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Narayanaswamy et al.

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(54) **BUSINESS PROCESS OPTIMIZER**

(75) Inventors: **Sreedhara Srinivasulu Narayanaswamy**, Plano, TX (US); **Sudhakar Anivella**, Hyderabad (IN)

(73) Assignee: **CA, Inc.**, Islandia, NY (US)

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(51) **Int. Cl.**
G06F 17/50 (2006.01)

(52) **U.S. Cl.** **703/13**; 717/102; 717/135; 706/45; 705/1.1

(58) **Field of Classification Search** 703/13, 703/22; 717/102, 124, 135; 706/45–48; 705/1.1, 7, 8, 11
See application file for complete search history.

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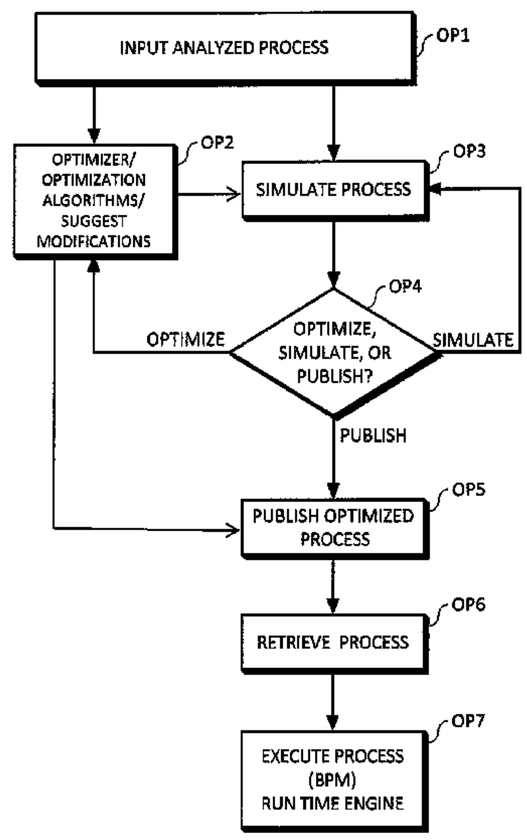
Primary Examiner — Russell Frejd
(74) *Attorney, Agent, or Firm* — Myers Bigel Sibley & Sajovec, P.A.

(57) **ABSTRACT**

A system and method for optimizing enterprise applications driven by business processes is provided. The method for optimizing business processes comprises the steps of obtaining process data, optimizing the process data using algorithms, simulating execution of one of the process data and the optimized process data, publishing the optimized process data, and deploying the published data for execution using a run time engine. In one embodiment, the simulator simulates using both process data and optimized process data. Modifications to process data can be input, and this modified data can be simulated, and also can be optimized.

3 Claims, 8 Drawing Sheets



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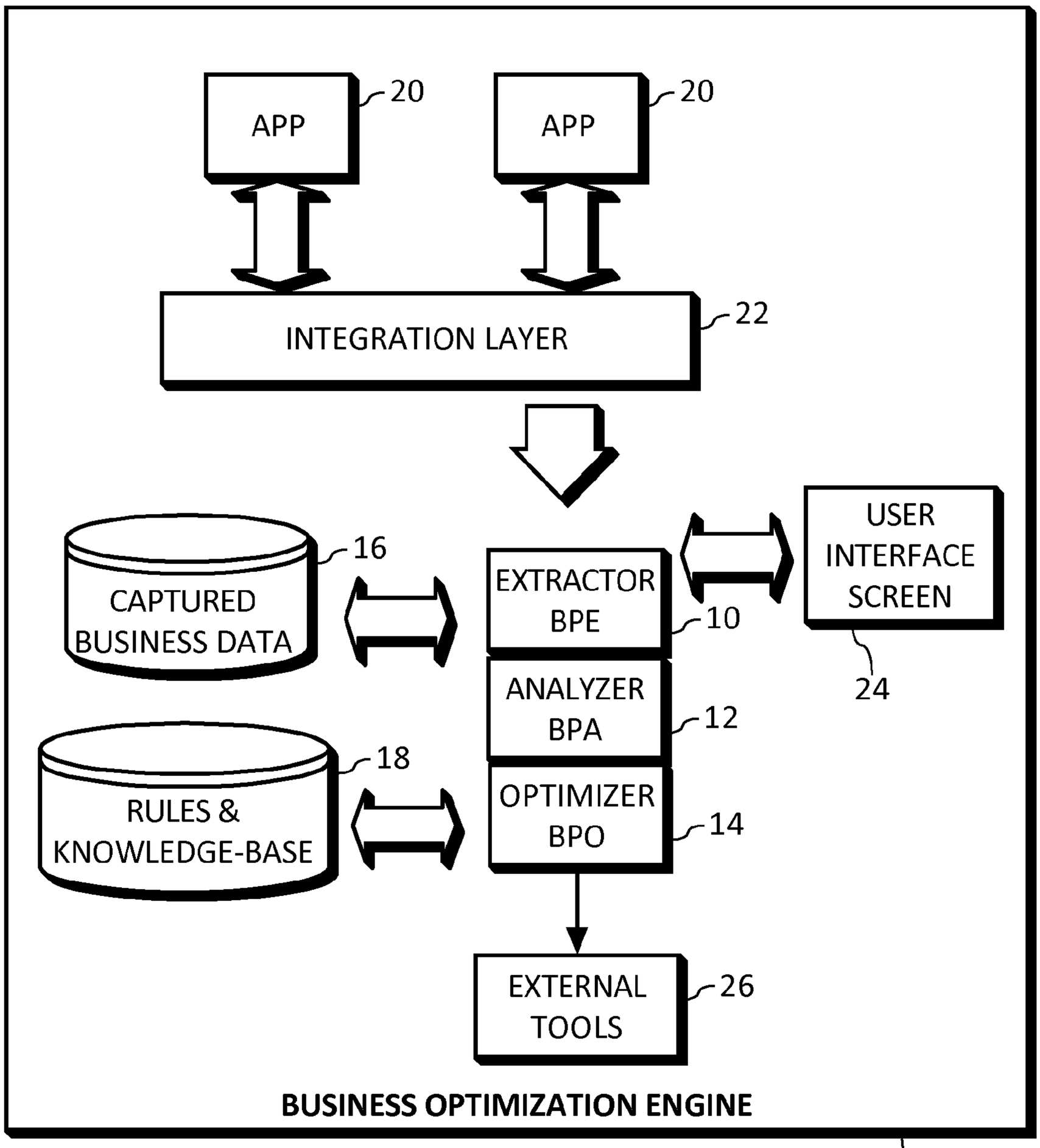
APP
20
APP
20
INTEGRATION LAYER
22
CAPTURED BUSINESS DATA
16
RULES & KNOWLEDGE-BASE
18
EXTRACTOR BPE
10
ANALYZER BPA
12
OPTIMIZER BPO
14
USER INTERFACE SCREEN
24
EXTERNAL TOOLS
26
BUSINESS OPTIMIZATION ENGINE
2

