

Using Fuzzy Petri Nets for Process Definition

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Agenda

1. Problem area
2. Workflow and process management
3. BPMS and WFMS problems
4. Our objectives
5. Used formalism
6. Designed tools and design issues
7. Further work

Software life-cycle

Two basic aspects in SW development process (customer's view):

- ◆ Quality software ASAP
- ◆ Minimize the cost of maintenance (bugs, changes, evolution)

Maintenance phase is the most time consuming, therefore:

- ◆ One of the most expensive (because of long duration)
- ◆ Every change in SW increase the cost (code comprehension, risk analysis, coding, testing)

! Reasons for change in SW – often change in enterprise business process !

Why to model processes (its rules): described enterprise infrastructure and its processes (means documentation of relations, advances, roles, resources), possibility of standardization, measuring, improving, automation.

Workflow and BPM concepts

Definition (workflow): Workflow means whole or part automation of enterprise process, during which are documents, information or tasks handed over from one process participant to another, according to a set of procedural rules so, that it contributes the performance of global enterprise objectives.

Workflow – automation of part of enterprise process, supported by one system, oriented on technology. WfMC definitions serves for that.

BPM (Business Process Management) is not oriented on technology, more management approach, main idea – support enterprise business processes.

Workflow system

Workflow system defines, creates and manages the process flow. This system is able to interpret process definition, communicate with workflow participants and if needed, run another applications (Hollingsworth, 1994).

Workflow system:

- ◆ Graphical workflow design, which defines the flow of tasks and activities.
- ◆ Roles assigning to activities.
- ◆ Rules defining the logic of process without programming.
- ◆ Exception solving, monitoring of process instances, measurement, statistic reports.
- ◆ Process simulation and testing, database interface, document affiliation.

BPMS a WFMS problems

Present process (workflow) modeling tools:

- ◆ Uses informal or semiformal notations (UML, BPMN, IDEF, ...)
- ◆ Only syntax defined, semantics imprecise, not clear how to solve some situations – problem with computer automation

Our solution (2 components – modeling tool, process wizard):

- ◆ User process notation (defined syntax and semantics)
- ◆ Formal background (notation mapped to PTN)
- ◆ Connection to IS functions + possibility of new functions generation (process wizard)
- ◆ Possibility of vague processes modeling

Not quite new approach or theory, use of known stuffs and their combination.

Asset: integration of these methods/approaches (workflow, MDD, PTN, code generation) into one concept for modeling vague processes.

Objectives

- ◆ To model complex processes with vague elements supporting by formal methods in information systems (currently IS QI).
- ◆ To design tool(s) for this with possibility of analysis and simulation.
- ◆ To design model for rules evaluation.

Why Petri Nets?

- ◆ Graphical nature helps to visualize complex systems
- ◆ Deadlocks can be easily detected
- ◆ Well defined practical and theoretical bases (simulation, analysis, automation)
- ◆ Possibility of use PTN variants:
 - Hierarchical colored PN (process decomposition, token colors corresponds to given elements – documents, resources, roles)
 - Fuzzy PN serves for vague process modeling

Vague elements in process

- ◆ When modelling process sometimes we need depict state, which we do not know if occurs or not or use vague values (e.g. invoices from beginning of month).
- ◆ Standard Petri net expresses states using tokens. Token is included into place, if given expression is true (1), if false (0), token is not included.
- ◆ We can employ fuzzy values ("small", "many", "middle", etc.) into Petri net. To work with these values we use fuzzy logics, specifically IF-THEN rules.

