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Modelling across the contractual boundary

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ABSTRACT

Model-Based Systems Engineering practices are starting to become accepted as beneficial practices on both sides of the acquisition boundary within Defence. Some projects are actively generating descriptive models of the capabilities required and receiving outputs from analytical models from tenderers and suppliers. It therefore seems a logical step for the two parties to share their respective models across the contractual boundary.

The sharing of models across the contractual boundary presents a number of issues throughout all stages of the Capability Life Cycle, and in particular during the risk mitigation and requirements setting and the acquisition phases. However, successful model sharing can have significant advantages for government and Industry sectors that range from reduced duplication of effort to a greater shared understanding of the system and subsequent capability.

This paper discusses the findings of a workshop session held at the Australian Systems Engineering Workshop 2017 which looked at: the benefits of model sharing when a contract exists between the parties; understanding the problems associated with model sharing; and the potential solutions to overcome these problems. The workshop session was well attended by a variety of government, Industry and academia representatives, ranging from Chief Engineers to Model-Based Systems Engineering Practitioners. The discussions during the workshop were open and frank, leading to a greater understanding of the potential for sharing of descriptive and analytical models across contractual boundaries and the hurdles that need to be overcome.

Key discussion points include: intellectual property issues; modelling tool compatibility issues; appropriate level of detail; reduction of duplicated effort; standardised modelling approaches; and the reuse of model components for different projects.

INTRODUCTION

Model-Based Systems Engineering (MBSE) practices are starting to become accepted as beneficial practices on both sides of the acquisition boundary within Defence. Some projects are actively generating descriptive models of the capabilities required and receiving outputs from analytical models from tenderers and suppliers. It therefore seems a logical step for the two parties to share their respective models across the contractual boundary.

At the 2012 DSTO MBSE symposium, a workshop was conducted to help understand the boundaries and issues preventing the passing of descriptive models generated by Defence projects to Industry. The results of that workshop informed research work conducted by Dr Quoc Do and Professor Stephen Cook at the University of South Australia (Cook et al. 2014).

This paper discusses the findings of a follow up workshop session held at the Australian Systems Engineering Workshop (ASEW) 2017 which looked at: the benefits of model sharing when a contract exists between the parties; understanding the problems associated with model sharing; and the potential solutions to overcome these problems. The workshop session was well attended by a variety of government, Industry and academia representatives, ranging from Chief Engineers to MBSE Practitioners. The discussions during the workshop were open and frank, leading to a greater understanding of the potential for sharing of descriptive and analytical models across contractual boundaries and the hurdles that need to be overcome.

PREVIOUS ACTIVITIES

Workshop at the 2012 DSTO MBSE symposium

A workshop was held at the 2012 DSTO MBSE symposium to understand the boundaries and issues preventing the passing of descriptive models generated by Defence projects to Industry during contracting activities. Facilitators of this workshop were Dr Quoc Do and Jon Hallett.

This workshop focussed on: model supported acquisition; model integrated acquisition; model centric acquisition; model information classes; and issues preventing the passing of models during contracting activities.

Discussions regarding the acquirer model found that some elements of the modelling effort are shared, while others are not. Model information that was often shared included: functional decompositions; performance rationales; related standards; support concept; and test and evaluation information. Model information that was not often shared included: internal costings; contractual information; and sensitive or Defence only information.

Discussions regarding the supplier model also found that some elements of the modelling effort are shared, while others are not. Model information that was often shared included: system behaviour; measures of performance; assumptions; rationales; applicable standards; test plans and test cases; technical forecast and resulting risks; technical integrity risk; and the support system model. Model information that was not often shared was primarily lower-level detail risk and cost assessments.

The workshop addressed the question of how the two models should be interfaced. The discussions resulted in suggestions that there is a need for a metamodel / framework defined and managed by government. It was agreed that interfacing standards (at the time) were lacking, and these needed to catch up before they can be mandated i.e. the OMG's XMI standard needs to include diagrams. An issue was raised that Industry may or may not be able to cost effectively comply with any defined standards or tools, especially when they are from overseas or have invested heavily in a different tool or class of standards.

The workshop concluded with a number of questions that remained unanswered including:

- Can model-based Request For Tender (RFT) evaluation be implemented within Defence?
- Can model-based RFT evaluation be implemented within Industry?
- What are the impediments to achieving the long-term goal of model-based acquisition (i.e. legal framework and IP issues)?

These questions, and more, would attempt to be addressed by research work conducted by Dr Quoc Do and Professor Stephen Cook at the University of South Australia.

