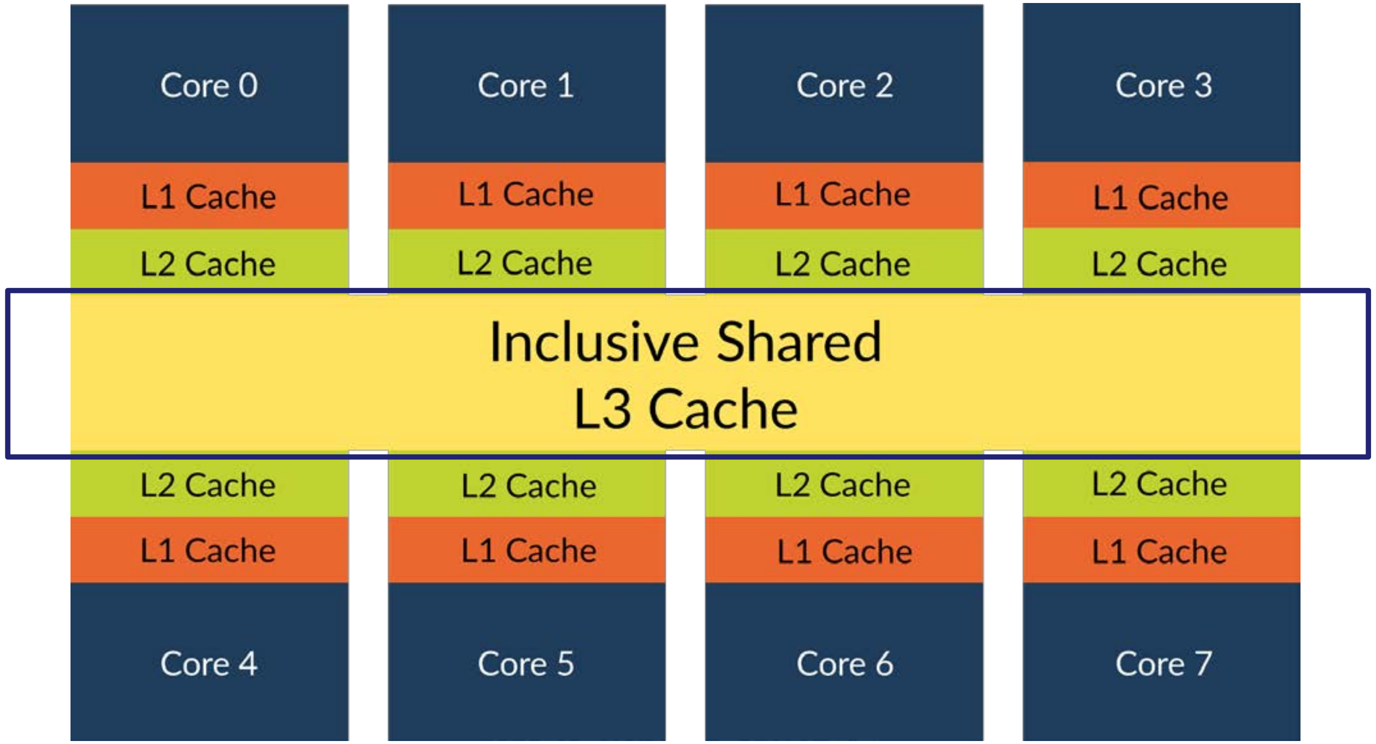
TSX-NI now available on mobile chipsets

Resource Allocation Strategies

- **Original Single Board Computer:**
  - OS and application ran on a single core
- **Modern Control Applications:**
  - Single OS per board
  - OS typically schedules an application to use all available CPU cores
- **Modern Server Applications:**
  - Multiple OS per board using bare metal or hosted virtualization
  - Virtual Machines are allocated a fixed number of CPU cores and memory

