



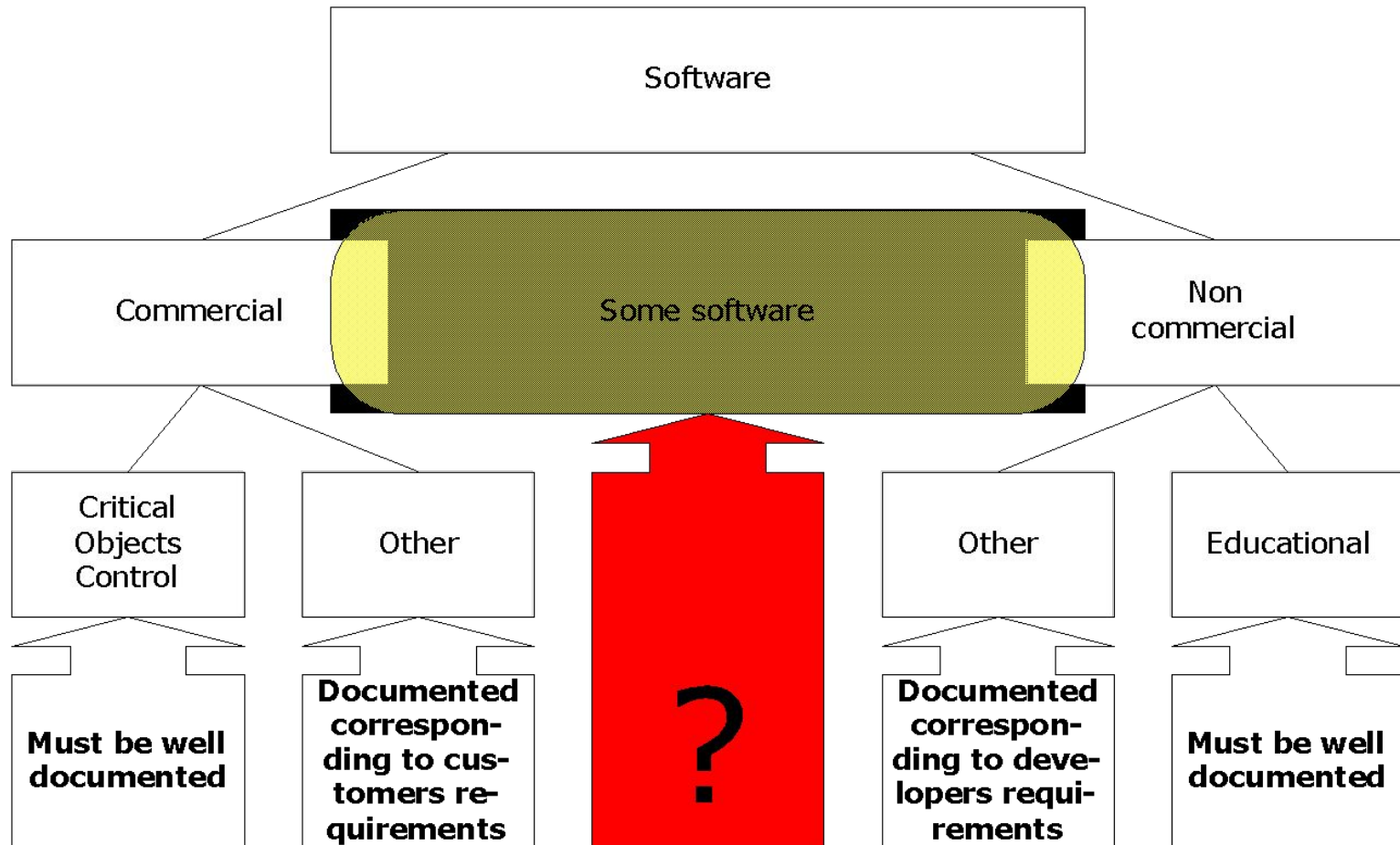
Foundation for Open Project Documentation

Anatoly Shalyto

shalyto@mail.ifmo.ru

Computer Technology Department
Saint-Petersburg State University of
Information Technology, Mechanics and Optics,
Russia

Project Documentation in the Real World (1)





Project Documentation in the Real World (2)

- Commercial Software
 - Critical Objects Control Software
 - Main — by standards
 - Extra — by customer needs
 - Other
 - By customers requirements
- Non commercial software
 - Educational
 - Good quality
 - Other
 - By developers wishes



