

# PROCEEDINGS

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of the Union of Scientists - Ruse

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Book 5  
**Mathematics, Informatics and  
Physics**

Volume 10, 2013



RUSE

**The Ruse Branch of the Union of Scientists in Bulgaria**

was founded in 1956. Its first Chairman was Prof. Stoyan Petrov. He was followed by Prof. Trifon Georgiev, Prof. Kolyo Vasilev, Prof. Georgi Popov, Prof. Mityo Kanev, Assoc. Prof. Boris Borisov, Prof. Emil Marinov, Prof. Hristo Beloev. The individual members number nearly 300 recognized scientists from Ruse, organized in 13 scientific sections. There are several collective members too – organizations and companies from Ruse, known for their success in the field of science and higher education, or their applied research activities. The activities of the Union of Scientists – Ruse are numerous: scientific, educational and other humanitarian events directly related to hot issues in the development of Ruse region, including its infrastructure, environment, history and future development; commitment to the development of the scientific organizations in Ruse, the professional development and growth of the scientists and the protection of their individual rights.

The Union of Scientists – Ruse (US – Ruse) organizes publishing of scientific and popular informative literature, and since 1998 – the “Proceedings of the Union of Scientists- Ruse”.

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**BOOK 5**

**"MATHEMATICS,  
INFORMATICS AND  
PHYSICS"**

**VOLUME 10**

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This is the jubilee 10-th volume of book 5 Mathematics, Informatics and Physics. The beginning was in Spring, 2001, when the colleagues of the former section Mathematics and Physics decided to start publishing our own book of the Proceedings of the Union of Scientists – Ruse. The first volume included 24 papers. Through the years there have been authors not only from the Angel Kanchev University of Ruse but as well as from universities of Gabrovo, Varna, Veliko Tarnovo and abroad – Russia, Greece and USA.

Since the 6-th volume the preparation and publishing of the papers began to be done in English.

The new 10-th volume of book 5 Mathematics, Informatics and Physics includes papers in Mathematics, Informatics and Information Technologies, Physics and materials from the Scientific Conference ‘Information Technologies in Education’ (ITE), held at the University of Ruse in November 2012 in the frame of Project 2012-FNSE-02.

## SYSTEMS FOR AUTOMATED SOFTWARE DEVELOPMENT

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**Abstract:** This paper presents some of the systems (the most famous ones) for automated software creation/generation and the stages of software development, as well as its documentation.

**Keywords:** Computer Science, program generation, software generation.

### INTRODUCTION

In many places people work in the automatic software generation area. That is a problem, connected not only with human resources and saving time for development. Program generation allows creating syntactically clear and logically correct units – that is connected with time and price for software development, too. There is another reason as well – sometimes it's difficult to find the suitable specialist to create the necessary correction in a software unit.

Another important point is the product or project documentation creation - it takes too much time and resources. This documentation has to respond to different requirements depending on the country or company it was created by. One of the prerequisites for their unification, in addition to the national and international standards, is the IBM's acquisition of Rational Software Corp. (2003) with its iterative software development process framework ( RUP ).

This article presents some of the leading systems in this area.

### DETAILED DESCRIPTION

#### 1. IBM WebSphere Lombardi [3]

This product is one of the leaders in the Automated generation and/or editing the existing three-tier client-server applications for corporate users. It is working in entirely pleasant and comfortable graphical interface. There are subsystems to create and edit SQL-database, to generate custom client interfaces (which will run through the browser on the client), to describe processes through UML, to generate business logic [6] (servlets and scriptlets, using UML functional description) and others.

Two types of languages are used mainly for business processes management [2] and their automation: BPML (Business Process Modelling Language) and BPEL (Business Process Execution Language). The second group is presented by XML, Java, Java Script, etc. In this group, using some kind of process description (according the certain rules – as data-flow diagram for example) working WEB-pages for database services are generated.

