PowerPC Thermal Management and Performance Modelling

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The project concerns the study of the effect of thermal management on the performance of the PowerPC Unit used for the Eurofighter Typhoon FCC programme. The focus of the first phase of the work is to develop Level1/Level2 cache models to be implemented into a WCET (Worse-Case Execution Tool). The tools main task is to safely certify program code, running within safety critical real-time solutions. After which multi-physics modelling tools (such as Flotherm) will be used to investigate the thermal modelling regimes of PowerPC units and study the effect of thermal management, linked to performance degradation.

The original aim of the project is to study the Effect of Thermal Management on the Performance of the PowerPC Unit. Following initial discussions with the BAe Vehicle Management Systems Team, it has been demonstrated that newer PowerPC units that use a hardware enforced system tend to stall and to pause throughput in order to allow for component cooling - in safety critical systems such as the PowerPC this is not permitted. Following literature review, the project team agreed to start with Work-package #2, and specifically, to first investigate the extent to which cache management regimes affect PowerPC Performance, before moving on to the determination of how PowerPC performance can be improved through thermal management. The focus of the initial phase of this research was to determine whether it is possible to use better management of cache resources to improve PowerPC performance (and thereby to control working temperature levels without compromising safety critical functions). The progress made to date and the key results of this study are summarised below:

An Apple Power Mac G4 was purchased for the project following long delays in sourcing the BAe recommended unit (note: the Apple Power Mac G4 option purchased has now been demonstrated to be very compatible and meets most of the project requirements). However, the porting of a different hardware system meant that all hardware setups and policies had to be revised to enable execution pipeline modelling. A major part of the implementation of the Apple Power Mac G4 was the installation of the stable Operating System and integration within the University Network, to allow for system updates and the download of necessary tools / extra software for work to continue. In the end the Operating System was updated because useful tools that were developed were not supported by the original environment. As part of the system development and verification; a number of simple programs have been developed, compiled and executed to demonstrate the technique for investigating the effect of Cache Management regimes on PowerPC Performance. The novelty of this work is that the technique allows for the use of the executable file for populating the pipelines and thus, tracking data through memory locations (a pre-requisite for cache modelling).

The plan is to extend the study to include a way of representing cache states which even seem forgotten from hardware literature. A study will also be made to compare how the differences in the codes, affect the pipeline and cache. Future codes of interest for analysis include: nested looping, memory testers which apply data maps to all memory locations, programs that consume 100% of the CPU resource, to aid testing of system stalling while over heating. The final phase of the study will be the investigation of the effect of Thermal Management on PowerPC performance and prediction of performance degradation.