A Basic Study of Technical Features of 32 bit and 64 bit Processors

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Abstract- Taking into account some of the INTEL processor families, the features of the processors have been explained. This will create a clear picture of the technologies which are added by INTEL in its processors and how these features make our processor to perform well and increase efficiency.

Keywords- *INTEL, Processors, Instruction Set, Pentium*

I. INTRODUCTION

There are various 32 bit and 64 bit processors introduced by INTEL. And sometimes it makes difficulty to select which processor is better than other. Here, there is a list of some of the 32 bit processor and 64 bit processor and explanation of the features they have. The processor's features are explained in a manner that by reading the next processor, we will learn a newly added feature which was absent in the last processor. As well as the instruction set architecture of the processors will be explained. In this way, an idea is set up in the mind about the features that the new generation processors have.

II. INTEL PENTIUM 32 BIT PROCESSORS

A. PENTIUM 4

INTEL PENTIUM 4 is the first processor in the category of NETBURST microarchitecture. It is a CISC (Complex Instruction Set Computer) Processor. It is introduced in November 20, 2000. Number of transistors present on the chip is 42 million. Speed of this processor is 32 GHZ to 3.2 GHZ. This family has three variations. The various families of Pentium 4 is shown in figure1 describing their features.

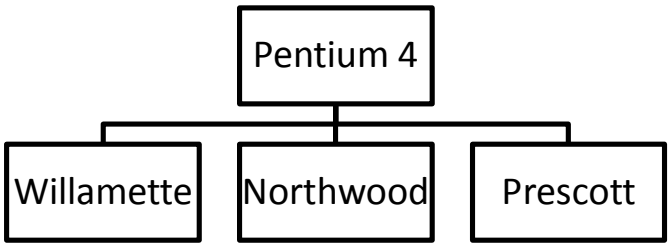

Fig.1: Pentium4 Processor Family

TABLE 1: FEATURES OF PENTIUM 4 FAMILIES

Willamette	42 million transistors	0.18 micron technology	Upto 3.2GHZ speed
Northwood	55 million transistors	0.13 micron technology	3.4GHZ speed
Prescott	125 million transistors	0.09 micron technology	3.8GHZ speed

1. FEATURES OF PENTIUM 4

- *HYPERTHREADING TECHNOLOGY*

The processor have faster response in case of multi-tasking situations due to this technology (HT). Scalability has been improved by combination of HT with 800MHZ front side bus and with a choice of 1MB or 2 MB of level 2 advance cache.

- *EXECUTE DISABILITY*

This is a feature of PENTIUM 4 processor .This feature will hinder the execution of some code that will be proved as fatal for our system. It protects the system from suffering from any virus attacks. It uses the Overrun method to get unauthorized access to the protected system .Usually the data taken from any source, is stored in program memory. The malicious data usually has some text which is longer than the size provided for the input data. When it is stored in memory, it is stored in such a way that the control transfer is changed and it leaves the execution of current program and start executing malware. At this time a bit named 'Execute Disable Bit' goes high which indicates the processor about the wrong transfer control. The processor stops execution of malicious code and protects the system from VIRUS attacks.

- *HYPER –PIPELINED TECHONOLGY*

CPU performance is directly proportional to its frequency and efficiency. Many processors architectures try to build a balance between frequency and efficiency. But NETBURST microarchitecture tries to influence performance by

pressurizing at frequency the cost of efficiency. Hyper pipelined technology has pipeline stages increased from 21 to 31 stages which is longer than previous generation pipeline stages. Longer pipelines have less efficiency but they result in higher performance. Comparison of pipelining stages of this processor with previous generation is shown in figure 2.

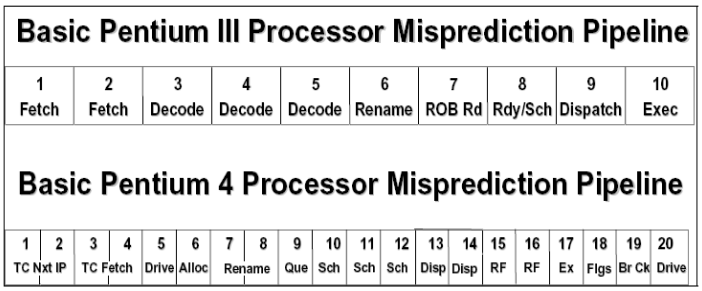

Fig.2: Comparison of pipelining stages of Pentium 4 with previous generation.

- *INSTRUCTION SET ARCHITECTURE PENTIUM 4*

  Processor supports: MMX AND SSE2 instruction set.

- *MMX*

It is SIMD set i.e. Single Instruction Multiple Data. MMX is Multimedia Extension. MMX set works only on integer operations. It has 8 registers MM0 –MM7.The main problem this set is that it reused existed floating point registers. This results into inefficiency of CPU to work on both floating point and SIMD data simultaneously.

