B2B Integration based on SOA using Web Service

Wiranto Herry Utomo
Faculty of Information Technology
Satya Wacana Christian University
Jl. Diponegoro 52-60

ABSTRACT
The purpose of this research are 1) build a new method of SOA-based integration by combining SOAD and MDA, 2) validate the new method by testing the applicability of the SOA-based integration (eShop applications) using Web Service, Enterprise Service Bus, and Business Process Execution Language.

The results of this research are a new method of SOA-based integration that results of MDA, SOAD and OOAD combined. This new method has been successfully used to perform analysis, design and implement of SOA-based integration with results 6 business process, 18 Web Services, and 6 composite applications.

Keywords
SOA, Web Services, BPEL, Enterprise Service Bus, MDA.

1. INTRODUCTION
Business system usually develops in a different speed from information system. Gradually, it creates problem in the synchronization of business and information system. It will lead to the application of information system that does not fully support business tasks. Sometimes there is a department in a company that is not linked to the main business process and does not support business needs. As a result, the organization becomes less flexible as it is difficult to adapt to market changes. Only companies, which applications are quickly and efficiently adapted to meet the changes of business needs will be still competitive in the global market.

The unconformity between business and information system commonly takes place in almost every company or organization. The effort to synchronize this unconformity usually does not bring much impact, mainly because of two things: 1) the complexity of Information Technology architecture which origin is from heterogeneous application, constructed from different architectures and programming languages as well as different platform 2) the existing application must still be operating while being improved.

According to Juric et al [2], SOA is not a sudden, new architecture but it is a result of the evolution of integration mode and distributed architecture. Before SOA, an inter-application integration method referred as EAI (Enterprise Application Integration) has been developed. At first, EAI focused on the application integration in a company (intra-EAI). In line with the development of the need of integration inter-companies (B2B, business-to-business), EAI focus is widened into inter-EAI.

Intra-EAI integration means to integrate applications in the company by creating services as functionality of existing applications. B2B integration or inter-EAI is related to message exchange outside company services.

SOA definitions vary, there is no general definition for SOA. In this research, SOA concepts will be reviewed based on the concept of SOA Delivery (SOAD) according to Erl [5]. SOAD according to Erl [5] is software architecture developed using service oriented principles design. This service oriented design means that system functionality is broken down into smaller logical unit referred to as services.

Even though it gives obvious contribution, SOAD has not been sufficient to carry out service based integration. There are some problems related to integration implementation in SOAD , which are 1) no language support for modeling, 2) no guideline of the implementation of the services attained from services identification, and 3) services orchestration use only web services.

Therefore, SOAD in itself has not been optimum to do the integration. That is why other methods that can deal with SOAD weaknesses are needed. Based on the review and comparison of some integration methods, a method to help dealing with SOAD weaknesses, MDA (Model-driven Architecture) proposed by OMG is chosen. The decision to integrate MDA and SOAD is based on: 1) MDA is a model-driven method based on the use of free platform technology model, 2) this method can be used to transform high level model business process to low level one (code), 3) the presence of standard modeling language.

With the combined of MDA and SOAD will give benefit that complete each other, which is, SOA provides infrastructure that reduce complexity in reusing service and integrate all kinds of technology, protocol and application, whereas MDA used in transforming high Business Process Model to low level model (programming code) that is platform free.

2. RESEARCH PURPOSE
The purposes of the research are to:

1. Identify SOA based integration method by combining SOAD and MDA methods;
2. Validate the method identified through applicability testing by carrying out SOA based integration using Web Services, ESB, and BPEL.

The significances of the research are:

1. The finding can be used to synchronize company business process and company information system. Company will be more flexible in adapting to its business environment. This flexibility takes place because the services, both services of the existing applications and new services, are easily developed and because new process can be developed from

services. Model layering will ease the synchronization between information system and business process or company strategy. With the fast changing business process, this layering process enables a fast process or services reconfiguration without interfering on going operational activity.