IBM WebSphere Lombardi comprises a number of components (Table 1):

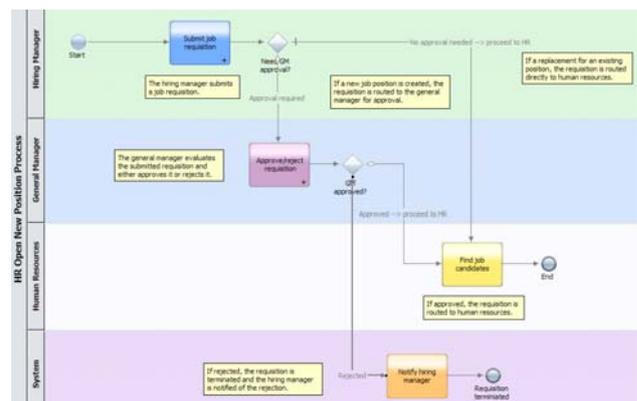


Fig.1 – IBM WebSphere Lombardi - BPML subsystem (editor)

Table 1. IBM WebSphere Lombardi components

Component	Function/Description
Process Center	Provides storage and centralized (single) development environment for many processes creating in <b>Process Center Console</b> and other interfaces in <b>Lombardi Authoring Environment</b> . Includes a <b>Process Center Server</b> and <b>Performance Data Warehouse</b> to enable the processes and applications creation and execution, so and store statistics and performance testing during development.
Process Server	Implements in <b>Lombardi Authoring Environment</b> the processes and the services in-store Process Center in a position to install them in execution environment.
Performance Data Warehouse	Collects and integrates process data in accordance with the requirements established in <b>Lombardi Authoring Environment</b> .
Process Center Console	Allows <b>Lombardi repository</b> management, including process applications management, workspaces, and instant copies. Also allows applications process installation on <b>Process Server</b> in the execution environment.
Authoring Environment	<b>Lombardi Authoring Environment</b> consists of several interfaces, that allow process creators to model, implement, simulate and verify business processes..
Process Portal	Provides an interface, allowing the actors in process to perform assigned tasks, to view task history, to view statistics of their processes. Using the <b>Process Portal</b> , the participants' process can be connected to the <b>Process Center Server</b> or a <b>Process Server</b> in any configured runtime environment, such as test environment and execution environment for example.
Process Admin Console	Provides an interface that allows administrators to set <b>Lombardi Process Server</b> for arbitrary execution environment, as an execution or testing environment, for example. It also allows administrators to set the <b>Process Center Server</b> and to manage it
Performance Admin Console	Provides an interface that allows administrators to set <b>Lombardi Performance Data Warehouse</b> for any run-time environment combination, such as testing or normal operation. Also enables administrators to configure and manage the <b>Performance Data Warehouse</b> , included in the <b>Process Center</b>

### The Lombardi Architecture [4]

The diagram in Fig. 2 illustrates a typical **IBM WebSphere Lombardi Edition** configuration[4].

From **Lombardi Authoring Environment** many users can connect to **The Process Center**

- In **Lombardi Authoring Environment** users create process models and supporting applications (process applications) and store those applications and associated items in the **Process Center** repository.

The **Authoring Environment** users, incorporated into the **Process Center**, can enjoy together the individual elements.

- **Process Center** includes a **Process Center Server** and **Performance Data Warehouse**, allowing users working in **Lombardi Authoring Environment** to carry out their application processes and store statistics for testing and reproduction during development.

- From the **Process Center Console** administrators install application processes that are ready for establishment, testing and operation in **the Process Servers** in the appropriate environment.

- From the **Process Center Console** the administrators manage the performance of instances of process applications in all configured environments.

- From the **Process Portal** the end users perform respective tasks. **Process Center Server** and **Process Servers** in configured execution environments can run application processes that are necessary for the according tasks.

- Using the **Process Portal** participants can connect to **Process Center Server** or **Process Server** in any configured run-time environment depending on whether the corresponding process is in elaboration, testing or is already established in the execution environment.

- **Lombardi Performance Data Warehouse** retrieves regularly tracking data from the **Process Server** or the **Process Center Server** at regular intervals. Users can create and view reports, based on this data, in **Lombardi Authoring Environment** and **Process Portal**.

- From **Process Admin Console** and **Performance Admin Console** the administrators can manage all **Lombardi** servers.