Fig. 1

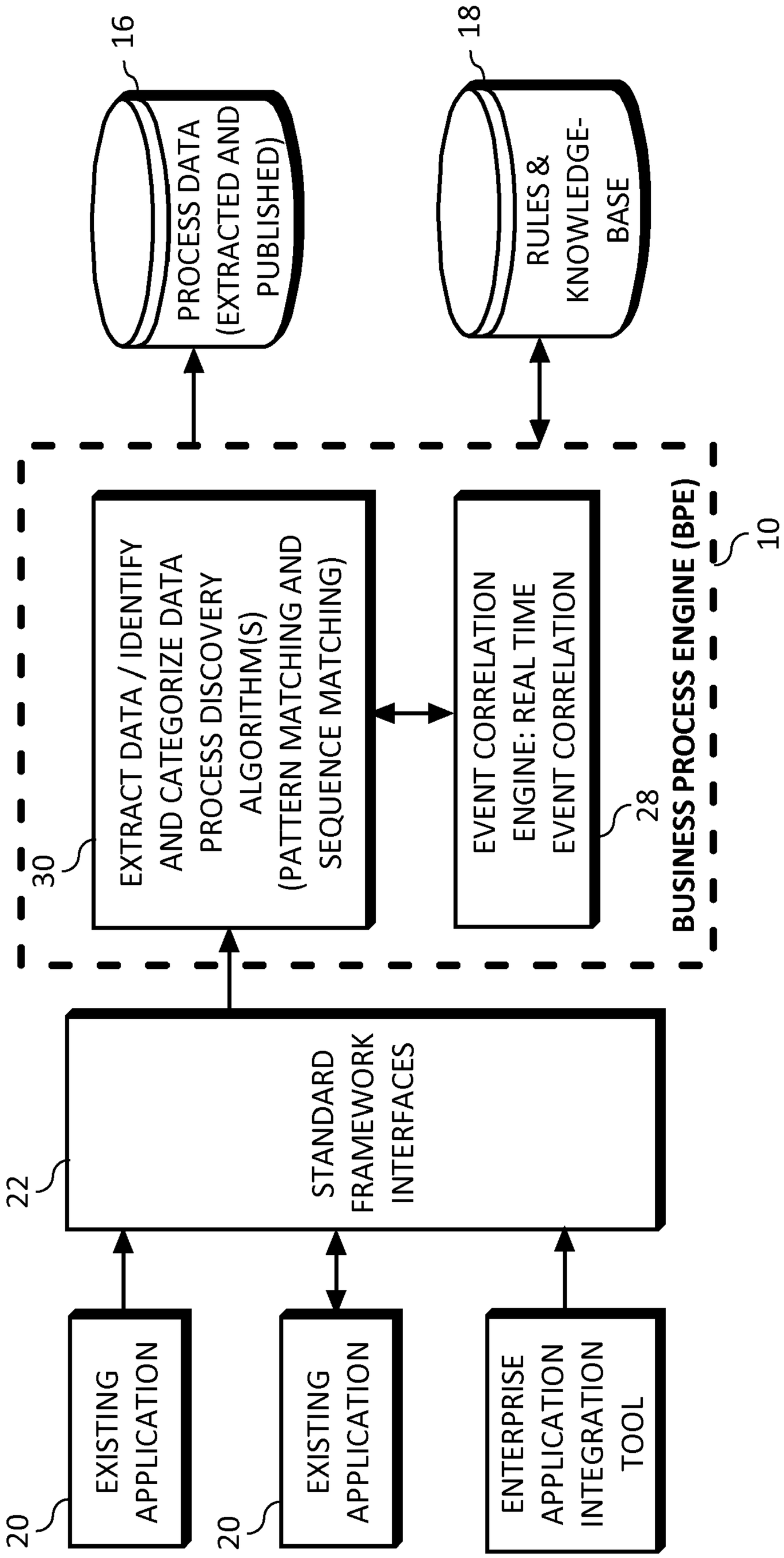
16
PROCESS DATA (EXTRACTED AND PUBLISHED)
18
RULES & KNOWLEDGE-BASE
BUSINESS PROCESS ENGINE (BPE
10
30
EXTRACT DATA / IDENTIFY AND CATEGORIZE DATA PROCESS DISCOVERY ALGORITHM(S) (PATTERN MATCHING AND SEQUENCE MATCHING)
EVENT CORRELATION ENGINE: REAL TIME EVENT CORRELATION
28
STANDARD FRAMEWORK INTERFACES
22
20
EXISTING APPLICATION
20
EXISTING APPLICATION
ENTERPRISE APPLICATION INTEGRATION TOOL

