

MODEL-DRIVEN ARCHITECTURE APPROACH FOR ENTERPRISE SYSTEMS

LAI Kok Kee, NG Wendy, LOW Kwee Boon

ABSTRACT

The Model-driven Architecture (MDA) approach has been recognised as a methodology that can help enhance agility and speed in the implementation of enterprise IT systems. This article introduces the concept of MDA and how it helps in managing the complexities of integration and improving business-IT alignment. It highlights how DSTA uses various MDA techniques to achieve a process-oriented software implementation paradigm, where business requirements (captured in process models) are linked to actual IT system configurations to shorten implementation cycles. This article also shares highlights and lessons learnt in the MDA journey.

Keywords: model-driven architecture, software development, application lifecycle management

INTRODUCTION

The Model-driven Architecture (MDA) is a software design approach defined by the Object Management Group (OMG). The OMG is an international, open membership and non-profit computer industry standards consortium that develops enterprise integration standards for a wide range of technologies and industries.

Models are key to MDA in a software development process. The MDA approach uses Platform-Independent Models (PIM) which include business processes to define the functionalities of a system. A strong foundation and institutionalisation of Enterprise Architecture (EA) practice within the organisation enforces a common modelling language to capture all PIMs. These PIMs are then translated and linked electronically to Platform-Specific Models recognised by computers for execution. This process of planning, design, development and testing is termed the Application Lifecycle Management (ALM). Tools that integrate across the ALM processes help ensure clear traceability, control of changes and assessment of change impact.

DEFINING MODEL-DRIVEN ARCHITECTURE AND APPLICATION LIFECYCLE MANAGEMENT

Model-driven Architecture

In DSTA's context, MDA is defined as an approach to organise and manage business requirements in PIMs, where automated tools can be reused for design and implementation into IT systems. The principle is to separate the specification of functionality from that of implementation.

This approach leverages the strong foundation and maturity of EA practice. Since 2006, EA has been adopted as a means to strengthen business-IT integration in DSTA. The EA framework was developed to ensure that business requirements (operational view) and IT implementation (system and technical views) are reflected accurately in an architectural model (see Figure 1).

The MDA approach entails two spirals of EA development (see Figure 2). The first is at the business paradigm level (what is modelled versus what is built). It is about re-engineering the

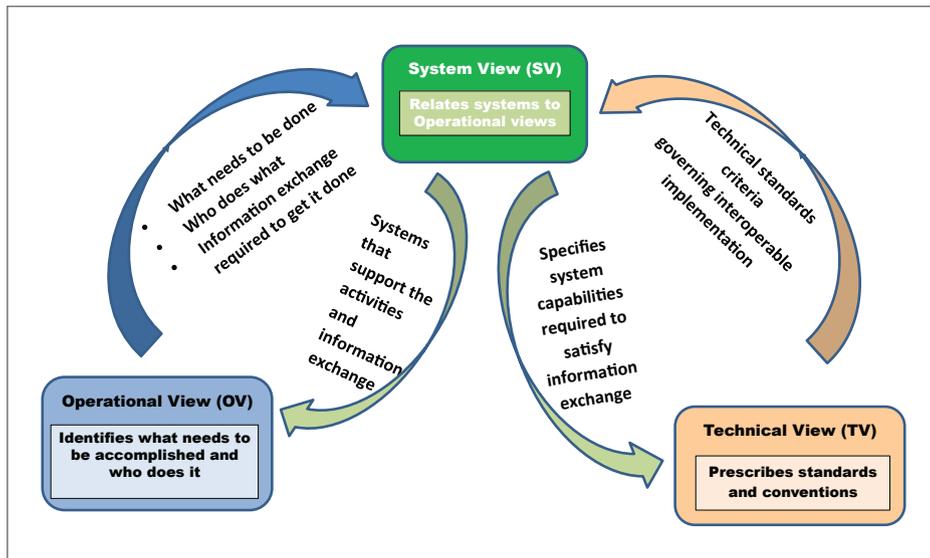


Figure 1. EA view

business paradigm into process-oriented models according to EA standards. The key benefit of this standardised approach is that final business models will be significantly simpler and refined, yet functionally richer than traditional methods. The second is at the IT paradigm level (what is built versus what is used). It is about enabling the re-usability of business models for design and implementation into IT systems with appropriate tools and services. This integration enforces the mapping of requirements captured in the business model onto actual implementation. With such consistency, the alignment between business and IT is also enhanced.

