

Contents

1	Introduction	1
1.1	Interconnection Networks	1
1.2	Metrics for Measuring Network Performance	9
1.3	Switch Architecture	10
1.4	High-Radix Switches	12
1.5	Congestion Management	17
1.6	Contributions	20
2	The PCIQ Switch Architecture	23
2.1	Introduction	23
2.2	Description of PCIQ	25
2.2.1	PC Crossbar Organization	26
2.2.2	Routing and Flow Control	27
2.2.3	PCIQ: Removing the Output Memories from PC	28
2.2.4	Arbiter	28
2.3	PCIQ as a Family of Switch Architectures	30
2.4	Impact on Scheduling Efficiency When Asymmetrical Cross- bars Are Used	31
2.5	Model for Asymmetric Crossbars	31
2.6	Evaluation with the Theoretical Model	34
2.7	Evaluation of PCIQ Through Simulation	36
2.8	Enhancing PCIQ by Adding RECN-IQ	40
2.9	Evaluation of PCIQ with RECN-IQ	41
2.9.1	Worst Case Analysis	44
2.9.2	Multi-stage Interconnection Network Analysis	45
2.10	Cost Analysis	46
2.11	Conclusions	49
3	The RECN-IQ Mechanism	51
3.1	Introduction	51
3.2	Previous RECN	54
3.3	The RECN-IQ Mechanism	56
3.3.1	Memory Management and Requirements	56

3.3.2	Congestion Detection	58
3.3.3	SAQ Allocation and Deallocation	59
3.3.4	Packet Processing	59
3.3.5	Congestion Information Propagation	60
3.3.6	Flow Control	61
3.3.7	Procedure Example of the RECN-IQ Mechanism	61
3.3.8	False Positives when Detecting Congestion	66
3.4	Conclusions	66
4	The RECN-IQ Switch Architecture	69
4.1	Description of the RECN-IQ Switch Architecture	69
4.1.1	Memory Management Unit	71
4.1.2	Mapping Unit	72
4.1.3	Routing Unit	72
4.1.4	Congestion Detection Unit	74
4.1.5	Post-Processing Unit	75
4.1.6	Flow Control Unit	76
4.1.7	Global Flow Control and Scheduler	76
4.2	Evaluation of RECN-IQ	78
4.2.1	Results for Uniform Traffic	79
4.2.2	Results for Hot-Spot Traffic	81
4.2.3	Reducing the Network Latency of RECN-IQ for Low Network Loads	82
4.2.4	Impact of the Number of iSLIP Iterations on RECN- IQ Performance	83
4.3	Conclusions	84
5	Conclusion and Future Work	85
5.1	Future Directions	86
A	Contributions	89
B	Summary of this PhD in Local Languages	91
B.1	Spanish	91
B.2	Catalan	92
	Bibliography	95