Fig. 2

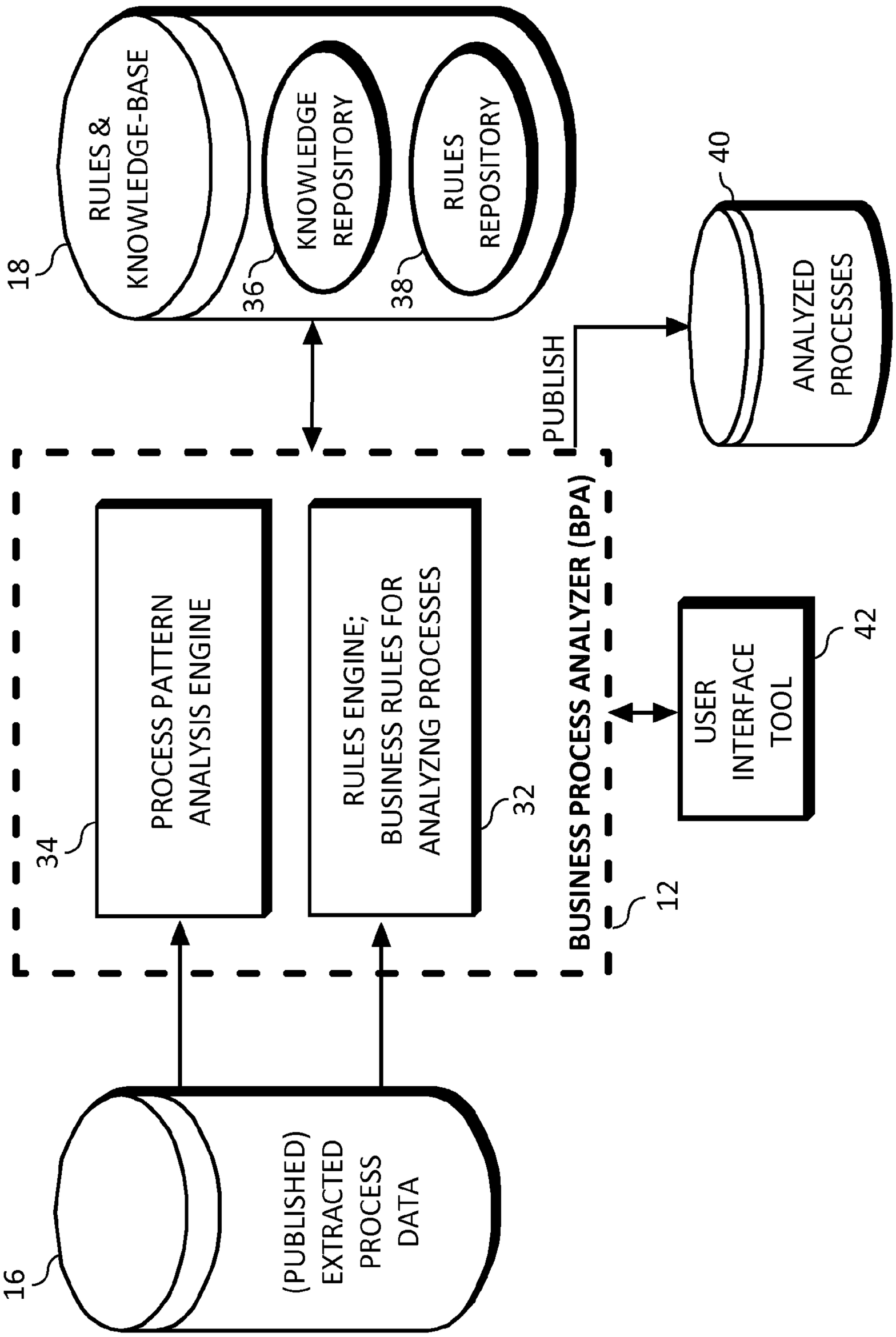
RULES & KNOWLEDGE-BASE
18
KNOWLEDGE REPOSITORY
36
RULES REPOSITORY
38
40
PUBLISH
(PUBLISHED) EXTRACTED PROCESS DATA
ANALYZED PROCESSES
BUSINESS PROCESS ANALYZER (BPA)
12
PROCESS PATTERN ANALYSIS ENGINE
34
RULES ENGINE; BUSINESS RULES FOR ANALYZNG PROCESSES
32
USER INTERFACE TOOL
42
16

Fig. 3

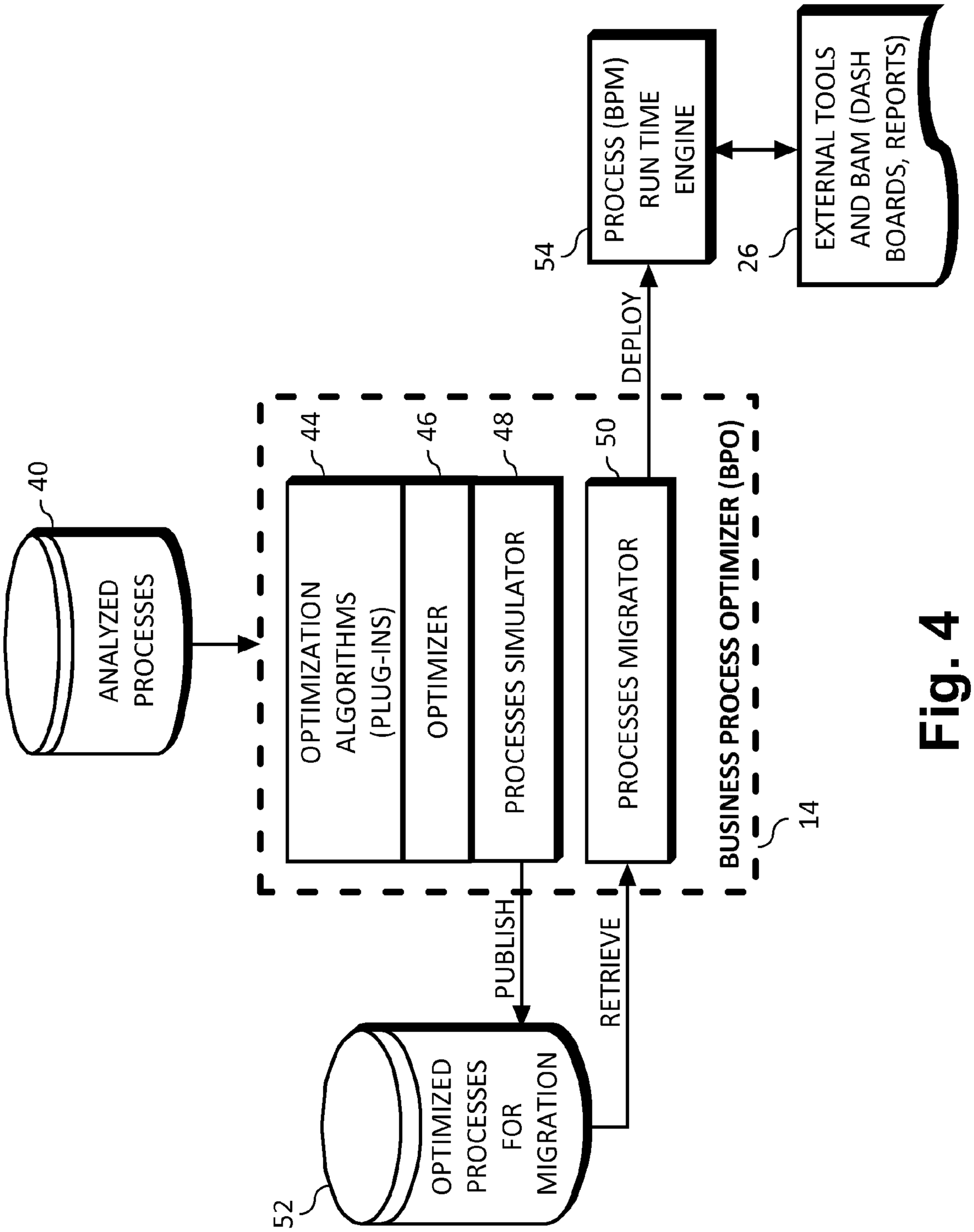
PROCESS (BPM) RUN TIME ENGINE
54
EXTERNAL TOOLS AND BAM (DASH BOARDS, REPORTS)
26
DEPLOY
40
ANALYZED PROCESSES
OPTIMIZATION ALGORITHMS (PLUG-INS)
44
OPTIMIZER
46
PROCESSES SIMULATOR
48
PROCESSES MIGRATOR
50
BUSINESS PROCESS OPTIMIZER (BPO)
14
PUBLISH
RETRIEVE
OPTIMIZED PROCESSES FOR MIGRATION
52

