

SERVICE-ORIENTED ANALYSIS AND DESIGN APPROACH FOR
DISTRIBUTED EMBEDDED REAL-TIME SYSTEMS

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A thesis submitted in fulfilment of the
requirements for the award of the Degree of
Doctorate of Philosophy (Computer Science)

Faculty of Computing
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FEBRUARY 2013

I declare that this thesis entitled “*Service-Oriented Analysis and Design Approach for Embedded Real-time Systems*” is the results 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.

A handwritten signature in blue ink, reading "Waqar Aziz", is placed over a light blue rectangular background. The signature is written in a cursive style with a large initial 'W'.

Signature :

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Date : 08-02-2013

To my beloved parents for their affection and efforts, brothers, wife and children

ACKNOWLEDGEMENT

Thanks and gratefulness to Almighty Allah (swt), Who made the process of completing the Ph.D. and writing this thesis easy. I highly appreciate the efforts of my main supervisor, Dr. Radziah Mohamad, and my co-supervisor, Dr. Dayang Jawawi, for their pieces of advice, criticism, discussions, encouragement and interest. Their guidance and support strongly contribute to several aspects of this work.

I am thankful to my parents, whose continued efforts set the base and provided me the vision of higher study, my brothers for providing me the encouragement and moral support during the course of my PhD, my wife for her constant love, care, patience, support and understanding and children for their understanding and use of their time. Here, I would like to thanks to my friends, Zahid Aziz and Shahid Zaib, for providing me the financial support and for their patience. I also appreciate the efforts of Dr. Sohail Qazi and my cousin Abdul Wadood, who took my care as an elder brother and supported me in my study.

Lastly, I am thankful to all persons who provide me different kind of assistance at various occasions, either directly or indirectly. In particular, Arif Mahamood, Lecturer Islamia College University, for proof reading this thesis. I also recognize the members of EReTSEL lap, especially Zulkifli Zaki and Adham Isa for their valuable suggestions and support throughout my work. I am also obliged to Universiti Teknologi Malaysia (UTM) and Ministry of Higher Education (MOHE) Malaysia for funding my Ph.D.

ABSTRACT

Distributed Embedded Real-time Systems (DERTS) are computing systems that are integrated inside real-world objects. Their unique characteristics and the wide spread demand with increasing functionality make their development different and complex as compared to enterprise software. Furthermore, companies need reusable design of DERTS to achieve reduced time-to-market and cost. Therefore, the designers of DERTS are always looking for the latest state of the art software engineering methods and techniques for analysis and design of DERTS. Previously, the Service-Oriented Computing (SOC) has been used for DERTS development, but it is mostly used in an ad hoc manner and without any focus on analysis and design. To address these issues, this thesis presents a systematic analysis and design approach for service-oriented DERTS development, aimed at reducing complexity and increasing reusability of DERTS design. The existing service-oriented concepts and methods were extended but the focus was on specific DERTS characteristics such as resource constraints, device considerations and real-time properties. The key findings of this study are service analysis and modelling mechanisms and service-oriented process for DERTS development. The service analysis mechanism includes service layer architecture and service identification guideline for DERTS. Secondly, the service modelling mechanism includes service meta-model, profile and levels of abstraction models. Finally, the service-oriented process defines the analysis and design phases for DERTS development. The applicability of the proposed approach is illustrated using case studies consisting of smart home, autonomous mobile robot and industrial automation. The quality of the approach is measured using complexity and reusability metrics for SOC and by comparing the results with the ones obtained from the SODES approach. The comparison showed that the proposed approach outperforms SODES in terms of design complexity and reusability. The study has demonstrated a systematic development of DERTS that reduces the complexity and increases the reusability of DERTS design.

ABSTRAK

Sistem Masa Nyata Terbenam Teragih (DERTS) adalah sistem pengkomputeran yang mengintegrasikan objek-objek di dalam dunia sebenar. Ciri-ciri yang unik serta permintaan yang tinggi selari dengan peningkatan terhadap kefungisian DERTS menyebabkan pembangunan DERTS berbeza dan menjadi kompleks berbanding dengan perisian perusahaan. Malahan, syarikat memerlukan rekabentuk DERTS yang boleh di guna semula bagi mencapai pengurangan masa pembangunan dan kos. Maka, perekabentuk DERTS sentiasa memerlukan pendekatan terkini bagi kaedah kejuruteraan perisian, serta teknik analisa dan rekabentuk DERTS. Terdahulu, Pengkomputeran Berasaskan Servis (SOC) telah digunakan bagi pembangunan DERTS, namun demikian, kebanyakan SOC digunakan berdasarkan pendekatan secara terus tanpa penekanan fokus terhadap analisa dan rekabentuk sistem. Bagi menangani isu-isu yang dinyatakan, tesis ini mencadangkan pendekatan yang sistematik terhadap analisa dan rekabentuk DERTS, dengan matlamat mengurangkan kerumitan dan meningkatkan boleh guna semula pada rekabentuk DERTS. Kajian terkini dalam konsep dan teknik berasaskan servis telah dikembangkan, namun, tumpuan hanya diberikan kepada ciri-ciri DERTS yang tertentu seperti kekangan sumber, perkakasan dan aspek masa nyata. Sumbangan kajian ini terdiri daripada analisa servis dan mekanisma rekabentuk, serta proses yang berorientasikan servis untuk pembangunan DERTS. Bagi mekanisma analisa servis, senibina servis berlapis dan panduan pengenalpastian servis telah dicadangkan. Manakala bagi mekanisma rekabentuk servis; metamodel, profil dan tahap keabstrakkan rekabentuk dicadangkan. Akhirnya, proses berorientasikan servis mendefinisikan fasa-fasa rekabentuk dan analisa untuk pembangunan DERTS. Keseluruhan pendekatan ini telah diuji menggunakan beberapa kes kajian seperti rumah pintar, robot bergerak dan pengautomatan industri. Hasil implementasi pula diukur menggunakan metrik kerumitan dan boleh guna semula untuk SOC, dan dibandingkan dengan pendekatan yang berkaitan, SODES. Perbandingan menunjukkan pendekatan cadangan memberikan kelebihan untuk ciri-ciri kekompleksan dan boleh guna semula berbanding SODES. Kajian menunjukkan pembangunan DERTS yang sistematik yang dapat mengurangkan kerumitan dan meningkatkan boleh guna semula rekabentuk DERTS.

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