

TRANSFORMING MODEL DRIVEN BASED WORKFLOW PATTERN INTO EXECUTABLE PROCESSES USING HEURISTIC ENABLED DEPTH FIRST TRAVERSAL ALGORITHM

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Abstract: *The E-Commerce, Customer Relationship Management, Supply Chain Management, Enterprise Application Interface (EAI), Electronic Data Interchange (EDI) and worldwide business processes are promoted through Information Technology (IT). Accordingly the requirement of web services as well as its composite services becomes mandatory in the field of business process management. This drives the people involved in the business process including managers into electronic information processing. This paper proposes a model driven workflow composition structure and execution of services along with the simulated pattern using Business Process Modelling Notations (BPMN) and Business Process Execution Language (BPEL). To carry out transformation process to BPEL from Business process diagram (BPD) the enhanced heuristic based depth first traversal algorithm has been proposed and implemented in the case study of a travel booking system.*

Index Term-- BPEL, BPMN, Heuristic, workflow, model driven, web services and composition

I. INTRODUCTION

Business scenarios have changed and emerged along with internet and World Wide Web evolution. On the other hand the classical technologies struggling to support the current requirements of business process management (BPM) such as business process integration, rapid and reliable decision making. Hence the BPM started to utilize the distributed computing approaches to overcome the complexity in business process execution and management. Different technologies like SAP (Systems, Applications, Products in data processing) are being used to implement business intelligence. As the business world required removing its boundaries in IT communication and transaction processing the web services are being disseminated in all respects of the business processes.

The functionality traits of web services are component reusability and interoperability. Accordingly the web services are used as the facilitating technology for business process management. The web services use XML (eXtensible Markup Language) to WSDL (web Services Description Language) and UDDI (Universal Description Discovery and Integration) for describing and publishing the web services respectively. Having centralized repository, messages are transferred using SOAP (Simple Object Access Protocol) and reliable communication using HTTP(Hyper Text Transfer Protocol).

To build a standard business application more than one service would be orchestrated. The service provider consists of number of business objects which are collection of related data and functionality. Applications that use the services form system of providers are called service consumers. Service consumers and service providers get connected through public or private repositories.

To model a workflow there are different modelling techniques available such as BPMN, UML(Unified Modelling Language), Flow chart, DFD (Data Flow Diagram), Role activity diagram, colored Petri nets, workflow techniques, Gantt charts. In this research work the BPMN has been used to model the workflow of a business process [2, 3].

In this paper the section II narrates the related work done on this working area of BPMN, BPEL, Business Process Management, Web services and other various modeling techniques. Section III describes the methodology followed to process the research. Section IV and V gives the experiment result and performance analysis. Section VI presents the overall conclusion of the research.

II. RELATED WORK

I R H T Tangkawarow et al.[4] projected about the structure and functioning approach of four modeling techniques DFD, BPMN, Activity diagram, and IDEF0 (Icam (ICAM -Integrated Computer Aided Manufacturing) DEFinition for Function Modelling) and stating that BPMN can be used by both business and technical people where as the other models endure flaws such as lack of symbols for branching process, complicated structure and need of domain expert to understand the workflow. Cor N. Verdouw et al.[5] proposed a framework for agri-food sector, and it is applied to various food sectors in particular to potted plants and fruit supply chain using BPD. This BPD shows the order-driven delivery by a fruit producer to a trader using interactive lanes. Dariusz Badura [6], envisioned presented BPMN and UML based business process models to represent the information flow of the production logistics. Hubert Scheuerlein et al.[7] illustrated a pilot project which uses BPMN for clinical pathways and the medical process. The inference saying that the time consumption is less and efficiency is more when compared with other models. Bruno Leonardo Barros Silva, et.al,[8] derived an approach for generating BPEL code from BPMN is detailed using XML. Here virtual travel agency is used to specify the number of scenarios for modeling.

