

Contents

Foreword	xix
Abstract	xxi
Acknowledgements	xxiii
1 Introduction	1
1.1 A hypothesis for the future: Wikinomics	1
1.2 With the feet in the air & the head on the ground	3
1.3 Supply Chain and Supply Chain Management	6
1.4 The Problem	7
1.4.1 Optimising make-or-buy decisions	7
1.4.2 Optimising make-or-buy-or-collaborate decisions	13
1.5 Contributions	17
1.6 Dissertation Outline	20
2 Mathematical Background	23
2.1 Linear and Integer Programming	23
2.1.1 Linear Programming	23
2.1.2 Integer Programming	24
2.2 Multi-sets	26
2.2.1 Operations on Multisets	27
2.3 Petri Nets	27
2.3.1 Reachability	31
2.3.2 The state equation	32
2.3.3 State equation and reachability	33
2.4 Preliminaries on binary relations and graphs	34
2.4.1 Relations	35
2.4.2 Graphs and Paths	36
2.4.3 Order relations	37
3 Related Work	39
3.1 Auctions	39
3.1.1 Taxonomy of Auctions	40

3.2	Combinatorial Auctions	41
3.2.1	Mechanism Design	42
3.2.2	Bidding Languages	42
3.2.3	Winner Determination Problem	43
3.2.4	Test Suites	44
3.3	Supply Chain Scheduling and Supply Chain Formation	45
3.3.1	Supply Chain Scheduling and Planning	46
3.3.2	Supply Chain Formation	47
3.4	Conclusions	49
4	MUCRA_{tR}	51
4.1	Beyond Combinatorial Auctions	51
4.2	The problem	55
4.2.1	Communicating the RFQ	56
4.2.2	Selecting the optimal decision	57
4.3	A first attempt: Place/Transition Nets	58
4.3.1	Modelling the internal production structure	58
4.3.2	Incorporating Bids	62
4.4	Weighted Place Transition Nets	65
4.4.1	WPTNSs and WPTNs	66
4.4.2	Dynamics of WPTNs	67
4.5	Representing auction outcomes with WPTNs	71
4.5.1	The Transformability Network Structure	71
4.5.2	The Auction Net	72
4.5.3	Constrained Maximum Weight Occurrence Sequence Problem	74
4.6	The Winner Determination Problem	75
4.7	Solving the WDP by means of IP	77
4.7.1	Solving the CMWOSP by means of IP	77
4.7.2	The IP Formulation in practise	79
4.7.3	Comparison with a traditional MUCRA IP solver	81
4.8	Conclusions	81
5	Mixed Multi unit Combinatorial Auctions	83
5.1	Beyond CAs for Supply Chain Formation	84
5.2	The problem	87
5.3	Bidding Language	89
5.3.1	Supply Chain Operation	90
5.3.2	Valuations	93
5.3.3	Atomic Bids	95
5.3.4	Combinations of Bids	95
5.3.5	Representing Quantity Ranges	96
5.3.6	Expressive Power	97
5.3.7	Examples of Bids	98
5.4	Winner Determination	100
5.4.1	Informal Definition	101
5.4.2	Formal Definition	101

5.4.3	Mechanism Design	104
5.5	Subsumed Auction Models	105
5.6	Conclusions	107
6	Solving the MMUCA Winner Determination Problem	111
6.1	Mapping MMUCA to WPTN	112
6.1.1	The intuitions behind the mapping	112
6.1.2	Representing Bids	115
6.1.3	The Mixed Auction Net	119
6.1.4	Expressing the MMUCA WDP as a CMWOSP	122
6.1.5	Solving the MMUCA WDP with IP	131
6.1.6	Advantages of the mapping to CMWOSP	133
6.2	Solving the WDP on Cyclic Mixed Auction Nets	135
6.2.1	Modifying the representation	137
6.2.2	The general IP formulation	139
6.3	Computational Complexity	142
6.4	Conclusions	142
7	Connected Component-based Solver	145
7.1	Motivation and Example	146
7.2	SCO Dependencies and Solution Template	153
7.2.1	The SCO Dependency Graph (SDG)	153
7.2.2	Computing the equivalence classes	157
7.2.3	Order Enforcing Function	157
7.2.4	Partial Sequences	159
7.3	The improved IP formulation	161
7.3.1	The Model	162
7.3.2	Eliminating some Equations	164
7.3.3	The CMWOSP-based solver is a special case of CCIP	167
7.3.4	CCIP amounts to DIP when the SDG is connected	168
7.4	Equivalence between solvers DIP and CCIP	168
7.4.1	Subsequences	168
7.4.2	Reordering Sequences	170
7.4.3	Order Fulfilling Sequences	172
7.4.4	Properties of partial sequences of SCOs	172
7.4.5	Equivalence between solvers	176
7.4.6	Proof of theorem 7.1	177
7.4.7	Proof of theorem 7.2	183
7.5	Conclusions	184
8	Empirical Evaluation	187
8.1	Motivation	187
8.2	The Artificial Data Set Generator	188
8.2.1	Bid Generator Requirements	188
8.2.2	An Algorithm for Artificial Data Set Generation	193
8.3	Empirical Evaluation	198

8.3.1	DIP versus CCIP	198
8.3.2	Performances of the CMWOSP-based solver	200
8.4	Conclusions	200
9	Conclusions and Future Work	203
9.1	Conclusions	203
9.1.1	Make-or-Buy Decisions	203
9.1.2	Make-Or-Buy-Or-Collaborate	207
9.2	Future Work	212
A	OPL models of the MMUCA WDP solvers	215
A.1	The CMWOSP-based Solver	215
A.2	The DIP solver	217
A.3	The CCIP Solver	219