Fig. 4

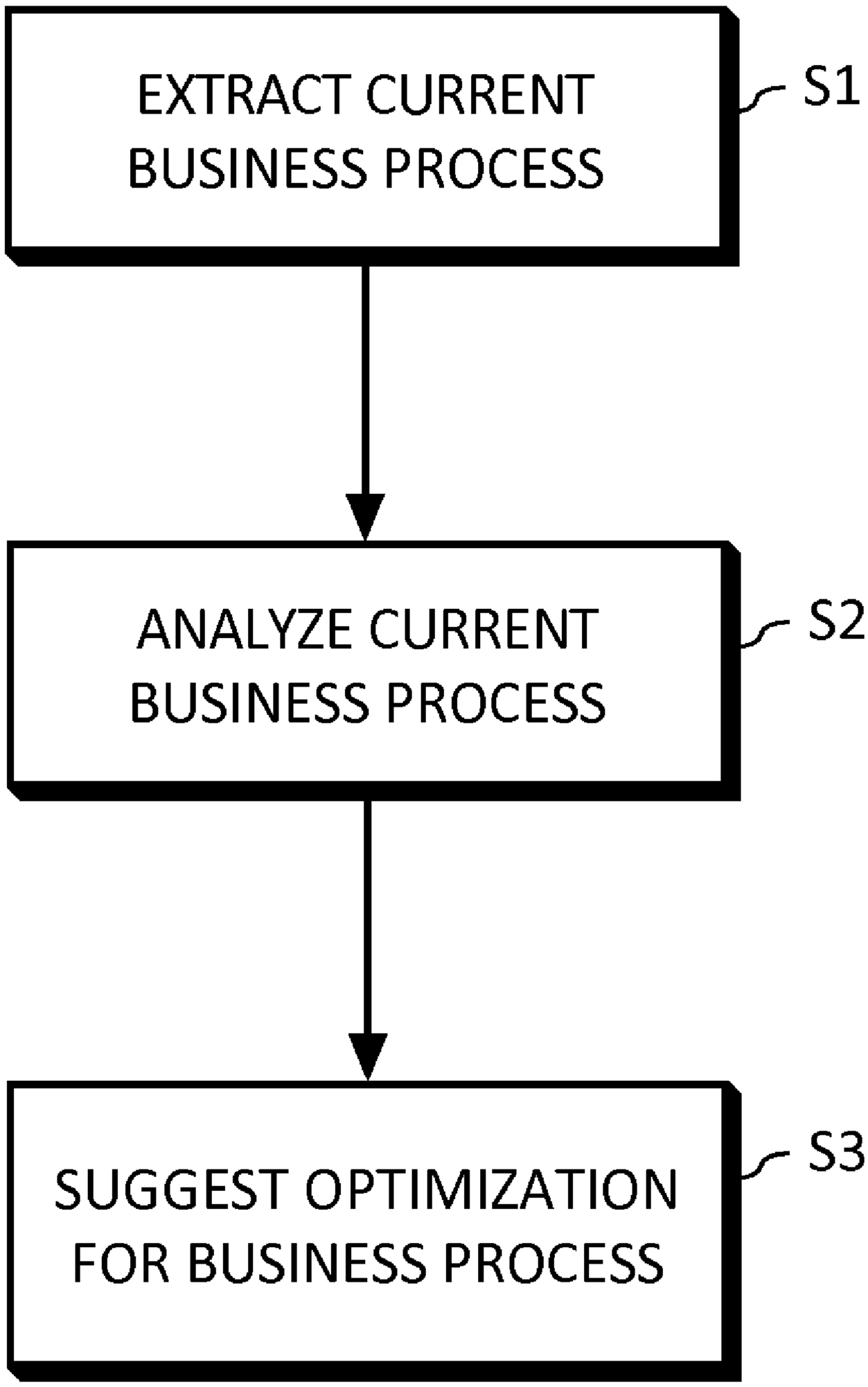
EXTRACT CURRENT BUSINESS PROCESS
S1
ANALYZE CURRENT BUSINESS PROCESS
S2
SUGGEST OPTIMIZATION FOR BUSINESS PROCESS
S3

Fig. 5

Fig. 6

BSO Business Optimization Engine

Extract | Analyze | Export BPML | Status: Optimizing done | Clear

Issue: 123 , **Title:**Mail not working
Priority:P1 , **Date Created:**01/02/2006T11:00:00