Laden Aldin and Sergio de Cesare[9] proposed a comparative analysis of the business process modelling techniques such as Flow chart, Petri net, data flow diagram, role activity diagram, BPMN, Business use cases, Business Object Interaction Diagram. These modeling techniques

are compared according to five criteria: flexibility, ease of use, understandability, simulation support and scope. The applicability of each model is discussed with simple student enrollment scenarios. Lars-Olof Johansson et al.[10] compared BPMN with EPC, UML and flow charts based on 9 criteria. The result analysis shows that the BPMN is having the score of +2 and standing at the top. X. Tian, H.S. et al[11] the scientific workflow has been described along with BPD notations. Four algorithms are compared and selected that Depth first traversal is simpler at the time of mapping the translation of BPMN to BPEL. Chun Ouyang et al.[12] say that no system can directly execute the BPMN models yet So the translation of BPMN to BPEL is done by decomposing the BPD into components and a translation algorithm is derived to do the mapping. The algorithm has been implemented on the complaint handling model successfully. Here the control links of BPE are not considered for translation. Ayoub Sabraoui et al.[13] presented the research based on the behavioural aspects the web services are composed using UML profile. The UML model driven architecture is translated into BPEL structure. The same is implemented using a case study of travel agency by means of Atlas Transformation Language ATL. The new approach is compared with various WSC approaches like Skogan approach, Bordbar approach, Lim approach, Ko approach and Yue approach regarding degree of automation, design type, aspect, based modeling and output format languages.

III. METHODOLOGY

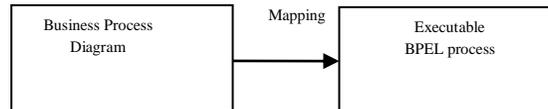


Figure 1. Overview of the Mapping

Business Process Modelling (BPM)

BPM is a mechanism for describing and communicating the current or intended future state of a business process. It represents the steps, participants and decision logic in business processes. It is a combination of various process related steps such as Process Mapping, Process Discovery, Process Simulation, Process Analysis and Process Improvement. Organizations use this modeling to visualize document, to understand, and to improve their processes. Thus it facilitates the understanding of comprehensive business process.

Business Process Language

The set of activities, their flow of movement and the dependencies of particular activities of a business are collectively known as business process. The business process is worked out through a typical example for business process is travel agency process. Suppose the customer requirements are fulfilled by activating the processes one by one manually it will consume minutes together to complete the process of booking or arranging a trip for the customer. For example if the time spent for a customer takes 30 minutes to complete a process then for thousand customers it will take 30000 minutes that is 42 days for doing the service. But today customers would like to have the agile and precise services. Meanwhile user inputs cause human errors and cost the business money and slow down the entire business. So, to reduce the complexity of working environment, to provide accurate, efficient and on time service to the customer the back office of the travel agency process should be automated through workflow model.

The simple workflow system encompasses three orthogonal aspects of the enterprise deliberately human resources, business processes and Information Technology. When the processes span within a single application then the workflow management alone might be a perfect solution to implement the business requirement. However the current web world scenario shows that hardly the requirements of the customers could be fulfilled through single application or service. Therefore it is prudent to combine the web services with workflow management to operate on the processes. It makes the responsiveness of the business agile, as the web services are reusable components the cost and time is reduced and the overall efficiency of the business process is improved. To compute the web services integration the front runner Business Process Execution Language - BPEL has been used.

The BPEL is an OASIS (Organization for the Advancement of Structured Information Standards) standard language that supports the orchestration of web services. It defines business process using XML and it is grounded on WSDL.