Hardware Documentation vs. Software Documentation

- Designers and manufacturers are different people
- Hardware Documentation
 - Project Documentation
 - Design Basis
 - Verification Results
 - User Guide
- Designers and manufacturers are same people
- Software Documentation
 - User Manual
 - Developers Guide
 - Source Code (for open source projects)



Open Project Documentation

- Why Project Documentation?
 - Software quality improvement
 - Better verification
 - Faster and safer modification
- Why Open Project Documentation?
 - Open project documentation increases freedom
 - Better project understandability
 - Project design borrowing
 - Educational purposes
 - For students
 - For specialists



Why Only **Open** Project Documentation?

- **Open** = Must be available for further using and development
- *Foundation for Open project Documentation* is **Free**, but it is in different area comparing with *Free Software Foundation* or *Open Source Foundation*
 - Foundation results is applicable not only for free software, but also for commercial, secret and other kinds of software



Software Project Documentation

- In engineering practice projects must be well-documented
 - So on www.sourceforge.net there are not 76000 project, but much fewer
- The code must be based on the project documentation, not vice versa
- Project execution flow must be documented, not only final results



SWITCH-technology (Automata Programming)

- Proposed in 1991
- Based on states decomposition
- Model-driven development
- Usage scope – systems with complex behavior
- Applicable for different type of computing devices
 - Logic Controllers Programming
 - Microcontrollers
 - Microprocessors



SWITCH-technology guidelines

- Logic control
- State-based procedural programming
- State-based object-oriented programming
- Computational algorithms



SWITCH-technology Basics

- State
- Set of states
- Input variables + Events = Input Actions
- States + Input Actions = Automata With No Output
- Automata With No Output + Output Actions = Automata
- States are encoded with multiple values
- Observation of the automata states
- Correlated automata systems
- Logging
- Project documentation



Automata in Automata Programming

- Logic specification language
- Isomorphic mapping to source code
- Program works and builds logs in terms of automata



Educational Experiment (1)

- Computer Technology Department in University of Information Technology, Mechanics and Optics, Saint Petersburg, Russia
 - Chosen students from the whole Russia
 - International Olympiads in Informatics medalists
 - ACM International Collegiate Programming contest medalists



Educational Experiment (2)

- 1998-2001 Common Teaching 1
 - Lectures and Exams
- 2001-2002 Common Teaching 2
 - Lectures, Course Works and Exams
- 2002-2003 Experimental Teaching
 - Lectures and Projects
 - Project Documentation Verification
 - More than 40 fully Developed and Documented Projects
- To be continued



Educational Experiment (3)

- Project Contents
 - Project Documentation (at least 60 hours)
 - Problem Definition
 - User Interface Description
 - Justifications
 - Automata and Classes Descriptions
 - Automata and Classes Diagrams
 - Verification Protocols
 - References
 - Source Code (at least 20 hours)
- Anatoly Shalyto spent approximately 10–15 hours per project



Projects Examples

- Games
- Skeleton animation
- Controlling systems
- Graphical User Interfaces
- Parallel problems
- Transliteration
- Many others



Three Examples

- Diesel-generator modeling
 - Procedural automata programming
- *RoboCode* Agent
 - Object-oriented automata programming
- Visualization Framework
 - Switch-technology based visualization of calculation algorithms
 - Object-oriented realization of procedural algorithms