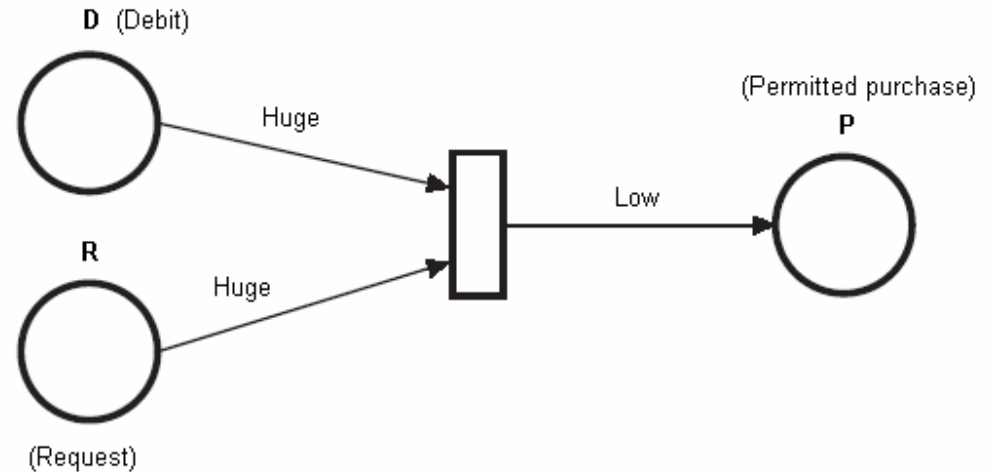
Fuzzy Petri net

Fuzzy Petri net dissimilarity from Chen definition:

- ◆ Token holds fuzzy set definition.
- ◆ Arcs are evaluated by natural language expressions.
- ◆ Transitions represent fuzzy relation corresponding to given IF-THEN rule. Relation creation depends on chosen inference method (closer explanation is out of range of this paper, for more information see paper Knybel, Pavliska, 2005).
- ◆ Fuzzy Petri net extends Petri net formal definition with:
 - D: set of expressions
 - $h: P \rightarrow D$ function represents relation place – expression
 - $a: P \rightarrow [0, 1]$ function represents place value
 - $l: T \rightarrow [0, 1]$ functions represent value transition

Fuzzy Petri net example

Situation: subscriber wants to buy a lot of goods (costs a lot) and has huge debit (but not more than we tolerate), system should make decision if sell everything required or not.



IF-THEN rule will look like:

IF D is huge **AND** R is huge **THEN** P is low

Where:

D is subscriber's debit

R is subscriber's purchase request

P is our permitted purchase amount

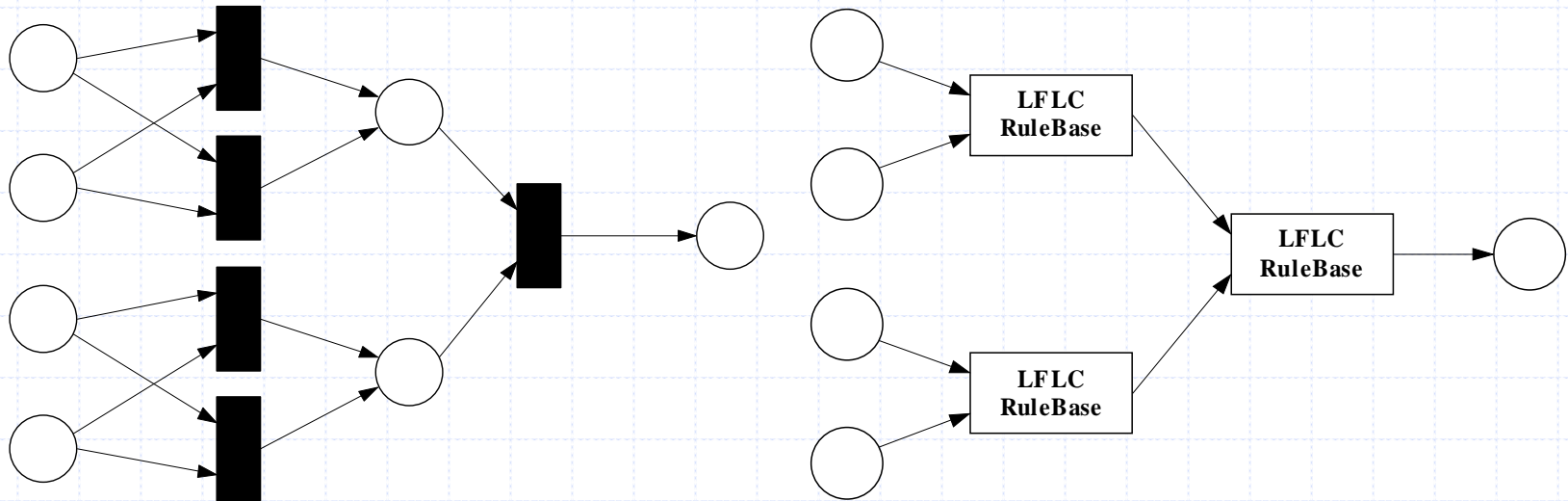
Visualization of fuzzy IF–THEN rules

- ◆ Simple models – one rule base.
- ◆ Cascade models – output value of one rule base is taken as input to another rule base.
- ◆ Hierarchical models – output value of one rule base determines which rule base will be used for computing of final result.

