Chapter 1: Introduction

1.1 Preamble

I would like to introduce this thesis with a note on my personal background that has inspired me to choose an area like this for my doctoral study. I started my professional career with PWC nearly 30 years back as a management consultant. I found that the strategic management in many of the multinational client organizations that I handled were keen to get instant total operational performances rather than mere transaction processing systems over the distributed environment. At that stage; network support, operating system level support, database support, and remote transaction processing systems were at their formative stages.

Over the years, the world of information processing has visualized a sea change in data and information processing. A decade back I myself switched to academia with an inclination to formalize some of my operational experiences over the distributed domain.

Initially, I was advised to study the related literatures and recent publications on the subject. The survey work brought me to a point where the commit operation during transaction processing over dispersed nodes appeared to be one of the primary challenges in designing a distributed system. Any one node out of a group of connected nodes may fail to respond. However, that should not bring down the entire commit process to an abort state despite the fact that some system components will fail regularly. The challenge was to model the distributed systems in such a way that concurrent distribution of messages over independent nodes should move in order, and in time without any support of shared memory or shared clock.

This thesis on “A Study on Data and Process Modeling For Distributed Systems Using High Level Nets” is the result of the work I have been working on for the last 5 years. During this, I have modeled a few existing systems from the real life background with a common objective of performance improvement by considering how data and controls works including uncertainties, and unevenness within it are analyzed. A model is said to be a formal representation of an actual system in a miniature form (like model of the Universe) or in an enlarged version (like model of an atom), while modeling the systems I am always critical about the scalability, performance, latency, availability, and fault tolerance issues.

My first modeling attempt was initiated with studies on the complexity of transaction management and information flow in distributed systems. The primary intention is to design an efficient, fault tolerant business development model free from resiliencies. The 2PC protocol is revisited over distributed database using PN to ensure the consistent commitment of sequence of updates on the stable storages in different locations or aborted as a single complete unit of work [BBS-9]. The uncertainties like happening of an event, synchronization, resource sharing and communications are further formalized from the industrial management perceptions [BBS-2].

The scope of the research further spread out to cover some real life applications from the BPR domain to study the modeling activity of distributed systems into finer points to make it exciting. A case study on global product ordering system is modeled. It is an agent based distributed frame work designed with a primary objective of decision making, product realization, and strategy building using workflow net [BBS-8]. I then modeled a virtual data warehouse to exploit the decision making functions and a frame work for dynamic analysis of the distributed system using high-level net is presented [BBS-3].

Health service domain was not in my original work scope. However, with passing time, Healthcare emerged quickly one of the major area of application. Fortunately, I had an access to some real life emergency data of a large size reputed hospital in Kolkata, India. I have used the same to design a real life meta-data service in the health domain as a part of a BPR. Mobile phones are used to extend telemedicine support services over hybrid networks and the study consists of survey of primary field data and collection of secondary data to model a remote tele health support service. It improves productivity, ensures availability at a reduced cost. Finally a distributed framework for Tele Health Monitoring System is presented, which supports a distributed updatable metadata services [BBS-6].

So far, the focus had been on regular events of definite occurrences. However, there are some open issues to formalize uncertainties and timing of events. A few case studies are modeled using GSPN from the SCM domain. As a premier attempt, I modeled the Beer Game phenomena. SCM formalism is taught at MIT using Beer Game. The winner finishes the game at a least cost. Some of the operating issues are: choice of supplier, over stock, delay in delivery,

shrinks in market demand and so on. It explains the reasons of non linearity in the SCM operation (Plan, Source, Make, Deliver, and Buy) and its effect [BBS-5].

The Beer Game teaches the internal details of the SCM operations, bullwhip is a critical phenomenon to almost all SCM operations. The aim is to design a generalized framework and formalize the issue of BWE from the software engineering perspective. It occurs when changes in consumer demand takes place in a supply chain. In effect more goods are ordered to meet the new demand [BBS-7]. Uncertainty is inherent to every supply chain, even when customer demand doesn't vary fluctuation of order prevails. Finally at the end, it is found that stock is getting accumulated with every chain partners and in effect efficiency, availability, and scalability issues are badly affected. A data warehouse of a multi stage, multi-tier SCM is built to measure the BWE and assess the effect of demand variability [BBS-4].

After assessment of BWE in SCM, a demand forecast variance analysis is modeled to supplement the controlling issues of the BWE phenomena. Forecasting and accuracy becomes complicated due to longer lead times among the geographically dispersed SCM players. A virtual DW with DM will be necessary to assess real time demand. The data stored in VDW will help forecasting process, strategic decision making, precision merchandising, and analyzing the process of comprehensive clustering with space planning. With this intention the frame work on "Modeling Demand Forecast Variance in a Distributed Supply Chain Network using Generalized Stochastic Petri Nets", is designed [BBS-1].

1.2 Thesis Organization

This thesis is organized as follows: Chapter 1 introduces scope of this research initiated with the studies on the complexity of transaction management and information flow in large distributed systems. In chapter 2 a brief review of the literature on each of the state-of-the-art scenario, on distributed Systems using Petri Net, is presented. Chapter 3 is composed of modeling and analysis of distributed data Repositories. The 2PC protocol is revisited to analyze transaction processing in a distributed environment. In chapter 4, BPR applications over distributed domains are discussed. Three case studies from the BPR domain on global product ordering system, VDW Modeling, and on Remote health Care Support System is presented. This is followed by the proposal of the framework to control the BWE. In chapter 5, three case studies from the SCM

domain are presented to demonstrate the uncertainty and timing of events. These are Beer Game analysis, demand forecast variance analysis, and BWE modeling for supply chain management followed by the proposal of a framework for distributed meta-data services.