- *SSE*

Streamlined SIMD Extensions. MMX instructions + it uses only single data type for 4 32 bit single precision floating point numbers.

- *SSE2*

It has extensions over MMX and SSE by having 144 new instructions:

- 128 bit SIMD integer arithmetic instructions
- 128 bit SIMD double precision floating point
- Enhanced cache and memory management
- Performs logical operations on double precision floating point numbers [1].

B. PENTIUM 4 MICROPROCESSOR

It implements 0.13 micron technology .It exhibits speed of up to 2.6GHZ.512kB of l2 cache is present on the chip. No hyper threading technology is present in this processor which was present in other processors as shown above. Also no Execute Disable Bit ability is absent. It has 77 million transistors on chip. It inhibits MMX, SSE, and SSE2 instruction set architecture. [2]

- *LOWER POWER DISSIPATION OF PENTIUM 4M*

It is a mobile processor differs from desktops in a way that it has lower power dissipation as compared to desktops because of the lower core voltage .It works on battery power and the reduced core voltage is 1.2V.

- *DEEP SLEEP MODE*

This is one of the feature of this processor which is not present in the above mentioned processor. In this mode, the processor operates at 1.0V instead of 1.2 or 1.3V which further reduces the power dissipation to approximately 4V. [3]

- *SPEEDSTEP V2.2*

This feature added an ability in PENTIUM 4M that is named as DEEP ALERT MODE. In this mode, the processor runs at the lower voltage levels, thus saving more battery life. One more feature of this processor in the Enhanced EIST. This feature further solve the power consumption problem by just shutting down that parts of processors which are not required at the current executable part of program [4].

III. PENTIUM 64 BIT PROCESSORS

A. ITANIUM PROCESSOR

It is the first family of Intel processors among 64 bit processors. CPU clock rate of this processor is 733MHZ. It employs EPIC (Explicit Parallel Computing Design). This design improves the parallelism of the processor and which further improves the efficiency and performance. It is the FIRST processor that introduces ILP (Instruction Level Parallelism) to the general purpose microprocessors.

1. FEATURES AND ARCHITECTURE OF ITANIUM

Itanium exhibits the following features:

- *SOFTWARE PIPELING*

Let us take example of a 2-issue processor i.e. the processor that is capable of issuing two instructions in one cycle [5].

TABLE 2 WITHOUT PIPELINING

Cycles	Iteration 1	Iteration 2
1	Read	
2	Add	
3	Mul	
4	Write	
5		Read
6		Add
7		Mul
8		Write

TABLE 3: WITH PIPELINING

Cycles	Iteration1	Iteration2
1	Read	
2	Add	
3	Mul	Read
4	Write	Add
5		Mul
6		Write

By comparing above two tables we have obtained a Speed Up factor of 8/6=1.33 when software pipelining is implemented.

- *10 STAGES OF PIPELINING*

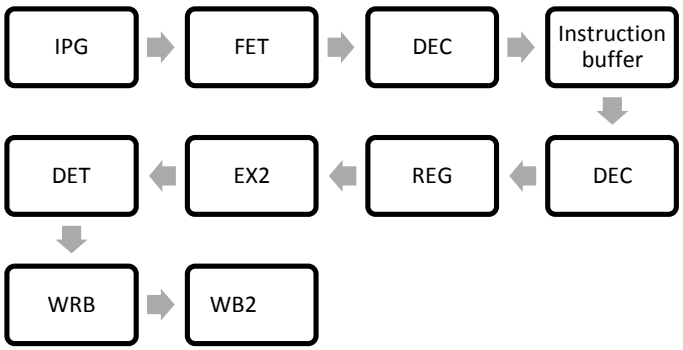

Fig.3: 10 Stages pipelining of Itanium processor

- IPG: Instruction fetch pointer generate
- FET: Instruction fetch
- FDC: Decode
- REN: Register rename
- IBD: Instruction buffer and dispersal
- REG: Register access
- EXE: Instruction Execution
- DET: Detect exceptions
- WRB and WB2: Write back and Write back 2[6]

- *Other Features*

Register stack implementation is there in this processor which is used to control the procedure calls. It exhibits speculation which means to predict in future in case of branches. There are two types of speculations, one is Data speculation and another is control speculation [7].

B. PENTIUM EXTREME EDITION(EE)

It inhibits Netburst microarchitecture, 0.065 and 0.09 micron technology, **Dual core**, upto 3.73GHZ, 2MB and 3MB L2 cache, SSE2, **SSE3** instruction set, Executable Bit, **and Virtualization.** Most of the features have been explained above. Following are the newly added features:

- *SSE3*

This feature was introduced by INTEL in 2004. In this instruction set 13 instructions are added to SSE2 set. The newly added features are horizontal operations and thread synchronization etc. [8].