Status	Description	Note By	TimeStamp
CREATED	Mail not working	Smith	01/02/2006 T 11:00:00
ASSIGNED	Mail not working	Bob	01/02/2006 T 12:00:00
WORKINPROGRESS	Please detail about it. Are you getting any specific error?	Bob	01/02/2006 T 12:30:00
WORKINPROGRESS	It is displaying an error unable to POP mail from server.	Smith	01/02/2006 T 12:45:00
WORKINPROGRESS	What is the version of Mail?	Bob	01/02/2006 T 12:58:00
WORKINPROGRESS	Mail 2000	Smith	01/02/2006 T 13:08:00

Issue: 124 **Title:**Account Locked
Priority:P2 **Date Created:**01/02/2006T11:16:00

Status	Description	Note By	TimeStamp	Hrs/ Events	Std Hrs./ Events	Deviation (Hrs)	Updated (Hrs:)
CREATED	Account is locked.	Brad	01/02/2006 T 11:16:00	0.0	0.0	0.0	0.0
ASSIGNED	Account is unlocked and reset.		01/02/2006 T 12:01:00	0.75	0.5	-0.25	0.75
WORKINPROGRESS	Account is unlocked. I am able...	Joe	01/02/2006 T 12:12:00	0.18	0.5	0.32	0.18
CLOSED		Brad	01/02/2006 T 12:33:00	0.35	5.0	4.65	0.35
				1.27	**6.0**	**4.73**	

User Input

Issue: 125 **Title:**Unable to access Internet

Issue	Priority	Date Created	Total Time Taken (Hrs.)	Original Time (Hrs.)	Total Deviation (Hrs.)
123	P1	01/02/2006 T 11:00:00	2.45	3.0	0.54
124	P2	01/02/2006 T 11:16:00	1.27	6.0	4.73
125	P2	01/02/2006 T 11:36:00	2.63	6.0	3.37
126	P3	01/02/2006 T 12:59:00	75.14	6.0	-69.14
127	P3	01/02/2006 T 14:34:00	212.22	6.0	-206.22

Original value computed by BPO

Fig. 7

BSO Business Optimization Engine

Extract | Analyze | Export BPML | Status: Optimizing done | Clear

Issue: 123 , **Title:** Mail not working
Priority: P1 , **Date Created:** 01/02/2006T11:00:00

Status	Description	Note By	TimeStamp
CREATED	Mail not working	Smith	01/02/2006 T 11:00:00
ASSIGNED	Mail not working	Bob	01/02/2006 T 12:00:00
WORKINPROGRESS	Please detail about it. Are you getting any specific error?	Bob	01/02/2006 T 12:30:00
WORKINPROGRESS	It is displaying an error unable to POP mail from server.	Smith	01/02/2006 T 12:45:00
WORKINPROGRESS	What is the version of Mail?	Bob	01/02/2006 T 12:58:00
WORKINPROGRESS	Mail 2000	Smith	01/02/2006 T 13:08:00

Issue: 124 **Title:** Account Locked
Priority: P2 **Date Created:** 01/02/2006T11:16:00

Status	Description	Note By	TimeStamp	Hrs/ Events	Std Hrs./ Events	Deviation (Hrs)	Updated (Hrs:)
CREATED	Account is locked.	Brad	01/02/2006 T 11:16:00	0.0	0.0	0.0	0.0
ASSIGNED	Account is unlocked and reset.		01/02/2006 T 12:01:00	0.75	0.5	-0.25	0.25
WORKINPROGRESS	Account is unlocked. I am able...	Joe	01/02/2006 T 12:12:00	0.18	0.5	0.32	0.18
CLOSED		Brad	01/02/2006 T 12:33:00	0.35	5.0	4.65	0.35
				1.27	**6.0**	**4.73**	

New User Input

Issue: 125 **Title:** Unable to access Internet

Issue	Priority	Date Created	Total Time Taken (Hrs.)	Original Time (Hrs.)	Total Deviation (Hrs.)
123	P1	01/02/2006 T 11:00:00	2.45	3.0	0.54
124	P2	01/02/2006 T 11:16:00	0.78	6.0	5.22
125	P2	01/02/2006 T 11:36:00	2.63	6.0	3.37
126	P3	01/02/2006 T 12:59:00	75.14	6.0	-69.14
127	P3	01/02/2006 T 14:34:00	212.22	6.0	-206.22