The MDA concept also allows process implementations, system configurations as well as test scenarios to be generated automatically through business models. Through early

prototyping and better communication across stakeholders, issues and conflicts are reduced during implementation. Overall, system development effort and time are reduced as compared to conventional systems development methods. This enhances the pace and agility of how systems are designed, built and tested in the application lifecycle of the system.

Application Lifecycle Management

ALM facilitates the coordination between the business and development teams (see Figure 3). This includes the management of requirements, building, testing and deployment so that applications can be managed effectively throughout the application lifecycle.

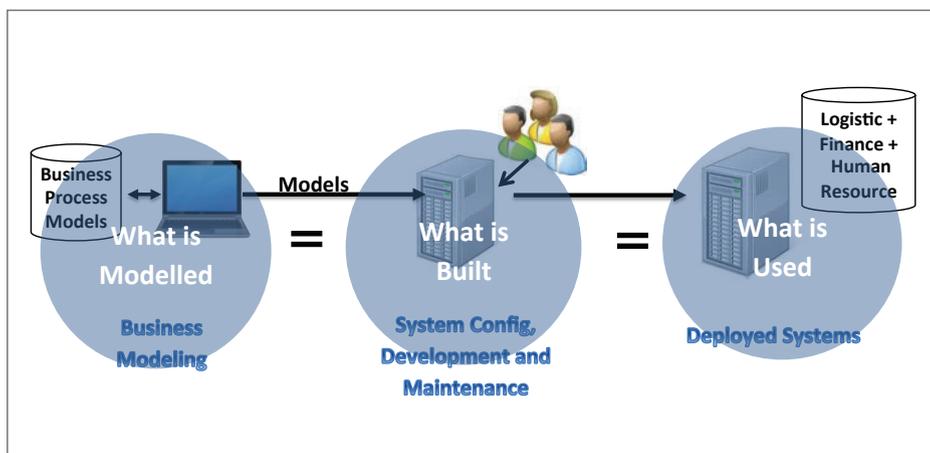


Figure 2. Consistency through an MDA approach

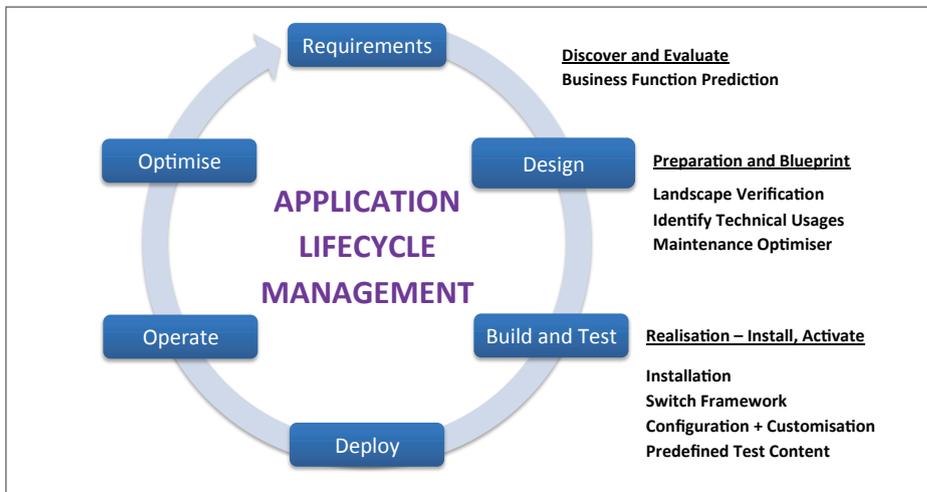


Figure 3. ALM

The main stages of ALM are as follows:

- a) **Requirements** – The requirements for a new application are gathered and expressed as business processes, events and actions taken by various stakeholders.
- b) **Design** – The requirements are translated into specifications for the IT components. They include the design of the application or any customisation to the standard packaged software as well as the design of the environment or operational model that the application has to run on.
- c) **Build** – Both the application and the operational model are made ready for deployment. Application components are coded or acquired, and then integrated and tested. For off-the-shelf software, required customisations will be done during this phase.
- d) **Deploy** – Both the operational model and applications are moved from the development environment to a test environment, and finally to the production environment.

The operational model is incorporated into the existing IT environment and the application is installed on top of the operational model. This is also typically governed through a release and deployment management process to ensure proper configuration control.

e) **Operate** – The IT services organisation operates the application as part of the delivery of a service required by the business. The performance of the application in relation to the overall service is measured continually against service levels and key business drivers.

f) **Optimise** – The results of the service level performance measurements are measured, analysed and acted upon. Possible improvements are discussed and developments initiated if necessary. The two main strategies in this phase are to maintain or improve service levels and lower cost.