2012 – 2014 Research findings

Following on from the workshop above the research investigated the use of MBSE on both sides of the acquisition boundary within Defence. It found that MBSE has been applied across the contractual boundary for over twenty years where mutual trust exists and mutual goals are well understood. Additionally, work on capturing design rationale to support requirements or component change evaluation looks very promising and representation of design rationale looks capable of improving the quality, completeness, and knowledge management of the system of interest.

Looking to the future, the research found that it is unlikely that a single model can be passed between the acquirer and supplier in a competitive tendering environment because the acquirer and supplier have different requirements that their model needs to fulfil. It appears that it would be best for each stakeholder group to possess a designed-for-purpose model that can interact with a central repository model. DST Group's Whole of System Analytical Framework (WSAF) is well suited to its task and can be passed directly to supplier. It was noted that as projects proceed, the System Supplier Model would become pre-eminent.

When looking at MBSE-based tendering, the research concluded that it looks viable, but feasibility was dependant on limiting the scope of the models to sharable information or the ability to segment and configuration-manage the models.

This research was first presented as interim work at the 2013 DSTO MBSE Symposium (Do et al. 2013) and later as final work at the SETE 2014 (Cook et al. 2014) and CSER 2014 (Do et al. 2014) conferences.

ASEW 2017 WORKSHOP

Overview

The ASEW 2017 workshop looked to see if anything had changed over the last 5 years and to brainstorm the advantages to projects to share models produced on either side of the contractual boundary, what the problems are in doing so and what could be done to improve the situation.

Workshop aims

The aims of the ASEW 2017 modelling across the contractual boundary workshop session were to:

1. Determine the benefits;
2. Define and understand the problem:
    a. Determine the current barriers to Defence passing descriptive models (used to generate Capability Design Document sets) across the contractual boundary;
    b. Determine the Industry-side issues in receiving descriptive models from Defence;

c. Determine the Industry-side issue of passing solution models back to Defence; and

d. Determine the Defence-side issues of receiving and assessing solution models provided by Industry.

3. Propose potential solutions:

   a. Defence-side solutions and initiatives; and

   b. Industry-side solutions and practices.

Workshop structure overview

The workshop was divided into two groups split as above the line (Defence / Acquirer) and below the line (Supplier / Sustainer). The following questions were addressed in the context of the group and facilitators supported each group.

Activity 1 – Current state of play

The questions for the first activity were:

> Q1.1 Is there evidence that Defence is generating more information models utilising MBSE methods in support of acquisition and sustainment?
>
> Q1.2 Has anything changed in Defence regarding the sharing of information models with Suppliers or Sustainers?
>
> Q1.3 Are there any project examples of where information models are routinely shared, and information updated between Defence and the Supplier or Sustainer?

Activity 2 – Benefits

The question for the second activity was:

> Q2.1 What benefits does the use, across the contractual boundary, of information models bring?

Activity 3 – Hurdles to overcome

The questions for the third activity were divided between the two groups. The questions for the Defence / Acquirer group were:

> Q3.1 What are the current barriers to Defence passing information models across the contractual boundary?
>
> Q3.2 What are the Defence issues in receiving and assessing information models provided by the Supplier or Sustainer?

The questions for the Supplier / Sustainer group were:

> Q3.3 What are the current barriers to the Supplier or Sustainer passing information models across the contractual boundary?
>
> Q3.4 What are the Supplier or Sustainer issues in receiving and assessing information models provided by Defence?

Activity 4 – Solutions

The questions for the fourth activity were:

> Q4.1 What could Defence do to realise the benefits of sharing the information model?

Q4.2 What could Suppliers or Sustainers do to realise the benefits of sharing the information model?

Defence / Acquirer Group Findings

Current state of play

The Defence / Acquirer group discussed the current state of play with respect to model development and use in the Australian Defence context. There was general agreement that while there is a marginal increase in the number of information models being generated by Defence, their increased use is not being directed by the Australian Defence Organisation and are only being used for acquisition. The group also agreed that the state of information model sharing across the contract boundary is non-existent and unchanged. The discussion concentrated on three major themes:

- types of information models generated by Defence;
- use of information models generated by Defence; and
- lack of organisational endorsement of MBSE.

While the group lacked quantitative evidence, there was general agreement that Defence is generating more information models by utilising MBSE methods. It was discussed that any increase in information model utilisation is almost entirely for acquisition purposes. There is no evidence to suggest that there are any information models being used to support sustainment, furthermore, any models which are being used for sustainment are unlikely to be the same models as those generated for acquisition.