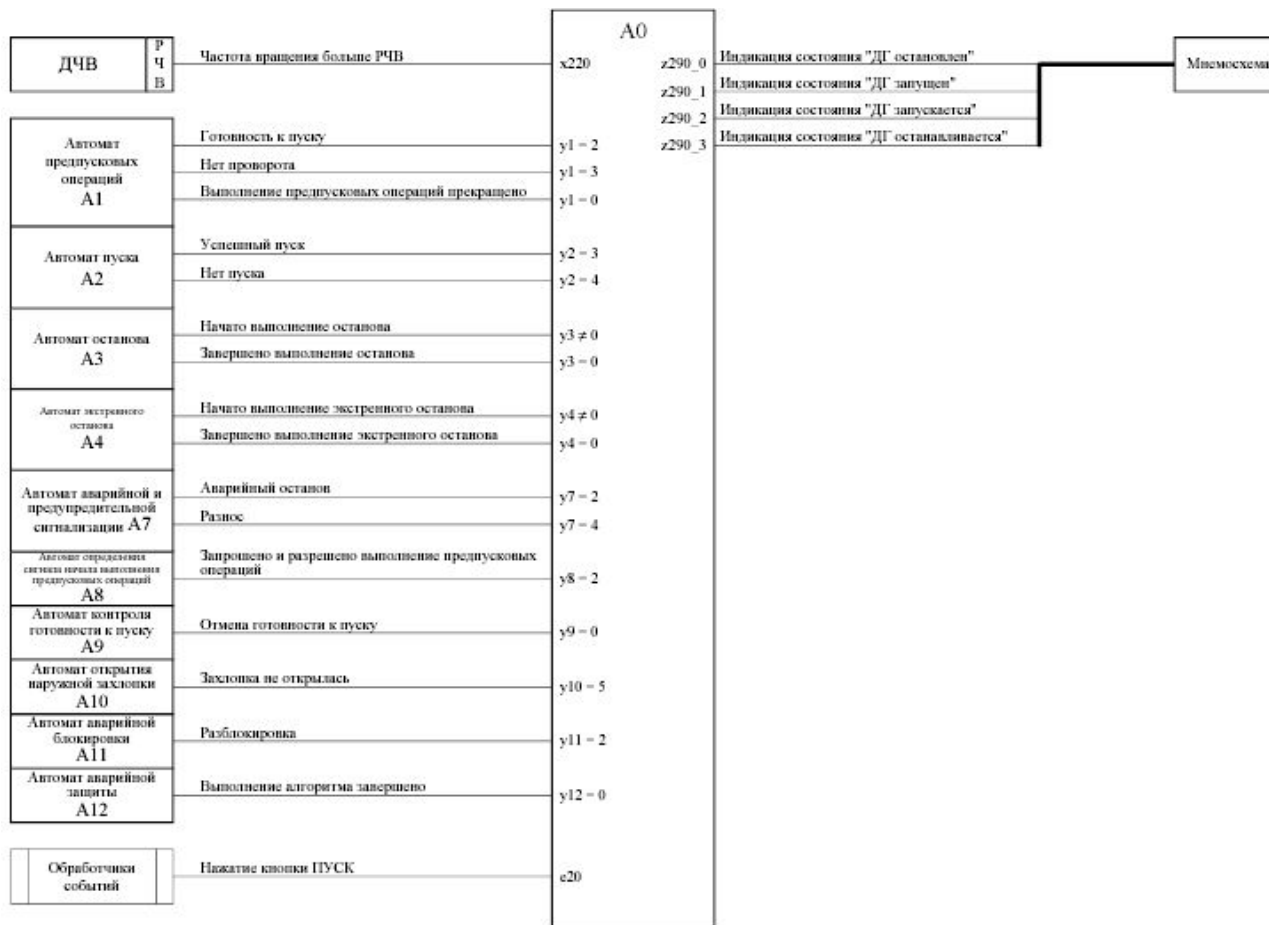
Diesel Generator Project Execution Flow

- Analysis
- Structuring (Automata Decomposition)
- Automata Interaction Diagrams
- Automata Verbal Descriptions
- Automata Interface Definition
- Automata Transitional Graph Definition
- Isomorphic Source Code Generation
- Verification logs



Diesel-generator

Automata Interface Diagram



Diesel-generator Automata Transition Graph





Diesel-generator Isomorphic Source Code

```
void A0(int e, dg_t *dg) {
    int y_old = dg->y0;
    switch(dg->y0) {
        case 0:
            A8(e, dg);
            if (x220(dg)) dg->y0 = 4;
            else if (dg->y7 == 2) dg->y0 = 7;
            else if (dg->y8 == 2) dg->y0 = 1;
            break;
        case 1:
            A4(e, dg); A3(e, dg); A1(e, dg);
            if (dg->y4 != 0) dg->y0 = 6;
            else if (dg->y7 == 2 || dg->y7 == 4) dg->y0 = 8;
            else if (dg->y3 != 0) dg->y0 = 5;
            else if (dg->y1 == 0) dg->y0 = 0;
            else if (dg->y1 == 3) dg->y0 = 7;
```

...