New process behavior automatically computed by BPO

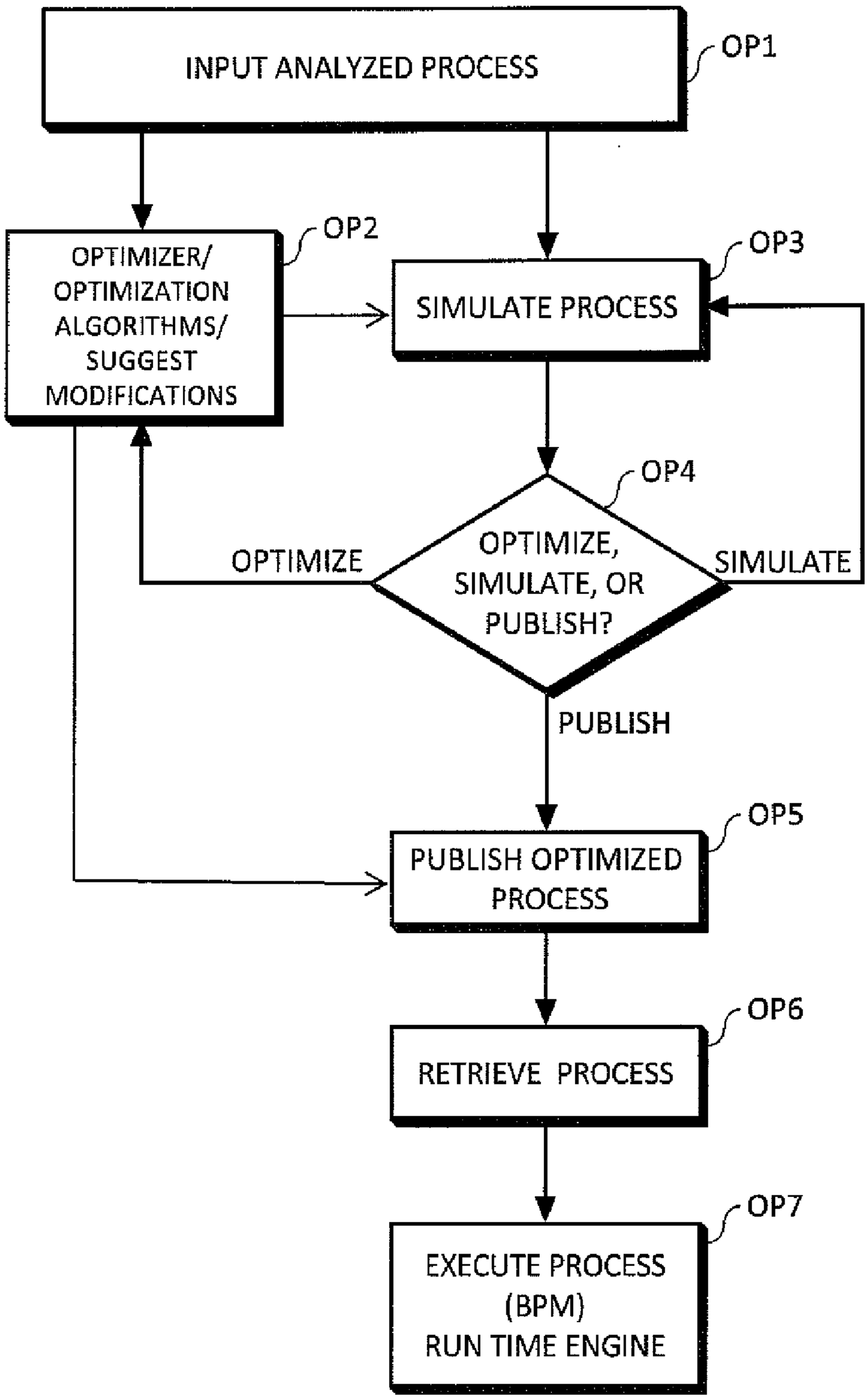
INPUT ANALYZED PROCESS
OP1
OPTIMIZER/ OPTIMIZATION ALGORITHMS/ SUGGEST MODIFICATIONS
OP2
SIMULATE PROCESS
OP3
OP4
OPTIMIZE, SIMULATE, OR PUBLISH?
OPTIMIZE
SIMULATE
PUBLISH
PUBLISH OPTIMIZED PROCESS
OP5
RETRIEVE PROCESS
OP6
EXECUTE PROCESS (BPM) RUN TIME ENGINE
OP7

Fig. 8

BUSINESS PROCESS OPTIMIZER

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is related to the following commonly-owned, co-pending United States Patent Applications filed on even date herewith, the entire contents and disclosure of each of which is expressly incorporated by reference herein as if fully set forth herein. U.S. patent application Ser. No. 12/023,618, for "BUSINESS OPTIMIZATION ENGINE"; U.S. patent application Ser. No. 12/023,741, for "BUSINESS PROCESS EXTRACTOR"; U.S. patent application Ser. No. 12/023,723, for "BUSINESS PROCESS ANALYZER".

FIELD OF THE INVENTION

The present invention relates generally to process optimization technology, and more specifically to a system and method for optimizing enterprise applications driven by business processes.

BACKGROUND OF THE INVENTION

In today's world, continuous optimization of operational methods and procedures is a major focus of all major businesses. However, performing enterprise operations often requires implementing multiple, discrete computer applications. As a result, capturing and understanding operations or business processes that are part of an enterprise's business information technology (IT) solution is critical for any organization's optimization initiative. Among the many challenges faced when trying to understand operations are heterogeneous applications throughout the organization with no uniform way to capture and/or extract information from these applications, business processes that age before the advent of business process management (BPM) tools that are currently used for designing them, a gap between designed processes and executable process, and a need for human investigation to identify problems and suggest improvements for business processes.

U.S. Pat. Nos. 5,734,837 and 6,073,109 disclose a typical workflow engine, that is, a programming tool for workflow. A process can be created based on the workflow. However, neither analysis nor optimization of the process is performed.

U.S. Patent Application Publication No. 2005/0289138 discloses a near real-time system and method that analyzes large amounts of data. While the system uses XML format, it analyzes only data, not processes, and merely reports results. No optimization is performed. Similarly, U.S. Patent Application Publication No. 2005/0154700 discloses an extraction, analysis and processing system for specialized data from service industries. This approach is somewhat like typical data mining systems but focuses on a specific type of data, that of services industries.

U.S. Patent Application Publication No. 2004/0187140 discloses an application framework that may contain business processes. However, no analysis or optimization of the processes is performed.

Among the problems of the aforementioned systems are the lack of a standard way to capture and/or extract information from heterogeneous business applications, and the lack of automated means to identify and interpret business process problems, and to suggest improvements to maximize process results.

BRIEF SUMMARY OF THE INVENTION

The present invention advantageously provides a system and method for optimizing enterprise applications driven by business processes. The system includes a data repository, an extractor to perform real time extraction of process life cycle information from business solutions integrating heterogeneous independent business applications, the extractor storing the extracted information in the data repository, an analyzer to identify usage patterns in the extracted information, and an optimizer to optimize the extracted information and to create exportable output usable by external tools. The analyzer can employ user-defined algorithms and/or rules to identify the usage patterns. The optimizer can use process simulation mechanisms, what-if analysis, data stored in the data repository, data stored in a rule repository, and user input data, in any combination, to optimize the extracted information.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is further described in the detailed description that follows, by reference to the noted drawings by way of non-limiting illustrative embodiments of the invention, in which like reference numerals represent similar parts throughout the drawings. As should be understood, however, the invention is not limited to the precise arrangements and instrumentalities shown. In the drawings:

FIG. **1** is a schematic of business optimization engine architecture;

FIG. **2** is a schematic of the extraction component of the exemplary architecture;

FIG. **3** is a schematic of the analytical component of the exemplary architecture;

FIG. **4** is a schematic of the optimization component of the exemplary architecture;

FIG. **5** is a flow diagram of business optimization engine;

FIG. **6** is a screen display of an exemplary embodiment;

FIG. **7** is another screen display of an exemplary embodiment;

FIG. **8** is a flow diagram of the optimizer component of the exemplary architecture.

DETAILED DESCRIPTION OF THE INVENTION

An inventive solution is presented to the need for a system and method to capture, evaluate, interpret, and optimize business processes that are part of business IT solutions. The disclosed business optimization engine (BOE) solves this problem with a system and method that provides a framework for extracting, analyzing, and optimizing business processes that bind heterogeneous enterprise applications together to deliver business functionality.

