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TOGAF™ ADM/MDA®
Synergy Project

Integration Proof-of-Concept Results

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TOGAF™ ADM/MDA® Synergy Project:
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Executive Summary

This White Paper describes the use of two complementary standards that define and implement business integration processes and requirements. The synergy between these standards was leveraged to combine four separate stovepipes into a single integrated technology solution.

The Torpedo Enterprise Advanced Modeling and Simulation (TEAMS) initiative is a project that adopted The Open Group Architecture Framework (TOGAF) as its method and Model Driven Architecture (MDA) tools and specifications to standardize how models from the four development teams could be integrated into one or more simulation tools. The Object Management Group (OMG) leads the MDA effort to develop specifications necessary to support model-driven business process and software development. MDA offers the "what", where TOGAF offers the "how" for developing an enterprise architecture.

TOGAF's Architecture Development Method (ADM) explains how to derive an organization-specific enterprise architecture that addresses business requirements and ensures they are satisfied in the final product. However, ADM does not offer any specifications for the content of the architecture deliverables.

This White Paper discusses TEAMS' role in the TOGAF ADM/MDA Synergy Project, which is demonstrating the viability of using OMG specifications to describe Open Group standards. The Synergy Project first developed a formal process model, which laid the foundation for mapping ADM work products to elements of OMG specifications. TEAMS verified this mapping by formalizing an enterprise architecture, documenting business processes and requirements, and achieving a business-driven technology solution. The result demonstrates how the synergy of the TOGAF ADM/MDA technologies added value and enabled TEAMS to achieve their end product.

Keywords: TEAMS, TOGAF, ADM, OMG, MDA, integration, architecture, standards, proof-of-concept, modeling, simulation, UML, SysML, SPEM

The TEAMS Integration Problem

Several organizations have a long history of developing and continuing to evolve modeling and simulation tools for the Navy that are used to develop systems and evaluate system performance in a variety of business and technical scenarios. While these organizations developed comparable tools with similar components to satisfy their sponsors' modeling and simulation needs, there was very little communication between them as to what tools were available, and under which conditions they were best applicable. Additionally, several components with similar functionality but varying fidelity were developed in parallel, with no forethought for how to integrate a lower fidelity version with a higher fidelity representation if a sponsor were to desire more realism in a system simulation.

Sponsors realized the business model for funding modeling and simulation development needed to change. Funding dollars were not available to support multiple yet similar models developed by several organizations. Sponsors had the desire to leverage what was already developed under previous programs, but did not have a framework in place to easily encourage organizations to share information.

To address this, the Office of Naval Research established the Torpedo Enterprise Advanced Modeling and Simulation (TEAMS) program [TEAMS 2007] to open the lines of communication among the Navy's modeling and simulation community, and to standardize how models from multiple development teams could be integrated into one or more simulation tools. Two organizations – the Naval Undersea Warfare Center, Division Newport (NUWCDIVNPT) the Applied Research Laboratory of the Pennsylvania State University (ARL/PSU) – were tasked to establish an Undersea Warfare (USW) Modeling & Simulation Consortium. The Consortium would define and develop a cross-enterprise, collaborative undersea warfare modeling and simulation environment utilizing re-usable components that can be composed into highly integrated simulations. The simulation environment would be driven by an open systems architecture framework that would result in the sharing and leveraging of both legacy and new-development resources. It will support both the development of modeling and simulation tools and the application of these tools across the lifecycle of undersea weapons.

TEAMS and TOGAF

Because NUWCDIVNPT and ARL/PSU did not have experience in developing a collaborative working environment among multiple organizations, they investigated the existence of other consortia to possibly leverage lessons learned. Their search brought them to The Open Group [TOG 2007]. The Open Group established and maintains a leading international consortium for information technology, and also offers Consortia Services to enable others to establish their own. They also have extensive experience working with customers to capture, understand, and address current and emerging requirements, establish policies, and share best practices. They have worked with vendors, consortia, and standards bodies to develop consensus and facilitate interoperability, to evolve and integrate open specifications and open source technologies.

In the process of learning about consortium management, NUWCDIVNPT and ARL/PSU learned about The Open Group Architecture Framework (TOGAF) [TOGAF 2007], Architecture Development Methodology (ADM) [TOGAF ADM 2007]. They quickly realized this process was essential to achieving the architecture goals of the TEAMS program.
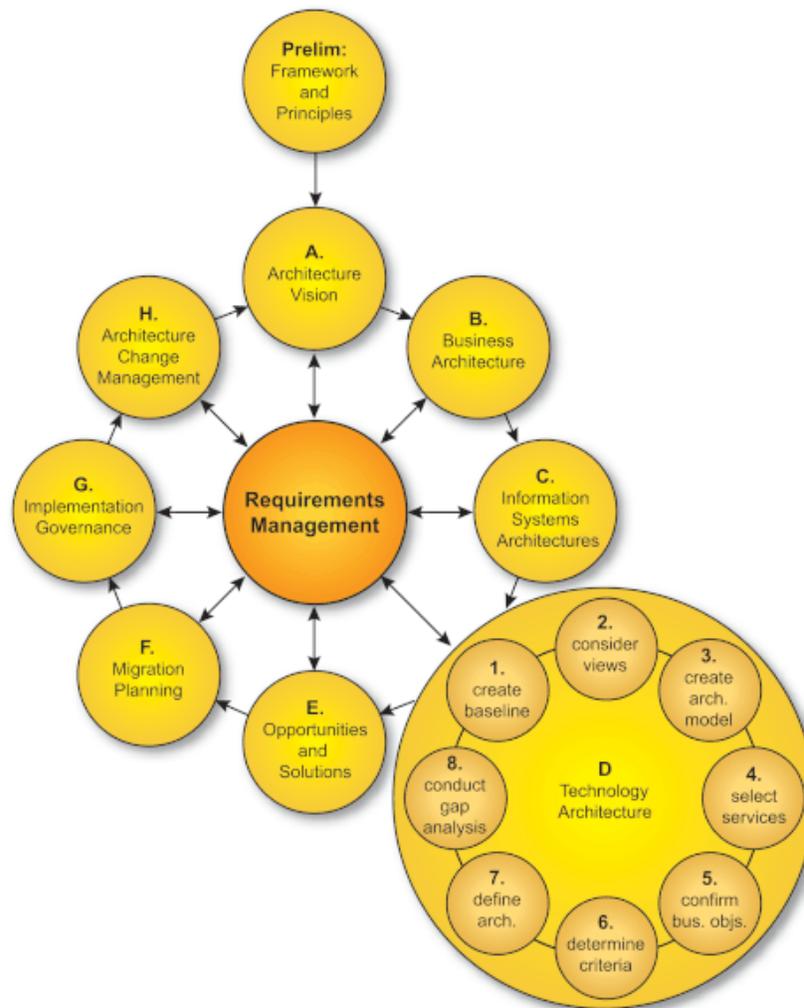
Figure 1: TOGAF 8.1 Architecture Development Methodology (ADM)

Figure 1 illustrates TOGAF 8.1 ADM. Details of how TEAMS used this process are provided in subsequent sections.