2. The finding of methodology aspect for SOA based integration can be used to integrate Business to Business (B2B), Business to Government (B2G) and Government to Government (G2G). It can also be constructed as a base to construct industrial network that integrate small businesses, big companies and government.
3. It can be used as an effort to develop knowledge and technology especially in the field of open source based information technology. This research contributes mainly to distributed computation technology with main focus in SOA based integration that includes some latest technology such as Web Services, BPEL, and ESB.

3. RESEARCH CONTRIBUTION

The research proposes the integration method of SOAD and MDA. The combination of these two methods is based on the thinking that each method in itself will not be optimum in integrating services. SOAD itself can only provide services analysis and identification which are mapped to User Interface Service Layer, but it does not provide guideline to implement services found. MDA method possess superiority in the transformation of high level Business Process Model to low level model (code) which is platform free but without guideline in term of finding services.

Therefore, the main contribution of this research is that the integration method will open the opportunity to bring service definition to a higher level of abstraction, which is platform free, in the form of a model in the higher level that can be transformed to services implementation. In this way, SOA can be made separately from lower level platform, infrastructure and implementations, that it will finally improve integration. This integration approach will enable the reuse and improvement of integration in a different model level.

In addition, the contribution of this research is to translate high level business process to programming code, with the following steps: 1) define high business process level that is platform free, 2) decompose this business process into services, 3) transform the free platform services into particular platform (Java EE). Without the support of this method, the translational of abstract business needs into programming code in supporting IT development will be intuitive.

4. RELATED WORK

Huang and Fan [4] proposed model driven methodology and service oriented enterprise integration methodology of model driven and service oriented enterprise integration. The methodology uses MDA as the methodology of system development to achieve integration at model level including all the enterprise systems' life-cycle models. It also uses SOA for the implementation of model and for the construction of integration platform.

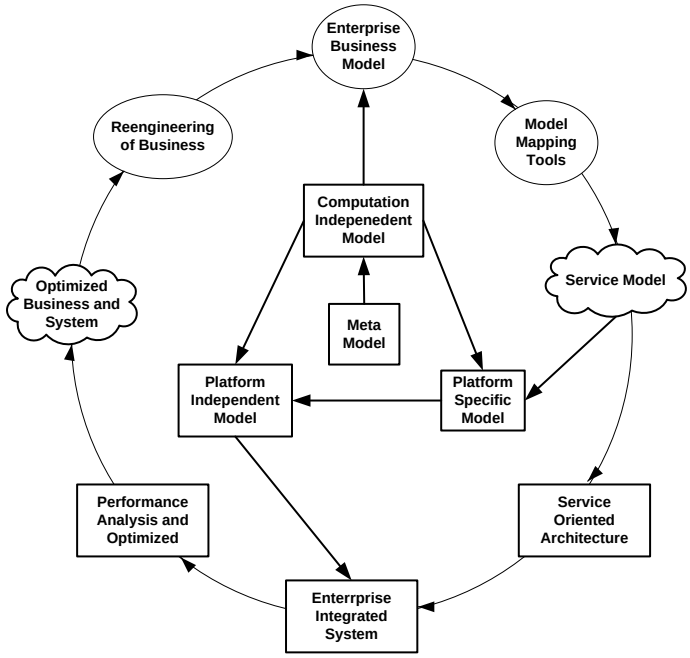

Figure 1. Methodology of model driven and service oriented enterprise integration [4]

Figure 1 shows the methodology of model driven and service oriented enterprise integration. As required by business integration, the enterprise integration model can be constructed based on integration meta-model. The enterprise integration model is a Computational Independent Model (CIM) that describes the business requirements of integration including integration roles, processes, information and services, etc.

In this paper, Huang and Fan [4] proposed the technological framework that can realize the integration both in model and service levels to support the implementation of the methodology presented. Figure 2 shows the framework of SOA and MDA based enterprise integration. The framework consists of three levels: Meta model level, modeling level, and service level.

In meta model level, the meta model of enterprise integration is aimed at describing fundamental construction for computation independent modeling language that can be used to model the integration from business perspective [4].

The modeling level comprises three main models: enterprie integration model (CIM), service model (PIM), implementation model (PSM) [4].

The service level includes service bus and service infrastructure. The service bus provides the necessary communication infrastructure required to deploy a distributed system. Service infrastructure enables integration between services through the composition, mediation, matchmaking and transformation of services [4].