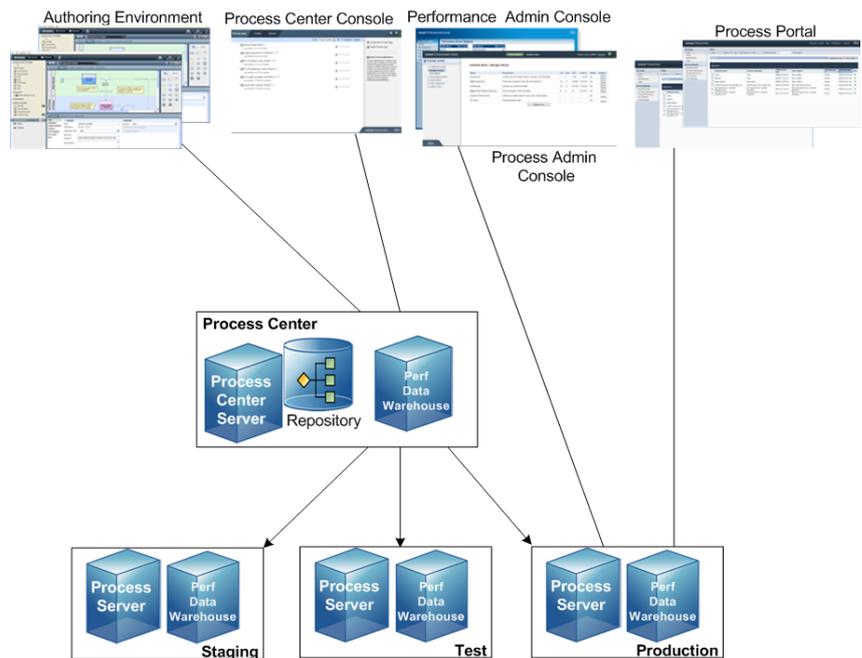


Fig. 2 - Calendar view of events

## 2. Enterprise Architect

**Sparx Systems Enterprise Architect [1]** is a visual modelling and design tool (Fig. 3) based on the [OMG UML](#). The platform supports: the design and construction of software systems; modelling business processes and modelling industry based domains. It is used by businesses and organizations to not only model the architecture of their systems, but also to process the implementation of these models across the full application development life-cycle.

## Overview

Systems modelling using UML provides a basis for modelling all aspects of organizational architecture, along with the ability to provide a foundation for designing and implementing new systems or changing existing systems. The aspects that can be covered by this type of modelling range from laying out organizational or systems architectures, business process re-engineering, business analysis, and service oriented architectures and web modelling, through to application and database design and re-engineering, and development of embedded systems.

Along with system modelling, Enterprise Architect covers the core aspects of the application development life-cycle, from requirements management through to design, construction, testing and maintenance phases, with support for traceability, project management and change control of these processes, as well as, facilities to model driven development of application code using an internal integrated-development platform.

The user base ranges from programmers and business analysts through to enterprise architects, in organizations ranging from small developer companies, multi-national corporations and government organizations through to international industry standards bodies.

Sparx Systems initially released Enterprise Architect in 2000. Originally designed as a UML modelling tool for modelling UML 1.1, the product has evolved to include other OMG UML specifications 1.3, 2.0, 2.1, 2.3 and 2.4.1.

## Supported Standards

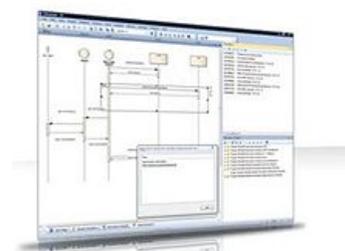
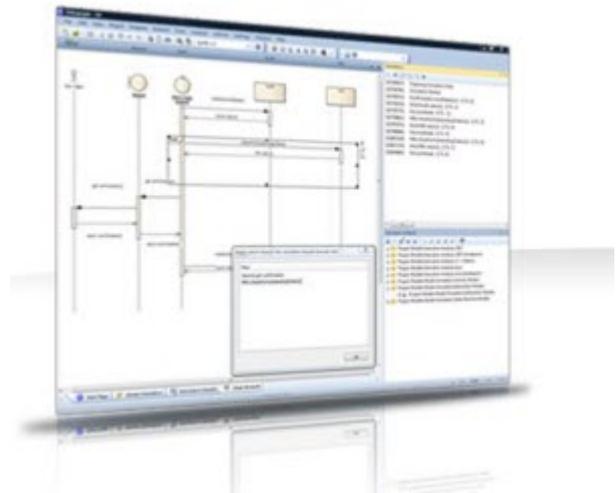
**Enterprise Architect** supports a range of open industry standards for designing and modelling software and business systems, as: UML 2.4.1, SysML, BPMN, BPEL, SoaML, SPEM, WSDL, XSD, DDS, ArchiMate, Geography Markup Language (GML), ODM, OWL and RDF.