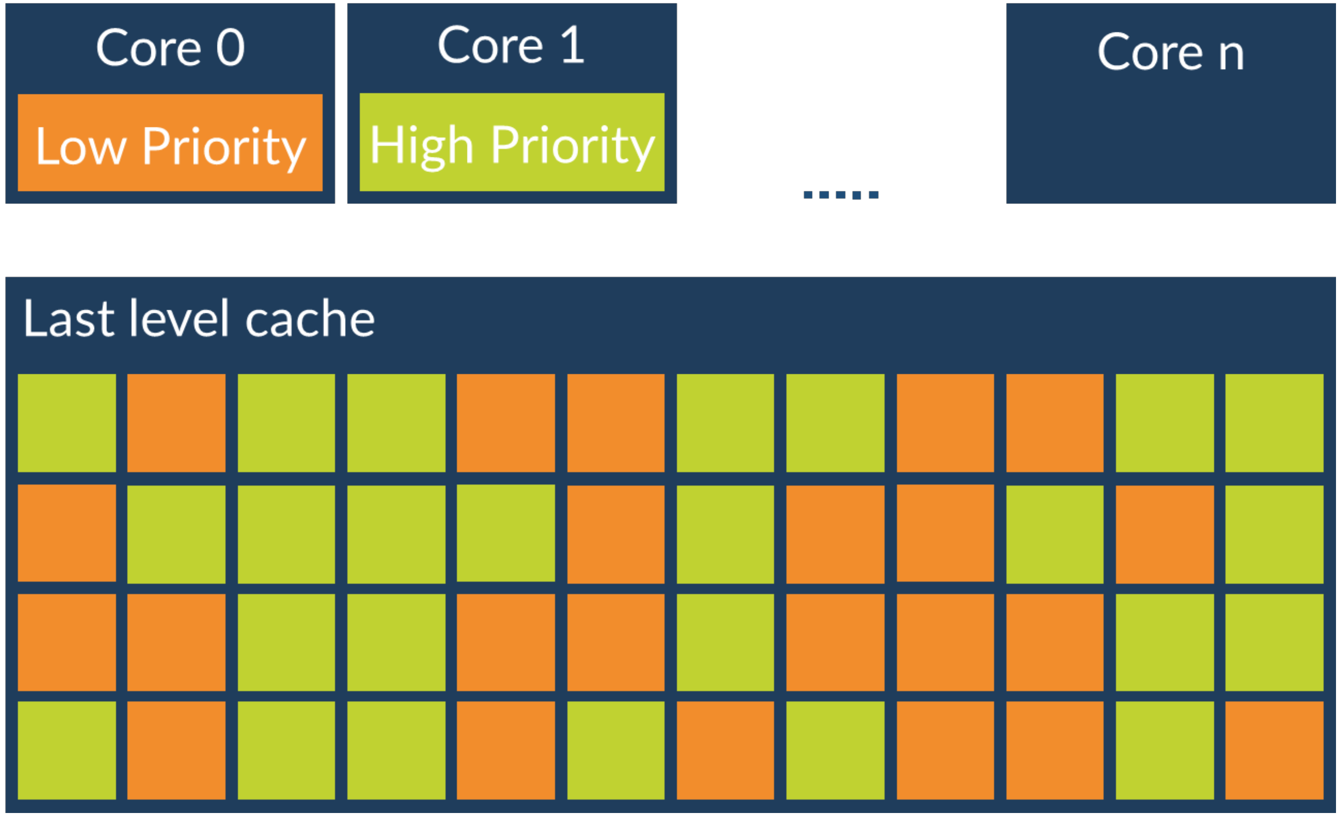
Resource Allocation

- **Some observations on Virtualization:**
  - Stable technology, data centre market mature
  - Not as low cost as you might want (Physicalization!)
  - Very attractive for embedded server applications with SWaP restrictions
  - Can affect performance when Virtual Machines contend for L3 cache space