BOE provides a framework for operational business intelligence applications that would enable business analysts to understand how current business processes, as implemented in heterogeneous applications, actually perform their tasks, by clearly showing each step or task as well as the interaction among tasks in detail. BOE goes beyond a workflow examination to explore process flows. With its thorough extraction and analysis method, BOE generates a complete and accurate extracted business process from which an improved process can be designed. BOE enables users to discover problems with the current business processes, such as weak spots, bottlenecks, manual steps, and redundancies. Further, BOE offers recommendations for solving these problems by using predefined knowledge and reference models modeling end-to-end business or life cycle processes, as well as individual rules describing various steps of a business process. In addition to providing problem solving recommendations, the

knowledge and reference models create a baseline for future analysis using adaptive learning techniques.

BOE does not require that a specific BPM tool be used in any of the applications. Instead, BOE can monitor messages generated by a variety of applications or middleware, so that integration among multiple applications can be achieved. Each component of BOE can function as a well defined set of web services to achieve seamless integration.

FIG. **1** is a schematic of BOE architecture **2**. BOE **2** consists of three components: a business process extractor (BPE) **10**, a business process analyzer (BPA) **12**, and a business process optimizer (BPO) **14**. Each component is described in more detail below. BOE **2** integrates with general BPM-based applications **20**. An integration layer **22** provides the interface between middleware and/or the applications **20** and BPE **10**. BOE **2** includes a user interface screen **24** described in more detail below. BOE **2** generates and manipulates process data, that is, business data and/or process cycles **16**, and creates a rules and knowledge base **18**. Reports (not shown) can be produced and output, and information can be exported to external tools **26**. Agents can be used within BOE's application framework. In one embodiment, BOE **2** resides on top of CMLINK software.

FIG. **2** illustrates the components of BPE **10**. BPE **10** extracts complete, i.e. end-to-end, process life cycle information from business solutions implemented by integrating heterogeneous independent BPM-based applications **20**. Integration layer **22** includes standard framework interfaces, as well as other interface processes known in the art, and can be used to interface between the applications **20** and BPE **10**. Real time processes are extracted from these applications **20**, enabling creation of an exact "picture", that is a description of the steps, inputs, etc., of each existing process. This picture can illustrate, among other things, gaps within the process.

BPE **10** supports multiple ways of extracting process information. Three such techniques follow, but other extracting methods can be used. One approach employs a plug-in, such as ECM Integration Bridge, which can interpret messages exchanged via an integrated platform. A second technique uses a message "publish and subscribe" mechanism, in which BPE **10** subscribes for specific messages published by the integrated business solution. A third method involves seamlessly inserting stubs into existing applications to expose relevant message data to achieve the extraction. BPE **10** can use these or other extraction techniques in any combination.

The extracted data is then correlated and stored as process data in a data repository **16**. In one embodiment, the message content of the extracted data is inspected using data present in the rules and knowledge base **18** to identify and categorize the process context within the message. Identification and categorization can be performed by process discovery **30** using pattern matching and sequence matching in conjunction with the data in the rules and knowledge base **18**.

Once the process context is identified, BPE **10** correlates the identified message with other related process messages to create a complete end-to-end life cycle. An event correlation engine **28** can perform real time event correlation.

After being correlated, the life cycle or process cycle is published to the data repository as process data **16** in an industry standard format such as business process modeling notation (BPMN) or business process execution language (BPEL). As a result, BPE **10** provides a clear picture of the real time process. Further, extracted life cycle data can be used to determine how many similar cycles are present in the data repository **16** to help identify patterns, and to process usage patterns. The stored process data **16** is further analyzed by the BPA **12** as described below.

FIG. **3** illustrates the components of the BPA **12** shown in FIG. **1**. BPA **12** analyzes extracted process data **16** with a process pattern analysis engine **34**. The analysis can be performed using reference models present in the knowledge repository **36** and/or rules from the rules repository **38** from rules and knowledge base **18**, and identifies usage patterns in the extracted process data or cycles **16**. In addition, this extracted process data **16** is correlated with data in the knowledge repository **36**, which may include analyzed processes **40** previously output from BPA **12**, as discussed below. The process data **16** can be used for identifying bottlenecks and fine-tuning a process. Also, information can be obtained from the analysis of the process data **16**, such as a root cause for a process problem, for example, why the approval process takes so long. The process data **16** can also be used for adaptive learning, that is, adopting an efficient real time process as a standard reference model in the knowledge repository **36**.

Analysis of the process data **16** by BPA **12** in relation to other extracted information from the knowledge/rules repositories **18** can provide insight into existing processes. BPA **12** can promote understanding of the interrelationships among business applications and processes, and can offer details regarding integration of different applications and process re-engineering including conversion of multiple parallel processes performed by different departments, to a single enterprise-level standard process.

A user interface tool **42** enables input and display of information and diagrams, such as extracted processes and/or steps of process data **16** being analyzed. BPA **12** can combine or compare the process data **16** with data from a knowledge repository **36**, best practices, user input, and a rules repository **38** in a rules engine **32** to establish what process is where, what belongs, and how it relates. In accordance with one embodiment, BPA **12** can determine if a similar process has been encountered using data in the rules and knowledge base **18**. Upon completion of the analysis, BPA **12** publishes analyzed processes **40**. Further, based on the analysis, BPA **12** can recommend an integrated solution.

FIG. **4** illustrates the components of the BPO **14**. These components include process optimization algorithms **44**, an optimizer **46**, a process simulator **48**, and a process migrator **50**. Optimization algorithms **44** can include algorithms that perform "what if" analysis, heuristic methods of optimization, and other techniques. Multiple optimization techniques can be combined. The optimizer **46** suggests required modifications to the analyzed processes **40**. The process simulator **48** simulates the processes **40** to determine how they perform. Optimized processes **52** are published for migration and can be input to the process migrator **50**. The process migrator **50** outputs processes to a standard run time engine **54** and/or to external tools **26** such as business activity monitoring (BAM) tools for obtaining reports.

BPO **14** uses information stored in the knowledge/rules repositories **18** to optimize an analyzed process **40**, creating an optimized process **52**. In one embodiment, a business analyst can interact with the system to manually optimize an analyzed process **40**.

