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Method of IBIS design and workflow realization

Abstract

Paper describes basic concepts of Internet-based information system (IBIS). Methodologies and tools of IBIS design and workflow realization are analyzed. Brief characteristics of business processes (BP) is made, BP conceptual and mathematical models are suggested as one of basics for IBIS design and workflow realization methods development, which includes BP modeling and analysis, BP model transformation to IBIS model, IBIS prototyping, IBIS workflow realization. The suggested method allows to raise the efficiency of IBIS design, deployment and reengineering, improving the technology of IBIS design and reduce human factor effect on both design and deployment processes.

Key words: internet-based information system, process modeling, prototype, workflow realization, Web-services.

Introduction

Internet based information systems are complex distributed systems, which are multi-module Web-based software applications, performing large number of operations simultaneously, have n-tier architectures, realized through parallelism and today based on web-services in most of the cases.

IBIS are considered from the point of view of their functionality, depending on the problem domain tasks it should solve (process approach). Proper and correct IBIS functionality realization depends on IBIS design stage realization, its integrity with other development stages and IBIS models conformity with problem domain tasks.

The main tasks of IBIS are to provide:

- distributed, flexible and interactive services;
- comprehensive data warehousing delivered with extreme efficiency.

IBIS has lots of advantages [1], but there are still some problems, limiting possibilities of IBIS development:

- too much middleware involved:
- redundant functionality;

- difficulty and cost of development, where design stage takes 70 % of time and recourses.

Analysis of state-of-the-art methodologies of IBIS design: SADT, IDEF0, IDEF3, DMD, UML, AMC, and also design tools: BPwin, Business Studio, MS Visio, ARIS [2], has shown that mentioned tools don't provide designer with possibility of fast and low cost design and reengineering, because of the:

- data loss and unconformity;
- models are not full and correct;
- poor analysis and optimization possibilities;
- gaps between problem domain area (business-process model) and solution domain area (IBIS model);
- gap between IBIS design stage and other stages of its development (testing, coding, implementation and deployment).

As the result of mentioned features of state-of-the-art methods and tools of IBIS design, the efficiency of development process is not high because of the:

- mistakes in fixed requirements and developed models;
- human factor dependence;
- high cost design and re-engineering;

All mentioned factors reduce efficiency of development process, raising development time and required recourses.

Main part

For improvement of IBIS design and workflow realization, the new method is developed, consisting of the following stages:

- Business system modeling, consisting of BP.
- BP modeling.
- BP analysis and improvement.
- BP model mapping on IBIS model.
- IBIS prototype development.
- IBIS workflow realization.

Business system model, consisting of BP, is used to represent functioning enterprise and its structure for its further mapping on IBIS model for providing problem domain tasks conformity with solution domain functions. In the paper the stress is made on BP modeling, analysis and IBIS workflow realization.

Basic concepts, terms and definitions

Developing certain approach to IBIS design, some terms which will be used, should be determined. They are: IBIS functionality, task, business-process and operation.

IBIS functionality is IBIS ability to perform set of functions, meeting exact problem domain task requirements for automated performance of which IBIS is developed.

Task is the notion of problem domain, which is compared with IBIS functionality and means the purpose, which should be reached.

A **business proce**ss is considered as a collection of activities, using inside and outside impacts, limits and recourses, and designed to produce a specific output for a particular customer. It implies a strong emphasis on how the work is done within organization. A process is thus a specific ordering of work activities across time and place, with a beginning, an end, and clearly defined inputs and outputs: a structure for action.

Operation is elementary functional component of BP, which is associates with IBIS function and can be realized with exact Web-service.

Business-process modeling

Business processes are the day to day drivers for most businesses. They are often a key connection between the business and the business customer. They are a combination of business operating procedures, business rules and supporting computer systems. But many BP are often still undocumented, misunderstood, not optimized, error-prone and inefficient.

Business process is characterized by:

- Purpose of BP execution;
- Inter-function approach;
- Exact enter and exit points;
- BP borders, determining BP properties, its intervening and final results;
- Interconnections with and interdependence on other BP (parallelism, consistency) or necessity to identify exact BP;
- Consumer of BP execution: other BP, external entities;
- Points and processes, starting BP execution and operations, which are the BP functional elements;
- Recourses, required for BP operations execution;
- Criteria of BP execution efficiency.

The suggested conceptual model of BP is represented on fig.1. It represents BP, which:

- consists of separate functional elements – operations;
- has name and exact execution scenario, describing parallelism and operations execution order, and saved in knowledgebase as separate entity and can be changed while re-engineering;
- has input and output data, which can be represented in the form of document parameters, allowing to design data flow;
- characterized with time and recourses, required for its execution.