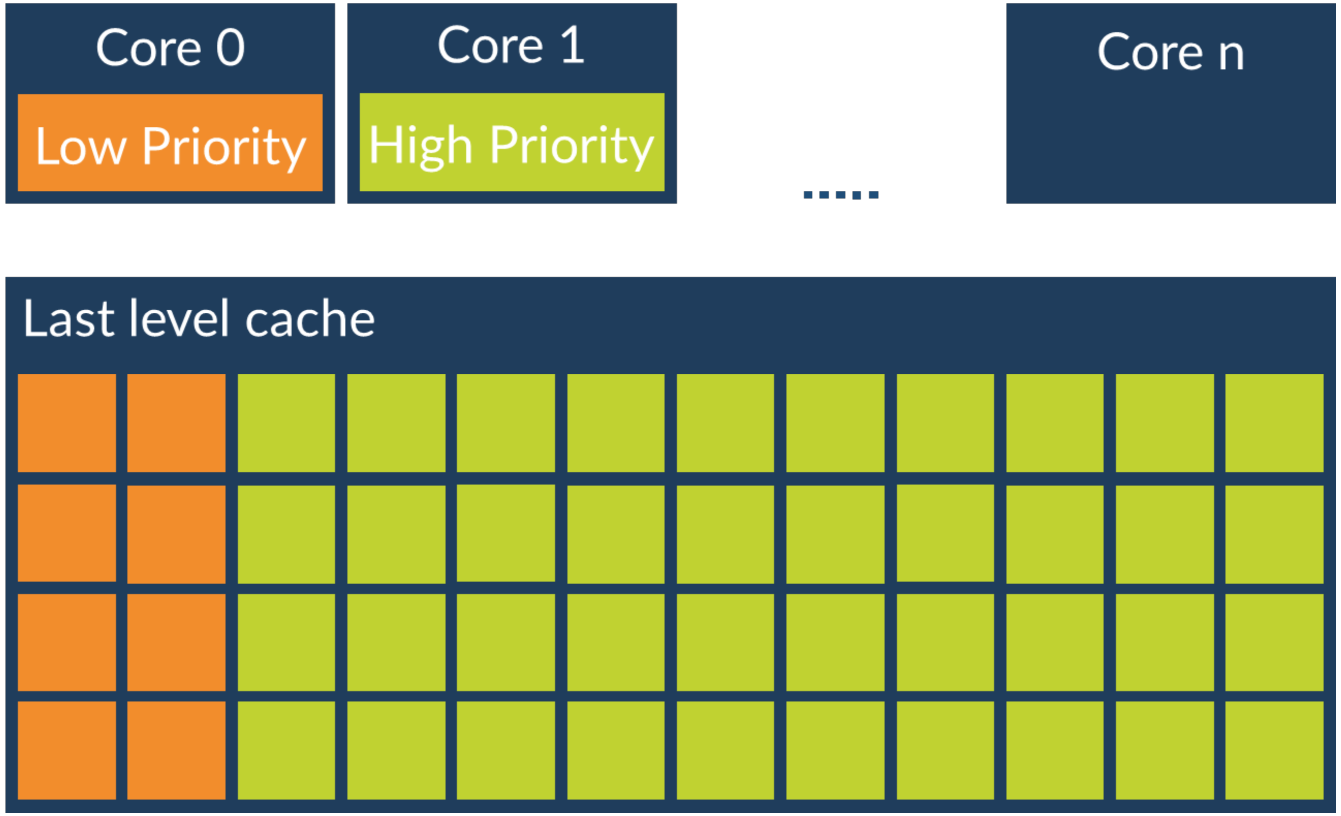
Cache Monitoring Technology (CMT)

- **Shows L3 cache allocation by Virtual Machine**
- **Identifies low priority tasks are consuming too much L3 Cache**
- **Known as ‘Noisy Neighbor’ syndrome**



Cache Allocation Technology (CAT)

