A Layered View Model for XML with Conceptual and Logical Extensions, and its Applications

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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.

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Abstract

EXtensible Markup Language (XML) is becoming the dominant standard for storing, describing and interchanging data among various Enterprises Information Systems (EIS), web repositories and databases. With this increasing reliance on such self-describing, schema-based, semi-structured data language XML, there exists a need to model, design, and manipulate XML and associated semantics at a higher level of abstraction than at the instance level. However, existing OO conceptual modelling languages provide insufficient modelling constructs for utilizing XML structures, descriptions and constraints, and XML and associated schema languages lack the ability to provide higher levels of abstraction, such as conceptual models that are easily understood by humans. To this end, it is interesting to investigate conceptual and schema formalisms as a means of providing higher level semantics in the context of XML-related data modelling. In particular we note that there is a strong need to model views of XML repositories at the conceptual level. This is in contrast to the situation for views for the relational model which are generally defined at the implementation level.

In this research, we use XML view and introduce the Layered View Model (LVM, for short), a declarative conceptual framework for specifying and defining views at a higher level of abstraction. The views in the LVM are specified using explicit conceptual, logical and instance level semantics and provide declarative transformation between these levels of abstraction. For such a task, an elaborated and enhanced OO based modelling and transformation methodology is employed. The LVM framework leads to a number of interesting problems that are studied in this research. First we address the issue of conceptualizing the notion of views: the clear separation of

conceptual concerns from the implementation and data language concerns. Here, the LVM views are considered as *first-class citizens* of the *conceptual model*. Second we provide formal semantics and definitions to enforce representation, specification and definition of such views at the highest level of abstraction, the conceptual level. Third we address the issue of modelling and transformation of LVM views to the required level of abstraction, namely to the schema and instance levels. Finally, we apply LVM to real-world data modelling scenarios to develop other architectural frameworks in the domains such as dimensional XML data modelling, ontology views in the Semantic Web paradigm and modelling user-centred websites and web portals.

List of Publications

During this research, several sections of this research and collaborative works have been published. This includes refereed journal articles, book chapters and refereed international conference papers. Some of these selected published articles (marked with two **) are given in Appendix A.

Journal Articles

1. Rajugan, R., Chang, E, Dillon, TS & Feng, L 2006, 'Modeling Views in the Layered View Model for XML Using UML', *International Journal of Web Information Systems (IJWIS)*, 2006 - vol. 2(2), pp. 95-117.
2. Rajugan, R., Gardner, W, Chang, E & Dillon, TS 2005, 'Designing Websites with EXtensible Web (xWeb) Methodology', *International Journal of Web Information Systems (IJWIS)*, vol. 1(3), pp. 179-91, September.
3. **Nassis, V, Rajugan, R., Dillon, TS & Rahayu, W 2005, 'Conceptual and Systematic Design Approach for XML Document Warehouses', *International Journal of Data Warehousing and Mining*, vol. 1(3), pp. 63-87

Book Chapters

4. Wouters, C, Rajugan, R., Dillon, TS & Rahayu, JW 2006, 'Ontology Extraction Using Views for Semantic Web', in D Taniar & W Rahayu (eds), *Web Semantics and Ontology*, Idea Group Publishing, USA.
5. Nassis, V, Dillon, TS, Rahayu, W & Rajugan, R. 2006, 'Goal-Oriented Requirement Engineering for XML Document Warehouses', in J Darmont & O Boussaid (eds), *Processing and Managing Complex Data for Decision Support*, Idea Group Publishing.

Refereed Conference Papers

6. **Rajugan, R., Chang, E, Feng, L & Dillon, TS 2006, 'Modeling Dynamic Properties in the Layered View Model for XML Using XSemantic Nets', *International Workshop on XML Research and Applications (XRA '06) to be held in conjunction with APWeb '06*, Springer-Verlag, Harbin, China, pp. 142-7.

7. Nassis, V, Dillon, TS, Rajugan, R. & Rahayu, W 2006, 'An XML Document Warehouse Model', *The 11th International Conference on Database Systems for Advanced Applications (DASFAA '06)*, Springer, Singapore - *to appear.*

8. **Rajugan, R., Chang, E, Dillon, TS & Feng, L 2005, 'A Three-Layered XML View Model: A Practical Approach', *24th International Conference on Conceptual Modeling (ER '05)*, Springer-Verlag, Klagenfurt, Austria, pp. 79-95.

9. **Rajugan, R., Chang, E, Dillon, TS & Feng, L 2005, 'Alternate Representations for Visual Constraint Specification in the Layered View Model', *The Seventh International Conference on Information Integration and Web Based Applications & Services (iiWAS '05)*, Austrian Computer Society (OCG), Kuala Lumpur, Malaysia, pp. 571-82.

10. **Rajugan, R., Chang, E, Dillon, TS & Feng, L 2005, 'A Layered View Model for XML Repositories & XML Data Warehouses', *The 5th International Conference on Computer and Information Technology (CIT '05)*, IEEE CS Press, Shanghai, China, pp. 206-15.