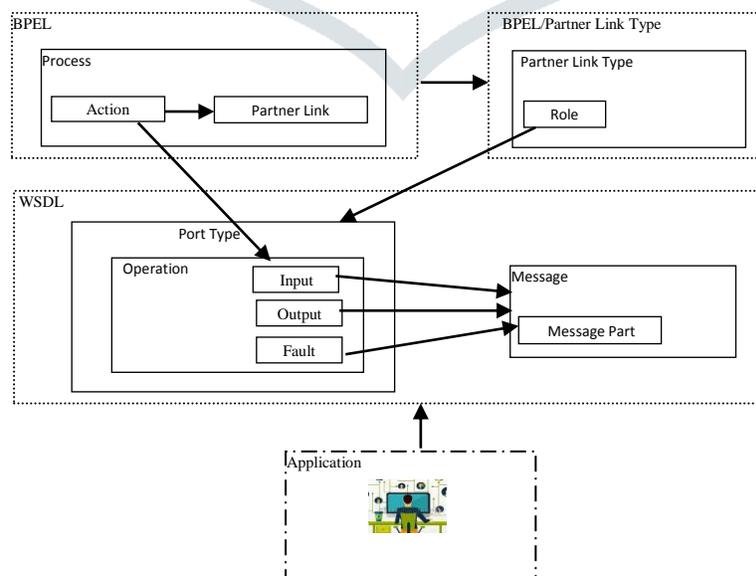


Figure 2. Logical view of BPEL process

The top-level concept of BPEL is process definition. A BPEL process definition relates a number of activities that need to be performed by a web service. The activities are generally divided into four categories such as Structuring activities, Communication activities, Exception handling activities and other miscellaneous activities. The structuring activities include the sequence, flow, switch, pick, while and scope. The control flow dependencies are managed using these activities. The communications activities include receive, reply and invoke activities. These activities perform the communication of workflow instances with other web services by means of sending and receiving messages. The exception handling activities such as throw, terminate and compensate are used to handle the erroneous situation. Assign, wait and empty activities are considered to be the miscellaneous activities and these are applied to data handling, unconditional timing and no operation behavior respectively. Specifically the message and its properties of a web a service is defined in WSDL file and that is utilized by the BPEL to access the web services.

There are number of execution engines developed to support BPEL accompanying with a graphical tool which shows the direct code of the notations used. So forcefully the developer should construct the BPEL for execution. As the abstraction level of BPEL is high and developer oriented it is difficult for the business analyst and designer to understand the workflow. Hence BPMN is required for workflow pattern design and for executing the process definition the BPEL is required. To make the bridge between BPMN and BPEL a mapping concept should be introduced so as to transform the structure and notations of BPMN into process definitions of BPEL. To make the pictorial representation of workflow of a business process in BPMN is implemented for execution through BPEL.

Business Process Components

BPMN uses BPDs to describe business processes. A BPD is made up of BPMN elements. A set of BPMN graphical elements can be used to build BPDs covering the fundamental control flows in BPMN [2]. These elements are depicted in Figure 3.

The elements are categorized as objects and sequence flows. The object element can be an event, a task, or a gateway. While designing a BPD, to connect any of these objects the sequence flow elements could be used. The description about the elements is summarized in Table 1.

Category	Elements and its activities			
Objects	Event	Start	Conditional, Signal, Message, Timer	
		Stop	Error, escalation, message, signal, terminate	
		Intermediate	Catch and Throw	
	Task	Task	Task	Task
			Manual Task	Manual Task
			User Task	User Task
			Script Task	Script Task
			Service Task	Service Task
			Business rule task	Business rule task
			Send task	Send task
			Receive Task	Receive Task
	SubProcesses	SubProcesses	Adhoc subprocess	Adhoc subprocess
			Sub Process	Sub Process
			Transaction	Transaction
	Global Task	Global Task	Global activity and tasks	Global activity and tasks
			Inclusive Gateway	Convergence, Divergence and Mixed
			Exclusive Gateway	
Parallel Gateway				
Event based Gateway				
Complex Gateway				
Sequence Flows	Connection Arrows, Message flows , Data flows			

Table 1. Summary of activities of BPMN elements

A gateway is a diamond shaped notation used to make decisions and construct the routing based on the decision to control the divergence and convergence of sequence flow of the business process. The gateways are divided into five categories such as 1)Inclusive gateway, 2)Exclusive gateway, 3)Complex gateway, 4)Parallel gateway, and 5)Event based gateway. The inclusive gateway splits the route into multiple based on the decision process. It selects one route or more than one route or all the routes for processing. The exclusive gateway is mutually exclusive. It selects only one route from the options. The complex gateway chooses at least any one route from the given multiple routes mentioned. The parallel gateway opt multiple routes in parallel and does the operation of the parallel routes without checking any conditions. There are two types of parallel gateway such as split and join. The purpose of split parallel gateway is it operates on divergent routes where as the join parallel gateway operates on convergent routes. The precondition of join parallel gateway is the all the convergent routes should have completed their task before convergence. The event based gateway has two types of routing. One is exclusive event based gateway and the other one is parallel event based gateway. Eventually the event based gateway process works based on events not on conditions.

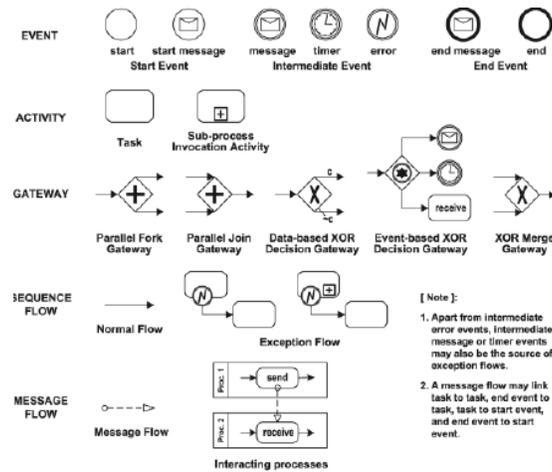


Figure 3. BPMN elements [15]