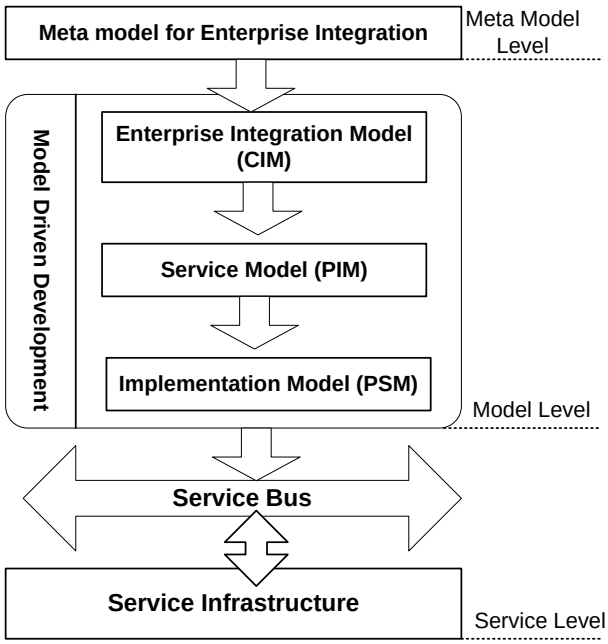

Figure 2. Architecture of SOA and MDA based enterprise integration platform [4]

5. SOAD AND MDA METHODS

This integration method provides series of concepts needed to model the two perspectives. The whole concepts can be seen in Figure 1, which is the representation of the two methods, SOAD and MDA. Concepts related to business perspective explain the embedded elements in business and are represented by CIM Model through Business Process Model. Concepts related to system perspective are elements used to describe functionality and system processing, and are represented in PIM and PSM Model, by Use Case Model, Service Model, Service Process Model, Component Model, Interface Web Service Model, Process Execution Model and Composite Application Model..
The paper aims at developing a methodology for model driven architecture and service oriented architecture. It combines SOA Delivery method of Erl [5], MDA [3], [6], [12] and Object Oriented Analysis and Design (OOAD) method [16].

SOA is a software architecture designed based on service oriented design principles [5][17][7][11][15][9], whereas service orientation is a concept in software engineering that represents different approaches to separate interest.

While services manifest business functionality in the service-based computing model, a Service-Oriented Architecture (SOA) provides a framework for an infrastructure to facilitate the interactions and communications between services. SOAs can be thought of as both an architecture and a programming model, more a way of thinking about building software than a software development technique[10].

According to Erl [5], in general, software that does not use SOA can be divided into two main layers, Application Layer where application runs and Business Process Layer that describes how business process in a company runs. Organization business process will be defined in application along with technical program code. In SOA implementation, service oriented process is implemented in a layer between Business Process and Application Layer where both are parts of logic enterprise. The layer is called Service Interface Layer

Model-Driven Architecture (MDA) is proposed by the Object Management Group (OMG) as a reference to achieve wide integration of enterprise models and software applications. MDA is a best choice to address how SOA should be designed, developed and integrated. MDA provides specifications for an open architecture appropriate for the integration of systems at different levels of abstraction and through the entire information systems' life-cycle [3][6][7].

The MDA comprises three main layers: Computation-Independent Model (CIM), Platform-Independent Model (PIM), Platform Specific Model (PSM) . MDA lies in separating the enterprise model from the technology infrastructure, making a clear division between the business functions and the implementation details. [14]

CIM is referred as business domain model that explains the knowledge of business domain, which is free from business process or particular software used **[1]**[18][8][13].

PIM can be seen as the specification of free technology system functionality that will be used to implement the functionality.

PSM explains how particular technology can be used to implement the function described in PIM. PSM is adapted with the system in term of implementation construction provided by a particular implementation technology. PSM possesses components for target platform. PIM can be transformed into one or more PSM. Particular platform is produced for every particular technology platform **[1]**[18][8][13].