TEAMS and MDA

The TEAMS program used TOGAF ADM as a guideline for developing a conceptual model, taxonomy structure, and standard interfaces for models used by the torpedo modeling community. This provided the "how" which TEAMS needed to frame their problem and potential solutions. But they were still missing the "what" to provide the specific representation of the artifacts needed to represent the architecture. TEAMS was dealing in a situation where the concept of "separation of concerns" was immediately evident. There were several specific torpedoes (the fired platforms) that needed to be considered. However, the acoustic environment could be identical for each of the torpedo platforms. This led TEAMS to the Object Management Group (OMG) [OMG 2007] and the "separation of concerns" concepts inherent in Model Driven Architecture (MDA) [OMG MDA 2007]. TEAMS realized that MDA provided an ideal mechanism to map between conceptual models, platform-independent implementations, platform-specific interface implementations, and working code. Figure 2 shows the artifacts necessary to transform from computation-independent models to working code.
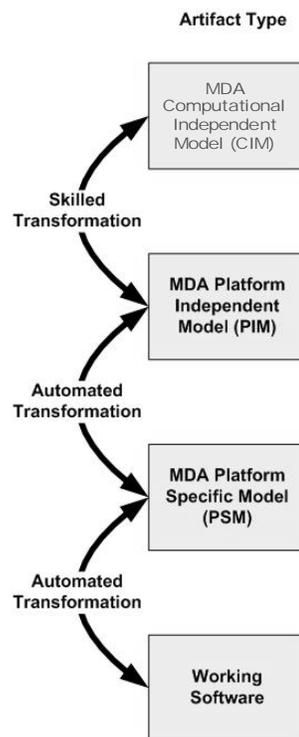
Figure 2: Model Driven Architecture (MDA) Artifacts

The OMG Unified Modeling Language (UML) [OMG UML 2007], Software Process Engineering Metamodel (SPEM) [OMG SPEM 2005], and System Modeling Language (SysML) [OMG SysML 2007] enabled TEAMS to capture detailed descriptions of static and dynamic class relationships, interface requirements, key data types, and components needed to create a standardized undersea weapon engagement simulation framework. This has facilitated TEAMS developing and integrating re-usable components of different acoustic models, torpedo models, and simulations.

At first, TEAMS' primary focus was to only represent their technology architecture using MDA. They used TOGAF to discuss business processes and strategic drivers, but never formally captured the information other than in text. After becoming involved in the TOGAF ADM/MDA Synergy Project, they quickly realized that several OMG specifications for business models would be invaluable for tracing business requirements through technology description to final software deployment.

TOGAF ADM/MDA Synergy Project Background

MDA is a model-based, standards-based, and tool-supported software engineering approach to developing, manipulating, storing, and sharing precise business, technology, services, and data models that can eventually result in working systems. Based on years of industry practice and research, MDA is an effort led by the OMG to develop the software specifications necessary to support model-driven business process and software development. In turn, vendors are developing tools based on these specifications that make this approach a reality. MDA offers the standards guiding tool development – the "what" – when developing enterprise architectures but does not address the methodology – the "how" – of developing such architectures. An MDA approach is independent of development methodologies as well as technology. This separation of business functionality from computing technology and methodology preserves a company's

core software assets in the constantly changing world of information technology. However, MDA, by design, offers little guidance to the practitioner as that is not its intended purpose.

TOGAF is a detailed method for developing an enterprise architecture. Adhering to the definition of framework, TOGAF provides "a taxonomy for relating the concepts that describe the real world to the concepts that describe an information system and its implementation." The TOGAF ADM explains how to derive an organization-specific enterprise architecture that addresses business requirements. The ADM provides a reliable, proven way of developing the architecture; architecture views which enable the architect to ensure that a complex set of requirements are adequately addressed; linkages to practical case studies; and guidelines on tools for architecture development. Hence, TOGAF ADM specifies the process – the "how". While classes of tools are discussed, ADM does not specify how tools are used to derive specific work products nor, more importantly, offers any specifications for the content of the architecture deliverables.

Recognizing that both of these industry technologies are complementary, a White Paper was published [TOGAF ADM & MDA 2004], to describe and promulgate the enormous synergy that exists within the industry if these concepts are used effectively together. The TOGAF ADM/MDA Synergy Project was then initiated, originally composed of members of OMG and The Open Group and later joined by the Integration Consortium (IC) [IC 2007].

The goals of this project are:

- To verify the viability of using OMG technology (standards and the tools that implement them) in conjunction with TOGAF ADM (methodology)

- To provide feedback to the OMG and The Open Group on gaps, inconsistencies, and errors in MDA standards and TOGAF ADM

- To enable architecture practitioners to see how TOGAF ADM and MDA can be used together to bring greater discipline and re-usability to the field of enterprise architecture

Project deliverables are designed to meet the goals stated above. These deliverables include:

- A recommended set of OMG standards and recommendations of tools implementing them

- Guidelines and descriptive business best practices offering examples of applying TOGAF methods and procedures to improved product/service quality from concept to implementation

- Identification and elaboration of the business value of the combined TOGAF ADM/MDA approach to enterprise architecture development

- Guidelines on how TOGAF practitioners can use the metamodels and profiles based on OMG specifications to represent their work products

The TOGAF ADM/MDA Synergy Project defined a workflow to meet its objectives and produce its deliverables in a straightforward manner, revolving around two central modeling activities:

1. Using OMG modeling standards to capture the TOGAF ADM

2. Validating a combined TOGAF ADM/MDA approach to enterprise architecture development through using these technologies in a proof of concept (an enterprise-level test case)

Complementing these technical activities is a business-focused activity striving to articulate the business value of this effort.