The key phases and the stakeholders involved in ALM are illustrated in Figure 4.

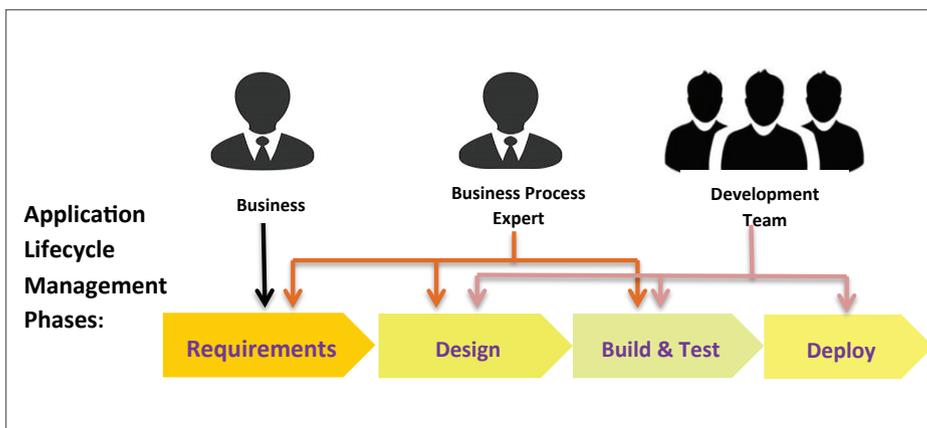


Figure 4. ALM phases

THE EVOLUTION OF MDA

MDA grew in sophistication with the maturity of EA, tools and people. It is used to: harmonise processes to facilitate IT implementation, transform business processes, and drive IT implementation.

MDA to Harmonise Processes and Facilitate IT Implementation

The MDA approach is largely driven by the successful implementation of the Enterprise System (ES) in transforming the logistics and finance operations of the Singapore Armed Forces (SAF).

Initiated in 2003, the ES was the first large-scale system in which business process models were developed extensively to analyse and establish business requirements. The approach proved crucial in facilitating the analysis, harmonisation and integration of the diverse business processes found in the different services and Lines of Business (LOB). Without these business models, it would have been extremely difficult to visualise and understand the complexity of the business operations. In all, the project harmonised and standardised more than 90% of some 600 processes defined across the Singapore Army, the Republic of Singapore Navy (RSN), the Republic of Singapore Air Force (RSAF), Joint and the Ministry of Defence (MINDEF). Based on these business process blueprints, ES(Logs) was implemented in phases starting with the RSN in 2005, the Singapore Army and Joint in 2006, followed by the RSAF in 2007 – all on time and within budget. The ability to reuse processes also resulted in cost savings of some S\$80 million in systems implementation. It also transformed the way logistics and financial operations are carried out today (Lim, Ham, Heng, & Koh, 2010).

This effort was extended to the domains of platforms, buildings and infrastructure, medical logistics, IT and R&D, leading to further benefits.

MDA to Transform Business Processes

The Business Process Management (BPM) Department under the MINDEF Chief Information Office was set up in February 2008 to facilitate and drive business transformation. In addition to working with business owners to lead business transformation projects, it is also responsible for building up the Defence Business Map¹ and facilitating enterprise integration.

The business transformation initiative is an enterprise-wide effort. For it to succeed, strong commitment and support from senior leadership is crucial. The existing IT steering committee, chaired by senior management from MINDEF and the SAF, extended its terms of reference to include business transformation initiatives. The steering committee, together with LOB leaders, provide overall leadership in transforming business capabilities. It reviews and endorses business transformation proposals, and also plays the critical role of identifying and resolving ownership issues for business areas where clear ownership is lacking (Lim et al., 2010).

A four-phase Integrated Methodology for Business Transformation was also established and practised. This approach starts off with the prioritisation and selection of business functions for process mapping, followed by the development of target business architecture, and subsequently the development of the conceptual solution. The last phase involves implementation of the solution.

Using this approach, various business process transformation projects have since been successfully implemented with enhanced capabilities across the management of areas such as human resource, building and infrastructure, transport and ammunition.

MDA to Drive IT Development

With the maturity of applications in the market, it is now possible to translate requirements from models into applications (see Figure 5). The trend of adopting MDA to drive IT development has been consistent across other defence agencies from other nations as well.

For commercial off-the-shelf (COTS) products such as the SAP² Enterprise Resource Planning (ERP) System, the MDA approach leverages the ALM function of SAP, where models are synchronised into a SAP application lifecycle management tool for application development.

For customised non-COTS systems, the MDA approach utilises BPM Suite (BPMS) to translate business process models into executable applications.

