



SAP RESEARCH

SYSTEMATIC THOUGHT LEADERSHIP FOR INNOVATIVE BUSINESS

# The Way to New ERP Horizons

**From Monoliths to Molecules, and  
How They All Can Make Humpty-Dumpty Whole Again**

Matthias Kaiser, Ph.D.

Sr. Research Scientist, SAP Research

Visiting Scholar at the Computational Logic Group, CS Dptmt. at Stanford University

THE BEST-RUN BUSINESSES RUN SAP





**SAP's ERP History: The Age of the Dinosaur**

**Problems with the Traditional Approach**

**A new Architecture for new Demands: ERP in Pieces**

**Still too much Tailoring**

**The Start is the Goal: POEM**

**With a little Help from my Friends:  
How Machine and User Benefit from Each Other**

- Founded 1972 in Germany
- Largest business application and enterprise resource planning solution software provider

- Integration of all data and processes
  - Realized in multiple components
  - Into a single, unified system

- R/3 stands for real-time data processing
- Based on a three-tier architecture:
  - **Database servers**
    - Management of documents, meta and master data
  - **Application servers**
    - Hosting application software
  - **Clients**
    - Interfaces for user-system interaction

- Business Intelligence Suite (Information Warehouse + Analytics)
- Customer Relationship Management (CRM)
- Supply Chain Management (SCM)
- Supplier Relationship Management (SRM)
- Human Resource Management Systems (HRMS)
- Product Lifecycle Management (PLM)
- Exchange Infrastructure (XI)
- Enterprise Portal (EP)
- Knowledge Warehouse (KW)

- **Systems tend to be very monolithic**
  - Envisaged advantage of integrated systems becomes a burden because relationships between modules become too complex to manage
  
- **Systems are hard to implement**
  - Systems are used in many different types of organizations, so they are heavily parameterized
  - To adjust all parameters appropriately to organizational needs is a very difficult and time-consuming implementation process, often over many periods of refinement cycles
  
- **The structure of systems essentially reflects the business-functional structure of an organization (a module reflects the business function of a whole department)**
  - This makes it hard to realize processes crossing traditional business-function boundaries
  - It makes the reaction to changing business processes or adhoc business process demands nearly impossible

# Requirements for a new ERP System Approach

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- Realize system components which are flexibly composed into applications
- Aid composition and parameterization of components for composition
- Provide possibility for easy adaptation to specific user needs regarding business structure to make changes of software to new demands manageable
- Allow for the possibility to integrate third-party or customer-proprietary solutions into the system

- Enterprise SOA is “an open architecture for adaptive business solutions”
  
  - Objectives:
    - Support rapid
      - Design
      - Development
      - Discovery
      - Consumption
- of standardized services across an enterprise

- Fundamental building blocks are enterprise services
  - Enterprise services are composite web services that support a process step meaningful in a business process
  - They can be seen as wrappers of business objects, providing business logic for their manipulation
  - They are described according to their requirements, deliveries, behavior in a standardized way
- A business object is an identifiable business entity (customer, product)
  - It can have complex structure and is manipulated by services through interfaces
- A business process is a sequence of business-relevant process steps towards a business goal
- Enterprise service repository
  - Provides information about services and business processes
- Business object specifications
- Service descriptions
- Business processes

1. Given a business process scenario
2. Design a business process model
3. Derive a choreography for the available services to instantiate the business process model
  - Building blocks are enterprise services (composed from lower level services) residing in the enterprise service repository
  - Services are used to compose applications
  - An application is built by combining multiple services. A composite application consists of functionality drawn from several different sources within a service oriented architecture (SOA)
  - The components may be individual web services, selected functions from within other applications, or entire systems whose outputs have been packaged as web services (often legacy systems)

- Existing applications can easily be modified/extended through the injection or extension with new services
- New and proprietary business processes can be composed from reusable available services or based (partially) on newly created services
  - This reduces the time for customizing and configuring of new (auxiliary) applications

- Processes have to be composed in advance to meet (potentially) relevant business goals
- Maintenance of composed processes is very high, especially to ensure consistency with a changing business process environment
- Changing components require re-tailoring of composed processes

## ■ Idea:

- Semantics of services are described using standardized means
- Rules/policies/laws are explicitly represented in the system (standardized)
- Business goals can be entered as declarations
- Given a goal and a current context (situation, constraints), a process can be generated mainly using deductive synthesis on the basis of available services (their descriptions) and under the constraints of relevant policies

**The heart of our research approach are policies.**

- **Policies are the rules and regulations set by the organization.**
- **They can be manifested as specifications, constraints on services, or contract criteria. They determine the constraints and laws of a business.**

## Hypothesis

- **Business objects are analogous to physical objects.**
- **Policies are analogous to physical laws.**
- **Services change objects within the constraints of policies.**

## Business Process in Enterprise Physics Universe

- **Goal description.**
  - ◆ **Properties and relations of business objects of and between business objects are declared.**
- **The current business situation (current properties and relations of and between business objects) is known.**
- **Business policies are declared.**
- **Processes are composed by orchestration of services to transform the actual situation into a situation in which the declared goal is true under the declared policies.**

## ■ General benefits of the new approach

- Processes can be “developed” fast without human programming. Human programmers do not have to deal with the complexities of process development, customization and integration.
- Fast realization of processes to meet flexibly changing ad hoc business goals.
- Complete adherence and consistent interpretation of policies during process generation (no interpretations conjectured by programmers).
- Processes can be proven with regards to their validity on the basis of theorem proving.
- Knowledge about company policies is well-maintained in the system (instead scattered in heads of experts).