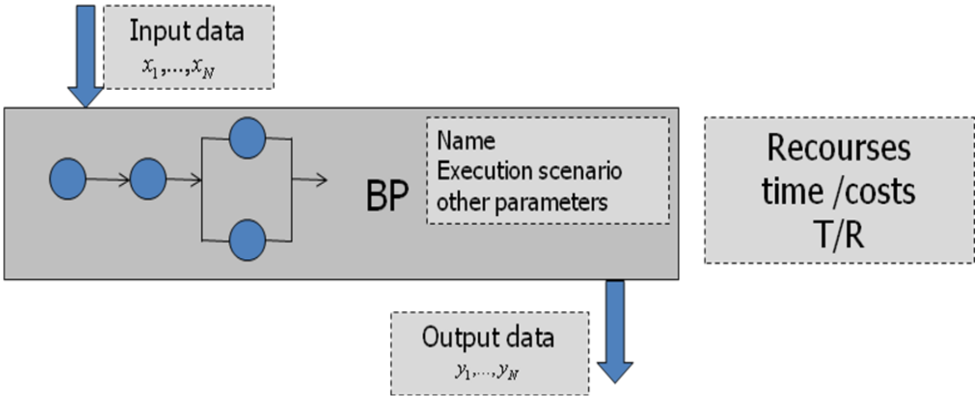

Fig.1 Conceptual model of business-process

BP analysis and improvement require its mathematical model development, which can be based on developed conceptual model (fig 1).

BP mathematical model can be represented in the following way:

$BP = (N, S, P, E_{in}, E_{out}, T\ ,\ R, x_1,..., x_N, y_1,..., y_N),$ (1), where

N – name;

S – execution scenario, describing operations execution order and parallelism;

T/R – time/costs of BP execution;

P – other specified parameters;

Ein – entity, starting BP execution;

Eout – entity, accepting the results of BP execution;

$x_1,..., x_N$ - parameters of input data;

$y_1,..., y_N$ - parameters of output data.

Business process analysis and improvement

Business-process can be analyzed and improved for raising the efficiency of their execution.

Analysis can be realized by operating with BP parameters: execution time, recourses distribution and confidence level of BP execution.

Business-processes analysis can be realized by the following stages:

- BP description and specification, setting the parameters;
- data processing;
- results representation.

BP model specification

Each BP execution is described by BP scenario (S). BP is considered to consist of sequential BP stages (Stf, f=1,l). Each BP stage can consist of one or more operations, executed parallel (Opfj, j=1,m). BP stages and operations are described with the parameters: recourses – R; BP stage execution time – Tf, BP operation execution time – ξfj ; BP operation execution time mathematical expectation – (a), and dispersion – (σ2).

Thus, BP model includes the following mathematical models:

1. BP scenario

$$S = \left(\{St_f\}, \{x_1.., x_{p1}\}, \{y_1.., y_{p2}\}, T\right), \ f = \overline{1,l} \quad , (2)$$

where T – time of BP execution;

p1 – number of input parameters;

p2 – number of output parameters;

l – number of stages in BP.

2. BP stage

$$St_f = (\{Op_{fj}\}, t_f), \ f = \overline{1,l}, \ j = \overline{1,m} \quad (3);$$

3. BP operation

$$Op_{fj} = \{N, \xi_{fj}, a, \sigma^2\}, \ f = \overline{1,l}, \ j = \overline{1,m} \quad (4),$$

where N is name of BP operation.

Thus BP analysis and improvement can be defined as the following problem:

- The search space $T = \sum_{f=1}^{l} \max_j \xi_{fj}$ (5);
- The set of goal functions $F = \{T \to \min\} = \min \sum_{f=1}^{l} \max_j \xi_{fj}$ (6);

The set of side conditions $R \le R_{\max}$.

Efficiency criteria are:

- BP execution time (T);Dedicated resources (X);
- Probability of BP execution (P).
- Performance requirements are:
- Execution time minimization;

- Recourses optimal distribution;
- High probability of BP execution.

BP improvement is realized by using developed algorithms [3], where dynamic programming principles [4] are applied:

- Algorithm for optimization of business-process concurrent operations;
- Algorithm for optimization of business-process sequential stages;
- Integrates algorithm for optimization of business-process sequential stages, consisting of concurrent operations.

These algorithms allow to minimize time of BP execution and efficiently distribute recourses between BP operations.

It is also possible to apply relational algebra rules for operating with BP operations for BP model improvement: conjunction, elimination, intersection, etc.

BP model mapping on IBIS model

Mapping is realized by exact transformations of models, using database and developed notation [5]:

BP model is transformed to BP graph, the last one is analyzed according to the requirements for automation of BP operations execution. Basing on such analysis BP graph is transformed to IBIS computing processes (CP) graph, which is the part of IBIS model and can be called computation model (CM). CM would be used for both IBIS prototype development and IBIS workflow realization.