There is still no evidence to suggest any information models are being shared by Defence with its Industry suppliers and sustainers. Rather, it was generally agreed that any information models Defence generates are primarily for the desire to make defendable acquisition recommendations when presenting options to Government. This current state of model use demonstrates a lack of organisational understanding into the benefits of system modelling and model sharing.

Despite the increased utilisation of information models by Defence, this trend is not the result of a changing Defence policy or culture. Currently there is no organisational directive to mandate the use of MBSE, or even systems engineering practices, throughout the Capability Life Cycle. Any decisions made to use MBSE methods by a project or program managers often comes down to the individual project or program manager's value judgement, which typically limits the use of information modelling to the larger and more complex capability projects.

Benefits

The Defence / Acquirer group discussed the benefits that sharing models across the contractual boundary would bring. The group unanimously agreed that there are key benefits which can be realised through model sharing. The discussion concentrated on two major themes:

- facilitating a shared understanding; and
- reducing inefficiencies.

Absolutely critical to Defence, when engaging an Industry supplier, is in communicating their desired intent. It was agreed by the group that the root cause of all project failures is a lack of shared understanding between the acquirer and the supplier. The group agreed that sharing the information model with the supplier is a means of reducing design ambiguity, and in providing clarity of intent.

Secondary in importance to the benefit of a shared understanding, are the efficiencies gained by avoiding

duplication through model re-use. There is a common capability information thread required from acquirer to supplier, and supplier to sustainer, however, currently at each transition point new information models needs to be created, which can be both time and cost prohibitive.

Hurdles to overcome

There are a number of hurdles required to be overcome before effective modelling across the contact boundary can become a reality. The Defence / Acquirer group discussed these hurdles with general agreement that they could all be overcome, however some would require a significant change in the Defence acquisition culture. The discussion concentrated on five major themes:

- difficulty interfacing information models between MBSE tools;
- reducing unintentional solution constraining;
- reducing legal concerns;
- insufficient capability to assess model gaps; and
- lack of Defence generated information models.

The various MBSE tools which enable generation of informational models do not typically support inter-tool model sharing. If any sort of model sharing is possible between tools, it is generally resource intensive to achieve or is incomplete. Sharing models across the contract boundary cannot be achieved without an effective way to interface the various MBSE tools.

The group agreed that Defence would be concerned with the possibility of unintentionally driving or constraining the supplier's solution-space, due to the supplier having access to the architecture used by the acquirer to model the problem-space. The group was unsure if model sharing would actual stifle solution innovation, however the possibility of this is a concern.

The group raised the point that Defence would be concerned with the ability to legally hold a supplier or sustainer accountable as effectively as can currently be done in a document format. It was agreed there is significant uncertainty in the ability for an information model to stand up in the current Australian legal framework.

As the acquirer, Defence must be able to suitably evaluate the quality of the capability design held within the information model. Currently, Defence lacks a sufficient number of trained personnel who can assess models provided by Industry for knowledge gaps and logic integrity. While Defence has limited capability to achieve this level of model interrogation, the group agreed there is a significant skills shortage.

Finally, a key hurdle to the goal of sharing models across the contract boundary is the actual existence of Defence generated information models. The group generally agreed that the decision to use information models has not been made, and furthermore is not self-evident to Defence leadership. A lack of endorsement by Defence leadership in the use of MBSE, or even system engineering, has and will continue to limit the prospects of sharing information models with Industry.

Solutions

The Defence / Acquirer group identified potential solutions to overcome the hurdles discussed in the previous section. The discussion concentrated on four major themes:

- information model interface standard;
- Defence leadership to decide on information model use;

- decrease skills shortage within Defence; and
- testing an actual project sharing a model with Industry to create a case study.

Key to overcoming the information modelling issue is the lack of an interfacing standard between MBSE tools. While Defence can mandate the MBSE tool used within the organisation, the group agreed that the only way for Defence models to be effectively shared with Industry is through a tool interfacing standard. While the group identified that Defence could look to drive the development of model interface standard, it would likely be more appropriate to support the INCOSE Model-based Conceptual Design Working Group to develop such a standard.

Without Defence leadership taking the initiative to direct an MBSE or systems engineering approach to capability design, project and program managers are unlikely be sufficiently motivated to develop information models. The group generally agreed that real progress in the uptake of information model sharing, and the associated benefits that come with model sharing, will not be realised without a sufficient critical mass of projects. Defence leadership must first decide if utilising information models is in their organisation's future, and then direct projects to go down that path.