TOGAF ADM/MDA Modeling

The TOGAF ADM/MDA Synergy Project's Modeling Work Group has built a formal process model of TOGAF 8.1 ADM using SPEM Version 1.1 [OMG SPEM 2005], an OMG specification for capturing development methods and processes. By using a proven process metamodel (SPEM) to capture TOGAF ADM, The Open Group and its members gain additional benefits, as follows:

- Leverage industry standards and best practices on process modeling

- Provide a foundation for ongoing, managed evolution of TOGAF ADM method content

- Provide the basis for ADM process enactment and management with tools (that implement SPEM)

- Use standard-based XML Metadata Interchange (XMI) as formal data storage for TOGAF assets

- Ability to integrate ADM with other processes (OpenUP, CoBIT, ITIL, CMMI, PMBOK, etc.)

The SPEM process model is the foundation of many of the Synergy Project's fundamental objectives including:

- To map every ADM work product (identified in the SPEM process model) to one or many OMG specifications (and very precisely to specific elements within each specification)

- To demonstrate the viability of using OMG specifications (such as MDA, UML, SPEM, BMM, etc.) to describe Open Group standards (i.e., TOGAF and ADM)

- To identify errors, inconsistencies, and gaps in TOGAF 8.1 and opportunities for improvement in future versions of TOGAF

- To identify inconsistencies, gaps, and errors in OMG specifications and thereby offer improvements in future versions of the specifications

SPEM Model

The ADM SPEM model was built by three team members distributed across the globe using MagicDraw 9.5 from No Magic, Inc. [No Magic 2007]. Using MagicDraw's standard reporting capabilities, the team has published the activity diagrams and class diagrams (SPEM activities are modeled as UML activities and SPEM concepts are modeled using UML Class Diagrams) that compromise the visual aspect of the process model. MagicDraw was also used to create an XMI 1.1 export of the SPEM 1.1 model.

The foundation of the ADM SPEM model was started by identifying all ADM work products that are represented as inputs and outputs for each phase. These were captured as classes in the SPEM model. Then the behavioral model was built using UML activity diagrams. The ADM SPEM model has detailed activity diagrams for each phase showing the corresponding steps.

TOGAF Work Products from SPEM mapped to OMG Specifications

While all three of the TOGAF ADM/MDA Synergy Project's objectives are critical to all participating standards organizations, the second one is perhaps the most immediately relevant to each organization's practitioner membership. People applying TOGAF on enterprise architecture projects in the real world want to know:

- Is there an industry standard specification for the work product I'm trying to produce?

- If so, which specification and which piece of the specification?

- Which tools implement the specification (so I know where to put the work product and in what form)?

- If this work product changes, what ADM activities might we need to revisit (because the work product is used as an input to other activities)?

- What is the relationship between this work product and other ADM work products?

An additional benefit of the mapping is the opportunity to identify gaps and redundancies in the MDA family of OMG specifications and suggest areas for future improvement. However, a complete mapping was still necessary before any of the above questions could be answered. The Synergy Project needed a case study to verify that a mapping and representation of artifacts grounded in standards would be useful to the community of interest.

TOGAF ADM/MDA Proof-of-Concept

Because TEAMS was already using the TOGAF process to develop a technology architecture, and invoked MDA principles when capturing technology work products in both UML and SysML, they were selected as the first proof-of-concept candidate for validating the synergy between TOGAF and MDA.

TEAMS first needed to revisit the earlier phases of TOGAF 8.1. They started their technology development effort using TOGAF 7, which addressed business requirements, but not from an enterprise architecture view. To remedy this, they held a workshop to verify that they had all of the necessary information available to populate TOGAF 8.1 Phase A and B work products.

They next worked with Open Group and OMG Synergy Project members to complete a one-to-one mapping of TOGAF work products and subcomponents of work products to individual elements of OMG specifications. They leveraged the expertise of the SPEM model developers, as well as the knowledge of OMG personnel who developed and adopted standard specifications to complete a mapping of TEAMS-specific ADM work products to OMG modeling standards. A snippet of the mapping results is shown in Table 1. TEAMS TOGAF work products, and how they are represented in OMG standard specifications, are described in the following sections.

TOGAF Process and TEAMS Work Products

TEAMS is using TOGAF 8.1 ADM as a guideline for mapping business requirements that will drive development and implementation of a technology architecture. Each phase of the ADM has a set of input and output work products. Outputs of previous phases serve as inputs to the next. For example, Phase A outputs include a vision statement, architecture principles, scope and constraints, baseline versions of business and technology architectures, and version 1 of targeted business and technology architectures, which will be refined throughout subsequent ADM phases.

TEAMS' architecture vision is:

"To develop a common technical architecture for torpedo modeling and simulation, including methodologies, tools, standards, and building blocks to build interoperable components, compose simulations quickly at reduced cost, and to support concept assessment, software development, test and evaluation of systems, training, and tactics development."

The scope of the TEAMS technology architecture for a torpedo simulation is limited to "launch-to-hit". TEAMS' architecture principles include allowing modelers to develop code in their choice of computer

language, allowing model implementers to have a choice of platform-specific implementation options, and ensuring standard interface specifications that TEAMS defines for model components are platform and language-independent.

TOGAF ADM Phase B outputs for business architecture include business requirements, views and viewpoints addressing key stakeholder concerns, technical requirements that drive technology architecture work, and a more detailed description of a target business architecture. Subcomponents of a target business architecture include organization structure, business goals, objectives, functions, services, processes, and roles.

TEAMS' stakeholders include:

- The US Navy fleet, which use the actual torpedoes that are being simulated. They realize that simulation is a valuable tool used to evaluate technology that can transition into their actual weapons sooner.

- Sponsors, who must fund organizations with simulation capability to develop and evaluate technology in the most cost-effective way.

- Developers of simulation tools and component model developers must play a major role in developing a standardized technology architecture since their tools and models must comply with the standards.

TEAMS' organization structure includes a list of all simulation tools and component tools currently in use by the Navy to evaluate torpedo performance in a launch-to-hit context. They include the Weapons Analysis Facility hardware-in-the-loop simulator at NUWCDIVNPT, the Technology Requirements Model digital launch-to-hit simulation at ARL/PSU, the Sonar Simulation Toolset at the Applied Physics Lab of the University of Washington (APL/UW), and Cassandra, a simulation engine used to validate threat torpedo implementations, also at NUWCDIVNPT.