Chapter 3 and 4 starts with subsections, which states the motivation of the work by clearly identifying the research problem and subsequently proposing a methodology towards a solution of that particular problem.

Often, adoption of research in practice lies in the details and the way the knowledge is transferred. In this research, I have struggled to orchestrate how a technique can be applied and implemented.

2. List of Publications

2.1 Refereed International Journals

[BBS-1] Bidyut Sarkar, Nabendu Chaki, Agostino Cortesi, (2013), " Modeling Demand Forecast Variance in a Distributed Supply Chain Network using Generalized Stochastic Petri nets", Scientific Journal Business Informatics, INFORMATYKA EKONOMICZNA,, Wrocław University of Economics, vol.3(29), pp. 128-151, ISSN 1507-3858

[BBS-2] Bidyut Biman Sarkar and Nabendu Chaki, (2010), "Transaction Management for Distributed Database using Petri nets", International Journal of Computer Information Systems and Industrial Management Applications (IJCISIM), Vol. 2(1), pp. 069-076, ISSN: 2150-7988

[BBS-3] Chaki Nabendu, Bidyut Biman Sarkar, (2010), "Virtual Data Warehouse Modeling Using Petri Nets for Distributed Decision Making"; JCIT: Journal of Convergence Information Technology, Vol. 5(5), PP. 8-21, ISSN1975-9320,

2.2 Refereed International Conference Proceedings

[BBS-4] Bidyut Biman Sarkar, Agostino Cortesi, Nabendu Chaki, (2013), "Modeling the Bullwhip Effect in a Multi-Stage Multi-Tier Retail Network by Generalized Stochastic Petri Nets", IEE, Proceedings of the Federated Conference on Computer Science and Information Systems, Italy, pp. 1157–1164. ISBN: 978-83-60810-53-8

[BBS-5] Bidyut Biman Sarkar, Nabendu Chaki, (2012), "A Distributed Retail Beer Game for Decision Support System", Elsevier Proceedings of the International Congress on

Interdisciplinary Business and Social Science 2012, Jakarta, Indonesia; December 01-02, 2012,. Volume 65, Pages 278-284, doi: 10.1016/j.sbspro.2012.11.123

[BBS-6] Bidyut Biman Sarkar, Sugata Sanyal, Nabendu Chaki, (2011), "Distributed framework for tele health monitoring system", Proceedings of the 1st International Conference on Wireless Technologies for Humanitarian Relief, ACWR , Amrita University Kerala,18-21, December, ACM Digital library, Pages: 385-390,doi> 10.1145/2185216.2185318, ISBN: 978-1-4503-1011-6

[BBS-7] Bidyut Biman Sarkar & Nabendu Chaki, (2010), "A distributed framework to analyze the bullwhip effect in SCM using Petrinets", Wisdom Voyage, Journal of Management Experts, Volume 1, Issue 1, March, ISSN No. 0975-9794

[BBS-8] B B Sarkar, N Chaki, (2009), "High level Net model for analyzing agent base distributed decision support system", Proc. Of the IACSIT International Spring Conference, pp:339-346, ISBN 978-0-7695-3653-8

[BBS-9] Bidyut Biman Sarkar and Nabendu Chaki, (2009) "Modeling and Analysis of Transaction Management for Distributed Database Environment using Petri Nets", Proc. of the 8th Int' Conf. on Computer Information Systems and Industrial Management Applications (CISIM 2009), ISBN:978-1-4244-5612.

2.3 Refereed International Journal and Conference Proceedings [Not with the guide]

[BBS-10] Bidyut Biman Sarkar, Manas Sanyal, (2011), "Growth and Limitations of E-Commerce A case of Indian Steel Industry", SURVEY, Vol. 51(3 & 4), pp: 110-121, journal of IISWBM , ISBN: 978-81-216-1566-2

BBS-11] Bidyut Biman Sarkar, Kundu Pulak, (2008), "E-procurement in Steel Industry through Intelligent Negotiation", WHICEB 2008, The Seventh Wuhan International Conference on E-Business, Vol:1, pp:42-49, ISBN:978-0-9800510-0-1

[BBS-12] Bidyut Biman Sarkar, Pulak Kundu, (2007), "Intelligent Negotiating Agent in Steel Procurement Process", International IEEE Conference on Computational Intelligence and Multimedia Applications, ICCIMA, pp: 93-97, ISBN: 0-7695-3050-8., doi:10.1109/ICCIMA.2007.374

2.4 Refereed International Journals Communicated

[BBS-13] Bidyut Biman Sarkar, Rajmohan Dey Sarkar, and Nabendu Chaki, (2014), "PHR Creation Using HDFS Framework for Smarter Health Care", Elsevier's, Journal of Pervasive and Mobile Computing, Special Issue on, Big Data Analytics for Smarter Health Care, Communication date: 6th November, Article Number: PMC-D-14-00357, distributed-computing-announce@datasys.cs.iit.edu

[BBS-14] Bidyut Biman Sarkar, Pulak Kundu, Nabendu Chaki,(2014),"Stochastic Modellingand Pilot Data Analysis towards Provisioning of Ambulance for Handling Emergency", manuscript Number: 870, Communication date: Dec 25, 2014,kjs@ku.edu.kwwebsite: http://journals.ku.edu.kw/kjs