The main features of the proposed methodology are:

- It uses SOA for the implementation of model and for the construction of integration platform. It defines a service-oriented approach for the development of ISs in providing guidelines for building ISs based exclusively on services, using them as first-class objects for the whole process of the IS development. This approach facilitates the development of service-oriented applications as well as their implementation using current technologies, such as Web services, BPEL and ESB.
- It uses MDA as the methodology of system development to achieve integration at model level including all the enterprise systems' life-cycle models.
- It is an OOAD-based approach. The steps of OOAD method are [16]: Requirement Engineering, Design Engineering, Implementation, Testing and Mantainance. Requirements Engineering is a technique employed to create the requirements model that illustrates the requirements of the system. The purpose of defining the requirements are: 1) To define a basic agreement between customers, stakeholders and developers on what the system should do, 2) To help system developers in understanding system requirements, 3) To define the scope and boundaries of the system, 4) To help with the planning of technical contents of each iteration of software development, 5) To help in estimating cost and effort in developing the software system, 6) To present the user-interface of the system while focusing on the needs and goals of the users. Design Engineering focuses on the creation of a representation or model that are concentrated on architecture

of software, data structures, interfaces and components necessary to implement the software. It involves a process of iterative refinement from a higher level of abstraction to lower level of abstraction.

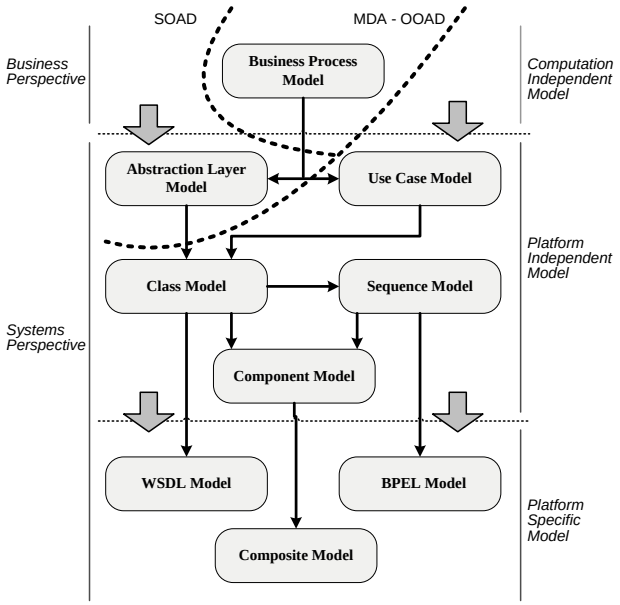

Figure 3. The new method of the result of combining of MDA, SOAD, and OOAD method

Figure 3 shows the methodology of the combined MDA, SOAD, and OOAD. Based on the business process model of the CIM Model, the PIM model can be constructed based on this Business Process Model. In terms of the concepts of services in SOA, the computational independent integration (CIM) model can be transformed to a platform independent model (PIM that can be realized and supported by computer systems (PSM).

The PSM platform can be implemented using many technologies, such as Java EE or.NET. In this research, we use Java EE to implement the PSM platform

6. THE RESULTS

The case study presented in this paper consists of e Shop application where consumers can shop and place orders for goods offered for sale there.

The e-Shop doesn't store inventory. It relies on third parties to warehouse and ship the goods. The third party consisted of the Amazon, Ebay and Paypal. As soon as the e-shop receives an order, it creates a purchase order and sends it to the backend purchasing system which, in turn, sends orders out to one or more suppliers for fulfillment (See Figure 4)

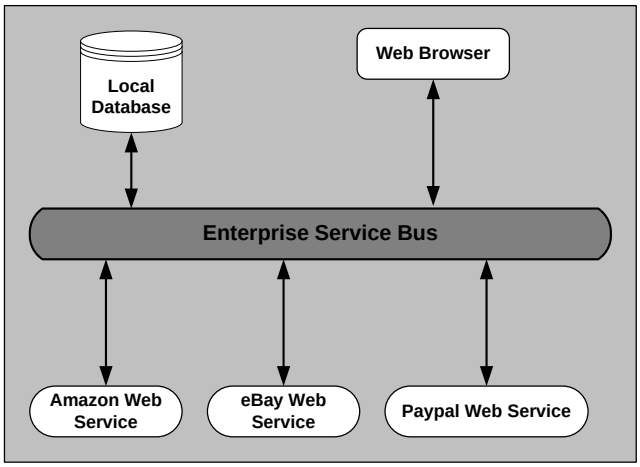

Figure 4. e Shop application as a proof of concept to validation of SOA-MDA-OOAD methods

Based on the case study, there are several outputs found according to the phases as follow: 1) CIM Level, 2) PIM Level, and PSM Level.

