

## Contents

<b>Acknowledgements</b>	<b>iv</b>
<b>Abstract</b>	<b>v</b>
<b>1 Introduction</b>	<b>1</b>
1.1 MDS Array Codes . . . . .	2
1.2 Efficiency through Redundancy . . . . .	6
1.3 Main Contributions of the Thesis . . . . .	10
1.4 Organization . . . . .	12
<b>2 X-Code: MDS Array Codes with Optimal Encoding</b>	<b>13</b>
2.1 Introduction . . . . .	13
2.2 X-Code Description . . . . .	14
2.2.1 Encoding Procedure . . . . .	14
2.2.2 The MDS Property . . . . .	16
2.3 Efficient Decoding Algorithms . . . . .	19
2.3.1 Correcting Two Erasures . . . . .	19
2.3.2 Correcting One Error . . . . .	23
2.4 Summary . . . . .	27
<b>3 Low Density MDS Codes and Factors of Complete Graphs</b>	<b>29</b>
3.1 Introduction . . . . .	29
3.2 B-Code and its Dual . . . . .	31
3.2.1 Structure of the B-Code . . . . .	31
3.2.2 Dual Array Codes . . . . .	32
3.2.3 A New Graph Description of the B-Code . . . . .	34
3.3 B-Code and P1F . . . . .	36
3.3.1 Perfect One-Factorization of Complete Graphs . . . . .	36
3.3.2 Equivalence between the B-Code and P1F . . . . .	37

3.3.3	Erasure Decoding of the B-Code . . . . .	39
3.3.4	Error Decoding of the B-Code . . . . .	41
3.4	Further Equivalence Discussion . . . . .	44
3.5	Summary . . . . .	46
<b>4</b>	<b>Efficient Deterministic Voting in Distributed Systems</b>	<b>48</b>
4.1	Introduction . . . . .	48
4.2	The Problem Definition . . . . .	49
4.2.1	NMR System Model . . . . .	49
4.2.2	Communication Complexity . . . . .	50
4.2.3	The Voting Problem . . . . .	50
4.3	The Solution Based on Error-Correcting Codes . . . . .	53
4.3.1	A Voting Algorithm with ECC . . . . .	54
4.3.2	Correctness of the Algorithm . . . . .	56
4.3.3	Proper Code Design . . . . .	57
4.4	Communication Complexity Analysis . . . . .	58
4.4.1	Main Results . . . . .	58
4.4.2	More Observations . . . . .	62
4.5	Experimental Results . . . . .	63
4.6	Summary . . . . .	66
<b>5</b>	<b>Improving the Performance of Data Servers</b>	<b>69</b>
5.1	Introduction . . . . .	69
5.2	Preliminary Analysis . . . . .	71
5.2.1	System Model . . . . .	71
5.2.2	Analysis Results . . . . .	71
5.2.3	Properties of Mean Service Time . . . . .	72
5.3	Server Performance Model . . . . .	74
5.3.1	Abstraction from Experiments . . . . .	75
5.3.2	Verification with $T(n,1)$ . . . . .	77
5.4	Design An Efficient System . . . . .	79
5.4.1	Data Distribution Scheme . . . . .	79
5.4.2	Data Acquisition Scheme . . . . .	80

5.5	Summary . . . . .	85
<b>6</b>	<b>Conclusions and Future Directions</b>	<b>86</b>
6.1	Conclusions . . . . .	86
6.2	Future Directions . . . . .	87
6.2.1	Reed-Solomon Codes as Array Codes . . . . .	88
6.2.2	Strong MDS Codes . . . . .	91
	<b>Bibliography</b>	<b>93</b>