The competency of Defence personnel to develop and interrogate information models is key to the successful utilisation of information models. A sustainable position for Defence as the acquirer would be to have a cadre of Defence personnel sufficiently skilled in MBSE practices. If MBSE as an organisational approach is endorsed, Defence should look to train staff with the help of Industry.

The group agreed that an important early step in addressing the legal and unintentional solution constraining concerns, and in demonstrating to leadership the benefits of model sharing, Defence should look to support an actual project develop and share its information model with an Industry partner. Piloting an actual project would de-risk process changes to the whole-of-Defence and would provide both Defence and Industry with useful learnt lessons.

Supplier / Sustainer Group Findings

Current state of play

The Supplier / Sustainer group discussed the current state of play with respect to model development and use in the Australian Defence context. There was general agreement that collaboration and efficiency of model use was less than desired. The discussion concentrated on three major themes:

- lack of incentives to share models;
- lack of project focus on whole of life cost; and
- reliability and consistency of models.

There is currently little incentive for suppliers to share models unless contractually obligated. Adding to the lack of incentives is the disincentive of sharing the intellectual property (IP) of the model, especially where there is resale value in the system design. This issue is magnified where the supplier and sustainer are different (and often competing) organisations.

The group agreed that there is a lack of focus on whole of life cost. Projects often focus on cost and schedule of the acquisition phase, not the sustainment phase. This creates an issue regarding modelling focus but an opportunity regarding the inclusion of model upkeep in the sustainment contract.

The group discussed the reliability of models across projects and raised that the behaviour side of the model could be shared and even reused, but the physical architecture side of the model is difficult to share. For configuration management (CM) purposes, there ultimately needs to be a functional and a

physical model, and the functional model needs to have some physical aspect to it so that the acquirer can perform what-if analysis.

Benefits

The group discussed the benefits that sharing models across the contractual boundary would bring. There was general agreement it is beneficial, but the process and contracting elements would need to be structured for mutual gain between suppliers, sustainers and Defence / acquirers. The discussion focussed on two major themes:

- providing a fuller and clearer picture of the system; and
- reducing inefficiencies.

The group agreed that sharing the model could create a better shared picture of the system leading to lower likelihood of misinterpretation. Additionally, there could be benefits with interfaces across contracts between different contractors/projects.

The sharing of models may result in cost savings due to not needing to remodel. The mechanism for how to do this could improve over time.

Hurdles to overcome

There are a variety of hurdles to overcome for modelling across the contact boundary to become a reality. The group discussed these hurdles and there was general agreement that the hurdles were not insignificant, but not irremovable. The discussion concentrated on four major themes:

- Intellectual Property;
- security and classification;
- variance in tools and modelling methods; and
- quality of the modelling effort.

The issue of Intellectual Property (IP) was of particular concern to the suppliers for resale reasons detailed in the previous sections. Additionally, it was raised that the models contain corporately sensitive information regarding the modelling effort, not just information on the system. This issue is difficult to resolve when the designers, suppliers and sustainers are corporate competitors.

As many acquisition projects contain information classified at the secret and higher levels, there needs to be significant consideration for how the information can be shared and what level of purging is required prior to a model being shared.

In the Australian Defence context, there are a variety of systems engineering tools that are used across different phases of the life cycle. This presents a challenge, particularly where tools are structured in a very different way. Moving to a standard modelling methodology and tool may significantly disadvantage companies as well as tool vendors.

The quality, completeness and currency of model information was discussed as a concern. If these aspects of the model cannot be trusted, there is a significant question over the benefit of actually handing them over the boundary.

In addition to the four major themes discussed above, this issue of dispute resolution was raised. There were concerns that if a resolution was required involving lawyers, they could not be expected to interpret the model.

Solutions

The group discussed potential solutions to overcome the hurdles discussed in the previous section. There was a general agreement that these solutions were possible but would require careful consideration before implementation. The discussion concentrated on four major themes, based on the hurdles discussed:

- overcoming IP concerns;
- overcoming security and classification concerns;
- standardisation of models; and
- ensuring value is obtained from the modelling effort.

The group discussed the IP concerns and specifically who should own the IP of the models. It was recommended that the functional models should be maintained by Defence and the physical models should be maintained by the suppliers. This would mean that IP would be maintained by the suppliers rather than delivered to defence. There would need to be firm contractual agreement that supports this.