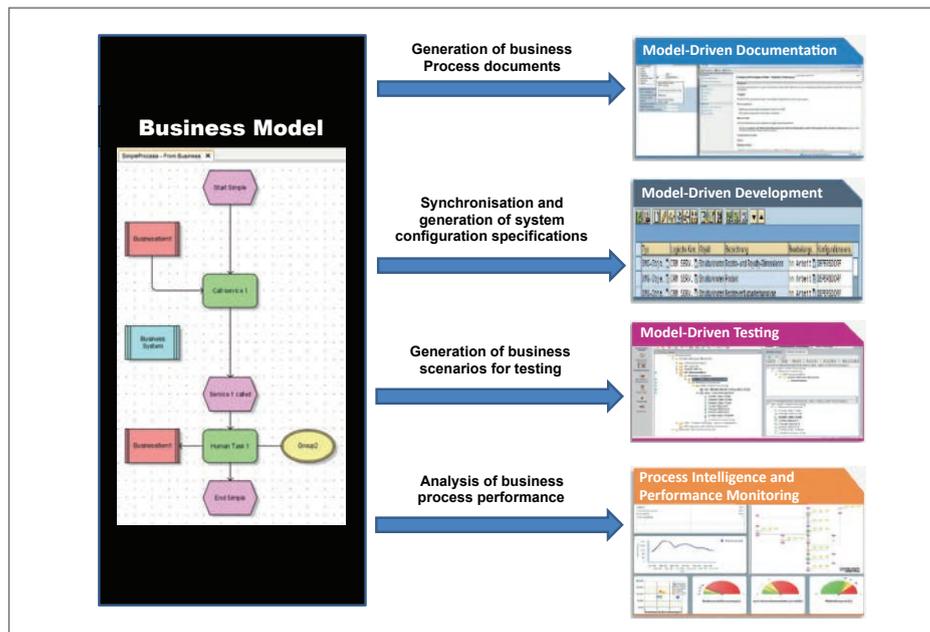


Figure 5. MDA to drive IT development

The three key areas of MDA implementation are as follows:

Model-driven Documentation and Development

DSTA has taken on a leadership role in the technical area of EA to ensure architectural alignment and sound technology implementation. In 2008, DSTA successfully delivered a central repository of business models called AVATAR³ using the Architecture of Integrated Information Systems (ARIS) platform. These models were created in accordance with EA modelling standards defined by a DSTA team.

In early 2011, a proof-of-concept was conducted to ascertain that the existing business process models captured in AVATAR could be synchronised with SAP Solution Manager (SAP SolMan). The synchronisation mechanism was tested to work both ways. First, business requirements defined as process models in AVATAR should be transferred and translated automatically to SAP systems so that developers can begin configuration. Second, SAP reference models and implementation in SAP SolMan should also be imported back into ARIS tools to jump-start or update the build-up of unique business requirements in AVATAR. This would help to reduce the development lead time and allow changes to be managed properly.

Model-driven Testing

Extensive testing is required for every piece of software during the various phases of software development. The scope of testing usually involves conducting some form of change impact analysis which requires a good knowledge of the business, software architecture and design details.

Model-driven testing is a new and promising approach for software testing as it reduces effort and turn-around time significantly. It enables efficient test scope planning by accurately identifying the affected business models due to changes introduced. This is made possible because of the better business-IT alignment of the MDA approach.

With business processes documented in the form of business process models, software development teams can now make use of these models to create test cases based on structured scenarios. Each test script proposed will correspond to a given scenario, thus enabling easy tracking and verification. This new methodology and toolset was pioneered in the Centralised Corporate Services (CCS) BPMS project and has proven to reduce the time to roll out new applications, while maintaining high standards in software quality.

Process Intelligence

CCS comprises a suite of services in the areas of human resource, corporate finance and budgeting, logistics and procurement and IT support. The aim of CCS is to bring together common corporate functions performed across entities to create synergies and leverage the competencies of respective professional agencies for greater efficiency. The intent is also to automate a significant number of manual processes such as asset stocktaking and condemnation.

To help CCS overcome the need to automate manual processes, DSTA piloted a BPMS tool that enables timely and accurate monitoring and analysis of business processes, thus enhancing efforts in streamlining, tuning and exception handling. The BPMS platform also serves as a common workflow tool to integrate existing disparate processes and reduce manual process hand-offs.

Using the MDA approach, the BPMS tool was able to accept existing business processes already mapped out under the EA framework and translate them into executable business workflows with minimum development effort. This helped to reduce the implementation lead time for IT systems while meeting business requirements.