- **CAT allows intelligent L3 cache partitioning**
- **High priority tasks can be allocated more L3 cache**
- **Improves determinism**



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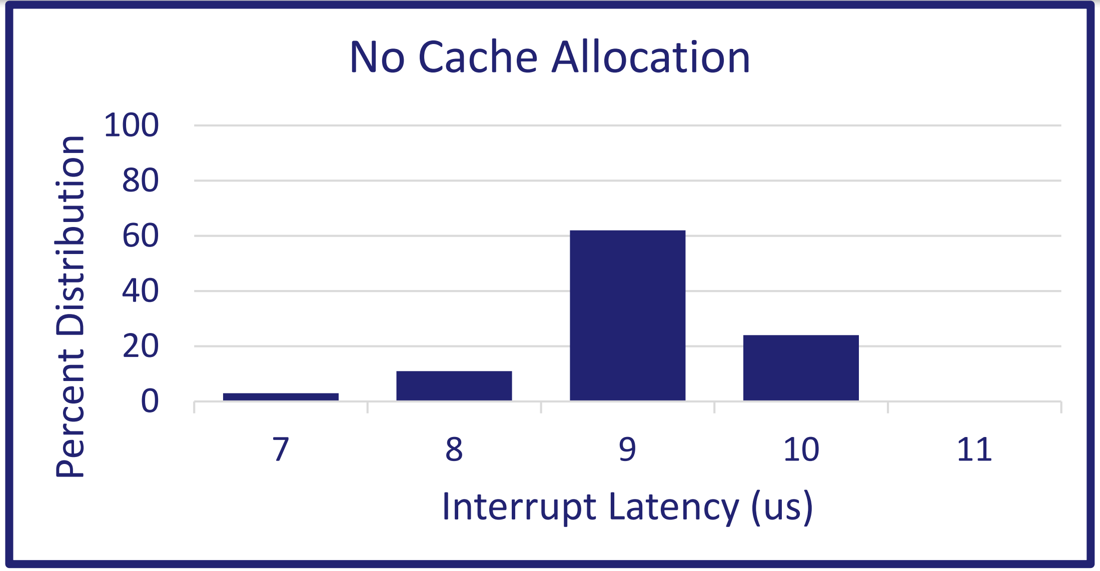
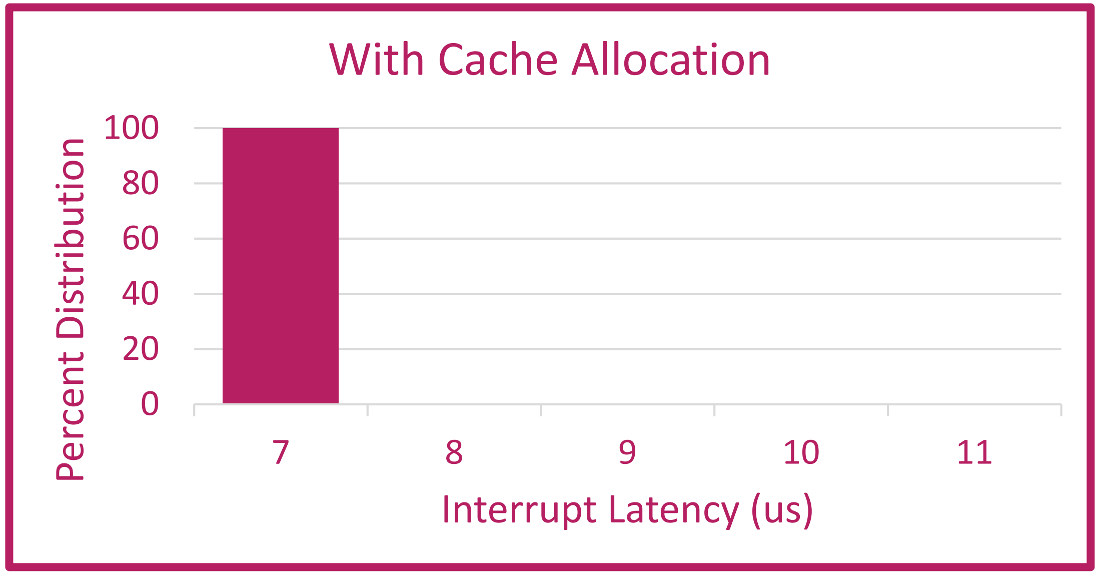
Improves Consistency