FIG. **8** shows the flow of BPO **14** in accordance with the architecture illustrated in FIGS. **1** and **4**. In step OP**1**, analyzed process data or life cycle **40** is input to the optimizer **46** of BPO **14**. The optimizer **46** processes this data using optimization algorithms **44**, and suggests required modifications to the analyzed process data **40** in step OP**2**. These algorithms for optimization **44** can be implemented using pluggable interfaces.

In step OP3, the process or life cycle **40** is simulated and its performance is monitored. The simulation can occur prior to optimization, using analyzed process data **40** as input. In the alternative, or in addition, the simulation can be performed on a process that has been optimized in the optimization step OP**2**. Also, the simulation can compare an optimized process with a non-optimized process. After simulation in step OP**3**, the next activity, optimize, simulate, or publish, is determined in step OP**4**. Hence, either the process **40** is optimized (again) in step OP**2**, the process **40**, including user modifications, is simulated again in step OP**3**, or the process **40** is published, in step OP**5**, as an optimized process **52**.

The published optimized process **52** is retrieved in step OP**6** by the process migrator **50**, which deploys the optimized process **52** to the process run time engine **54** in step OP**7**. In step OP**8**, the run time engine **54** executes the optimized process **52** in accordance with external tools **26** including business activity monitoring (BAM) tools, and creates displays and reports about the optimized process **52**.

FIG. **5** is a flow diagram for an exemplary embodiment of BOE **2** as illustrated in FIG. **1**. In step S**1**, the BPE **10** extracts one or more current business processes **16** from BPM-based applications **20**. These business processes **16** are stored as extracted process data **16**, and individually analyzed by the BPA **12** in step S**2**. The analysis can include identifying usage patterns, comparing extracted processes **40** with pre-defined processes in the rules repository **38**, and other techniques. Upon completion of the analysis, analyzed processes **40** are output. In step S**3**, based on the analysis, BPO **14** provides optimization suggestions for each individual process **40** analyzed in step S**2**. In one embodiment, current business processes can be monitored.

FIGS. **6** and **7** show a sample user interface screen **24** for one embodiment of BOE **2**. The top portion of the screen displays a process flow for Issue **123** and the middle portion of the screen displays a process flow for Issue **124**. This data has been extracted by BPE **10** and saved as extracted process data **16**. As shown in FIGS. **6** and **7**, each entry or activity in the process flow includes a status, a description, a "note by" employee, and a time stamp. These items are displayed on both the screen's top portion and the screen's middle portion. The screen's middle portion also includes analysis and displays the actual hours each event took (Hrs./Event), along with a standard number of hours per event (Std Hrs./Event) obtained, for example, from a rules repository **38**. The deviation or difference between actual and standard is calculated and displayed (Deviation (Hrs.)) along with an updated column (Updated (Hrs.)) in which "what-if" analysis can be performed. The updated column is initially populated with the data from the actual hours/event column, as shown in FIG. **6**. A user can perform "what-if" analysis by changing one or more entries in the updated column. FIG. **7** illustrates a "what-if" analysis, described in more detail below.

The screen's bottom portion, shown in FIGS. **6** and **7**, illustrates optimized process outcome for multiple extracted process flows, including the Issue **123** displayed in the screen's top portion and the Issue **124** displayed in the screen's middle portion. Changes in the updated column in the middle portion are reflected in the corresponding row of the bottom portion. As shown in FIG. **7**, the user changed the ASSIGNED row for Issue **124** in the screen's middle portion from 0.75 (Hrs.) to 0.25 (Hrs.). This resulted in the "total time taken" column in the top row of the screen's bottom portion, that is, the row for Issue **124**, changing from 1.27 (Hrs.) to 0.78 (Hrs.), and the "total deviation" column changing from 4.73 (Hrs.) to 5.22 (Hrs.). The "total deviation" is computed by BPO **14** as the "total time taken" subtracted from the "original time", that is, the amount of time originally allocated for the task. The original time can be obtained, for example, from the rules repository **38** or knowledge repository **36**.

BOE **2** seamlessly translates the identified process in the form of BPMN and/or BPEL. Translated business processes can be exported to external tools **26** like MS Visio®. This feature simplifies the making of process changes, by enabling the use of any tool that supports BPEL and BPMN standards to implement changes. Accordingly, BOE **2** not only helps in identifying bottlenecks in the existing solutions but also improves performance of the solutions to the optimum level.

While the present invention has been described in particular embodiments, it should be appreciated that the present invention should not be construed as limited by such embodiments, but rather construed according to the below claims.

What is claimed is:

1. A method for optimizing business processes, comprising:

extracting information from the integration of heterogeneous applications within an organization;

analyzing process data from the extracted information using user-defined algorithms and reference models from a knowledge repository to identify processes in the extracted information;

optimizing the identified processes using adaptive learning to generate optimized processes including suggested modifications to the identified processes and to place the optimized processes into the reference models in the knowledge repository;

simulating said optimized processes to determine how they perform;

publishing said optimized processes; and

deploying said published data for execution using a run time engine.

2. A computer readable storage medium having a computer readable program for operating on a computer for optimizing business processes, said program comprising instructions that cause the computer to perform:

extracting information from the integration of heterogeneous applications within an organization;

analyzing process data from the extracted information using user-defined algorithms and reference models from a knowledge repository to identify processes in the extracted information;

optimizing the identified processes using adaptive learning to generate optimized processes including suggested modifications to the identified processes and to place the optimized processes into the reference models in the knowledge repository;

simulating said optimized processes to determine how they perform;

publishing said optimized processes; and

deploying said published data for execution using a run time engine.

3. A system for optimizing business processes, comprising:

an extractor for extracting information from the integration of heterogeneous applications within an organization;

an analyzer for analyzing process data from the extracted information using user-defined algorithms and reference models from a knowledge repository to identify processes in the extracted information;

an optimizer for optimizing the identified processes using adaptive learning to generate optimized processes including suggested modifications to the identified processes and for placing the optimized processes into the reference models in the knowledge repository;

a simulator for simulating said optimized processes to determine how they perform;

a process migrator;

a user interface tool for displaying said optimized processes; and

a run time engine, wherein said simulator publishes said optimized process data and said process migrator deploys said published process data to said run time engine.

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