

**DEVELOPMENT PROCESS WITH SCHEDULABILITY ANALYSIS (DePSA)
INTEGRATED APPROACH FOR REAL-TIME SYSTEMS**

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I declare that this thesis entitled “Development Process with Schedulability Analysis (DePSA) Integrated Approach for Real-Time Systems” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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Date : 8 June 2011

*Dedicated to my beloved family
and best friend who has always believed in me...*

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ABSTRACT

Real-Time System (RTS) is a complex system consisting of several tasks and processes. Thus, the designer finds it difficult to ensure that the system is designed using an effective model. Unified Modelling Language (UML) provides a set of rich visual notations to support the analysis and design activities. Currently, there are some UML profiles that include certain specific features to design RTS. Timing constraints of RTS is crucial because a late response may lead to failure. In this sense, schedulability analysis (SA) is used to ensure the accuracy and predictability of hard RTS since it checks the timing constraints. In addition, SA can be automatically done using tool such as RapidRMA. Literature has shown that various integrated approaches have been proposed to develop a predictable RTS design by integrating an SA tool with a modelling tool. However, there is still a lack of incorporation between the integrated tools and systematic handling of timing constraints in RTS. Thus, the goal of this research is to propose an integrated approach named Development Process with Schedulability Analysis (DePSA) in order to obtain more systematic and predictable RTS design. The first objective is to investigate the best fit UML profile that provide rich features in handling functional and timing requirements in a less complicated design. To meet this objective, certain comparisons were done between features of two UML models (UML-Real Time (UML-RT) and UML-Schedulability, Performance and Timing (UML-SPT)) based on a designed case study. Then, Zhou's metrics were used to measure the structural complexity of both modelling class diagrams. The second objective is to map the schedulability domain concepts of RTS into the chosen UML model. This was done by performing the mapping process to study the extent of how the chosen UML supports SA concepts by means of using its stereotypes and tags. This will assist future researchers in developing or selecting a suitable SA tool. The third objective is to propose the steps in the process to obtain more systematic and predictable RTS design. These steps indicate when SA can be performed throughout the generic development life cycle. This objective was met by applying the proposed steps on the designed case study and then comparing it with the existing steps. Finally, the fourth objective is an evaluation of DePSA approach that consists of the integrated tools (RapidRMA and Rhapsody), mapping issue and the DePSA steps. The final objective was conducted by comparing DePSA with the existing approaches and the results showed that the approach was effective for guiding on how to develop more predictable RTS design systematically by using integrated tools. As a conclusion, DePSA approach with UML-SPT provides less complex design and having a better design opportunity for a more systematic and predictable RTS modelling.

ABSTRAK

Sistem Masa Nyata (RTS) sebuah sistem yang kompleks kerana mengandungi beberapa tugas dan proses. Oleh sebab itu pereka sukar menentukan sama ada sistem ini direka menggunakan model yang efektif atau tidak. *Unified Modelling Language* (UML) menyediakan aneka set notasi visual bagi menyokong analisis dan aktiviti reka bentuk. Kini terdapat beberapa profil UML yang memasukkan ciri-ciri khusus untuk mereka bentuk RTS. Tempoh had masa sangat penting bagi RTS kerana tindak balas yang lewat akan menggagalkannya. Oleh yang demikian, analisis penjadualan (SA) digunakan untuk memastikan ketepatan dan kebolehramalan RTS kerana SA boleh menyemak tempoh had masa dalam RTS. Selain itu, SA juga boleh dilaksanakan secara automatik menggunakan peralatan tertentu seperti RapidRMA. Daripada literatur menunjukkan pelbagai pendekatan terpadu telah dicadangkan untuk mereka bentuk RTS yang boleh diramalkan dengan menyatukan peralatan SA dengan permodelan. Namun, masih terdapat kekurangan dalam keserasian antara peralatan terpadu dengan pengawalan tempoh had masa yang sistematik dalam RTS. Oleh yang demikian, penyelidikan ini bertujuan untuk mencadangkan pendekatan terpadu yang dinamakan *Development Process with Schedulability Analysis* (DePSA) untuk mendapatkan reka bentuk RTS yang lebih sistematik dan boleh diramalkan. Objektif pertama adalah untuk menyiasat profil UML terbaik yang menyediakan ciri-ciri kelengkapan dalam mengawal kefungsian dan keperluan masa RTS dalam reka bentuk yang kurang rumit. Untuk mencapai objektif ini, beberapa perbandingan ciri-ciri dilakukan diantara model UML (*UML-Real Time* (UML-RT) dengan model *UML-Schedulability, Performance and Timing* (UML-SPT)) berdasarkan reka bentuk kajian kes. Kemudian, metrik Zhou digunakan untuk mengira kerumitan struktur rajah kelas bagi kedua-dua model. Objektif kedua ialah memeta konsep domain penjadualan RTS ke dalam model UML yang dipilih. Ini dicapai dengan menjalankan proses pemetaan untuk mengkaji sejauh manakah model UML yang dipilih dapat menyokong konsep SA dengan penggunaan stereotaip dan tag. Ini dapat membantu penyelidik dalam membangunkan atau memilih peralatan SA yang sesuai. Objektif ketiga ialah mencadangkan langkah dalam proses bagi mendapatkan reka bentuk RTS yang sistematik dan boleh diramalkan. Langkah ini menentukan bilakah SA boleh dilaksanakan sepanjang kitar hayat pembangunan. Objektif ini dicapai dengan mengaplikasikan langkah cadangan pada reka bentuk kajian kes dan membandingkannya dengan langkah cadangan sedia ada. Akhir sekali, objektif keempat ialah penilaian terhadap pendekatan DePSA yang terdiri daripada peralatan terpadu (RapidRMA dan Rhapsody), isu pemetaan dan langkah DePSA. Objektif terakhir dicapai dengan melakukan perbandingan antara DePSA dan pendekatan sedia ada dan keputusan menunjukkan pendekatan ini lebih efektif dalam penghasilan reka bentuk RTS yang sistematik dan boleh diramalkan dengan menggunakan pendekatan terpadu. Kesimpulannya, pendekatan DePSA dengan UML-SPT menghasilkan reka bentuk RTS yang kurang kompleks dan memberikan peluang penghasilan reka bentuk yang lebih baik bagi permodelan RTS yang lebih sistematik dan boleh diramalkan.

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