EVENT BASED TRANSIENT NOTIFICATION ARCHITECTURE AND NoSQL SOLUTION FOR ASTRONOMICAL DATA MANAGEMENT

A thesis presented in partial
fulfilment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY
IN COMPUTER SCIENCE

at Massey University,
Albany (Auckland), New Zealand.

MASSEY UNIVERSITY
NEW ZEALAND

Yu Zhao

2015

Abstract

This thesis describes the development of a messaging system for astrophysical transient event notifications, and explores the use of NoSQL databases for astronomical data management. The Microlensing Observations in Astrophysics (MOA) Project is used as a case study for which respective implementations are provided.

The Java Message Service (JMS) was chosen as the most suitable message implementation. Full implementation details of this new generation transient event notification architecture are described. It was found that the JMS-based architecture can provide a high performance on data delivery and could be up-scaled to meet high event rate situations.

For NoSQL databasing, it was found that using a document-oriented database for astronomical data management is much easier than traditional relational databases, and significantly improves overall data access performance. In addition, a NoSQL database can be very easy to scale up in order to meet demands of large workload, and the scaling approach is very cost effective. Full design details of using a document-oriented NoSQL database for astronomical data management are presented in this thesis.

The approaches developed in this research will provide scalable and efficient solutions for resolving similar computational challenges in astronomy. There are great opportunities to further extend this research and to make additional contributions to the field.

Acknowledgements

I would like to thank my supervisor Ian Bond and my co-supervisor Winston Sweatman for their guidance over these four years. This thesis could not have been completed without their support, encouragement and help. I enjoyed every meeting and discussions of my research with them; they give me lots of fun during my PhD life.

I would also like to thank everyone at the Institute of Natural and Mathematical Sciences for their inspirational seminars, discussions, suggestions and helps.

My family is very important to me and I could not complete this thesis without their continued support. Special thanks to my mother for her sacrifices over the years in New Zealand. I would also like to especially thank my father for his support.

Table of Contents

List of Figures

List of Tables