TEAMS' business goals include demonstrating component interoperability (April 2007), and establishing a governance and change management policy for the simulation framework and interface requirements (2008). The end result is to deliver a complete standardized torpedo modeling and simulation framework (2009).

TEAMS' objectives include interoperable simulation components, documented standards, and interface requirements. Paramount is realizing a cost-effective process for achieving interoperability and composability among the Navy's modeling and simulation tools.

Business processes and services for simulation include supporting a torpedo's ability to be launched, search for, and acquire a potential target, home on the correct target, and eventually kill. This must be provided in a realistic acoustic environment for this simulated engagement to take place.

TOGAF Phase C (Information Systems Architecture) is subdivided into two areas: data architecture and applications architecture. Output work products for a target data architecture include a business data model, logical data model, data interoperability requirements, and different views and viewpoints such as data dissemination, data lifecycle, data security, and data model management. Outputs for a target applications architecture include a place systems model, process systems model, time systems model, and application interoperability requirements, as well as views and viewpoints for applications services, interoperability, and information flow.

TEAMS' business data model for a simulation is a data model of the game board; i.e., the "world" in which a simulation engagement unfolds. It must support the business process of launch, acquire, home, and kill in a realistic acoustic environment. TEAMS represented this as a conceptual data model using a UML class diagram.

TEAMS' logical data model is the component description of a torpedo, and how it interacts with a simulated environment. TEAMS captured this using a SysML block definition diagram for a torpedo system model, shown in Figure 3. TEAMS' data interoperability requirements were captured in a SysML requirements block diagram, which is shown in Figure 4.

TEAMS used UML and SysML activity diagrams to represent the process and time systems models for its target applications architecture. Their activity diagram for a simulation loop represents who is playing on the game board, and who controls the time step for all players in the simulated engagement. TEAMS represented the actual game board, the place systems model, by a SysML internal block diagram for multiple platforms.

Two views and viewpoints of an applications architecture for a torpedo system – applications services and interoperability views – can be represented by either a SysML Internal Block Diagram (IBD) or UML component diagram. Figure 5 shows TEAMS' interoperability view for a torpedo using a SysML IBD. The "balls and sockets" indicate whether components "provide" information (ball) or "receive" information (socket). These serve as initial interface definitions of standard wrappers for re-usable software components. They are structured so that a high-level component can be treated as a black box to a developer, but also can be drilled into to extract subcomponents as required. In the TEAMS example, the "black box" is a torpedo model, but subcomponents for a torpedo controller and sonar can also be extracted. The data structures for clustered reports and tracks (trajectories) are represented as "balls" and "sockets" in these subcomponents.

Finally, TOGAF Phase D outputs for a technology architecture include architecture principles, requirements traceability, views for computing and hardware, standards to be used, processing constraints, cost constraints, and a gap analysis report. TEAMS' technology architecture is the full systems engineering model of a torpedo system, as well as the simulated environment a torpedo model must interact with to satisfy the business requirements for launch-to-hit engagements.

TEAMS Work Products in OMG Specifications

The above section discussed how TEAMS captured a great deal of information in TOGAF ADM artifacts that enabled TEAMS to trace business requirements directly to technology architecture development and implementation. While work products for TOGAF Phases C and D were represented in OMG standard specifications of UML and SysML, most of the original business artifacts for TEAMS were captured in text or pictures. This section shows examples of OMG specifications representing TEAMS work products for TOGAF Phase A work products for the architecture vision and Phase B work products for the business architecture.

Work products from Phase A focus on business principles, goals, and strategic drivers of the TEAMS program. Figure 6 is a UML object diagram that shows one TEAMS business goal: interoperable simulation components as an instance of the business goal work product and its traceability relationships to other instances of work products. A TEAMS business driver is the need to re-use diverse legacy simulation content. A business strategy to achieve this goal is to migrate to open standards. This leads to a TEAMS business principle: must use open standards. The business goal of achieving interoperable simulation components also fosters business processes. The TEAMS program must perform systems engineering to achieve the business goal, and must implement architecture governance to ensure components generated in the systems engineering process conform to TEAMS open standards for interoperability. As a further example, the business process of simulation must support a torpedo's ability to be launched, search for, and acquire a potential target, home on the correct target, and eventually kill, within a realistic acoustic environment. These and the remaining business process, procurement, become the basis of the target business architecture from TOGAF Phase A.

TOGAF ADM Phase B outputs for business architecture include business requirements, views and viewpoints addressing key stakeholder concerns, technical requirements that drive technology architecture work, and a more detailed description of a target business architecture. Subcomponents of a target business architecture include organization structure, business goals, objectives, functions, services, processes, and roles, all of which map directly to elements of OMG's Business Motivation Model (BMM) [OMG BMM 2006].

The simulation business process can be further expanded to allow new acoustic models or new torpedo components to be integrated into the existing simulation framework in a standard way. Figure 7 is a detailed representation of the integrate simulation models business process shown as a UML activity diagram. An external project technical lead requests a non-compliant model to be integrated into a TEAMS-compliant simulation. He provides this component to TEAMS, who provide the baseline reference model for this type of component. TEAMS then extracts the Platform-Independent Model (PIM) and Platform-Specific Model (PSM) descriptions for this component. The external project technical lead develops working code to adhere to the TEAMS PIM and PSM, performing gap analysis and modifying the PIM and PSM if necessary. TEAMS then receives the new TEAMS component to include into an updated version of the baseline reference model. A simulation developer also receives the modified component to integrate into a simulation tool according to the standard interface definitions that TEAMS provided.

Business Driven Integration – TEAMS Integrated Solution

The ability to integrate simulation models – the business process described above – is exactly what TEAMS was tasked to demonstrate to the torpedo modeling and simulation community. Three models and data sets, developed using non-standard formats by three independent development teams, needed to be integrated into a fourth organization's simulation to evaluate the effect that a shallow water environment of interest would have on torpedo performance. Models included an ocean environmental data set from the Naval Oceanographic Office, an upgraded model for ocean bottom reflection loss developed at APL/UW, and a propagation algorithm developed by the Naval Research Laboratory. These three entities are currently being integrated into ARL/PSU's simulation tool. In addition, NUWCDIVNPT developed a generic torpedo model from the TEAMS system definitions captured in SysML and UML. TEAMS will also demonstrate that this generic torpedo, based on standard data and application interface definitions, can quickly be incorporated into a simulation tool to assess an ocean environment's impact on performance.

