A parsimonious agent-based emergency call centre model

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

Master of Philosophy

The University of Newcastle, Australia

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Statement of Originality

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

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Signature_________________________________

Date_____________________________________
ACKNOWLEDGMENTS

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Thanks to Chris Beatson, the Director of the Police Assistance Line and the NSW Police Force for their continuing support.
DEDICATION

Dedicated to our children and grandchildren
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Abstract

A parsimonious agent-based emergency call centre model

by Bruce Graham Lewis

This thesis presents an agent-based model of an emergency services call centre. The original contribution of this thesis is to demonstrate that agent-based modelling can be used to simulate the operation of an emergency services call centre. The thesis demonstrates that a simple calibrated parsimonious agent-based computer model of an emergency call centre is capable of simulating a real emergency call centre by directly emulating the interaction between the call queue and the customer service representatives who service the calls.

The model is parsimonious in that it looks at the interaction between inbound calls and servers with a manager and without modelling the call centre technology or other agents. It was designed to run at a simulated one second resolution and results are available at any time during or at the end of a simulation run. This level of resolution was not found in models reported in the literature.

The New South Wales Police Assistance Line in Australia (NSWPAL) was the first of its type in the world for the reporting of urgent and non-urgent crimes and incidents, and is used as a case study in this thesis.

The thesis presents the first detailed research analysis of police emergency inbound call queues and the first detailed research analysis of the NSWPAL emergency and non-emergency queue data over a four year period is presented. The model’s servers’ parameters were calibrated against the NSWPAL data.

A number of experiments demonstrated the model’s utility including showing differences and anomalies in the methods used to calculate service level, the impact of talk time on performance, the differences in call allocation methods, the impact of unexpected exogenous events, the use of historical data to examine past performance and the differences between the thesis and Erlang C models.
The following were published in conference proceedings and journal publications:


VITA

Bruce Graham LEWIS

Bachelor of Engineering (Electrical), University of NSW, 1974.


Bachelor of Applied Information Technology (Hons), University of Newcastle, 2004.
## GLOSSARY

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
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<tbody>
<tr>
<td>131444</td>
<td>The NSWPAL telephone number customers call for non-urgent matters.</td>
</tr>
<tr>
<td>ABM</td>
<td>Agent-Based Model.</td>
</tr>
<tr>
<td>ACW</td>
<td>After Call Work. This is also known as wrap-up time (Koole, 2007). It is the additional time an agent spends on a call after the call with the customer has ended.</td>
</tr>
<tr>
<td>AHT</td>
<td>Average Handle Time. It consists of the call talk time and the ACW.</td>
</tr>
<tr>
<td>ASA</td>
<td>Average Speed of Answer.</td>
</tr>
<tr>
<td>AWT</td>
<td>Acceptable Wait Time (Koole, 2007, Essafi and Bolch, 2005). The time within which a business or organisation would like all of its telephone calls to be answered(^1).</td>
</tr>
<tr>
<td>CSR</td>
<td>Customer Service Representative.</td>
</tr>
<tr>
<td>CTA</td>
<td>Call Taking Agent. This term is used in the program code to distinguish the model agents from the human CSRs.</td>
</tr>
<tr>
<td>CTI</td>
<td>Computer-Telephony Integration.</td>
</tr>
<tr>
<td>ESO</td>
<td>Emergency Services Organisation.</td>
</tr>
<tr>
<td>GUI</td>
<td>Graphical User Interface.</td>
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<tr>
<td>IBM</td>
<td>Individual-Based Model.</td>
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</tbody>
</table>

\(^1\) Based on the researcher’s experience in the call centre industry
Glossary

NSWPF  New South Wales Police Force.
NSWPAL New South Wales Police Assistance Line.
OOD    Object-Oriented Design.
OOP    Object-Oriented Programming.

Service level  The percentage of calls a business or organisation
deems acceptable to be answered within the AWT.
Although there is no standard for this, 20% is seen
as representative for non-emergency call centres
and 10% for emergency call centres².

TSF    Telephone Service Factor. See Service level above.

Triple Zero (000) The Australia-wide emergency telephone number
for Police, Ambulance or Fire Brigades.

² Based on the researcher’s experience in the call centre industry