CHALLENGES

Although the MDA approach is still at its infancy, several challenges have been encountered so far.

Practicality of a Single Modelling Standard

The MDA approach was piloted in the implementation of the Enterprise System and CCS BPMS. For both platforms, there were significant efforts to ensure that the models captured in AVATAR were usable by SAP and BPMS for subsequent application development. Through the pilot tests, it was concluded that a single prescribed EA standard and modelling tool may not be able to meet both SAP and BPMS platform specific requirements. Hence, a hybrid model will have to be developed to better meet the needs of both COTS and bespoke developments.

Industry Competency and Readiness

When the MDA approach is fully operationalised, all IT implementations will need to comply with the MDA requirements. This means that System Integrators (SI) undertaking any project implementation will need to have the

necessary competency in MDA. As the adoption of the MDA approach is still new in the IT industry, this may pose a risk to the projects' timeline and cost. DSTA has taken a proactive approach to address this by providing the necessary training and guidance on the MDA approach to SIs engaged in IT projects. The competencies to take on the MDA approach is also expected to mature as more software firms and SIs adopt the MDA approach across the IT industry.

MOVING FORWARD

The first phase adoption of MDA has met its intended goals. The next phase will be to proliferate the practice across Corporate IT (CIT) systems progressively. To do this, the current MDA approach will be reviewed in order to be more effective and efficient in catering to different types of IT systems.

The focus will also be centred on further enhancing the integration of AVATAR with SAP ERP applications. This could be achieved through further automation of the management of the application lifecycle, as well as the enhancement to the quality of existing models captured within AVATAR.

Beyond the objectives of achieving business agility and shortening the duration from application development to roll-out, the MDA approach also ensures business continuity in the event that there is a need to re-platform the SAP ERP system.

CONCLUSION

The concept of using the MDA approach to automate the integration of business requirements captured in business process models into actual application development is both desirable and exciting for business users and IT teams. The MDA approach has demonstrated the ability to reduce the duration from application development to roll-out, for IT systems through the use of models that drive application development.

REFERENCES

Lim, H. C., Ham, Y. F., Heng, C. C. L., & Koh, C. Y. (2010). Driving Business Transformation through a Process-centric Approach. *DSTA Horizons*, 28-43.

Object Management Group. (n.d.). *Object management group terms and acronyms*. Retrieved from http://www.omg.org/gettingstarted/save_terms_and_acronyms.htm.

ENDNOTES

¹ The Defence Business Map illustrates the CIT lines of business (such as finance management, human resource management) and respective business capabilities to support the enterprise's strategic outcomes and objectives. The Defence Business Map will be further colour coded to indicate the IT-enablement status of each business capabilities and for planning of future IT enablement.

² Systems Application and Product in Data processing, or SAP, is an enterprise resource planning software which comprises a number of fully integrated modules covering virtually every aspect of business management.

³ **AVATAR** stands for “The **A**ctionable, **C**ollaborati**V**e and **A**ligned **E**n**T**erprise **A**rchitecture **R**epository”.

BIOGRAPHY



LAI Kok Kee is a System Manager (Enterprise IT) who currently oversees the operations and support management of enterprise SAP systems. Kok Kee is also a SAP Certified Technology Consultant. He graduated with a Bachelor of Science (Information Systems) degree from the Thames Valley University of London, UK, in 2003.



NG Wendy is a Principal Engineer (Enterprise IT) who is currently involved in realising the Model-driven Architecture infrastructure through the implementation of SAP Application Lifecycle Management (ALM) for the Ministry of Defence (MINDEF) Enterprise Systems(Logs). She was previously involved in the development of Corporate IT's Enterprise Architecture for MINDEF and the Singapore Armed Forces (SAF). Wendy is a certified SAP consultant in SAP applications and a TOGAF (The Open Group Architecture Framework) Certified Enterprise Architecture Practitioner. She graduated with a Bachelor of Science in (Computer and Information Sciences) degree with Merit from the National University of Singapore (NUS) in 1998.



LOW Kwee Boon is a Senior Systems Architect (Enterprise IT). Since joining DSTA in 2000, he has been involved in various SAP implementation projects for MINDEF and the SAF in areas ranging from functional, technical to cross-application modules. He is well versed in the latest development and evolution of technologies in the area of Enterprise Resource Planning. He has charted out strategies and implementation road maps in areas including Governance, Risk and Compliance as well as ALM for MINDEF and the SAF. Kwee Boon is also a certified SAP consultant in SAP applications. He graduated with a Bachelor of Engineering (Mechanical Engineering) degree with First Class Honours from NUS in 1997.

