An Example of Business Process Simulation Using ARENA

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Abstract. In this paper a modelling methodology for business systems simulation is introduced. The methodology is based on the business transaction concept in conjunction with Petri nets notations. Next to these two components, the Arena simulation package is discussed to build an animated simulation model. Since the simulation model will be demonstrated using the software, it is not included into this paper, but it is shown how to use AREAN elements.

1 The transaction concept

The transaction concept introduced in this paper is originated from the DEMO (Dynamic Essential Modeling of Organization) methodology authored and developed by [2]. According to this concept, each business transaction is comprised of three phases that are called order phase, execution phase, and result phase (O-phase, E-phase and R-phase correspondingly). The underlining concept of the transaction is based on the Language/Action Perspective [2, 3] that considers communication as a way of acting and carrying tasks.

Each transaction involves two actors: the actor that initiates the transaction is called the initiator, while the actor that executes the transaction is called the executor.

As discussed above, each transaction is completed in three phases. The order phase (O) is an interaction between the initiator and the executor of the transaction. During this phase the initiator makes a request towards the executor for some service or task. The execution phase (E) is solely completed by the executor alone. The result phase (R) is again an interaction between the executor and the initiator. During this phase the executor communicates the result to the initiator. The structure of the business transaction is shown in the figure below.

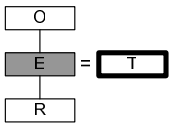

Fig. 1. The transaction structure

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On the left side of the figure, a transaction is represented as a sequence of the three phases (O-phase, E-phase, R-phase) that take place one after another, while, for compactness, the right side of the figure compresses the three phases into one single unit called a transaction (T).

2 Petri Nets (PN)

Petri nets are graphical and mathematical tool which is particularly well suited for discrete event systems. The Petri nets structure consists of places, transitions and directed arcs, as depicted in the figure below. Places can contain tokens (one or more). Graphically, places are represented by circles, transitions by rectangles (or bars), and tokens by black dots. For more reading, refer to [4, 5, 6, 7, 8, 9].

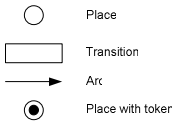

Fig. 2. Graphical notions of Petri nets

A transaction using the PN notations can be represented as in the figure below.

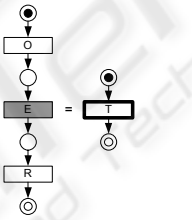

Fig. 3. The Petri net diagram of business transaction

In order to illustrate the application of the transaction concept and Petri nets, a health care center is studied and modeled in this section. This center is referred to as HCC hereafter.

3 HCC: Business Process Description

A patient upon arrival signs in the “Check In” sheet at the front desk and waits in the waiting room to be called by a nurse.

The nurse calls the patient and conducts preliminary general checkup/physical test/exam and records chief complaints, and reasons of the patient for the visit.

After completing this preliminary exam, the nurse escorts the patient to an available examination room and places the chart into the designated box at the door of the examination room.

Doctor examines the patient and updates the patients chart. After completing the examination, the patient is given a copy of the face-sheet and escorted to the side desk to check out. The patient goes to the side-desk to check out, to make the (co-)payment relevant to the service delivered, and also if needed to make a follow up appointment.

The HCC is capable of providing most of services and treatments a patient may need, however, in rare cases, patients may need further examination by external healthcare provider (specialist). In this case, the HCC accomplishes an appointment with the external healthcare provider based on the availability of the network provider. Some procedures may need the insurance company's pre-approval in which case the HCC first requests for pre-approval and then makes the appointment arrangement. Usually this takes a day or two and a nurse will arrange it.

3.1 Activities Identification

Making an appointment is the first activity in the series of processes taking place in the "patient examination". In this activity, the patient is the initiator and the receptionist is the executor. So this activity comprises the first business transaction (T1) in the process of "patient examination". Thus, this and the other main activities are described as follows:

T1 - making an appointment:
Initiator: patient
Executor: receptionist
Result: a new appointment is made
T2 – delivering health care:
Initiator: patient
Executor: HCC
Result: patient is given health care

Since this activity is a complex process that nests quite few other activities, this transaction is called nested transaction. The following transactions are initiated during the execution of this transaction.

T3 – conducting general physical test: Initiator: patient; Executor: nurse

T4 – arranging an external appointment: Initiator: HCC; Executor: external health care provider

Some of the external services may require a pre-approval of the insurance company, therefore before T4 can be completed, HCC needs to initiate a request to the insurance company for a pre-approval. Therefore, T4 is also nested transaction that nests transaction T5.