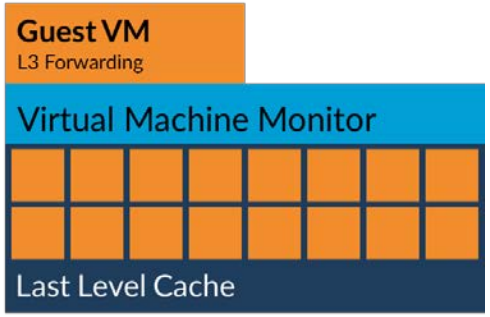
- **Without cache allocation the noisy neighbor causes the latency to vary**
- **With cache allocation the solution becomes more deterministic**

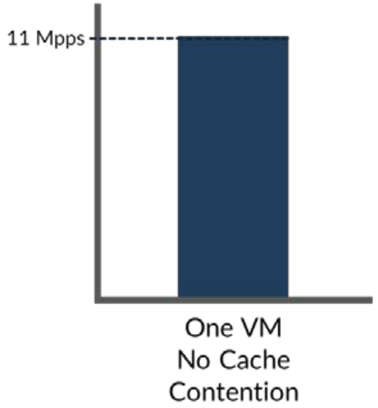




Throughput

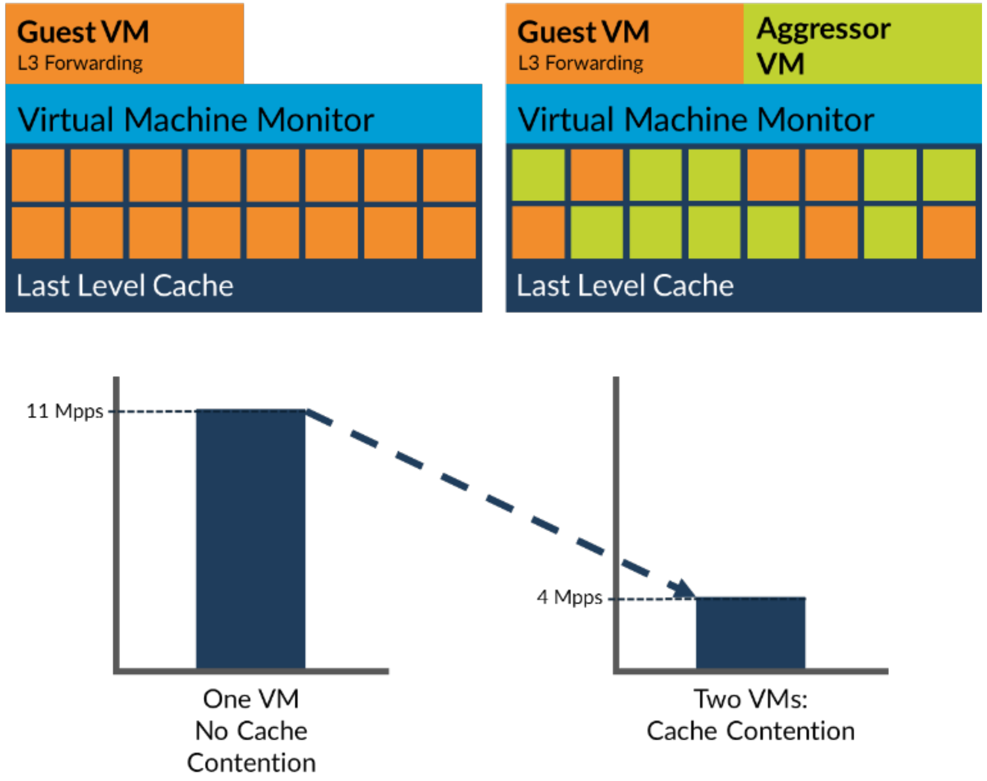
- **A single Virtual Machine runs a packet processing application consisting of a classification and scheduling stage**
- **This delivers 11 million packets per second (Mpps) of 64-byte packet throughput**





