task 1

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Stuxnet Project: Use of Sandy Bridge Architecture

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The primary hardware architecture which was used in the 2010 Stuxnet computer malware attack was Sandy Bridge. Developed and released by Intel in 2009, Sandy Bridge hardware microarchitecture is primarily designed for the second generation Intel based processors namely Core i3, Core i5 as well as Core i7. The hardware architecture was preferably used during the Stuxnet attack due to the fact that it was one of the best processor at the time of the attack. The primary advantage offered by the processor for the Stuxnet Project was that it provided an enhanced performance of up to 17% better than the previous versions of Xeon as well as Core i5 and Core i7 processors. Moreover, Sandy Bridge also featured more than twice the performance of integrated graphics compared to the Clarkdale processors which was used being used in Core i3 and Core i5 of the time. The chip also come with a number of advanced features namely a greater turbo boost, improved HD 3000 graphic controllers, advanced vector extensions and support for active management technology.

With regard to bottlenecks of the Sandy-Bridge architecture, the chip is primarily designed in such a way that the instructions which are stored in the main memory are made to processed at a higher rate via the 32 KB L1 instruction cache (ICache). Moreover, the instructions are also dispatched through a unique buffer which helps in tracking the original instruction sequence. Generally, the Sandy Bridge bottlenecks are designed to be as efficient as possible. Both machine microarchitectural optimization aims to keep the pipeline going to prevent stalls. For example, several instructions can simultaneously be executed due to the core architecture's super-scalar properties. It is also worth noting that the bottlenecks of Sandy Bridge are based on a new architecture and a brand new main concept that is both faster and more energy efficient. The front-end has been completely overhauled to include a new decoded pipeline and OP cache. The backend is a whole new PRF-based renaming architecture with a huge parallelism window. In comparison to its contemporaries, Sandy Bridge has a much higher level of integration, resulting in a complete device on a chip architecture.

There are a number of reasons why Sandy-Bridge architecture is better than Nehalem architecture. Firstly, as compared to Nehalem, Sandy-Bridge not only supports all the features which were available in the Nehalem microprocessors but also supports several additional Advanced Vector Extensions instructions. In addition, although Nehalem is still considered to be a quite capable chip, it is much slower than Sandy-Bridge. For instance, Sandy-Bridge is widely estimated to be between 10 and 12% faster than Nehalem. This is critically important when performing highly demanding tasks as the high clocking rate of Sandy-Bridge ensures better performance (Rotem, et al., 2012).

On the other hand, Sandy Bridge is also better than Nehalem architecture because it does not usually require the users to take two steps back when using some of the contemporary applications. This has particularly been achieved by enabling ISA extensions in the chip. One of the most significant physical improvements in the Sandy Bridge age was the LGA 1155. During the time, the inclusion of a new chipset generation and the upgrade of the embedded GPU in these chipsets, which became a part of the processor itself as if it were another processing core was considered to be a significant improvement over its predecessors.

Besides, Sandy Bridge offered improved power consumption, stability, and Turbo Boost improvements, as well as integrations of Turbo Boost with the GPU, improved graphic output, a new set of AVX instructions (Advanced Vector Extension), and video coding and decoding algorithm enhancement, making it the best processors available at the time. Finally, Sandy Bridge processors also have an Advanced Vector Extensions (AVX) set of instructions which is deigned to support 256-bit wider vectors for floating point arithmetic. Sandy Bridge processors have been found to offer up to a 17 % boost in CPU capacity over Lynnfield processors based on the Nehalem architecture.

The computers of the period between 2008 and 2020 when the Stuxnet malware attack was executed were characterized by relatively slow processing power (Albright, Brannan & Walrond, 2011). This was particularly attributed to the dominance of single processor computers during the period. For example, during the era of 2008-2010, most of the computers used had single core Pentium 4 processors which can not even match the performance of the current low end multi-core processors and may be considered to be unusable by modern standards. However, among the high end computers of the time, Nehalem processor architecture was the most widely used. The architecture was primarily based on the 45 nm manufacturing methods. Although Nehalem architecture introduced a number of notable features such as hyperthreading capabilities, it had a number of limitations such as lower L3 cache and memory controller speed performance and poor media transcoding. This is a likely explanation why Stuxnet was able to exist for a considerable period during those years with little detection.

References

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