**Enterprise Architect** supports industry Frameworks as: Zachman Framework, TOGAF (including FEAF), UPDM framework that supports DoDAF, MODAF and NAF, SOMF.

**Enterprise Architect** supported Frameworks supplied by industry bodies are TRAK, GeoSciML.

## Modelling

Underlying UML modelling include several key aspects that most modelling tools support. The core aspects supported by Enterprise Architect are: Profiles, Patterns, MOF, OCL, MDA Transforms, Corba IDL. UML Validation can be run against the model.

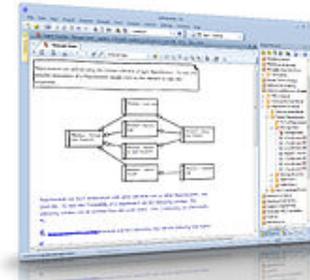


**Fig. 4 - Simulation in Enterprise Architect**

## General features

### Requirements management

The common features of Requirements Management supported by Enterprise Architect include customization of how requirements are documented, linking requirements to the design and implementation details, and providing Requirement Traceability through the design and construction phases. These requirements can be subject to change management, workflow processing, baseline comparison and auditing. There is also a model glossary that is interactive with notes for requirements.



**Fig. 5 - Requirements Management in Whiteboard**

### Business modelling and analysis

Enterprise Architect supports a number of methods of modelling business processes using UML as the foundation modelling language. The core languages for business modelling and analysis include BPMN and BPEL, with various historic profiles such as the Eriksson-Penker profile. Enterprise Architect also supports the definition of Business Rules with the ability to generate executable code from these rules. Business modelling can be combined with GAP analysis to view potential gaps in proposed solutions.

### Simulation

Model simulation of Behavioral diagrams is supported for:

- State Machines
- Interaction (Sequence diagrams)
- Activities
- BPMN

Execution flow is defined using Triggers, Guards and Effects. The simulation supports re-runs with alteration to the triggered events and supports viewing variables, the call stack and setting debug markers. There is also support for interaction with emulated User-Interface screens containing common UI fields.

### System development

In line with the **Model Driven** design principles Enterprise Architect supports **MDA** transforms of **PIM** Class structures to **PSM** Class structures, **Round-trip engineering** of code for 10 software languages and several key embedded **HDL** systems languages (**Ada**, **VHDL** and **Verilog**). It also supports code generation from Behavioral models.

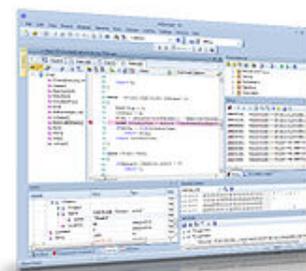
### Supported languages:

**ActionScript**, **C**, **C#** (for both .NET 1.1 and .NET 2.0), **C++** (standard, plus .NET managed C++ extensions), **Delphi**, **Java** (including Java 1.5, Aspects and Generics), **PHP**, **Python**, **Visual Basic**, **Visual Basic .NET**

In accordance with Model Driven Development principles, Enterprise Architect provides an Integrated Development Environment that supports code editing (with Syntax highlighting and **Intellisense**), for Building, Debugging and Code Testing all from within the model.

### Supported compilers and interpreters:

- Microsoft Windows Native C
- Microsoft Windows Native C++



**Fig. 6 - Code Editing and Debugging**

- Microsoft Windows Visual Basic
- Microsoft .NET Family (C#, J#, VB)
- Sun Microsystems Java.
- PHP
- GNU Compilers for C++, C and Ada (GCC & GDB )

There are also Add-ins available for integration *with MS Visual Studio* and *Eclipse*.

### Test management

For code based testing there is support for:

- xUnit Testing

This involves MDA transformation of Classes to NUnit or Junit Classes with the ability to generate unit tests from the model and automatically record the results against the tested Classes.