Diesel-generator Verification Logs

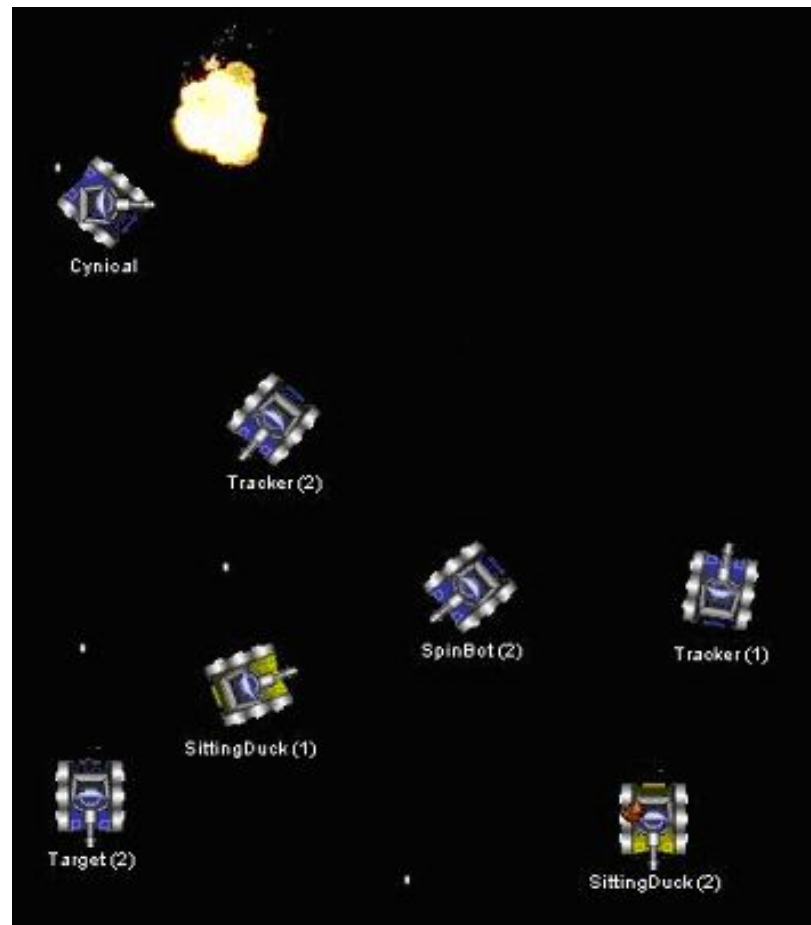
```
11:34:02.507{ DG1: A20: started at state 2 with event e10
11:34:02.507{ DG1: A7: started at state 0 with event e10
11:34:02.507{ DG1: A71: started at state 0 with event e10
11:34:02.507> DG1: x320 - lubricating oil temperature less than Tmm
11:34:02.507> DG1: x330 - lubricating oil temperature greater than Tmpr
11:34:02.507} DG1: A71: stopped at state 0
11:34:02.507{ DG1: A72: started at state 0 with event e10
11:34:02.507> DG1: x220 - rotation frequency greater than RCV
11:34:02.507} DG1: A72: stopped at state 0
11:34:02.507{ DG1: A73: started at state 0 with event e10
11:34:02.507> DG1: x220 - rotation frequency greater than RCV
11:34:02.507} DG1: A73: stopped at state 0
11:34:02.507{ DG1: A74: started at state 0 with event e10
11:34:02.507> DG1: x430 - water temperature less than Tvm
11:34:02.507> DG1: x440 - water temperature greater than Tvpr
...
11:34:02.517} DG1: A20 stopped at state 0
```