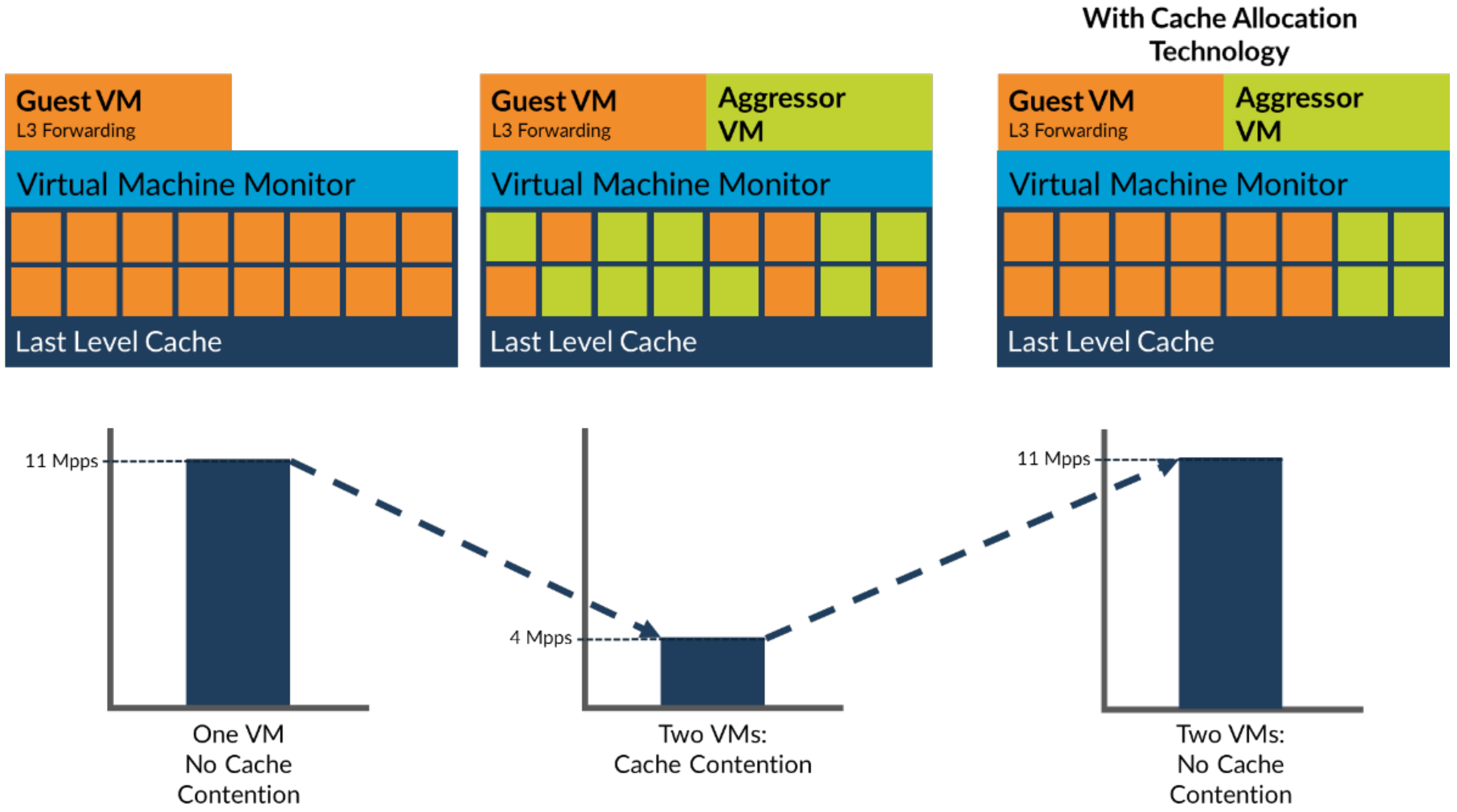
Throughput

- **When a noisy neighbor Virtual Machine is introduced which takes a substantial portion of L3 cache, packet-processing application performance drops to 4 Mpps**