There needs to be agreement regarding the level of classification that can be passed across contract boundaries. This intellectual discussion and decision would need to be led by Defence and supported by Industry.

It was agreed that Defence needs to specify a common framework that can be used. This would not mean a specified toolset, but at least a mandated architecture. Defence should provide a framework that shows the intent of the next 5 years so that Industry can prepare its teams to best support the new paradigm in information sharing across contractual boundaries.

The group discussed that aim of passing models across contract boundaries is to add value to the overall process and ultimately to Defence. It is recommended that KPIs are defined to quantify the added value. Additionally, it was discussed if this should be approached with a pilot implementation or broad implementation. There were concerns raised that a pilot may not be representative due to the potential differences in practise across Industry.

CONCLUSIONS AND WAY FORWARD

The workshop session was well attended by a variety of government, Industry and academia representatives, ranging from Chief Engineers to MBSE practitioners. The discussions during the workshop were open and frank, leading to a greater understanding of the potential for sharing of descriptive and analytical models across contractual boundaries and the hurdles that need to be overcome.

Key discussion points included: intellectual property issues; modelling tool compatibility issues; appropriate level of detail; reduction of duplicated effort; standardised modelling approaches; and the reuse of model components for different projects.

Although the workshop was biased towards Defence, a number of Transport sector people attended and contributed. Their participation and comments identified that the Transport sector has similar desires, hurdles and potential solutions to those proposed by attendees working in the Defence sector. There is therefore some potential for sharing lessons learnt and solutions between the sectors.

Overall there was good correlation between the Defence / Acquirer and Supplier / Sustainer groups when understanding the benefits of sharing descriptive and analytical models across the contractual boundary,

once contracts are in place. Both groups saw knowledge gain and reduced rework as being highly beneficial and a route to developing trust and reducing misunderstandings during system / equipment design, construction and testing.

As for the hurdles, there were some difference between the two groups including concerns regarding limiting the solution options and skills gaps (Defence) and IP management, product sales and investment costs (supplier). There were however a number of common hurdles that could therefore be addressed together which include: the need to transfer models between tools from different vendors; the need to determine how dispute resolution could be handled; and the correctness and completeness of models if elements cannot be passed across the boundary for security or commercial reasons.

From the workshops there are two solution areas that can be pursued in the near term by Defence and could be supported by the wider SE community, namely 1) a common modelling framework and 2) definition of KPIs and "golden rules" to help Projects determine if sharing the model across the boundary is beneficial.

To address the common modelling framework there are a number of starting points as many purpose specific frameworks already exist within Defence. The development of the framework should be led by the Engineering Centre of Excellence (CoE), supported by MBSE experts from Defence and Industry together with workshop / working group sessions at the SETE conference and ASEW each year to provide development roadmap and progress updates and get a wider perspective on and peer review of the developing framework. The INCOSE MBCD working group and MBSE Initiative may be sources of help as well.

Aligned to the framework is the ability to utilise different MBSE tools to view and work on the models. Improvements in this area will mainly be implemented by the tool vendors but Defence and Industry have the ability to influence this implementation either directly to the vendors via their user groups and conferences or indirectly through the INCOSE Tool Integration and Model Lifecycle Management Working Group and Object Management Group's Tool Output Integration Framework standards development activities.

The topic of the identification of KPIs and "golden rules" to support Projects and Industry in 1) determining the project benefit of creating and sharing the descriptive and analytical models, 2) measuring the model maturity and 3) monitoring the ongoing benefit of sharing the model may lend itself to a PhD topic that Defence's Engineering CoE could support / sponsor. The work could build on existing Return of Investment research tailoring it to the specific issue of model sharing in contracted conditions.

The biggest hurdle to overcome in order to make sharing models across the contractual boundary "business as normal" sits within Defence – namely encouraging the generation and sharing of models. There is always scepticism and reluctance to change centred on changing practices without having evidence to show the benefits. Whilst the benefits were obvious to those at the workshop who are advocates of Systems Engineering and model-based approaches, it is not so obvious to Project and Program Managers or the majority of uniformed staff in Defence. Therefore, stakeholder communication activities coupled to a meaningful pilot study is required. There are a number of Projects currently active in Defence (close to or just through Gate 2) where descriptive models exist and it is believed that the suppliers use model-based Engineering methods. If the right Project can be identified and agreements made internally and between Defence and the specific suppliers a suitable pilot study could be conducted. The authors accept that this may not be easy but believe the results will go a long way to determining how beneficial, or not, the sharing of models can be.

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BIOGRAPHIES

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