- Testpoint testing

This is a model based code testing. It is parallel to test contracts defined in 'Design by Contract' and it runs using debug definitions.

In terms of model based testing; both of these methods support the test definitions and test results being logged against related Classes in the model.

### Visual execution analysis

Integrated with building and debugging code Enterprise Architect allows the developer to perform abstract analysis of the software using Profiling and Sequence diagram generation:

- Sequence diagram generation provides a means to analyze the general process flow and iron out inconsistencies
- Profiling summarizes, by thread and routine, the code's general efficiency

### System engineering

System Engineering is supported with **SysML 1.2** modelling which can be coupled with executable code generation. **SysML** supports modelling from requirement definition and system composition using **SysML Blocks** and **Parts**, through to parametric model simulation. The executable code generation supports embedded **HDL** system languages ([Ada](#), VHDL and [Verilog](#)), or it can be coupled with Behavioral code generation of the standard code languages defined above.

### Data modelling

Enterprise Architect supports Data Modelling from the Conceptual to Physical levels, Forward and Reverse Engineering of Database Schemas, and MDA transformation of the Logical (platform independent) to Physical DBMS (platform dependant). Diagram types supported include:

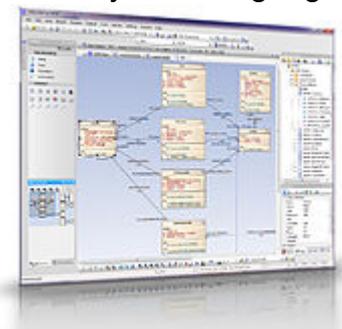
- DDL notation
- ERD notation
- IDEF1X notation
- Information Engineering notation

Supported DBMSs:

DB2, Firebird/InterBase, Informix, Ingres, MS Access 97, 2000, 2003, Access 2007, MS SQL Server 2000/ 2005/ 2008, MySQL, SQLite, Oracle 9i, 10g and 11g, PostgreSQL,



**Fig. 7 - Code Editor and Testpoints Manager**



**Fig. 8 - Database Modeling using a DDL**

Sybase Adaptive Server Anywhere (Sybase ASA), Sybase Adaptive Server Enterprise (Sybase ASE), ArcGIS

### Project management

Features supporting project management include:

- Resource Allocation and Tracking using Gantt charts
- Event Logging using model calendars
- Workflow scripting for setting workflow processes
- Security
- Model Metrics
- API Scripting (macros).

### Change management

The key facilities supporting change management are:

- Auditing
- Baseline Difference and Merge
- Version Control

The auditing feature supports logging changes to the model. The Baseline Management feature allows snapshots of parts of a model to be created periodically. A baseline can be compared and merged with the current model or a branch of that model. This supports Branching model information to another repository, then adding updates and merging them back.

The Version Control interface supports the major version control applications:

- Subversion
- CVS
- Team Foundation Server
- SCC interface to any SCC compatible version control system.

### Team-based development and collaboration

The Team Interaction facilities include:

- Model Mail: Internal model based mailing system.
- Team Review: Inter-repository forum for lodging discussion on issues.

discussion on issues.

• Model Views: User definable Views, prompting users on relevant model updates

Client Customer Collaboration:

- User definable Word Compatible RTF reporting
- HTML reporting
- EAlite – provides free read-only viewing of models with support for client/customer interaction via the Team Review

Review

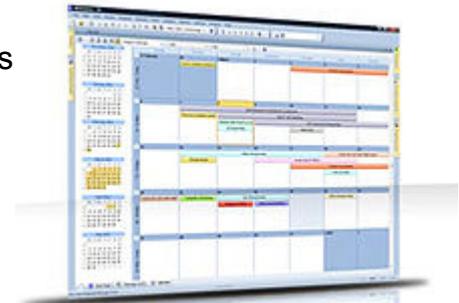
### Service Oriented Architectures

Supports of the core Service Oriented Architectures: **SoaML** and **SOMF**, along with Round Trip engineering of WSDL, XSD used to facilitate BPEL generation.