# POEM Example – Situation, Goal, and Process

## Initial situation

- Car tire dealer “John’s Tire Center”
- Accepts “Dave’s” order of four “GS21” high-performance tires
- GS21 not on stock

## Goal

- Bill Dave for his order of four GS21 tires.

## Expected business process

- Contact tire manufacturer “Best Tire and Rubber”
- Procure 100 GS21 due to special conditions for large orders
- Best Tire and Rubber delivers the 100 tires, and sends invoice to John’s Tire Center
- Pay Best Tire and Rubber’s bill
- Ship the four GS21 and customer invoice to Dave



## General constraints of policy-oriented enterprise management systems

- A bill can be issued for a shipment.
- A shipment can be executed from stock.
- If a shipment cannot be fulfilled from stock, the goods to be shipped must be acquired from an appropriate supplier.
- Goods will be procured from a supplier only if needed.
- A bill from a supplier has to be paid.
- No shipment is done without a prior order.

## Constraints of John's Tire Center

- We procure any types of tires only from Best Tire and Rubber.
- We procure GS21 from Best Tire only in amounts equal to or larger than 100 pieces in a single purchase order. (due to special deals)

## Transformation to the enterprise physics domain

### ■ Prerequisite

- ◆ Policies and situation description are logically *satisfied* statements
  - Example 1: The fact that there is an order of four tires from Dave.
  - Example 2: The constraint that each ordered item not on stock must be procured.
- ◆ Goal is logically *unsatisfied* statement
  - Example: It is not yet true that there is a bill for Dave's order.

### ■ Goal identification

- ◆ Identify goal in a way that it can be decomposed into sub goals to be matched by services regulated by policies
- ◆ Results in business specification of the goal for transformation into technical use case description
- ◆ After refinement, actual use case is derived in appropriate form for processing, ranging from BPMN to first order predicate calculus (FOPC)
- ◆ Supported by system through proposing matching services and policies

## Reaction of the enterprise physics system

- Technically, goal constitutes inconsistency in the logical data base
- A planner helps to organize the sequence of sub goals, assigns services to realize them under given policies / constraints
- Executing the plan resolves the inconsistency

## Goal identification

- Goals of business processes are often complex and difficult to state by a user correctly
- How can the system help the user to determine correct (potentially) achievable goals on the basis of an initial situation and available resources (services, policies, ...)?

## Semantic data integration and inter-operability

- We have to analyze which formal languages can meet our needs and have the scope required stretching over descriptions of services, policies, processes, human information exchange, and so on.
- Alternative: explore controlled natural language as "lingua franca" for communication between humans and machines, and perhaps between machines.

## Dynamic Web service integration

- We have to find a method to integrate Web services into a plan to achieve a business goal specified by the user.
- It has to handle service discovery, consumption, composition and verification.
- Critical is that it can reuse successful former plans.

## Policy acquisition, formalization, modification, monitoring, detection and handling inconsistencies and incomplete data is crucial

- How can we transfer policies from complicated wording into clear logic?

## Processes have to be documented for human understanding and inspection

- How do we do documentation of dynamically generated processes?

## ■ Objectives:

- Determination and description of context phenomena in a software environment achieving "real world awareness" for situation description
- Assistance in formulating achievable process goals based on resources and context
- Decision support for conflict resolution, policy acquisition and monitoring
- Explanation of generated process designs (proofs)
- Automatic generation of process design documentation

- Alert discovery / prioritization
- Find cases on similar situations
- Determine relevant situation constituents on the basis of service requirement descriptions and policies (if policies are violated, alert is triggered)

- Receives alerts from situation analyzer
- Receives goals achieved in similar situations
- Determines validity of goals based on service delivery descriptions and given situation constituents under established policies

- Generation of process step justifications based on service deliveries/situation constituents under policies
- Can generate justifications for feasibility of alternative steps

- Report of conflicts (alternative generation progress possibilities)
- Reports conflicts (requirements with policies...)
- Accepts input for simulation from user (e.g., policies)
- Recommends valid ways to proceed

- Generates documentation/specification from proofs (or process notations)
- Outputs in form human - and machine readable
- Accepts specification criteria to meet user purposes
- Can generate hypertext documents for information on demand

## ■ Conceptual / Data Level

- ESR = service descriptions, policies process models...
- Sensor data
- Case base of processes
- Ontologies
- POEM

## ■ Inference Level

- Situation analyzer, goal recommender, guide, explainer, documenter

## ■ Presentation / Interaction Level

- Interface components

- Traditional ERP systems are too inflexible to be customized, used and modified in real companies
- Enterprise service-oriented architecture provide the means for flexible composition of business processes but requires more intelligent ways to build business processes from the resources available on the basis of achievable goals
- Users need to identify process goals which are achievable in a given software environment, they want to understand the decisions made by an intelligent process design system, they need to provide their knowledge to the system and have to refine their resources for further better business process design.



# Further Information

E-Mail-Address: [matthias.kaiser@sap.com](mailto:matthias.kaiser@sap.com)

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