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Author(s)	押手, 俊
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Modeling and Verification of Cosminexus Workflow System using Coloured Petri Nets

Takashi OSHITE (510022)

School of Information Science,
Japan Advanced Institute of Science and Technology

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In this paper, we propose a method for modeling and verification of a commercial workflow system ‘Hitachi Cosminexus’, which is actually used in several enterprises and local governments, with respect to various requirements that arise from relationship between domain models (structure of organization, role, authority, approved/obligation, and business rules, etc.) and actual business activities.

We can say that the present society is an e-Society. Various activities in enterprises and our daily life are supported and operated based on information systems. To make the e-Society reliable and trustworthy, it is necessary to verify various kinds of requirements (validity, fairness, security, evolution, accident, breakdown, and accountability, etc.) beforehand. Recently, Japanese version of SOX law (financial instruments and exchange law) was approved, following the SOX law in the United States that prevents illegal accounting in enterprises. This law requires internal control by internal control reports and information technology. In order to disclose proper financial affairs and corporate information, every enterprises are required to submit the internal control reports for evaluating internal control concerning financial reports. The internal control by the information technology is introduced to guarantee transparency of organizations and the businesses. This enables us to build information systems that do not allow

illegal activities and to trace undesirable cases using logs of business activities. Therefore, introducing information technology is an effective way to evaluate safety and validity of social activities of organizations. In addition to such social trend, business reforming and reengineering using information systems were frequently done in enterprises from the early 1990's. One of main approaches to them is building information systems based on description of business process. Describing workflows of information systems in organizations formally, we can orchestrate various components and resources such as software subsystems, databases, and human activities etc.

The existing researches on workflows mainly focus on checking whether the order of business activities to be processed is correct or not, and testing workflow systems using test cases and simulation. Considering various situation in e-Society, correspondence between domain models of organizations and actual activities in workflows is very important. However, it has not been well studied. In this research, we use a workflow system that allows modeling of domain models using relational database (RDB) and allows dynamic allocation of resources based on their attributes, and study how to build models of workflows and how to verify them.

As a case study, we use the workflow for registration and evaluation of lectures in JAIST. The workflow consists of one main process, together with several subprocesses that are invoked during each term, where subprocesses are registration to a lecture, re-registration, registration reporting, canceling lectures, and evaluation. We describe business processes of the flow on the workflow system. Next, we define transformation rules from business processes together with task-distribution rules to formal models used for verification. Coloured Petri Nets (CPN), a class of high-level Petri nets proposed by K. Jensen are used for the verification model. In CPN, each token can have attributes. This enables to handle various attribute of resources in the domain model. Using this, we can verify business rules related to attributes of persons and organizations. Also CPN can handle any kinds of verification techniques proposed for (non-coloured) Petri nets. Moreover, relationship between the main process and the subprocesses can be described by Hierarchical CPN (HCPN). Using the transformation rules, we obtain a HCPN model for the workflow.

A computer tool for CPN and HCPN, called CPN Tools, is available. Us-

ing it, we can easily build models for concurrent and complex systems and analyze them using the state space analysis tool. We can compute the state transition graph, called the occurrence graph, of the model by exhaustive simulation in the state space. Using occurrence graphs, we can analyze many important properties such as reachability, liveness, and detection of deadlocks. Moreover, a model checking algorithm is also implemented in the tool.

In the transformation rule, we first specify hierarchical structure of CPN from the business processes. Each business task is transformed into a place of CPN, and each transition of task is transformed into a transition with connected arcs of CPN. Next, for each data container to be sent from person to person, the responsible person, entries, and attributes of it are identified and are defined as data types in CPN. Using the transformation rules, we obtain a CPN model of the workflow, and can verify general properties such as reachability and liveness. In addition, we can also verify whether business rules with respect to attributes of data and persons are satisfied or not, and also check possibility of illegal situations caused by human errors.