Multiple stakeholders from the above organizations worked with the TEAMS program to ensure that their components and simulations adhered to the TEAMS interface definitions. Sponsor requirements dictated that these components were to be re-used, reducing duplicate efforts, and that component integration time was to be reduced. Simulation developers also required less component integration time, but needed to continue using legacy systems. Interface hooks were defined to comply with the TEAMS business data model definitions – the "world" in which torpedo engagements would take place. Model developer requirements include having the ability to write components with standard interfaces, but they also expect matching interface hooks within the simulation tools to support this. These requirements are all supported by the architecture vision statement from TOGAF Phase A.

TEAMS' architecture principles include allowing modelers to develop code in their choice of computer language, allowing model implementers to have a choice of platform-specific implementation options, and ensuring standard interface specifications that TEAMS defines for model components are platform and language-independent. For the TEAMS integration task, the environmental data is being delivered through web services, in a compatible format that the simulation tool expects. This format was developed using the interoperability view from TOGAF Phase C's data and applications architecture. The ocean bottom

component was fitted with a CORBA [OMG CORBA 2007] wrapper based on TEAMS' standard Application Program Interface (API), and the simulation was fitted with a compatible CORBA socket, so that a component written in the C language could interface directly to a FORTRAN simulation engine *without rewriting the component or the simulation*. In both of these cases, platform and language-independent interface definitions were invoked to develop two different platform and language-specific implementations within the same simulation tool, all based on the TEAMS technology architecture. The propagation model and generic torpedo are still being integrated into the simulation tool at the time of writing.

Proof-of-Concept: Value Added

Going through the exercise of mapping TOGAF ADM work products to elements of OMG specifications was invaluable to TEAMS. The project team gained insight into their requirements, which they were able to formally capture and articulate to stakeholders with multiple views. They also could provide complete requirements traceability from their architecture vision, business processes, and data and applications architectures down to the technology architecture that was developed to demonstrate component interoperability for the torpedo modeling and simulation community.

Performing the mapping also provided valuable feedback to OMG regarding the need for specification support in defining new UML diagram types and in identifying gaps in OMG modeling standards.

By using TOGAF ADM to capture architecture vision, principles, and requirements, and using OMG specifications to formalize TOGAF's business processes, data, and applications architecture work products, TEAMS produced a roadmap for developing a modeling and simulation technology architecture. As a result, TEAMS can leave behind a business model for future cross-organization modeling and simulation funded efforts outside of the torpedo community whose objective is to achieve interoperability within their modeling and simulation domain area.

Appendix A

ADM Work Product	OMG Specification(s)	Specification Element(s)	Comments
Architecture Principles	BMM, SysML		
Architecture Contract	BMM		
Architecture Principles	BMM	BMM::Business Policy	
Architecture Vision	See Business Scenario	BMM::Vision	What is the strategy from which this is derived (and goals and objectives)? Perhaps the business strategy?
Business Architecture	UML, BPMN, BPDM, OSM, SBVR, BMM, IPTMF	BMM::Business Process	Business architecture is a composite work product that contains many elements that need to be identified and individually mapped to different metaclasses.
— Organization Structure	BMM	BMM::Organization Unit UML::Package <<organization unit>>	
— Business Functions	UML	UML::Activity	
— Business Services	BMM, UML	UML::Use Case <<business use case>> BMM::Business Process	
— Business Processes	BMM, UML	UML::Collaboration <<workflow realization>>	
— Business Roles	UML	UML::Actor <<business actor>> UML::Class <<business worker>>	
— Correlation of organization and functions	UML	UML::Association	
Business Drivers	BMM	BMM::Assessment	
Business Goals	BMM	BMM::Business Goal	
Business Principles	BMM	BMM::Business Policy	
Business Requirements	BMM, SysML	SysML::Requirement	
Business Strategy	BMM	BMM::Strategy	
Enterprise Continuum	RAS and everything else	RAS::Asset	Asset can be comprised of any number of artifacts (and subsequently point to any other OMG specification); does not have to be a "software" asset.

ADM Work Product	OMG Specification(s)	Specification Element(s)	Comments
Framework Definition	BMM, SPEM	SPEM::Process BMM::Business Process	Organization-specific tailored process framework; identified as one or many BMM::Business Processes and described using SPEM2 (process content [such as TOGAF] integrated with other process content [such as ITIL, CoBIT, etc.] and tailored using SPEM2).
Statement of Architecture Work	BMM, SPEM	ITPMF::Agreement	Document
TOGAF ADM	SPEM		