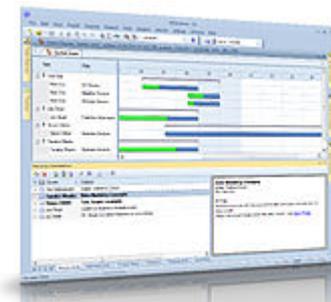
### Integration with other tools

The key features that support integration with other tools include:

- XMI Import/Export: Supports the XMI 1.1, 1.2 and 2.1 specifications (and import of .emx files).
- CSV import/Export
- Automation interface – supports a comprehensive API interface for use with any COM based language (and Java).



**Fig. 9 - Calendar view of events**



**Fig. 10 - Gantt Chart of Project Tasks and Model Mail views**

- MDG Add-ins are available, supporting interfaces to: VS .Net, Eclipse, TcSE, HP Quality Center, Import Visio diagrams, Import DOORS requirements, Atlassian JIRA integration, SAP netweaver Integration

### **Reporting**

Features for creating model documentation include:

- User-definable (MS Word) compatible RTF Reporting
- User-definable HTML generation of the model
- Model slide show presentations
- User definable query based reporting

### **Deployment**

There are many scenarios for deployment. For the multi-user and multi-site development there is support for WAN based connectivity using a WAN Optimizer. Information can be exchanged and merged between repositories for off-site analysis and development or for exchanging models between diverse development groups. The core logistics are:

- Repository Types:

Supports .eap files as well as DBMS repositories (the 10 more commonly used DBMS).

- Tool Deployment:

Supports a simple workstation installation and, if required, a simple DBMS installation.

- Scalability:

The tool is very scalable with options for large scale cross-corporate or WAN based interconnections.

Supported platforms

- Windows XP, Windows Vista, Windows 7 (32 bit and 64 bit)
- Linux & Mac OS installations are supported using CrossOver

### **3. Sirma Rapid Application Development (SRAD)**

The developers' idea is creating a system which facilitates the three-tier client-server applications creation.

It is developed on a modular basis, providing synchronization between business analysts, programmers and customers.

One of the modules provides functionality resembling work with graphs, which create models and describe business data and the relationships between them. Another group of modules implement forms creation for user interface. Third group are modules for creating business logic validation.

Friendly graphical editor allows the user interface formation in the very process of system designing in a dialogue with the potential customer.

Generators, created to validate business rules, provide code for full or partial validation of business data, with various relationships between them, such as:

- Monitor the completion of the required fields;
- imposing rules to restrict some fields;