Implementation (modelling tool)

- ◆ PNML (XML) – standard file format for storing classical FPN
- ◆ Interconnection with LFLC 2000 – FPN is converted to Linguistic Fuzzy Logic Network (LFLN), which uses kernel routines from LFLC 2000 software package for doing inferences to obtain final result.

Example



Process wizard

The name could invoke mighty capability, but in IT, the wizard is program or component, which helps user or developer to create or finalize some document, application class, application component, form, etc.

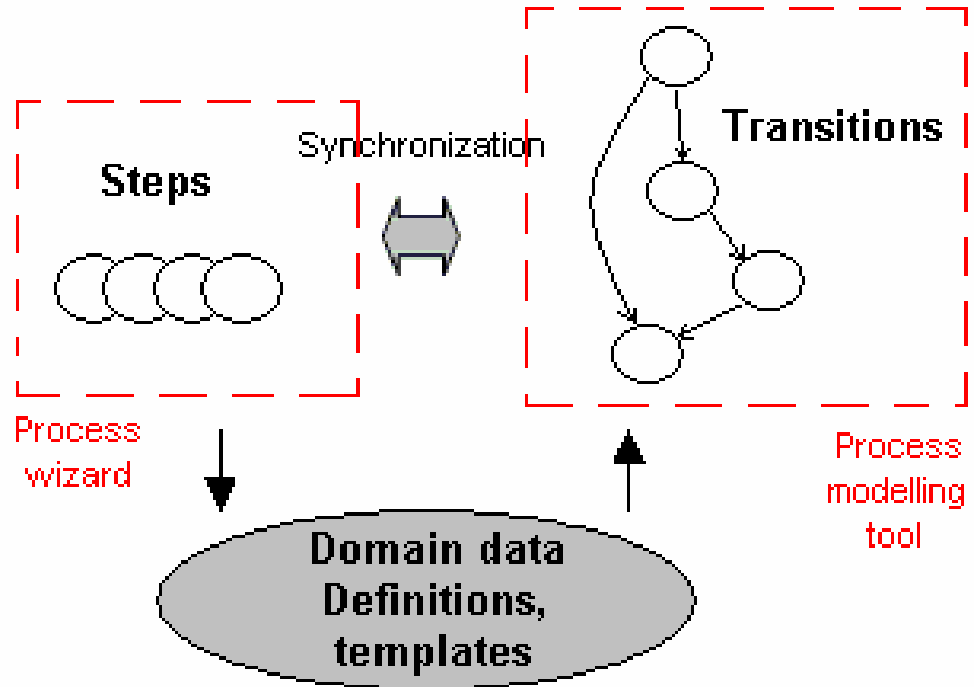
General SW wizard has following qualities:

- ◆ All wizard data compose a single transaction.
- ◆ Steps are processed in sequence from given beginning to given end.
- ◆ There exist one starting step, several intermediate steps, and one ending step.
- ◆ The wizard validates its state before advancing to the next step.
- ◆ There can be several different paths to reach the ending step.
- ◆ It is possible to navigate back to review and update values entered in previous steps.
- ◆ A wizard can be cancelled before completion.

Design issues

View - screen forms

Address:
Amount:
ZIP: ...
Psswrd:
Login:

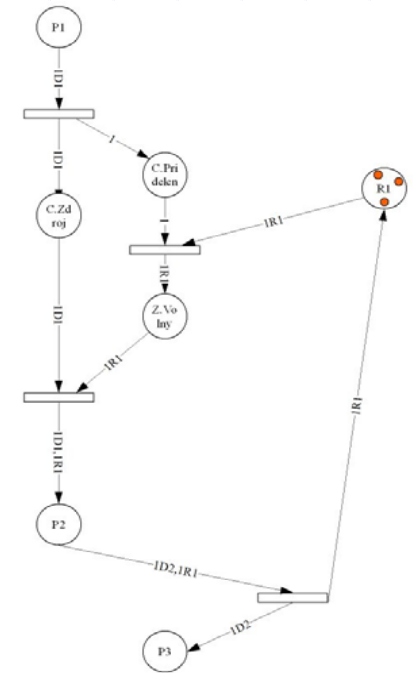
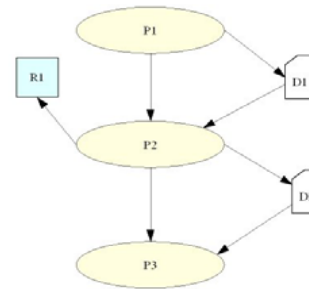