11. Rajugan, R., Chang, E, Dillon, TS & Feng, L 2005, 'Engineering XML Solutions Using Views', *The 5th International Conference on Computer and Information Technology (CIT '05)*, IEEE CS Press, Shanghai, China, pp. 116-23.

12. Rajugan, R., Chang, E, Dillon, TS, Feng, L & Wouters, C 2005, 'Modeling Ontology Views: An Abstract View Model for Semantic Web', *1st International IFIP WG 12.5 Working Conference on Industrial Applications of Semantic Web (IASW '05)*, Springer IFIP Book Series, Jyvaskyla, Finland, pp. 227-46.

13. Rajugan, R., Chang, E, Feng, L & Dillon, TS 2005, 'Modeling Views for Semantic Web', *First IFIP WG 2.12 & WG 12.4 International Workshop on Web Semantics (SWWS '05), In conjunction with On The Move Federated Conferences (OTM '05)*, Springer-Verlag, Agia Napa, Cyprus, pp. 936-46.

14. Rajugan, R., Chang, E, Feng, L & Dillon, TS 2005, 'Semantic Modelling of e-Solutions Using a View Formalism with Conceptual & Logical Extensions', *3rd International IEEE Conference on Industrial Informatics (INDIN '05)*, IEEE Computer Society, Perth, Australia, pp. 286-93.

15. Rajugan, R., Chang, E, Dillon, TS & Feng, L 2005, 'Modeling Abstract Views as a Mechanism for Developing Sub-Ontologies', *The 1st IEEE International Conference on Next Generation Web Services Practices (NWeSP '05)*, IEEE Computer Society, Seoul, S.Korea.

16. Steele, R, Gardner, W, Rajugan, R. & Dillon, TS 2005, 'A Design Methodology for User Access Control (UAC) Middleware', *Proceedings of the IEEE International Conference on e-Technology, e-Commerce and e-Service (EEE '05)*, pp. 385-90.

17. Nassis, V, Rajugan, R., Dillon, TS & Rahayu, W 2005, 'A Systematic Design Approach for XML-View Driven Web Document Warehouses', *International Workshop on Ubiquitous Web Systems and Intelligence (UWSI '05), Colocated with ICCSA '05*, Singapore, pp. 914-24.

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19. Rajugan, R., Chang, E, Dillon, TS & Feng, L 2005, 'XML Views, Part III: Modeling XML Conceptual Views Using UML', *7th International Conference on Enterprise Information Systems (ICEIS '05)*, INSTICC, Miami, USA, pp. 19-28.

20. Rajugan, R., Gardner, W, Chang, E & Dillon, TS 2005, 'xWeb: An XML View Based Web Engineering Methodology', *International Workshop on Ubiquitous Web Systems and Intelligence (UWSI '05), Colocated with ICCSA '05*, Singapore, pp. 1125-35.

21. **Rajugan, R., Chang, E & Dillon, TS 2005, 'Conceptual Design of an XML-View Driven, Global XML FACT Repository for XML Document Warehouses', *1st International Workshop on Data Management in Global Data Repositories (GRep '05), held in conjunction with the 16th International Conference on Database and Expert Systems Applications (DEXA '05)*, IEEE Computer Society, Copenhagen, Denmark, pp. 1139 - 44.

22. **Nassis, V, Rajugan, R., Dillon, TS & Rahayu, JW 2005, 'A Requirement Engineering Approach for Designing XML-View Driven, XML Document Warehouses', *The 29th Annual International Computer Software and Applications Conference (COMPSAC '05)*, IEEE Computer Society, Edinburgh, Scotland, pp. 388-95.

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24. Gardner, W, Rajugan, R., Chang, E & Dillon, TS 2004, 'xPortal: XML View Based Web Portal Design', *17th International Conference on Software & Systems Engineering and their Applications (ICSSEA '04)*, Paris, France.

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26. **Rajugan, R., Chang, E, Dillon, TS & Feng, L 2003, 'XML Views: Part 1', *14th International Conference on Database and Expert Systems Applications (DEXA '03)*, vol. 2736, ed. WR Vladimír Marík, Olga Stepánková, Springer-Verlag, Prague, Czech Republic, pp. 148-59.

27. Chang, E, Dillon, T, Gardner, W, Talevski, A, Rajugan, R. & Kapnoullas, T 2003, 'A Virtual Logistics Network and an e-Hub as a Competitive Approach for Small to Medium Size Companies', *2nd International Human.Society@Internet Conference*, Springer-Verlag, Seoul, Korea, pp. 265-71.

28. Chang, E, Gardner, W, Talevski, A, Gautama, E, Rajugan, R., Kapnoullas, T & Satter, S 2001, 'Virtual Collaborative Logistics and B2B e-Commerce', *e-Business Conference*, Duxon Wellington, NZ.