6.1 CIM Level

CIM Level is an abstract level that represents business needs. The model of CIM Level is Business Process Model. This model is used to describe the environment in which the system will be used,with no direct reference to how the system will be implemented.

The output in Business Process Model consists of six sub-business process (SearchingBP, ShoppingBP, UserRegistrationBP, PaymentBP, OrderFulfillmentBP, and OrderNotificationBP) that will be used to construct Use Case Model and Service Layer Model and used as the base of services analysis and identification (see Figure 5)

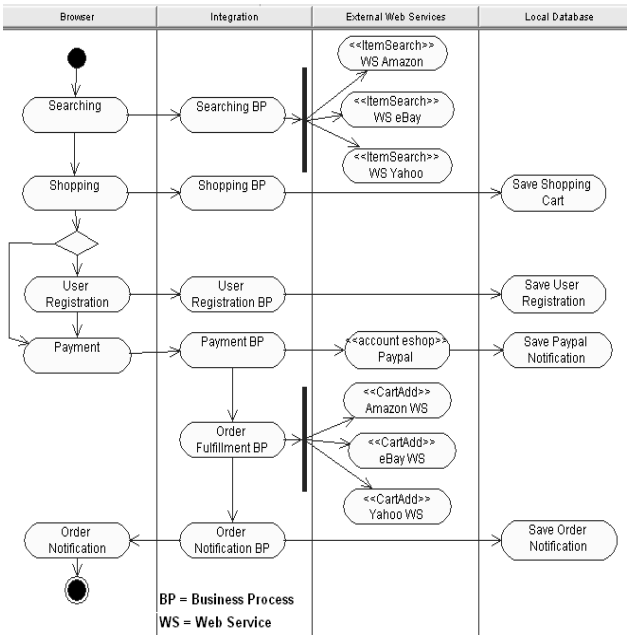

Figure 5. Business Process Model

6.2 PIM Level

PIM Level is a platform free modeling level derived from CIM level. The models of PIM Level are Use Case Model, Abstraction Layer Model, Class Model, Sequence Model and Component Model.

Six functional requierment are identified in Use Case Model, they are Searching, Shopping, UserRegistration, Payment, OrderFullfillment, and OrderNotification. (See Figure 6)

