Review Report on Semantic web service composition using Petri nets

POOJASHREE ROUT
School of Computer Engineering
KIIT University
Bhubaneswar, India
poojashree.rout@gmail.com

ABHISHEK RAY
School of Computer Engineering
KIIT University
Bhubaneswar, India
ar_mmclub@yahoo.com

Abstract- Petri nets are graphical and mathematical modelling tool helpful for representation of semantic web service composition. Semantic web service composition explained by OWL-S language. OWL-S language supports control constructs to explain each phase of semantic web services. Control constructs mainly responsible to identifies the service interaction and compositions of semantic web services. These control constructs are represented by Petri nets. In this paper we present a review of some existing Petri nets models and technology for semantic web service composition.

Keywords- Semantic web service, semantic web service composition, OWL-S, Petri nets

I. INTRODUCTION

Semantic web service is automated, discoverable, interoperable and interactive service. It describes service functionality, data semantics and quality of services [1]. Service functionality has ability to describe pre and post conditions of semantic web services. Data semantic is helpful for checking the information for semantic web services. Quality of semantic web service explains about service reliability. More than one Semantic web service are connected with each other to provide better enabled service is called web service composition. By composition of web services new value and functionality are added to the atomic web services [3]. Semantic web service composition consists of services which are consists of RDF schema, XML schema and ontology named OWL-S [7]. RDF schema consists of meta data of semantic web services. OWL-S ontology is used to describe semantic web service in order to support composition and interoperability, which enable a user to compose, discover and execute semantic web service automatically under certain conditions. An OWL-S advertisement is structured in to three parts named the service profile, the service process model and service grounding and each of them provides a different channel of a service. Service profile explains service name and category of a semantic web. Web service grounding identifies interaction between web services process model which describes composition of web services. For composition of web services process model consists of eight control constructs named atomic process model, sequence, spilt, split-join, choice, if -then- else, repeat while and repeat until model. These control constructs are mapped in to Petri nets due to its graphical and formal semantic structure . Petri nets are graphical and mathematical modelling tool helps to identify the data flow, web service composition and interaction between services with the help of Petri net places which are represented by circle, Petri net transition represented by square and Petri net tokens represented by black dots. These Petri net models are verified using different algorithm and through some case study which are implemented using different tools.

This paper has been organized as follows: In section-II, we have represented review of the literature, in section-III, we have highlighted the comparison among various web service composition with the help of Petri nets, in Section-IV, we have summarizes the discussion. Finally, in section-V, we have given our conclusion and future work.

II. REVIEW OF LITERATURE

In this section Petri net models are proposed for web service composition by different researchers. This section discuss number of Petri net models and their verifications using algorithm and case study.

Hamadi et al.,2003[2] has proposed some Petri net models for web service composition. The Petri net models used to capture the control flow of web services. The models used for web service composition are (1) *Sequence,* where after completion of one service another service starts its operation, (2) *Alternative choice operator,* represents chosen service between two service, (3) *Unordered sequence,* here one service is followed by another service, (4) *Iteration operator,* where one service can be executed number of times, (4) *Parallel* *operator with communication,* represents the parallel execution of two services and describes the interaction between the services, (5) *Discriminator,* where number of services executed in parallel but there is no interaction between the services, (6) *Selection,* here one service is chosen dynamically from 'n' number of services, (7) *Refinement,* here one service is substitute by another service which is a non empty service.

This work of Hamadi is proposed by a relational algebra given by equation (1):

$$S = \varepsilon \mid S1 \Theta S2 \mid S1 \oplus S2 \mid S1 \Diamond S2 \mid \mu S \mid$$
$$S1 \| CS2 \mid (S1 \mid S2) \succ S3 \mid S(p1,q1) : S(pn,qn) \mid \mathrm{Re}\, f(S1,a,s2) \qquad (1)$$

Where ϵ represents empty service, X represents constant service, $S_1\ \Theta\ S_2$ represents service one and service two which performs *Sequence* operation, $S_1 \oplus S_2$ service one and two followed by *Alternative choice operator,* $S_1 \Diamond S_2$ represents *Unordered sequence* operator of two service , µS represents *Iteration operator,* $S_1||CS_2$ represents *Parallel operator with communication* of two service , $(S_1|S_2) \sim S_3$ represents *Discriminator,* $S(p_1,q_1):S(p_{n,},q_n)$ represents *Selection* and *Refinement* by $Ref(S_{1,}a, S_2)$ respectively. Here the semantic web service composition translated from relational algebra to Petri net models.