RoboCode Agent

<http://robocode.alphaworks.ibm.com>

Top Five

1. GlowBlowMelee 1.1
2. Cigaret 1.20
3. **Cynical**
4. GlowBlow
5. **Cynical_3**

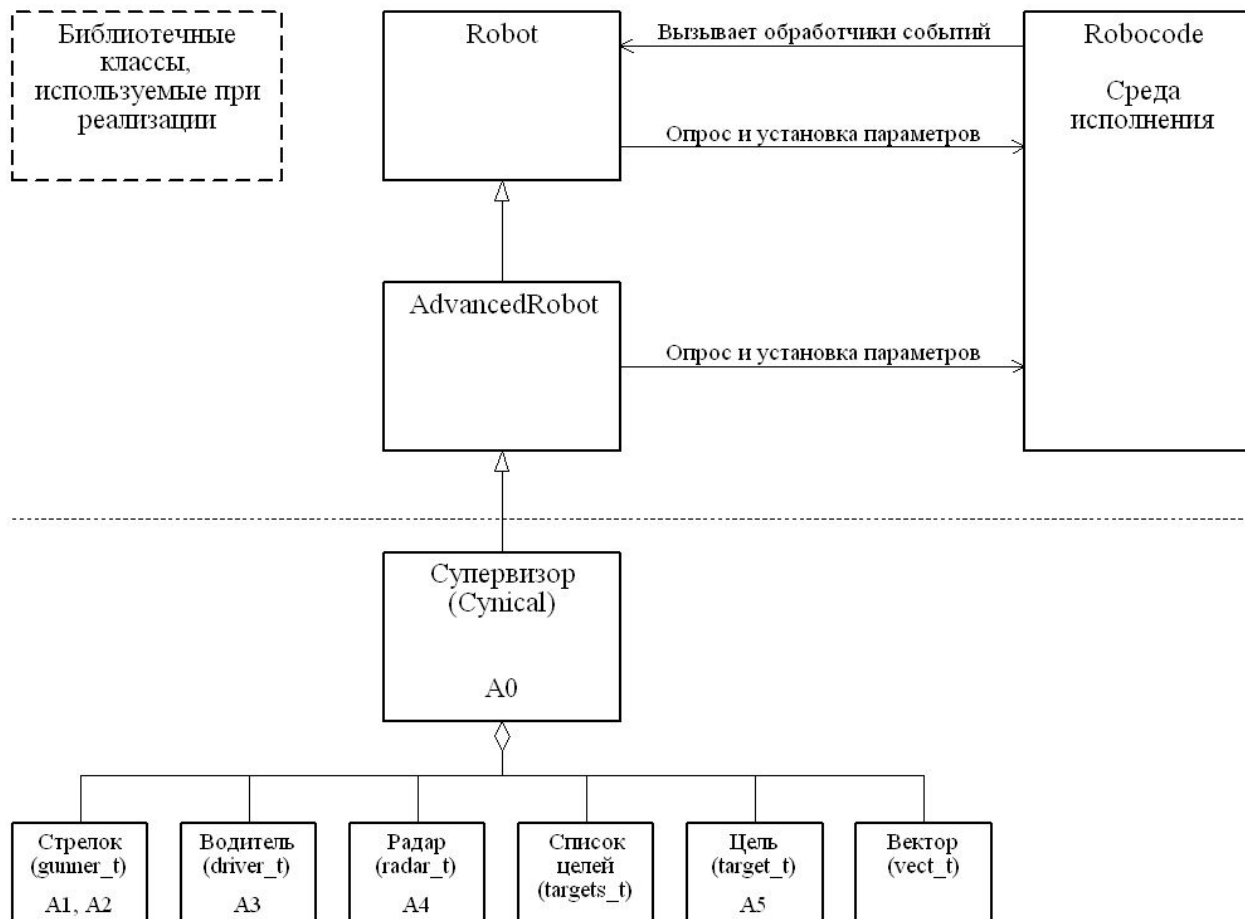