IBIS prototyping

IBIS prototyping is realized as represented on fig.2. and consist of the folowing stages:

1. BP modeling, analysis improvement and mapping on IBIS model as described in above mentioned paragraphs.
2. IBIS platform-independent interfaces and functionality modeling, using CP graph, S2 I2 approach, forms, functions and developed notation [6, 7].
3. Graphical user interfaces (GUI) and dummy functions development.
4. Binding GUI with models of IBIS interfaces.
5. Running and testing IBIS prototype.

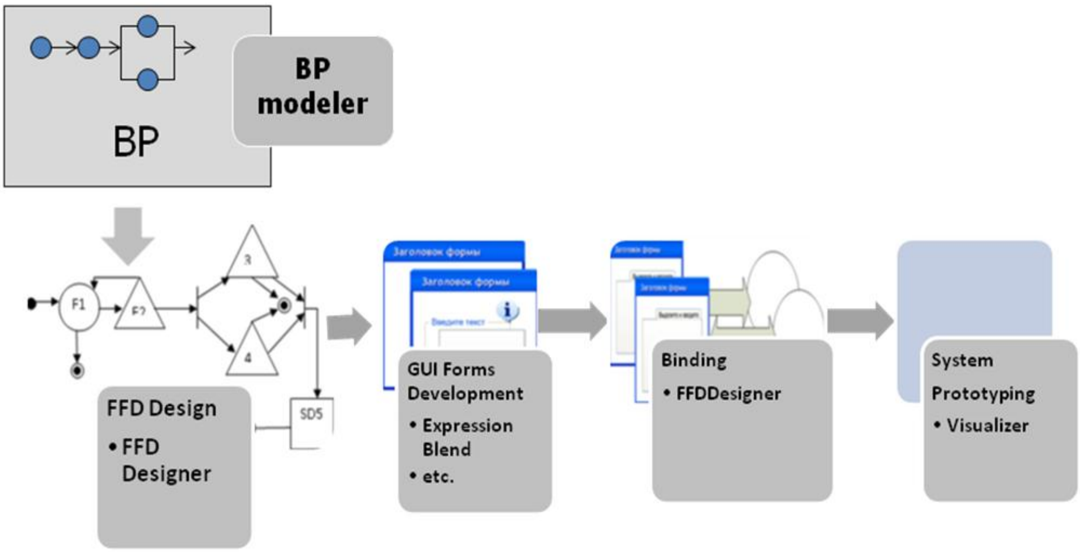

Fig.2 Software environment for IBIS design

IBIS workflow realization

The design stage finishes with the computation model. This model contains the execution order of the stages and the operations inside the stages as well as the description of the operation's input and output data. We propose BPEL [8] a formal description of the execution order and the WSDL [9] "portType" element as formal description of an operation's interface.

The scope of the realization process is now to select and bind web service operations for each operation of each stage of the business process, in order to make it executable. As soon as there are several equivalent candidates realizing the same business process operation a decision has to be made. Mostly the business process's execution time is used as decision criteria, but our approach is flexible enough to handle other properties, like availability or costs as well. Typically the restriction of the business process' quality properties are set as lower or upper bounds, e.g. maximal 50 Euro or minimal 50 % availability. Thus realizing a workflow is an optimization problem, which w. l. o. g. can be defined as the following maximization problem:

- The search space $S = WO_1 \times WO_2 \times ... \times WO_n$ (7);
- The set of goal functions $F = \{ f_k : S \to IR \}$ (8);
- The set of side conditions $N = \{ f_k \succ r \mid f_k \in F, \succ \in \{>, \geq\} \}$ (9).

With $n \in \mathbb{N}$ is the number of operations of the business process, WOi is the set of all web service operations implementing the business operation i and $k \in \mathbb{N}$ is number of goal function.

The search space contains all possibilities, also called execution plans, to make the given computation process executable. The goal is to select that execution plan, which maximizes the values of all goal functions and fulfils the side conditions. At this, each goal function describes the mathematical formula to calculate a certain quality value of an execution plan and the appertaining side conditions defines the restriction of this quality criterion. The optimization is done automatically using the dynamic programming. It is the most efficient and most correct optimization algorithm solving our problem.

The advantage of our approach is the automatically adaptation of the business process to different quality level. Above of all this is very profitable if the process owner has to satisfy several clients who are heterogeneous in their quality requirements.

Conclusions

Suggested method and software environment for IBIS design allow to raise the efficiency of IBIS design and provide fast and low-cost reengineering.

Unified and comprehensive database, business and computing processes modeling, analysis and improvement allow to improve technology of IBIS design and developed IBIS quality, automate design process and decrease human factor influence.

Applying suggested method of IBIS workflow realization, IBIS executable workflow is to be generated, which fulfills a given quality requirements and satisfy several clients, which work in heterogeneous environment.

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