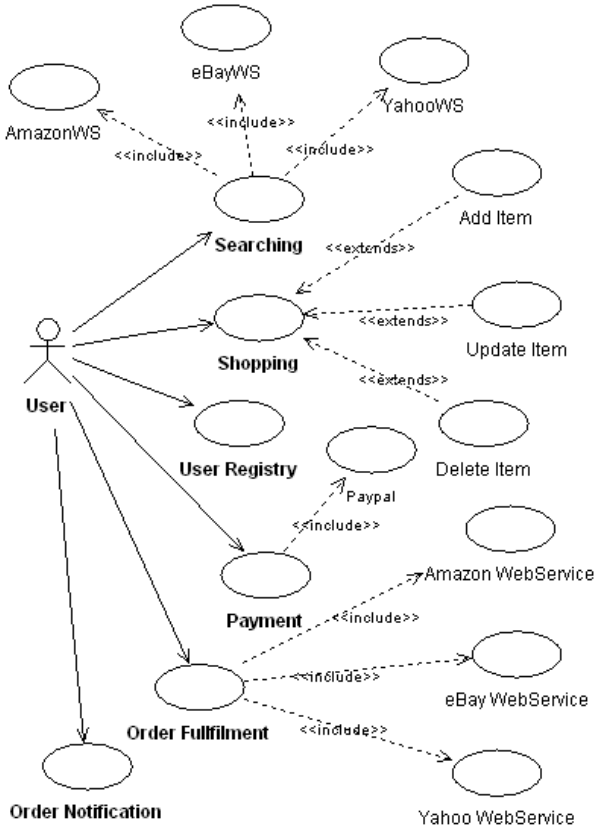

Figure 6. Use Case Model

The business process model is used to understand and describe the business processes related to the environment in which the system to be built will be used. A business process describes a set of tasks that need to be performed to achieve a given business result. This research proposes the representation of the business process model through a activity diagram. This diagram allows the identification of the business services. Each activity or set of activities of this model can give rise to the identification of one or more business services. From the Business Process Model, we identfied 18 services.

Eighteen services are mapped in Abstraction Layer Model, they consist of six Inbound Service and 12 Outbound Service. (See Figure 7)

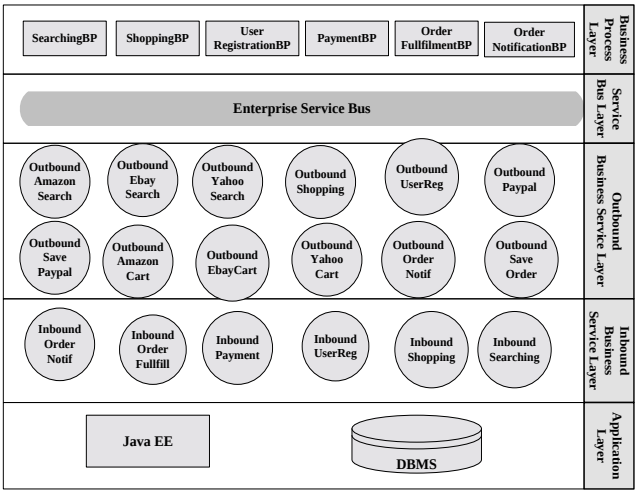

Figure 7. Abstraction Layer Model

Class Model is constructed based on the output of Use Case Diagram and Abstraction Layer Model, and it finds Class Diagram consists of five Boundary Classes, five Control Classes, four Entity Classes, and six Inbound Service Classes and 12 Outbound Service Classes. (See Figure 8)

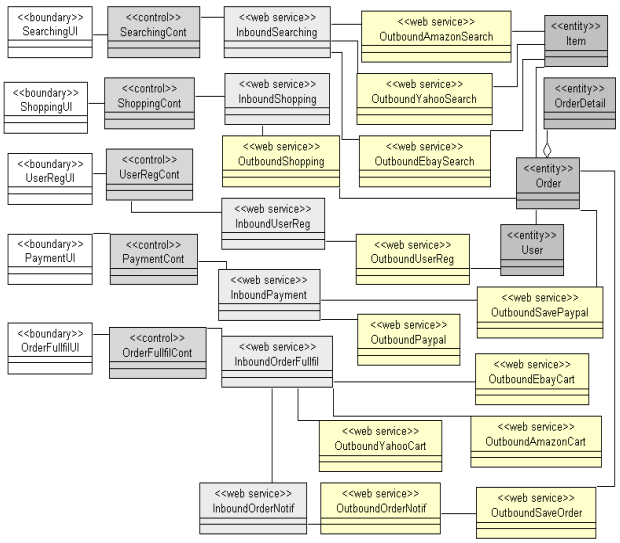

Figure 8. Class Diagram

Sequence Model is used for the representation of a service process, and therefore shows the set of logically related activities that need to be performed in the system to carry out a business service. So, the activities of this model represent a behavior that is part of the workflow needed for the performance of a business service.