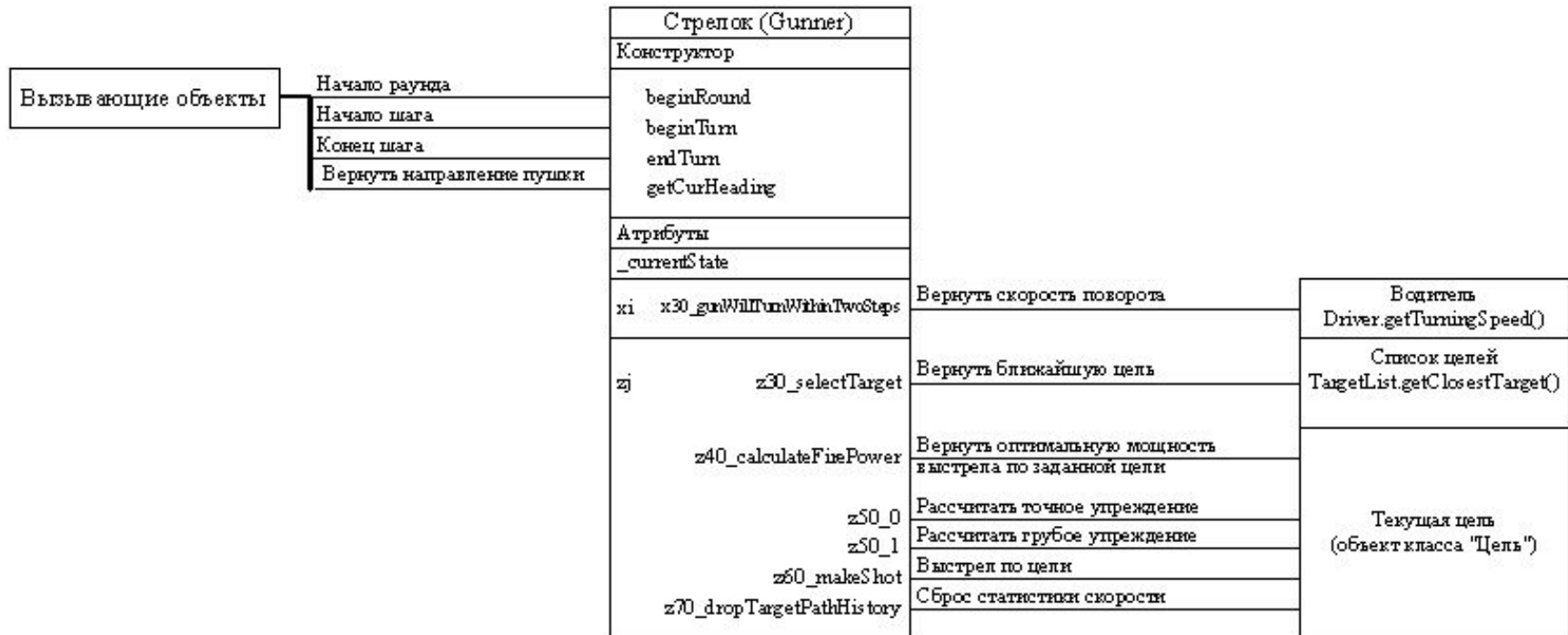
RoboCode Agent **Project Execution Flow**

- Analysis
- Structuring (Class Decomposition)
- Classes Diagram
- All the stages from diesel-generator project execution flow