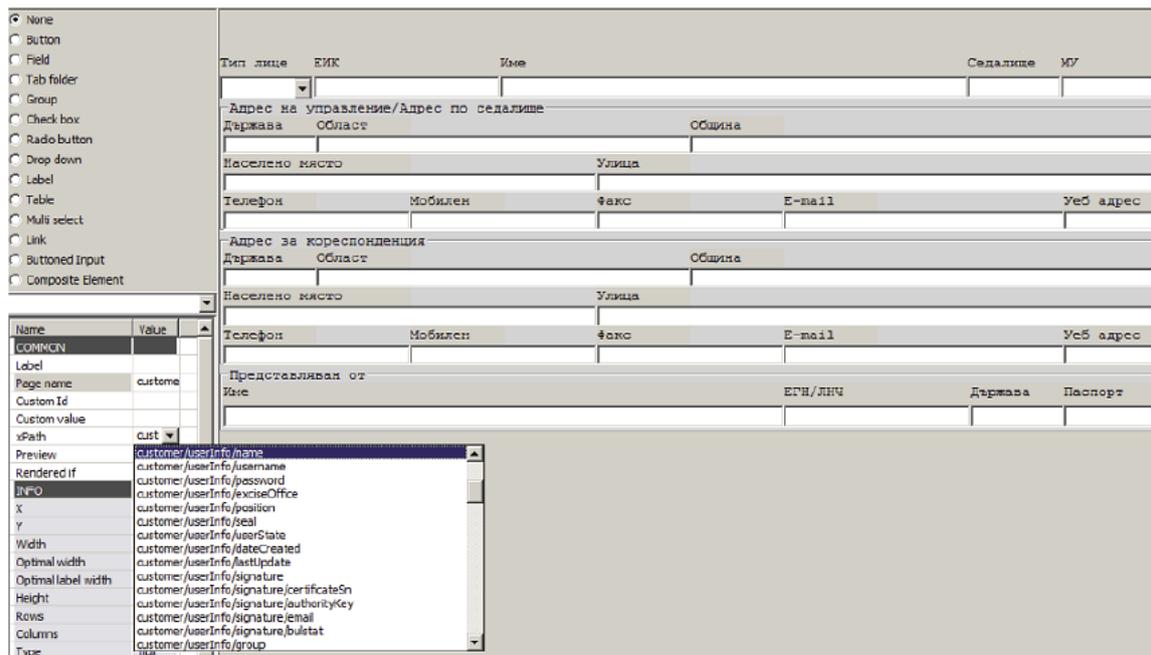


Fig. 11 Graphical editor in SRAD

- rules for initial initialization;
- rules for computing;
- rules for inapplicability.

An interesting possibility is the partial validation - if an event on the client side appears (editing or completing a field from the User Interface) business validation is run on that portion of the processed object only, for which the change is important.

The system development direction is to add more options to describe business rules and automated software generation for work in the interlayer of the client-server application.

#### 4. Rational Rhapsody

**Rational Rhapsody [5]** is an IBM company product (since 2003). It offers opportunities for collaborative design for systems engineers and software developers when creating the real-time systems.

The first version of the product was launched in 1996 by the I-Logix company and was originally developed as a tool for object-oriented modelling. Later, it was purchased from the IBM, which led to the product improvement, adding the support of a number of established values and separating the product to several editions according to user requirements. There are four editions:

- **Rational Rhapsody Developer** provides an environment that allows easy evaluation of the behaviour of different systems to detect defects at an early stage. It supports the possibility of visual debugging. Other features are:

- Generate code for C, C ++, Java and Ada applications.
- Support for UML, SysML.
- Design of object-oriented or functional C applications.
- Integrity in the Eclipse environment.

- **Rational Rhapsody Designer for System Engineers** is aimed at system engineers. It provides an environment for collaborative design and simulation at an early stage according to specified requirements and architecture.

Its main features are:

- An environment supporting UML and SysML.
- Tracing and analysis of the entire product life cycle.
- Automation of most system engineers tasks.
- Automated documentation creation throughout the product life cycle.
- Configuration and maintenance of parallel development system.
- **Rational Rhapsody Architect for Software** provides a UML- and SysML-based environment for developing real-time systems.

Its main features are:

- Architecture visualization through UML.
- Generation of C, C++ or Java code.
- Reverse Engineering of C, C++ or Java code.
- Integration with Eclipse.
- Automatic integrity maintenance of the architecture, code and documentation.
- Application development using AUTOSAR.
- **Rational Rhapsody Architect for System Engineers** helps systems engineering teams design complex functionality in less time.

Its main features are:

- UML and SysML support.
- Full life-cycle tracing, with automated documentation preparing.
- Automatically models checking.
- Many tasks automation for the system engineer.
- Maintenance mode for joint development.

One of the main **Rational Rhapsody** advantage is its platform independence, which implies a more successful product distribution. Separation of individual systems with a specific role is a prerequisite for high performance and efficiency. The system supports an operating mode in which multiple users work on a project in real time, which contributes to the successful joint development.

The disadvantage of the product is the relatively high complexity of individual modules, which requires a better users' knowledge of the particular area and makes most of the features unusable by end users.

## CONCLUSION

1. There is a great number of various software systems, accomplish documents generation at different levels (XML and other formats), diagrams, software.
2. The majority of these systems are not open-source, i.e. - Internal machine representation of the structures is not available (Know-How). Even be found it, in question is the possible manipulation of these structures (copyright, etc.).
3. Best products are commercial. Their price is such, that even big Bulgarian developers and potential customers would think.
4. The last opens up a market niche for new developments in the field.

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## СИСТЕМИ ЗА АВТОМАТИЗИРАНО РАЗРАБОТВАНЕ НА СОФТУЕР

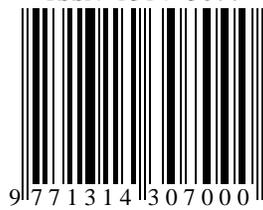
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*Русенски университет “Ангел Кънчев”*

**Резюме::** Статията представя някои (водещи) от системите за автоматизирано разработване/генериране на софтуер или на етапите в неговата разработка, а също и на документация към него.

**Ключови думи:** информатика, генерация на програми, генерация на софтуер.

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