Sequence Model is constructed based on Class Diagram output. It finds six Sequence Diagrams that model message flow from service users to service providers that consist of Sequence searching Diagram, Sequence shopping Diagram, Sequence userregistration Diagram, Sequence payment Diagram, Sequence Orderfullfillment Diagram, and Sequence OrderNotification Diagram. (See Figure 9)

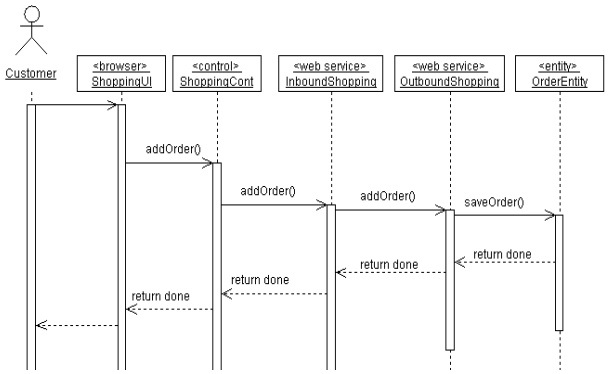

Figure 9. Sequence Diagram

Component Model is constructed from Class Diagram and Sequence Diagram and has found six Component Diagrams consist of Component Diagram searching, shopping, userregistration, payment, orderfullfillment, and Component Diagram ordernotification. (See Figure 10)

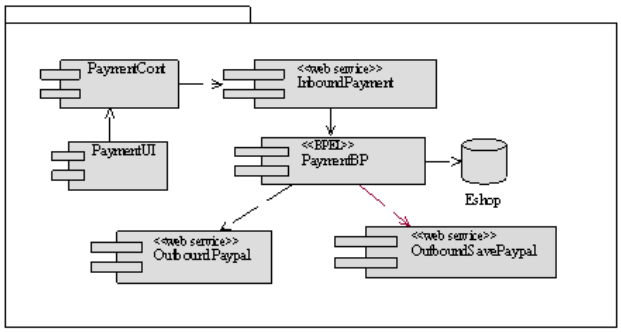

Figure 10. Component Diagram

6.3 PSM Level

PSM Level is the implementation of PIM level by using Java EE platform. The models of PIM Level are BPEL Model, WSDL Model and Composite Model.

BPEL Model is a special language, designed to execute business processes using a special server—the process server. From the BPEL Model we found 6 BPEL modules. (See Table 1)

Table 1. The result of BPEL Model

Business Process Model	BPEL Model
SearchingBP	searchingBP.BPEL
OrderBP	orderBP.BPEL
UserRegistrationBP	userRegistrationBP.BPEL
PaymentBP	paymentBP.BPEL
OrderFulfillmentBP	orderfulfillmentBP.BPEL
OrderNotification	orderNotification.BPEL

WSDL Model is used to describe the interface of the Web services that will be used in the delivery of each of the services offered by the system. The WSDL model is based on the WSDL (Web Service Description Language) standard.

WSDL is the language proposed by W3C to describe Web services and allow us to describe the service interface in an XML format. The Web service interface model proposed allows us to obtain a graphical representation of the interface of a Web service, from which it is possible to generate the corresponding WSDL code automatically. From the WSDL Model we identify 18 WSDL. (See Table 2)

Table 2. The result of WSDL Model

Class Model	WSDL Model
InboundSearching	InboundSearching.wsdl
InboundShopping	InboundShopping. wsdl
InboundUserReg	InboundUserReg. wsdl
InboundPayment	InboundPayment. wsdl
InboundOrderFullfill	InboundOrderFullfill. wsdl
InboundOrderNotif	InboundOrderNotif. wsdl
OutboundAmazonSearch	OutboundAmazonSearch. wsdl
OutboundEbaySearch	OutboundEbaySearch. wsdl
OutboundYahooSearch	OutboundYahooSearch. wsdl
OutboundShopping	OutboundShopping. wsdl
OutboundUserReg	OutboundUserReg. wsdl
OutboundPaypal	OutboundPaypal. wsdl
OutboundSavePaypal	OutboundSavePaypal. wsdl
OutboundAmazonCart	OutboundAmazonCart. wsdl
OutboundEbayCart	OutboundEbayCart. wsdl
OutboundYahooCart	OutboundYahooCart. wsdl
OutboundOrderNotif	OutboundOrderNotif. wsdl
OutboundSaveOrder	OutboundSaveOrder. wsdl

Composite applications are SOA applications that consist of several components, such as web services, BPEL, ESB module, and so on. All these components have to work together and support one or more composite applications. From the Composite Model, we found 18 Composite Application modules (JBI module). (See Table 3)

