

Contents

Introduction	1
1 Basics	5
1.1 Preliminaries	5
1.2 Background	11
1.3 The ship traffic control problem	13
1.3.1 A precise geometric model	13
1.3.2 Scheduling on transit segments	17
1.4 Bidirectional scheduling	19
1.5 Related work	22
2 Solving the Ship Traffic Control Problem	25
2.1 Realizing a combinatorial frame via iterated routing	26
2.2 Collision-free routing for a single ship	29
2.2.1 Graph for collision-free routing	31
2.2.2 Forbidden time windows	32
2.2.3 Routing details for the canal	32
2.2.4 Running time	35
2.3 A heuristic for the STCP	38
2.3.1 Construction of solutions by sequential routing	38
2.3.2 Improving schedules by local search on the combinatorics	39
2.3.3 Rolling horizon	41
2.4 Computational study	42
2.4.1 Algorithmic components	42
2.4.2 Combinatorial relaxation	44
2.4.3 GPS data realized	45
3 Offline Complexity of Bidirectional Scheduling	49
3.1 Hardness for multiple segments	51
3.2 Hardness of custom compatibilities	57
3.2.1 Makespan minimization	57
3.2.2 Minimization of total completion time	62
3.3 Dynamic programs for restricted compatibilities	63
4 Competitive Analysis for Bidirectional Scheduling	65
4.1 The general problem	66
4.1.1 Lower bound	66
4.1.2 Upper bound	68
4.1.3 Polynomial running time	71
4.2 Identical jobs on a single segment	76
4.2.1 Lower bound	76

Contents

4.2.2	Upper bound	77
5	Competitive-Ratio Approximation Schemes	83
5.1	General simplifications and techniques	85
5.1.1	Simplification within intervals	86
5.1.2	Irrelevant history	90
5.2	Abstraction of online algorithms	96
5.3	Extension to non-preemptive scheduling	101
6	Approximation Schemes for Bidirectional Scheduling	107
6.1	Polynomial time approximation scheme	108
6.2	Competitive ratio approximation scheme	114
	Conclusions	121
	Bibliography	125