ProC/B goes OMNeT++: Efficient Simulation of Process Chains

Jan Kriege, Sebastian Vastag

Technische Universität Dortmund, Informatik IV,
D-44221 Dortmund, Germany*
{jan.kriege,sebastian.vastag}@udo.edu

Key words: *ProC/B*, *OMNeT++*, Process chains, DES

1 Introduction

In recent years model based analysis has become more and more important for the development of business processes, manufacturing systems and logistics networks [4]. The *ProC/B*-toolset [1] is a framework for the modelling and analysis of logistics networks using the process chain based formalism *ProC/B*. This paper describes the integration of *OMNeT++* into the toolset that allows an efficient simulation of process chain models. *ProC/B* consists of a graphical editor for model and experiment specification that allows to define detailed measures for every FU. Analysis of *ProC/B*-models is realized by external tools, that are linked to the *ProC/B*-toolset by transformers: Currently converters to the APNN-toolbox and the simulation tool *HIT* providing analysis by simulation, Product-form Queueing Network analysis and numerical analysis of GSPNs are available. We have extended the toolset with a converter to *OMNeT++* and a library that implements elements from the *ProC/B*-formalism as *OMNeT++* modules recently, thus allowing for simulation of *ProC/B*-models with *OMNeT++*. In this paper we will give an overview of model and measurement specification with the *ProC/B*-editor, the conversion of *ProC/B*-models to *OMNeT++* and the result visualization in the *ProC/B*-toolset.

2 Model and Experiment Specification

ProC/B-models consist of Function Units (FUs) to capture the structural hierarchy of a system and Process Chains (PCs) that reflect the behavioral hierarchy. FUs offer services that can be used by PCs to perform some task and are modeled by PCs again. Standard FUs like server or counter offer predefined services. The *ProC/B*-editor provides two different views, one for modelling and one for the selection of system properties of interest, thus allowing a mostly graphical specification of models and experiments.

* This research was supported by the Deutsche Forschungsgemeinschaft as part of the Collaborative Research Center "Modelling of Large Logistics Networks" (559).

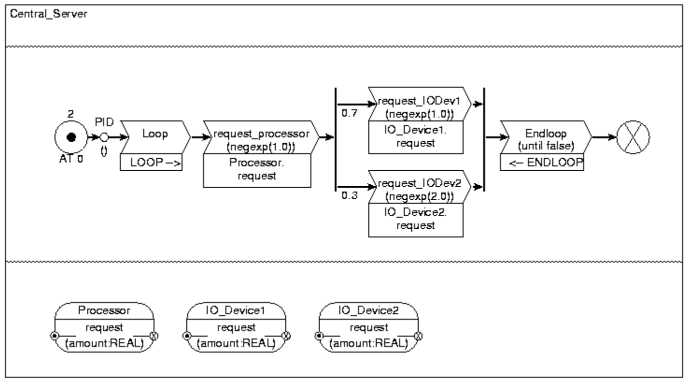

Fig. 1. Central Server Model

The elements of a *ProC/B*-model can be placed on a canvas and connected afterwards. For parametrization the *ProC/B*-editor offers attributes for each element, that can be used to enter interarrival times, scheduling disciplines etc. Fig. 1 shows a simple example of a central server model (cf. [3]) with two processes and three servers modeled in *ProC/B*.
In the experiment view the *ProC/B*-editor allows for measuring system properties at every function unit. Therefore *ProC/B* offers three different types of measurement streams (*event*, *count* and *state*), that are used for standard measures like throughput, response time or population and user defined measures. In *ProC/B* streams can be itemized, so that only processes that move along a specific path through the model are taken into account.
For the analysis of the model the *ProC/B*-toolset is connected to several tools by converters (cf. Sec. 1). Focus in the remainder of this paper is on the simulation with *OMNeT++* and on the conversion necessary for this purpose.

3 Mapping of *ProC/B*'s language

ProC/B's model descriptions are mapped to the discrete event transaction based simulation interface in *OMNeT++*. A library of basic *OMNeT++* modules was compiled, containing the corresponding behavior of each *ProC/B* language element [2]. Mapping Process Chain Elements and Function Units from *ProC/B* model descriptions to *OMNeT++* is done by inserting their respective *OMNeT++* modules to the model.
The subsequent step is to map process flow through a process chain by establishing connections between PCE modules. The acting entities of *ProC/B* are all processes within a module. It was a natural choice to map exactly one process to exactly one message in *OMNeT++*. Hence, *ProC/B*'s connections between process chain elements are mapped to module connections in *OMNeT++*.
As an important structural element hierarchies introduced by Function Units

in *ProC/B* are preserved. A constructed Function Unit is represented by one Compound Module in *OMNeT++*, formed by grouping basic modules from the library with it's NED-language.
ProC/B's measurement streams are supported for basic and composed Function Units. The update of streams is implemented in simple modules. The itemization of streams is realized by a new message class, that can carry path information.

4 Simulation of *ProC/B*-models

The *ProC/B*-toolset offers automatic conversion of the *ProC/B*-model to one of the analysis tools. Furthermore plots can be created from the results.

Compared to *HIT*, the mapping of *ProC/B* to *OMNeT++* improves the speed of simulative analysis. Table 1 shows results of the central server example (fig. 1) executed with both analyzers over 1000000 time units. Concerning CPU time usage *OMNeT++* is in advantage over *HIT*, saving approx. 30% execution time. Experiments with other models show the same gain of speed, results of larger models are available in [2].

	Population	Throughput	Response	CPU time
HIT	1.1559 ±0.16%	0.7491 ±0.15%	1.5429 ±0.23%	35.11 sec.
OMNeT	1.1548 ±0.15%	0.7499 ±0.15%	1.5398 ±0.23%	23.87 sec.

Table 1. Central Server (90% confidence interval)

5 Conclusions

We presented a mapping of *ProC/B* process chain models to the well known simulation environment *OMNeT++*. Language elements were translated directly to modules used to build simulation models in *OMNeT++*. As far as possible semantics were preserved, including detailed measurement streams. Animation features of *OMNeT++* are used to visualize process behavior.
Future developments will concentrate on additional speed improvements.

References

1. F. Bause, H. Beilner, M. Fischer, P. Kemper, and Markus Völker. The ProC/B Toolset for the Modelling and Analysis of Process Chains. In T. Field, P. G. Harrison, J. T. Bradley, and U. Harder, editors, *Computer Performance Evaluation / TOOLS*, volume 2324 of *Lecture Notes in Computer Science*, pages 51–70. Springer, 2002.
2. F. Bause, P. Buchholz, J. Kriege, and S. Vastag. Simulating Process Chain Models with OMNeT++. In *Proc. of 1st International Conference on Simulation Tools and Techniques for Communications, Networks and Systems (SIMUTools)*, 2008. to appear.
3. S. Lavenberg. *Computer Performance Modeling Handbook*. Academic Press, 1983.
4. W.M.P. van der Aalst, J. Desel, and A. Oberweis. *Business Process Management*. Springer LNCS 1806, 2000.