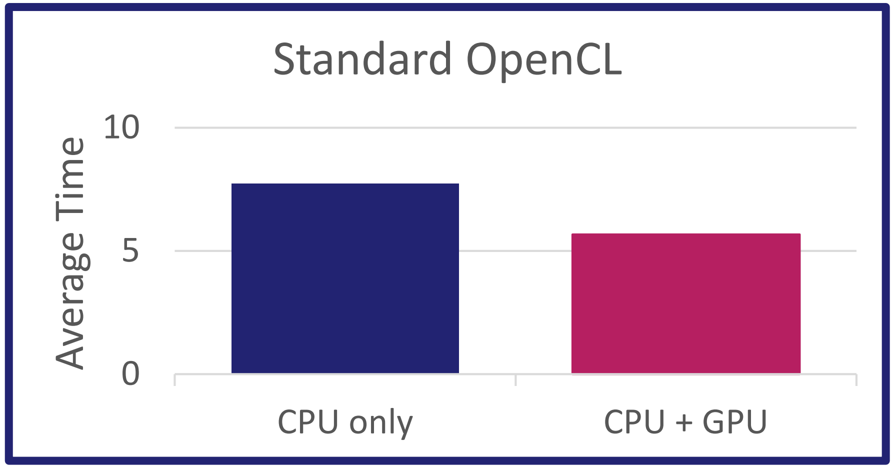
Throughput

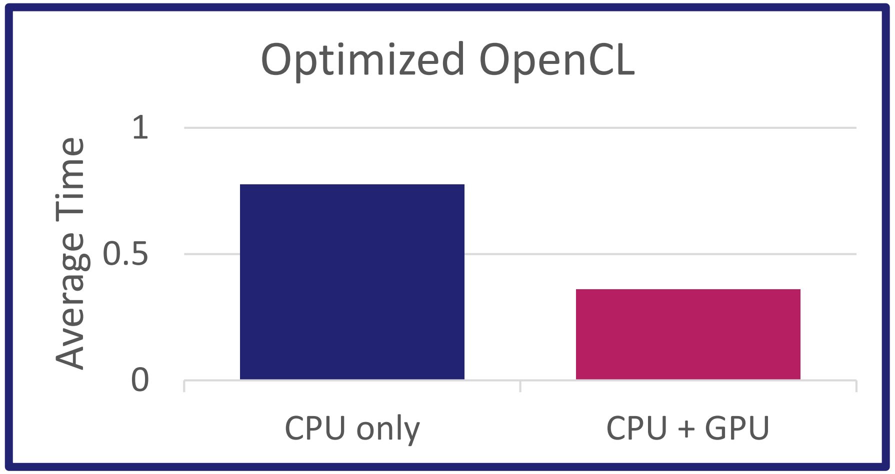
- **Limiting the aggressor VM's access to L3 cache, allows the packet-processing application performance to revert to the original 11 Mpps**