Table 1: Partial Mapping of TOGAF ADM Work Products to MDA Specifications
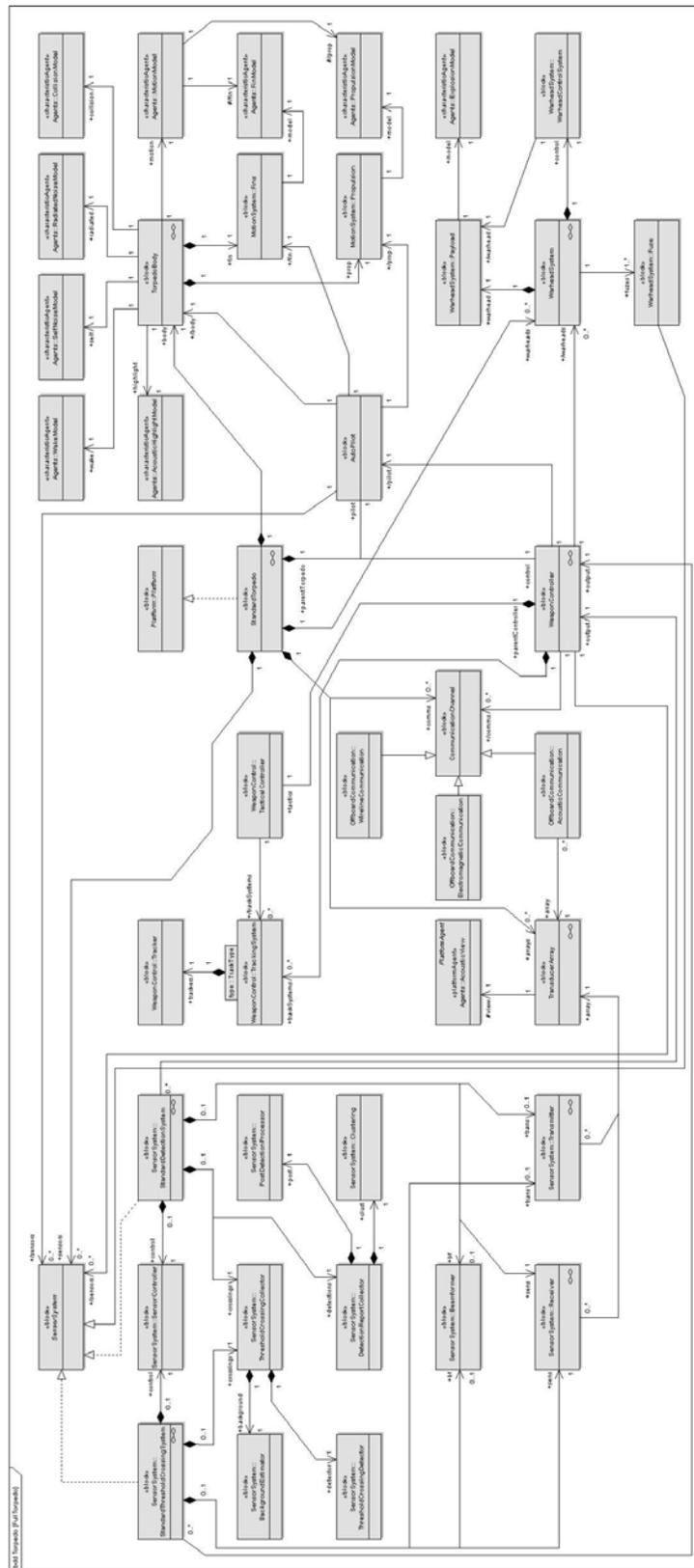
Figure 3: TEAMS Logical Data Model: SysML Block Definition Diagram for Torpedo System