T5 – requesting a pre-approval: Initiator: HCC; Executor: insurance

T6 – Paying the bill: Initiator: HCC; Executor: patient

3.2 Petri Nets Model of the HCC Case

Now that all the transactions are identified, an analyst using the Petri net elements can easily build the models as depicted in the following figure.

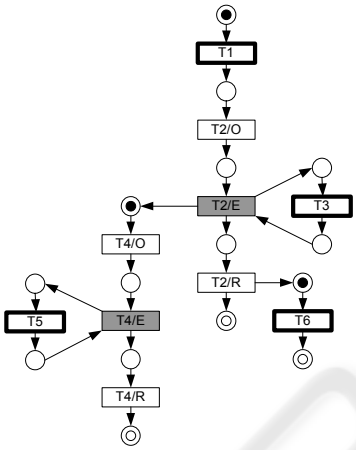

Fig. 4. Detailed PN model of HCC

After getting a business process model built in the fashion shown above, it is a straightforward process to build an animated simulation model using the Arena simulation package.

4 Business Process Simulation Using Arena

The Arena simulation tool is considered to be one of the appropriate tools that can be used for business processes simulation. This tool has rich animation facilities that make simulation models interesting, attractive and easy for training employees for a new job, visualizing workflow or just for demonstration purposes [1]. The way that Arena represents an activity, action or process is as follows. Each activity in Arena can be represented as three interrelated elements like Arrive, Server and Depart.

In order to better illustrate the Arena simulation tools, there are some logical models of the Arena discussed here. These logical models represent typical features of process modelling such as conditional interrelations, synchronization, parallelism, sequence and choice. The fragments in the figure below show how these situations can be captured by the Arena modelling tools. The first fragment represents a single and simple process having a set of consequent activities. The second fragment represents a process consisting of two parallel activities shown by 'Duplicate' and synchronization shown by 'Batch'. Finally, the third fragment represents relatively a more complex process consisting of three activities in parallel shown by 'Duplicate' and a conditional activity shown by 'Choose'. This fragment also contains a synchronization 'Batch'. The Choose module provides entity branching based on the

'If' conditional rule in conjunction with the deterministic 'Else' and 'Always' rules. Branch destinations are defined by connectors or by specifying a label destination.

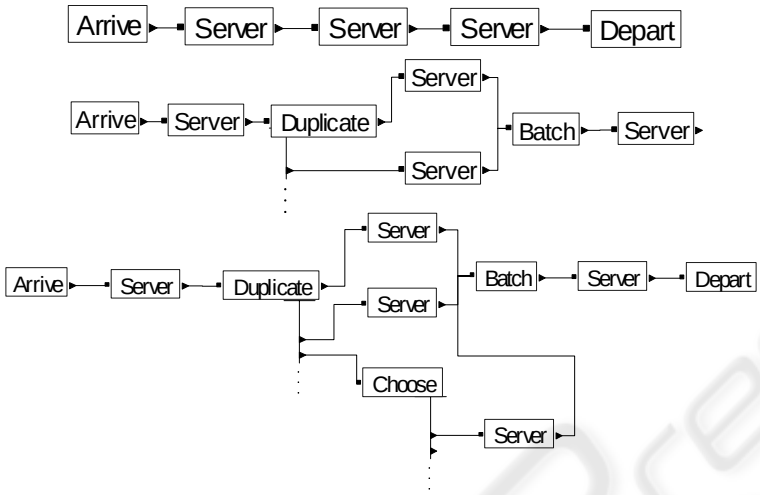

Fig. 5. Examples of process simulation models using the Arena notations

Actually the above fragments include almost all possible options of processes or a work flow such as causal, conditional and optional links, and also parallel initiation of several actions and synchronization of several actions before succeeding further. In its turn, these small examples demonstrate capability of Arena's notations for building simulation models. As mentioned earlier, another strong aspect of Arena is its animation capability, however, without computer demonstration, it will not make strong sense to include the animation model her. As for the actual simulation model of the example, it needs to be demonstrated using the Arena simulation software.

5 Conclusion

This paper introduced a modelling methodology and tools that helps analysts in business process modelling, analysis and design. The introduced methodology, also, to a great extend, helps when a new information systems is designed, an existing information systems is analyzed, or an IT application to be designed. The transaction concept is a profound concept in business transactions identification. Petri net notations are used to build a model, where all the transactions are put together in relation to each other. The resulting business processes model, as the HCC example shows, is represented in an easily readable fashion. Consequently, it will not require any expertise or technical skills to communicate such a model to business managers or owners. The way that the HCC model is presented, this model can serve as a direct input to ARENA simulation software to build an animation simulation tools.

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