



**Generic Benchmarking for Application Specific
Wireless Sensor Networks Multi Criteria
Performance**

**A thesis submitted for the degree of
Master by Research**

**By
Dong YU**

2012

CERTIFICATE OF AUTHORSHIP/ORIGINALITY

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Signature of Student

Production Note:

Signature removed prior to publication.

Acknowledgements

I would like to express my sincere appreciation to Dr. Priyadarsi Nanda and Professor Xiangjian He, my supervisors, for their encouragement and guidance.

I would like to express my thanks to my colleagues and friends in the Centre for Innovation in IT Services and Applications (iNEXT), for the inspiration I got from their innovative ideas presented in workshops and presentations.

ABSTRACT

Due to stringent energy constraint and demand for performance requirement, a generic architecture like TCP/IP or Internet is not feasible with sensors used across various applications. Instead, application specific design methodology is the de facto consensus accepted among Wireless Sensor Network (WSN) community. While it wins WSN performance gains for individual applications, the methodology sacrifices all plausible attributes a generic architecture can contribute. Without a unified reference model as comparing foundation, the profound problem in true protocols contribution evaluation and comparison remains challenging. Moreover, the stochastic and statistical nature of WSNs makes realistic performance analysis fairly complex. In multi criteria QoS context, this problem is further magnified by big design space with not yet fully understood parameters and the competing relationship between multi objective performance metrics. This work introduces a generic wireless-benchmarking methodology not only qualitatively evaluation from high level abstraction, concerning only profound pros and cons from a general viewpoint of tradeoffs between generality, performance and cost, but also a set of practical workflows that are designed to support quantitative evaluation and analysis of WSN protocols for application-specific objectives. This methodology and the accompanying new benchmark concepts, such as performance efficiency, development efficiency and performance stability, are designed to gain new insight of the dynamic behavior of WSN protocols in a systematical way

compared to the current ad-hoc evaluation approaches applied by most of the community.

LIST OF FIGURES

1.	Transitional Region with Probability Link.	20
2.	Uncertainty Modeling in WSN	21
3.	A Typical PDF Bell Curve Graph	23
4.	A Typical Cumulative Distribution Function (CDF) Graph	24
5.	Competing Performance Metrics under Wide Design Space.	27
6.	Single Performance Index (SPI) Composition.	29
7.	Triangular Constraints.	34
8.	Conflict between Three Main Metrics.	37
9.	Architecture Efficiency in Two Aspects.	38
10.	SDLC and Architecture Efficiency.	40
11.	Workflow of Proposed Benchmarking Solution.	46

Contents

Acknowledgements	iv
Abstract	v
List of figures	vii
1 Introduction	1
2 Literature Review.	7
3 Fundamentals Issues in WSNs Evaluation and Design	11
3.1 Application specific design as a challenge in system evaluation . . .	11
3.2 Uncertainty attribute of WSN performance	15
3.3 WSNs performance dynamic modeling at system level.	19
3.4 Characterizing WSNs performance with statistical concepts.	22
3.5 Multi QoS metrics and energy constraint conflicts in WSNs.	26
4 A Generic WSNs Evaluation Framework	32
4.1 System architecture evaluation fundamental concepts	33
4.2 Triangle constraints in general system architecture evaluation . . .	33
4.3 Triangular constraints reduce to bilateral constraints tradeoff . . .	39
5 A Practical Benchmarking Solution for QoS Performance Index	45
5.1 A practical workflow of benchmarking solution	45
5.2 Metrics development and interdependency analysis	48
6 Parameter Reduction and Interdependency Analysis.	52
6.1 Interaction effect of multiple variables	52

6.2 The limitation of existing work.	54
6.3 General problem formulation	55
6.4 P-value with linear regression model	55
6.5 The Choquet model: a nonlinear model	60
6.6 Comparison of the two models	67
7 Conclusion and Future Prospect.	69
References	