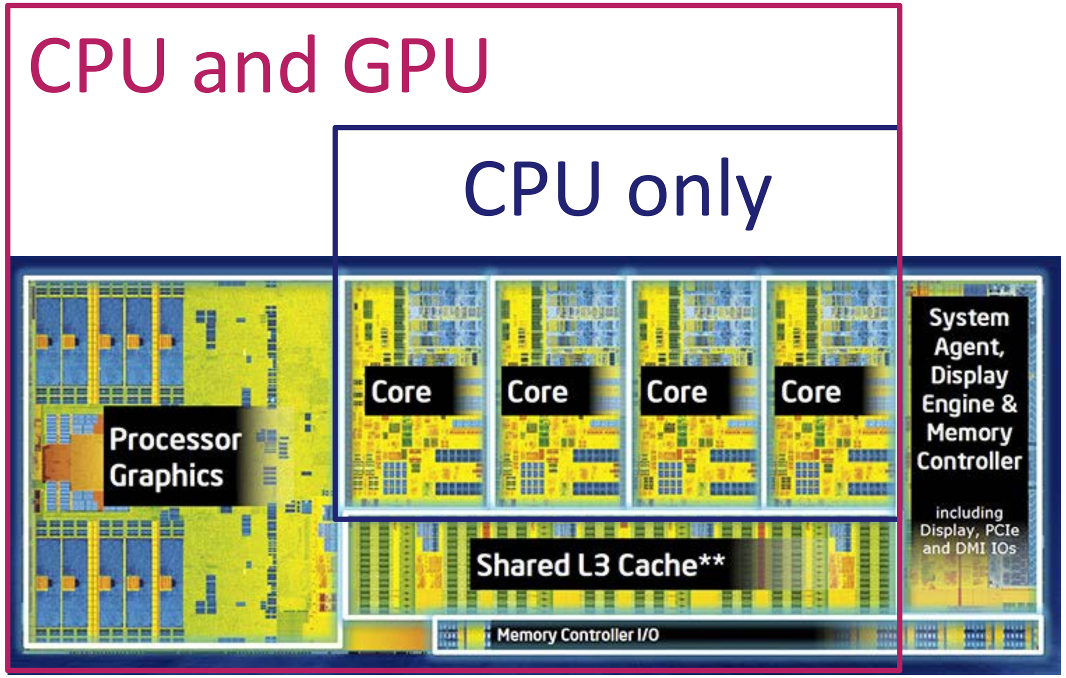


Using Intel Media Server Studio 2016 SDK

3072 x 3072 matrix multiplication





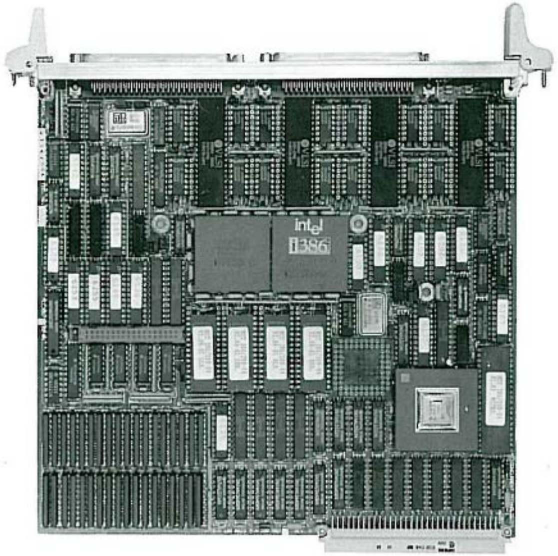


Intel: Haswell Processor

Board used AM C1x/msd, 4-core i7-4700EQ, 2.4GHz
Comparing standard C code, standard OpenCL code, Intel optimized OpenCL code and OpenBLAS scientific library
Full details available from Concurrent Technologies

How far have we come since 1990?

- **CC 386/x08 used 80386 @ 20MHz**
- **4MB DRAM, 4MB of EPROM**
- **Built In Self Test**



- **Compared to a Kaby Lake board AM G6x/msd**
- **4-core @ 3GHz**
- **32GB DRAM, 2TB storage**

Processor — **x 600**

Memory — **x 8,000**

Storage — **x 500,000**

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Thanks for listening