Yong-sang et al.,2007[3] proposed semantic web service composition using colored Petri nets. Semantic web service described by OWL-S. The *service process models* and *service profile* phase of OWL-S are described by colored Petri net models. Colored Petri nets can be defined by colors and more number of tuples. In these Petri net model precondition, post condition, input and output are replaced by Petri net's tokens. Services are replaced by Petri net's place, service operations are represented by Petri net's transition. The proposed Petri net models for semantic web service compositions are (1) *Atomic process model,* which represent a single service with its one operation, (2) *Sequence model,* where set of services performed one after another, (3) *Split model,* where set of services are executed simultaneously, (4) *Split-join model,* services are executed in parallel with an fence, (5) *Choice model,* one service which is represented as a process if content some condition, that condition will be executed. (6) *If-then-else model,* based on if-else conditions. If *if* condition is correct then if condition section will executed else *else* section will executed, (7) *Any order model,* where services are not executed in parallel and follows a undefined order, (8) *Repeat while model,* which follows a certain condition and after that it stops when given condition is incorrect. (9) *Repeat untill model,* which act as just opposite to the previous model where the model stops when given condition is correct.

These proposed model is verified by the help of incidence matrix algorithm to test reachability, deadlock and to test boundness property of Petri nets followed by a case study.

Kang et al.2007[4] proposed colored Petri net models for web service composition to analyze and verify composite web services. For composition of web service business process execution language(BPEL) plays an important role. Here BPEL is translated in to CPN (colored Petri net) model for verification of web service composition. These CPN models helps to identify the errors in composition process. They proposed two types of activities named (1) *Primitive activities* contains activities like message exchange , data manipulation and (2) *Structural activities* includes activities like *a) Sequence activity model,* where activities are performed one by one order, *b) Switch activity model,* which is based on some condition of activities, *c) While activity model,* where one activity is performed until the condition is true for a process, *d) Pick activity model,* helps to identify the required transition and based on that transition of one event is performed, *e) Flow activity model,* helps to identify the message transition and completes its operation, when all message transitions are executed in parallel, *f) Link activity model,* it checks whether one activity completed its operation or not , based on that another activity is selected.

These models are converted in to CPN models and verified through occurrence graph and CPN tool.

Miao et al.2008[5] proposed Petri net models for semantic web service composition. They have used the models as , *Atomic process model, Sequence model, Split model ,Choice model, If-then-else model, Repeat while model, Repeat untill model* and represented these models using elementary Petri nets, except *Any order model.* Elementary Petri nets contains four to five tuples. These models are defined by some set of tuples given by BN, S, F, W,M_0. Where BN is defined as set of Petri nets, S is defined as set of service, F is defined as the operation of service, W is defined as the input and output of the service operation and M_0 is represented as state of a service. Here all the Petri net based models are represented by 'n' number of services. These models are also helpful to identify the deadlock or a dead cycle in a semantic web service composition through some mathematical definition.

These models are verified through some theorems to test reachability , liveness properties of elementary Petri nets model followed by reachability graph algorithm.

Lianzhang et al.2009[6] proposed models for web service composition using colored Petri nets where the Petri net's transition represent service operation and Petri net's place represent input and condition value of the web service. Then after they have calculated state space function of CPN models. State space function describes particular state of a Petri net through places and transitions. CPN models also picks the true values of web service composition and state space analysis is done by directed graph and followed by a case study.

Wang et al.2010[7] proposed CPN (colored Petri net) models for analysis and verification of semantic web service composition. According to them the web service composition model includes dead lock and dead cycle due to improper design. In dead lock and dead cycle a service can not able to complete it operation as it depend upon another service and performs a cyclic structure. So the models should be verified through some algorithm and tools. To verify this models first they map service elements to Petri nets place, transition and tokens. Here the service profile and service model phase of OWL-S ontology of semantic web service mapped in to CPN models and lastly verified through rechability graph followed by an example.

Zhu et al.2010[8] proposed logical Petri nets for web service composition. Logical Petri nets are used to identify the uncertainties in semantic web service compositions. Logical Petri nets are high level Petri nets where input and output condition of semantic web services are represented by logical input and logical output, which are expressions. They proposed three logical Petri net models named (1) *Logical input transition* ,which gives input value for Petri net models, (2) *Logical output transition*, which gives output value for Petri net models, (3) *Delay transition*, states about transitions. All these expressions are represented by logical operator " Δ ". They proposed an case study to validate this model. The case study is based on three layers of web service composition. They are named as session layer, information management layer and service composition layer. Session layer explain about user interaction, information management layer describes quality constraint and service composition layer responsible for web service composition.