TOGAF™ ADM/MDA® Synergy Project
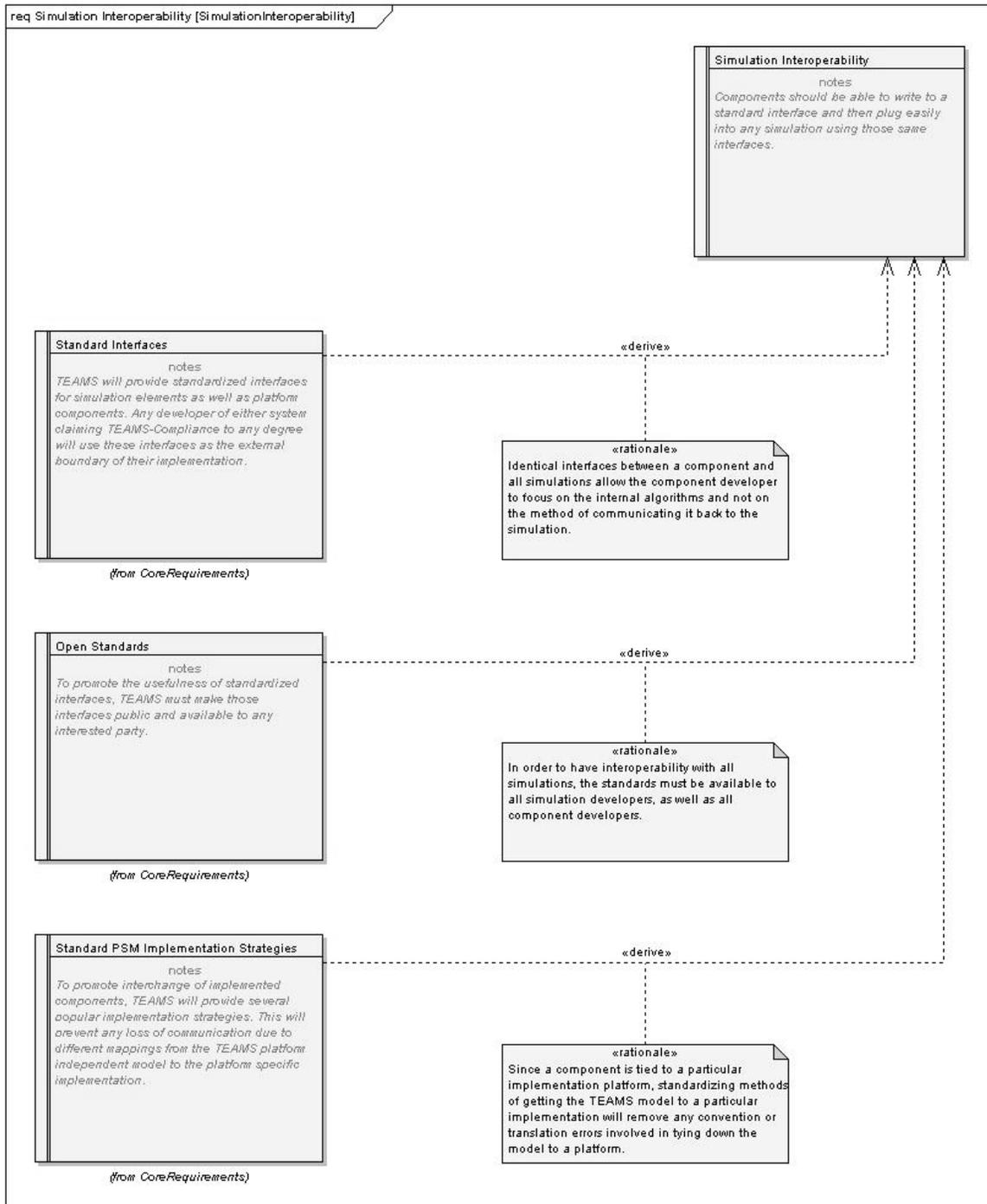
Figure 4: TEAMS Data Interoperability Requirements: SysML Requirements Block Diagram
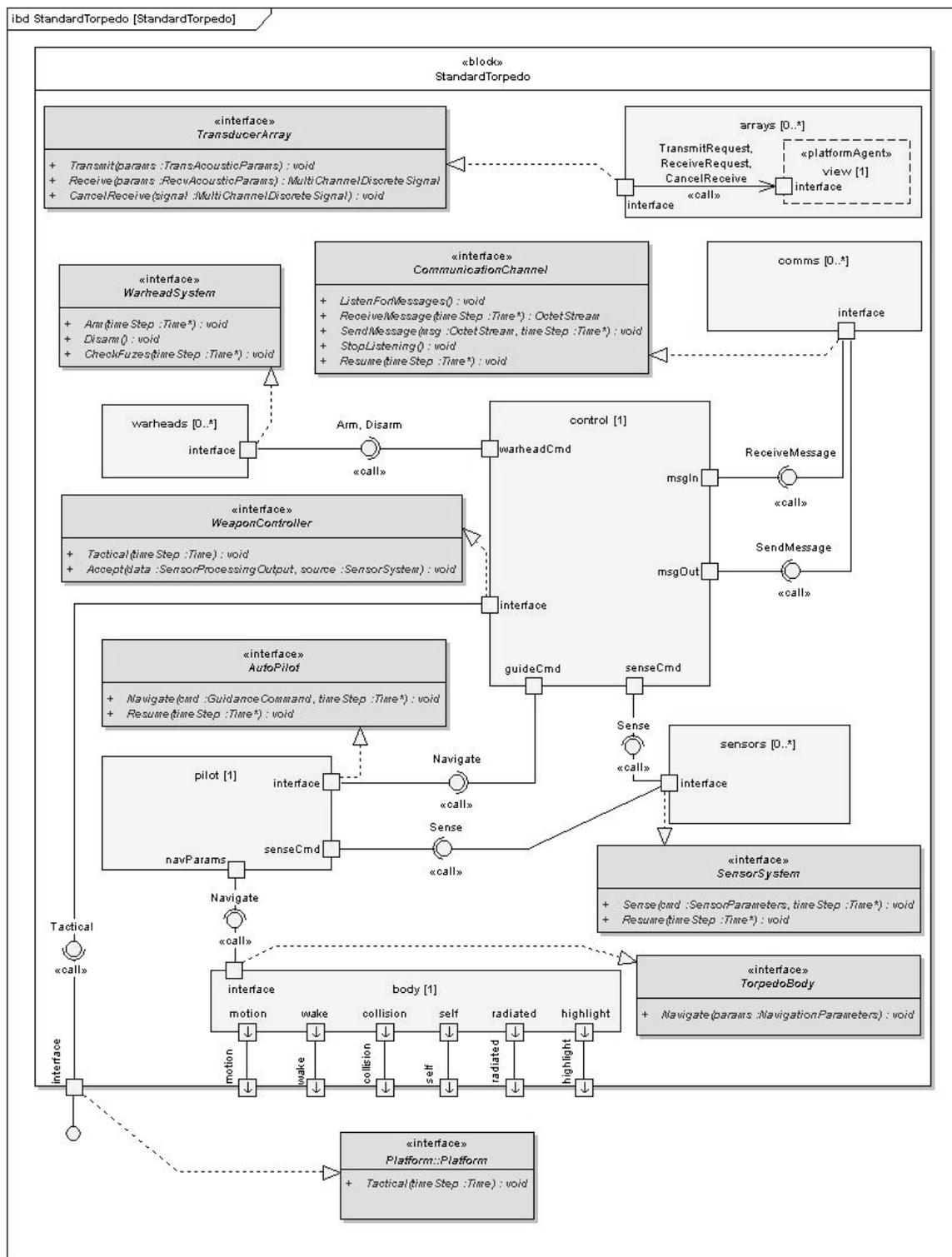
Figure 5: TEAMS Interoperability View: SysML Internal Block Diagram of a Torpedo System
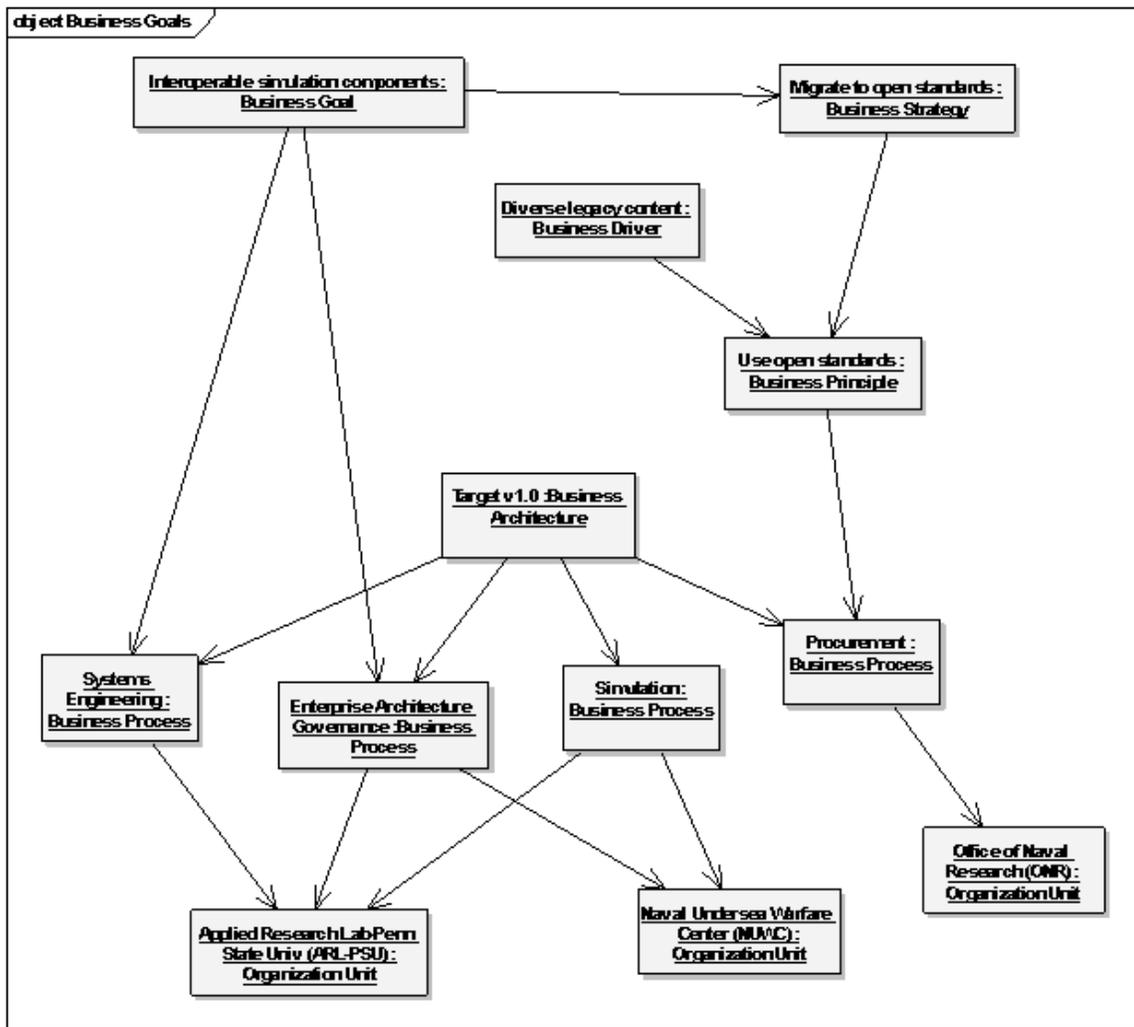
Figure 6: TOGAF Phase A: TEAMS Business Goals, Principles, Strategic Drivers, and Processes
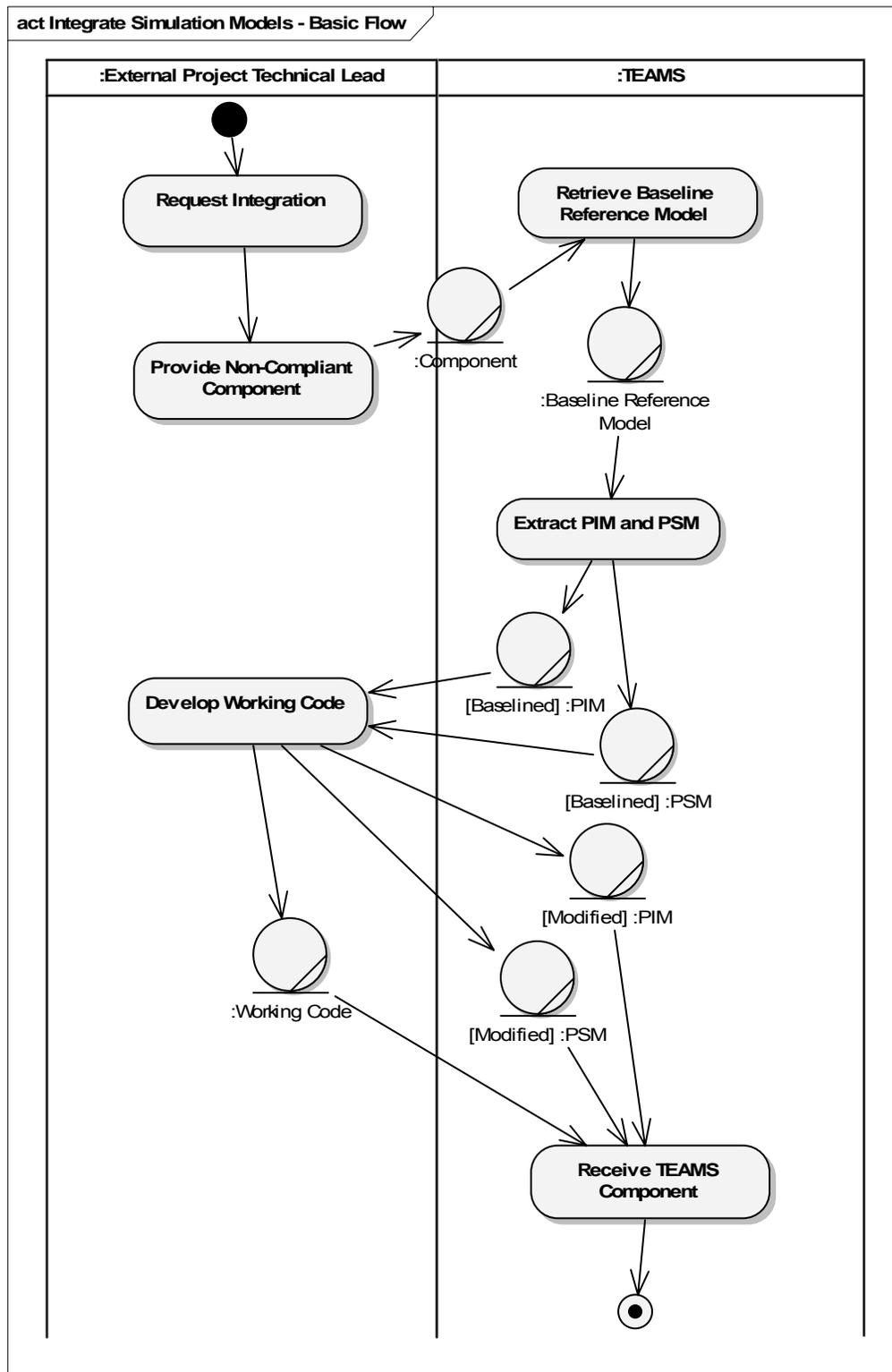
Figure 7: Phase B: Activity Diagram for TEAMS Integrate Simulation Models Business Process

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[TOGAF ADM 2007]	TOGAF Architecture Development Methodology (ADM); see www.opengroup.org/public/arch/p2/p2_intro.htm
[OMG 2007]	Object Management Group (OMG); see www.omg.org
[OMG MDA 2007]	OMG Model Driven Architecture (MDA); see www.omg.org/mda
[OMG UML 2007]	OMG Unified Modeling Language (UML); see www.uml.org
[OMG SysML 2007]	OMG System Modeling Language (SysML); see www.omgsysml.org
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Acknowledgements

About The Open Group

The Open Group is a vendor-neutral and technology-neutral consortium, whose vision of Boundaryless Information Flow™ will enable access to integrated information within and between enterprises based on open standards and global interoperability. The Open Group works with customers, suppliers, consortia, and other standards bodies. Its role is to capture, understand, and address current and emerging requirements, establish policies, and share best practices; to facilitate interoperability, develop consensus, and evolve and integrate specifications and Open Source technologies; to offer a comprehensive set of services to enhance the operational efficiency of consortia; and to operate the industry's premier certification service, including UNIX® system certification. Further information on The Open Group can be found at www.opengroup.org.