Table 3. The result of Composite Model

Component Model	Composite Model
SearchingCA	searchingBP.zip
OrderCA	orderBP. zip
UserRegistrationCA	userRegistrationBP. zip
PaymentCA	paymentBP. zip
OrderFulfillmentCA	orderfulfillmentBP. zip
OrderNotificationCA	orderNotification. zip

Output of each modeling can be seen in Figure 11. Figure 11. also shows that there are some activities done 1) has succeeded in defining business process in CIM level, 2) has succeeded in decomposing the business process into services that are transformed into PIM Model and 3) has succeeded in transforming free platform services in PIM level to PSM Model by using Java EE platform. It can be concluded that the integration method of SOAD and MDA can be applied to integrate services based. Thus, the finding of the validation test done through applicability method is said to be successful.

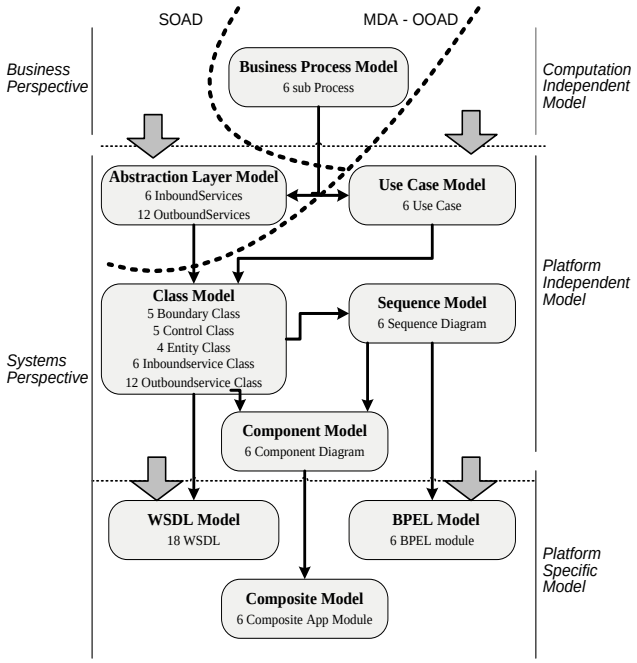

Figure 11. The results of each modeling phase

7. CONCLUSION

From the results of analysis, design, implementation and testing done, it can be concluded that:

1. This new method has tested successfully to integrate eShop application with some phases of activities: 1) Construct a Business Process Model that can be decomposed into services 2) Transform from abstract level Business Process Model (CIM) into PIM level model and 3) Transform from PIM level model to PSM level with Java EE platform. Without the support of this method, the translational business needs into the programming code in supporting IT development will be difficult.
2. The strengths of the new method of SOA based integration are:
   a. The division of CIM, PIM and PSM level creates a clear division between business function and the detailed implementation, that whenever there is a change in business needs, this change is reflected in the abstract level (CIM) and will be directly mapped to the system through PIM and PSM. The enterprise model is then transformed to be applied in different technology platforms.
   b. This layer division helps the company to be more flexible in adapting with its business environment.
   c. Model layering will ease the synchronization between information system and business process or company strategy.
   d. In relation to the fast changing business, the layering enables a fast processes or services reconfiguration without interfering on going operational activity.
   e. The use of ESB in integration method can also help in dealing with complexity of IT architecture from heterogeneous applications, constructed from different architectures and programming languages as well as different platform.
3. Even though this new method has succeeded in carrying SOA based integration, this methods still have some weaknesses
   a. This new method has not been tested outside Java EE platform.
   b. It is still difficult to apply this new method in the services from the third party.

8. RECOMENDATION

In order to develop knowledge and technology in the field of SOA based integration and for those who are interested in developing the findings of this research, some recommendations are brought up:

1. To transform to PSM Model in Java EE platform, it is recommended to use other tool instead of OpenESB, such as MuleESB or ServiceMix. With the acquisition of Sun Microsystem by Oracle, OpenESB is no longer developed. Oracle has brought OpenESB features into Oracle Suite commercial software.
2. In the following research, it is expected to develop PSM model into platform .NET or other platform which possesses middleware ESB infrastructure.

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