Mapping Algorithm Description

The structure of BPEL is constructed through XML which is a platform independent language and applied in functioning of web services. Hence it is essential to convert the graphical BPD into BPEL code. In this paper, the depth first algorithm is used to convert the BPD sequential patterns into BPEL code with a heuristic of count of start node and end node. The BPD components are decomposed and checked for the type of gateway, loop and exception handling. In the previous research [11, 14] the exception handling and the event based gateway of BPMN is not considered while doing the transformation. In a situation like non availability of web service for example car booking then over all process will get interrupted. To handle these abnormal behaviours the exception handling is implemented during the processing period. This work enhances the algorithm [11] by introducing exception handling which plays crucial role in business process management.

Mapping Algorithm BPD to BPEL



Figure 4. Mapping Algorithm BPMN To BPEL

IV. EXPERIMENTS

The ticket booking process for tourism is designed using BPMN. The actual scenario of travel booking process BPD is given in the Figure 5 and part of its BPMN coding is given in Figure 6.

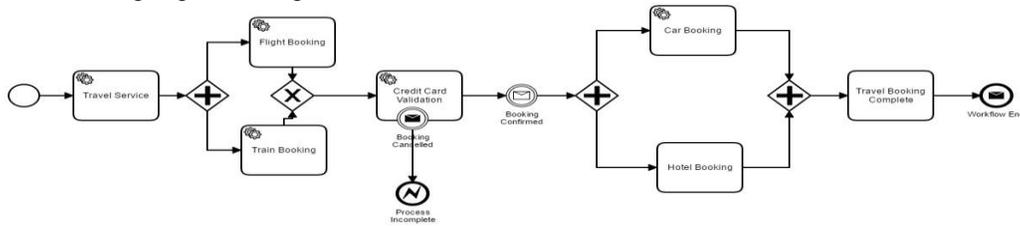


Figure 5. Tourism Business Process Workflow – BPD

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</bpmn:serviceTask>
<bpmn:serviceTask id="Task_1xcoo7a" name="Flight Booking">
  <bpmn:incoming>SequenceFlow_0gfgqiv</bpmn:incoming>
  <bpmn:outgoing>SequenceFlow_0vzr9lu</bpmn:outgoing>
</bpmn:serviceTask>
<bpmn:serviceTask id="Task_1wne4of" name="Train Booking">
  <bpmn:extensionElements>
    <camunda:executionListener event="start">
      <camunda:script scriptFormat="ss" resource="vv" />
    </camunda:executionListener>
  </bpmn:extensionElements>
  <bpmn:incoming>SequenceFlow_0ii3s6g</bpmn:incoming>
  <bpmn:outgoing>SequenceFlow_1e14hw0</bpmn:outgoing>
</bpmn:serviceTask>
<bpmn:serviceTask id="Task_0d75v5k" name="Credit Card Validation">
  <bpmn:incoming>SequenceFlow_0eb571l</bpmn:incoming>
  <bpmn:outgoing>SequenceFlow_074632c</bpmn:outgoing>
</bpmn:serviceTask>
<bpmn:intermediateCatchEvent id="IntermediateThrowEvent_176butl" name="Booking Confirmed"
camunda:asyncAfter="true">
...
...
bpmnElement="ExclusiveGateway_1267cgv">
  <dc:Bounds x="806" y="178" width="50" height="50" />
  <bpmndi:BPMNLabel>
    <dc:Bounds x="831" y="232" width="0" height="12" />
  </bpmndi:BPMNLabel>
</bpmndi:BPMNShape>
<bpmndi:BPMNEdge id="SequenceFlow_1of4d93_di" bpmnElement="SequenceFlow_1of4d93">
  <di:waypoint xsi:type="dc:Point" x="831" y="178" />
  <di:waypoint xsi:type="dc:Point" x="831" y="98" />
  <di:waypoint xsi:type="dc:Point" x="894" y="98" />
  <bpmndi:BPMNLabel>
...
...
</bpmndi:BPMNDiagram>
</bpmn:definitions>

```

Figure 6. BPMN XML Coding

This BPD is divided into number of components using the given heuristic algorithm and traversed using the depth first algorithm to translate it into corresponding BPEL code. The corresponding BPEL code structure is given in the Figure 7.

Figure 7. BPEL Code for the Tourism plan BPMN

V. PERFORMANCE ANALYSIS

The automated process of translating BPMN BPD into BPEL code is achieved through the mapping algorithm mentioned in the Figure 4. Both the processes do not have the link, so that the developer has to develop a corresponding coding for the BPD designed. Hence this research work reduces the complexity of designing as well as deviation between the BPD and the actual business process execution is reduced. The automation of the business process is increased. The following Table 2 shows the performance of the research work.