- *Virtualization*

This technology was implemented in November, 2005(VT). This makes users easy to run various operating systems in independent parts of the memory. Also the system will still work any of the user application program or any operating system fail.

- *EM64 Feature*

This feature represents the Extended Memory. After introducing this feature INTEL will add this technology to all new generation processors. It has two sub modes:

1. COMPATIBLE MODE: All the programs running on 64 bit O.S. can run on a 32 bit O.S.
2. 64 BIT MODE: Programs can access up to 16EX (Exabyte's) of RAM.

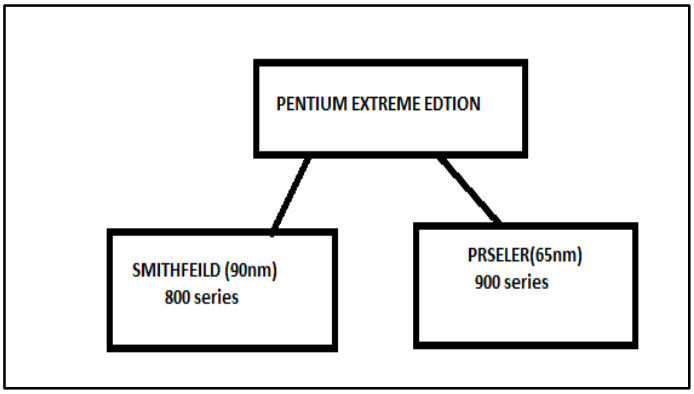

Fig.4: Families of Pentium Extreme Edition

C. *XEON PROCESSOR*

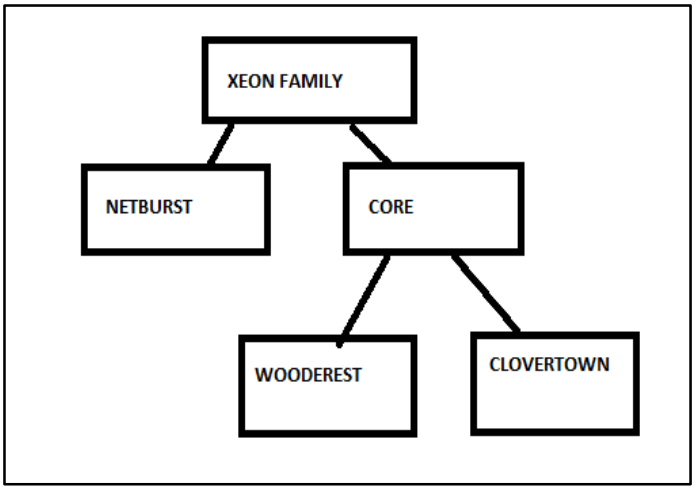

Fig.6: Xeon family

TABLE 4: FEATURES OF XEON FAMILIES [9]

WOODEREST	**CLOVERTOWN**
65nm	65nm
June 26,2006	Dec 13,2006
Dual core	Quad core
Multiple O.S.	Multiple O.S.
Execute disable bit	Execute disable bit
TXT feature	**TXT feature**
SSE3	SSE3

The Xeon has two architectures: Netburst microarchitecture and Core architecture as shown in figure 6. The Netburst architecture has been explained above. The Core has two families which has been explained above .Most of the features are present in previous processor.TXT feature is explained below which is modification in the previous processors.

- *Trusted Execution Technology (Txt)*

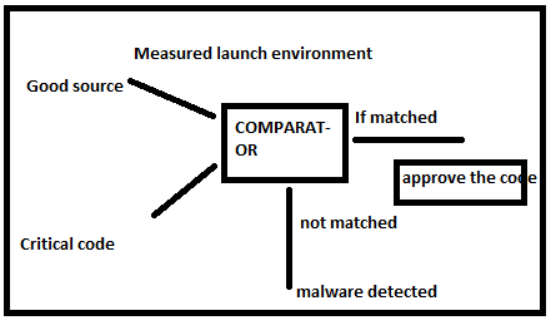

Fig.5: How does TXT work

Intel introduces a technology (VT) that protects the system from VIRUS attacks and provides authentication to data. It provides the security software's like anti-virus. This technology provides more secured environments. This will work as shown in figure 5. Intel will provide unique identifier for each approved code and then compare the critical data and if they match then it will allow the execution of program otherwise block the code [10]. All other features mentioned above have been explained in the above sections.

IV. CONCLUSION

It has been shown in all the above sections by taking into considerations some of the 32 bit and 64 bit processors ,the features they implements as well by incrementing to further processors mentioned above the features which are added to the processor .e.g. virtualization technology has been added by INTEL after the processor PENTIUM EE. The step by step increase in the technologies are there which improve the performance of the processor by having more and more features associated with them.

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