A MAST ANALYSIS OF A RAVENSCAR APPLICATION EXAMPLE

TECHNICAL REPORT

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ABSTRACT

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1 Introduction

There is increasing recognition that the software components of critical real-time applications must be provably predictable. This is particularly so for a hard real-time system, in which the failure of a component of the system to meet its timing deadline can result in an unacceptable failure of the whole system. The choice of a suitable design and development method, in conjunction with supporting tools that enable the real-time performance of a system to be analysed and simulated, can lead to a high level of confidence that the final system meets its real-time constraints.

The use of Ada has proven to be of great value within high integrity and real-time applications, albeit via language subsets of deterministic constructs, to ensure full analysability of the code. The research work in schedulability analysis has been mapped onto a number of new Ada constructs and rules that have been incorporated into the Real-Time Annex of the Ada language standard [RM D]. This has opened the way for these tasking constructs to be used in high integrity subsets whilst retaining the core elements of predictability and reliability.

The Ravenscar Profile is a subset of the tasking model, restricted to meet the real-time community requirements for determinism, schedulability analysis and memory-boundedness, as well as being suitable for mapping to a small and efficient run-time system that supports task synchronization and communication, and which could be certifiable to the highest integrity levels.

The example presented in this paper is extracted from "Guide for the use of the Ada Ravenscar Profile in high integrity systems" [1] and it is designed to illustrate the expressive power of the Ravenscar Profile and the associated coding paradigms, which aim to facilitate off-line scheduling analysis.

The extended application example uses all of the concurrency components permitted by the Ravenscar Profile. The structure of the example models, on a reduced and simplified scale, the operation of real-world embedded real-time systems.

The example system includes a periodic process that handles orders for a variable amount of workload. Whenever the request level exceeds a certain threshold, the periodic process farms the excess load out to a supporting sporadic process. While such orders are executed, the system may receive interrupt requests from an external source. Each interrupt treatment records an entry in an activation log. When specific conditions hold, the periodic process releases a further sporadic process to perform a check on the interrupt activation entries recorded in the intervening period. The policy of work delegation adopted by the system allows the periodic process to ensure the constant discharge of a guaranteed level of workload. The correct implementation of this policy also requires assigning the periodic process a higher priority than those assigned to the sporadic processes, so that guaranteed work can be performed in preference to subsidiary activities.

MAST, a Modeling and Analysis Suite for Real-Time Applications, is a model for representing the temporal and logical elements of real-time applications [2]. This model allows a very rich description of the system, including the effects of event or message-based synchronization, multiprocessor and distributed architectures as well as shared resource synchronization.

2 FPS analysis

Transaction	Worst case response time (s)	Slack	Worst blocking time (s)
rp_transaction	0.020393	2477.0%	2.000E-06
ocp_transaction	0.026525	10852.0%	1.000E-06
alr_transaction	0.030109	27088.7%	0.00
event_queue_interrupt	1.100E-05	N/A	1.000E-06
event_queue_interrupt	3.818E-05	N/A	1.000E-06

Table 1: Holistic analysis results for FPS

The system slack is 2401.2%.

3 Introduction

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4 Headings: first level

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See Section 4.

4.1 Headings: second level

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$$\xi_{ij}(t) = P(x_t = i, x_{t+1} = j | y, v, w; \theta) = \frac{\alpha_i(t) a_{ij}^{w_t} \beta_j(t+1) b_j^{v_{t+1}}(y_{t+1})}{\sum_{i=1}^{N} \sum_{j=1}^{N} \alpha_i(t) a_{ij}^{w_t} \beta_j(t+1) b_j^{v_{t+1}}(y_{t+1})} \tag{1}$$

4.1.1 Headings: third level

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5 Examples of citations, figures, tables, references

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[**?**, **?**] and see [3].

The documentation for `natbib` may be found at

`http://mirrors.ctan.org/macros/latex/contrib/natbib/natnotes.pdf`

Of note is the command `\citet`, which produces citations appropriate for use in inline text. For example,

```
\citet{hasselmo} investigated\dots
```

produces

> Hasselmo, et al. (1995) investigated…

`https://www.ctan.org/pkg/booktabs`

5.1 Figures

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See Figure 1. Here is how you add footnotes. [1] Sed feugiat. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Ut pellentesque augue sed urna. Vestibulum diam eros, fringilla et, consectetuer eu, nonummy id, sapien. Nullam at lectus. In sagittis ultrices mauris. Curabitur malesuada erat sit amet massa. Fusce blandit. Aliquam erat volutpat. Aliquam euismod. Aenean vel lectus. Nunc imperdiet justo nec dolor.

[1] Sample of the first footnote.

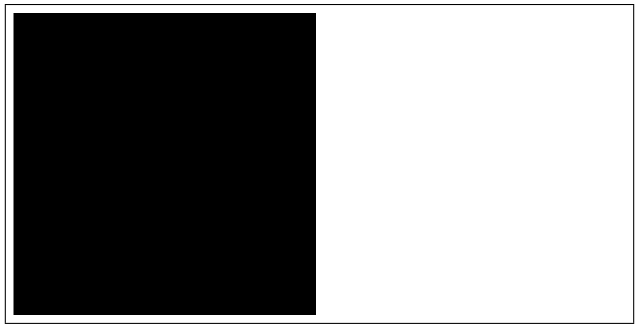

Figure 1: Sample figure caption.

Table 2: Sample table title

Part		
Name	Description	Size (μm)
Dendrite	Input terminal	$\sim$100
Axon	Output terminal	$\sim$10
Soma	Cell body	up to 10^6

5.2 Tables

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See awesome Table 2.

5.3 Lists

- Lorem ipsum dolor sit amet
- consectetur adipiscing elit.
- Aliquam dignissim blandit est, in dictum tortor gravida eget. In ac rutrum magna.

References

[1] A Burns, B Dobbing, T Vardanega. Guide for the use of the Ada Ravenscar Profile in high integrity systems. In *University of York Technical Report YCS-2003-348*. January 2003.

[2] M. GonzAlez Harbour, J.J. GutiCrrez Garcia, J.C. Palencia GutiCrrez, and J.M. Drake Moyano. MAST Modeling and Analysis Suite for Real Time Applications. In *Proceedings 13th Euromicro Conference on Real-Time Systems*. 2001.

[3] Guy Hadash, Einat Kermany, Boaz Carmeli, Ofer Lavi, George Kour, and Alon Jacovi. Estimate and replace: A novel approach to integrating deep neural networks with existing applications. *arXiv preprint arXiv:1804.09028*, 2018.