	Completion Time	Number of Processes	Automation	Design and development correlation
Without Mapping	768 ms	46	Partial	Chances for deviation is High
With Mapping	322 ms	34	Complete	No deviation

Table 2 Performance Analysis

VII. CONCLUSIONS

This research work enables the generation of an executable coding of BPEL form a BPD which is supported by BPMN. The simplified heuristic algorithm reduces the gap between the transformation of BPD workflow pattern into BPEL code. This approach reduces the complexity of workflow management, facilitates ease of understanding the business process activities, supports process automation and links graphical representation with executable mode. Hence this is suitable for making graphical plans while integrating the web services.

VIII. ACKNOWLEDGMENT

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REFERENCES

- [1] Laden Aldin and Sergio de Cesare, "A Comparative Analysis of Business Process Modelling Techniques", Proceedings of the U.K. Academy of Information Systems, 14th Annual Conference, 2009.
- [2] BPMN 2.0 BY Example, Version 1.0, Object Management Group, Inc., 2010.
- [3] Ayoub Sabraoui, Ahmed Ettalbi, Mohammed El Koutbi, Abdeslam En-Nouaary, "Towards an UML Profile for Web Service Composition Based on Behavioral Descriptions", Journal of Software Engineering and Applications, 2012, 5, 711-721.
- [4] I R H T Tangkawarow and J Waworuntu ,A comparative business process modeling techniques, International Conference on Innovation in Engineering and Vocational Education, IOP Conference Series: Materials Science and Engineering 128 012010, IOP Publishing, 2016'
- [5] Cor N. Verdouw, Adrie J.M. Beulens, Jacques H. Trienekens, Sjaak Wolfert, Business Process Modelling in Demand-Driven Agri-Food Supply Chains, Proceedings in System Dynamics and Innovation in Food Networks, 307-322,2010'
- [6] Dariusz Badura, Modelling Business Processes In Logistics With The Use Of Diagrams BPMN and UML, Forum Scientiae Oeconomia Volume 2,2014.
- [7] Hubert Scheuerlein, Falk Rauchfuss, Yves Dittmar, Rüdiger Molle, Torsten Lehmann, Nicole Pienkos and Utz Settmacher, New methods for clinical pathways—Business Process Modeling Notation (BPMN) and Tangible Business Process Modeling (t.BPM), Langenbecks Arch Surg (2012) 397:755–761, Springer-Verlag 2012.
- [8] Bruno Leonardo Barros Silva, Robson Wagner et.al, An Approach for Reducing the Gap between BPMN Models and Implementation Artifacts, RITA, Volume XVI , Number 2, 2009.
- [9] Laden Aldin and Sergio de Cesare, A Comparative Analysis Of Business Process Modelling Techniques, Proceedings of the U.K. Academy for Information Systems (UKAIS 2009), 14th Annual Conference, UKAIS 2009.
- [10] Lars-Olof Johansson, Magnus Wårja and Sven Carlsson, An evaluation of business process model techniques, using Moody's quality criterion for a good diagram, 2012.
- [11] X. Tian, H.S. Li, Y.J. Huang, Q. Cai., A Mapping Algorithm of Scientific Workflow from BPMN to BPEL, International Conference on Artificial Intelligence and Industrial Engineering, 2015.
- [12] Chun Ouyang, Marlon Dumas, Arthur H.M. ter Hofstede, Wil M.P. van der Aalst, From BPMN Process Models to BPEL Web Services, IEEE International Conference on Web Services (ICWS'06), 2006.
- [13] Ayoub Sabraoui, Ahmed Ettalbi, Mohammed El Koutbi and Abdeslam En-Nouaary, "Towards an UML Profile for Web Service Composition Based on Behavioral Descriptions", Journal of Software Engineering and Applications, 2012,
- [14] Atefeh Khalili Azimi, An Optimized Way for Mapping BPMN to BPEL, 5th SASTech Symposium in Advances in Science & Technology, Iran 2009, May.
- [15] Achraf Lyazidi and Salma Mouline Formal verification of BPMN models using petri nets, <https://www.researchgate.net>.