Design issue - mapping

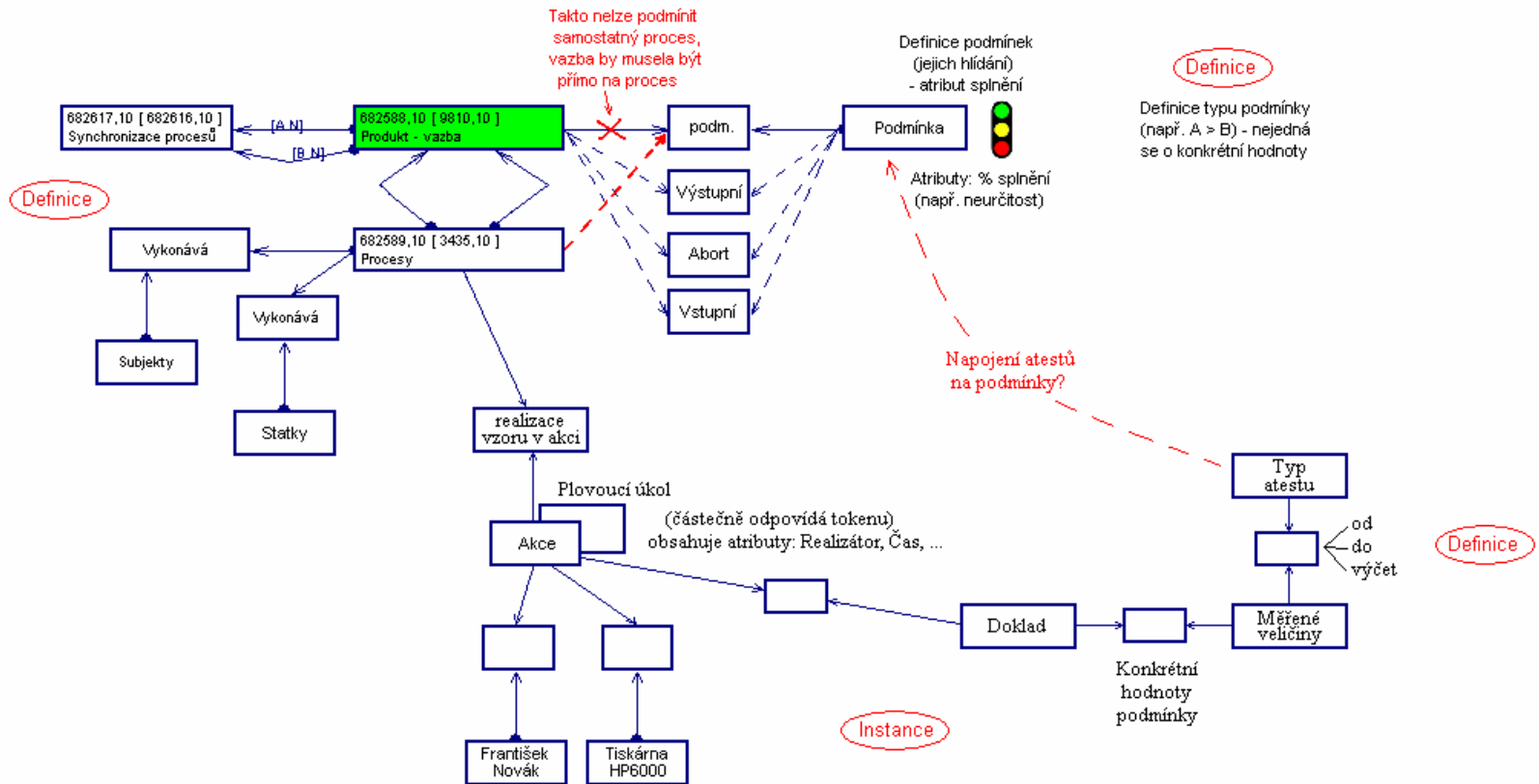
The first design issue is to map all process elements to Petri net. It means that activities, participants, sources (people, money, machine), documents (bill, contract, ...) and all its relations have appropriate position in Petri net.

E.g. activity is represented by place (place includes token, activity is performed).

This task we need to do before we include fuzzy elements to Petri net.



Data model



Further work

- ◆ Final preparation QI Data Model for PTN storing – classes and attributes.
- ◆ Vizual user notation definition.
- ◆ Design and implement graphical design interface FPN and LFLC



Thank you for your attention