Bao et al.2013[9] proposed semantic web service composition using generalized stochastic Petri nets. They described this web service composition through OWL-S service profile and service model. They analyze these OWL-S service profile and service model and converted them in to generalized stochastic Petri nets (GSPN). Then these GSPN models are analysed through a case study. They proposed GSPN for semantic web service composition are (1) *Sequence executive structure*, where processes are executed one by another, (2) *Choose perform combination process*, where after completion of one sequence executive structure based on some conditional value the process will be executed. (3) *Choose execute group member service*, where group of processes are executed according to conditional value. (4*) Parallel execution*, which helps to execute the service in parallel, (5)*choose executive structure 1*, execute until the condition changed and (6) *choose executive structure 2* ,where after execution of service decide to continue the process or execute the process.

These model are analyzed with help of incidence matrix followed through a case study.

III. COMPARISION

TABLE

SL. NO.	AUTHOR'S NAME AND YEAR	PETRI NET MODEL	OWL-S SERVICE PROFILE AND SERVICE MODEL	VERIFICATION OF SEMANTIC WEB SERVICE COMPOSITION BY	OWL-S SERVICE GROUNDING(INTERACTION)
1.	Hamadi et al.2003 [2]	Elementary Petri nets	Yes	Case study	Partially Yes
2.	Yong sang et al.2007 [3]	Colored Petri nets	Yes	Incidence matrix algorithm	No
3.	Kang et al.2007 [4]	Colored Petri nets	Yes	Occurrence graph and CPN tool	Partially yes
4.	Miao et al.2008 [5]	Elementary Petri net	Yes	Reachability graph	No
5.	Lianzhang et al.2009 [6]	Colored Petri nets	Yes	State space analysis	No
6.	Wang et al.2010 [7]	Colored Petri nets	Yes	Reachability graph	No
7.	Zhu et al.2010 [8]	Logical Petri nets	Yes	Case study	No
8	Bao et al.2013 [9]	Generalized stochastic Petri nets	Yes	Incidence matrix algorithm and case study	No

IV. DISCUSSION

After review of literature on semantic web service composition using Petri nets we concluded that the Petri net models are used to represent OWL-S service profile and service model Phase of semantic web services. We have already discuss service profile and service model helps to identify the functionality of the services and process models respectively. Another main phase of OWL-S is service grounding, which identifies the interaction between services. But above models are not able to represent the interaction of semantic web service composition. Two of them able to represent partially but specific model representation is not given. So to represent service grounding phase of semantic web services we need to propose some advance Petri net models, which are helpful for to represent the interaction between web services. So our main aim to verify “Semantic web service composition from OWL-S to advance Petri net models". In our future work we will propose some advance Petri net models which helps us to identify the service interaction phase of semantic web service composition, then we will validate our model by incidence matrix algorithm following by a case study.

V. CONCLUSION

After study of few papers related to semantic web service composition using Petri net models, we came to know that composition of semantic web service plays an important role to explain service functionality and service execution processes of OWL-S due to its properties like inter operable, self descriptive and automation. To represent these properties of semantic web service through OWL-S, Petri nets are helpful to identify formal semantics and also responsible for representation of control flow and data flow of semantic web services. In our future work we will include some advance Petri net models for service grounding phase of the semantic web service composition which will helpful for interaction between services and verify them along with an algorithm followed by a case study.

REFERENCES

[1] "Semantic web technology", “www.semantic-web-book.org/page/foundation-of-semantic-web technology.

[2] R. Hamdi,B. Benatallah, “A Petri net based model for web service composition”, Proceedings of the fourteenth australian database Conference on database technology,ACM press,Feb 1,2003,pp.191-200.

[3] C. Yong-shang, W. Zhi-jian,W.-cong-ming,T. Long-ye and S. ling, “Modelling and Verifying composite semantic web servicesbased on colored Petri nets”, IEEE, 2007.

[4] H. Kang, X. Yang and S.Yuan, " Modeling and Verification of Web Services Composition based on CPN", IFIP International Conference on Network and Parallel Computing - Workshops,IEEE,2007.

[5] H. Miao, T. He and Z. Qian," Modeling and Analyzing Composite Semantic Web Service Using Petri nets", IEEE International Conference on e-Business Engineering,2008.

[6] Z. Lianzhang and R. Chengchang, “CPN-based Web Service Composition Technology”, International Conference on Information Management, Innovation Management and Industrial Engineering, IEEE,2009.

[7] Y. Wang and S. Pan ," CPN-Based Verification of Web Service Composition Model", International conference on Educational and Information Technology, IEEE,2010.

[8] C. Zhu and Y. Du," Application of Logical Petri Nets in Web Service Composition", Proceedings of the international conference on mechatronics and automation,IEEE,2010.

[9] X. Bao,J. Gao, X. Xie, H. Lin and N. Zhang, ,"Research of the web service automatic composition based on Generalized stochastic Petri nets",International journal of multimedia and ubiquitious engineering,july 2013.