RoboCode Agent Classes Diagram



RoboCode Agent Class Structure Diagram

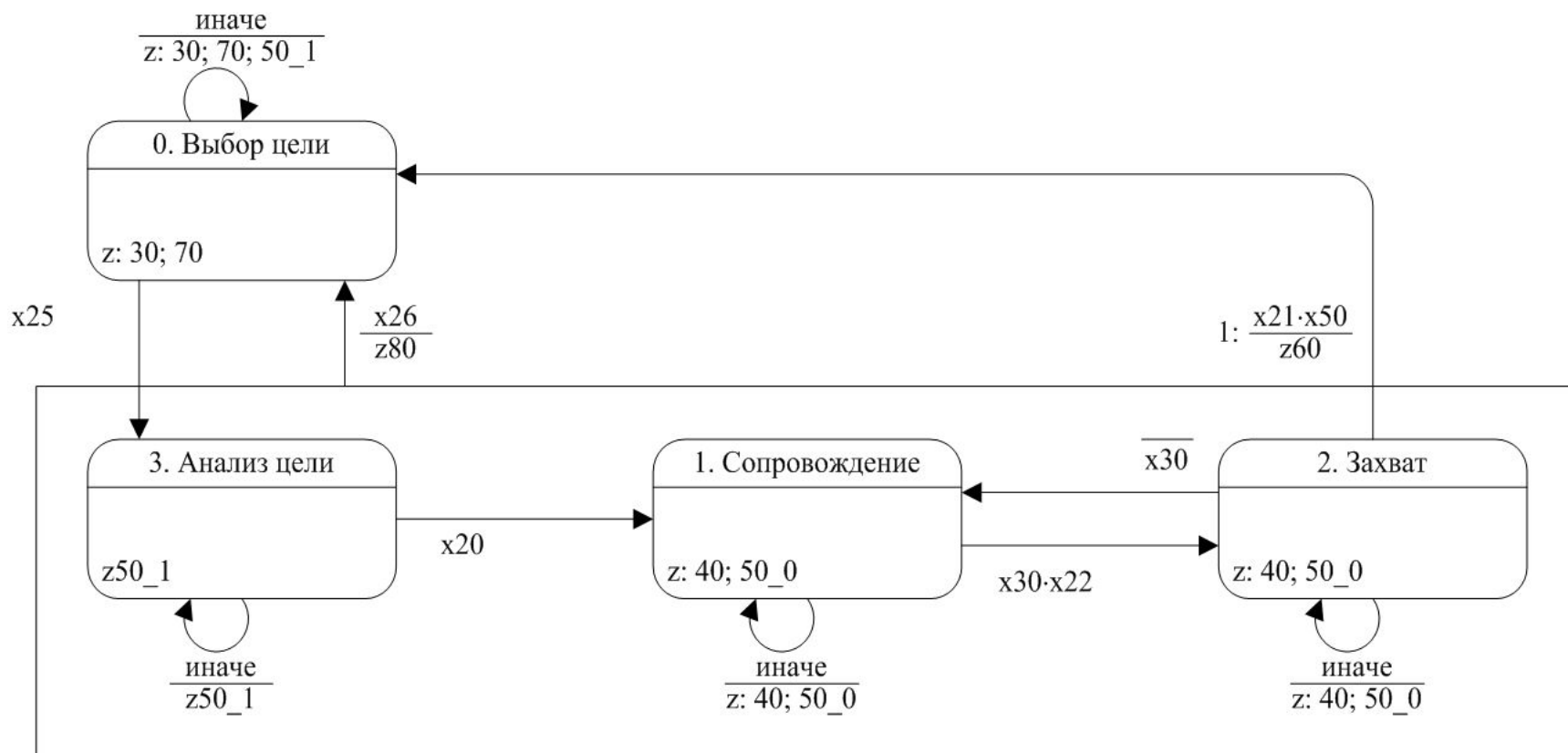




RoboCode Agent Automata Interface

cur_gun_heat	Пушка скоро охладится	x20	A1	z30	Выбрать цель	cur_target
	Пушка охладилась	x21				
	До конца охлаждения пушки осталось меньше двух ходов	x22			z40	Рассчитать энергию выстрела
cur_target	Цель выбрана	x25		z50_0	Рассчитать точное упреждение и направить пушку	cur_aim, da
	Цель потеряна	x26			z50_1	Рассчитать грубое упреждение и направить пушку
cur_heading	До конца поворота пушки осталось меньше двух ходов	x30		z60	Выстрел	firepower
	Наведение точное	x50				
Обработки событий	Начало шага	e10		z70	Сбросить историю маневрирования цели	cur_target
					z80	Сбросить текущую цель

RoboCode Agent Transition Graph



RoboCode Agent

Debugging through Protocols

----- 0 ----- Начальный шаг (событие 9)

Для объекта 'Супервизор':

{ A0(Supervisor): Автомат A0(Supervisor) запущен в состоянии State 1 с событием e10

* z10_2: Инициализация в начале шага.

} A0(Supervisor): Автомат A0(Supervisor) завершил свою работу в состоянии State 1

Для объекта 'Стрелок':

{ A1(Gunner): Автомат A1(Gunner) запущен в состоянии State 0 с событием e10

i x25: Цель выбрана? - НЕТ.

* z30: Выбрать цель.

* z70: Сбросить историю маневрирования цели.

* z50_1: Рассчитать приблизительное упреждение и направить пушку.

} A1(Gunner): Автомат A1(Gunner) завершил свою работу в состоянии State 0

Для объекта 'Радар':

{ A4(Radar): Автомат A4(Radar) запущен в состоянии State 0 с событием e10

i x70: Цикл сканирования завершен? - НЕТ.

i x70: Цикл сканирования завершен? - НЕТ.

* z100_0: Повернуть радар влево.

} A4(Radar): Автомат A4(Radar) завершил свою работу в состоянии State 0

Для объекта 'Водитель':

{ A3(Driver): Автомат A3(Driver) запущен в состоянии State 0 с событием e10

i x100: Враг близко? - ДА.

i x110: Сработал таймер T110? - ДА.

* z200_0: Инициализация движения по траектории 'Маятник'.

* z200_1: Добавить случайную составляющую к траектории 'Маятник'.

* z200_2: Определить направление и скорость движения 'Маятник'.

} A3(Driver): Автомат A3(Driver) завершил свою работу в состоянии State 0

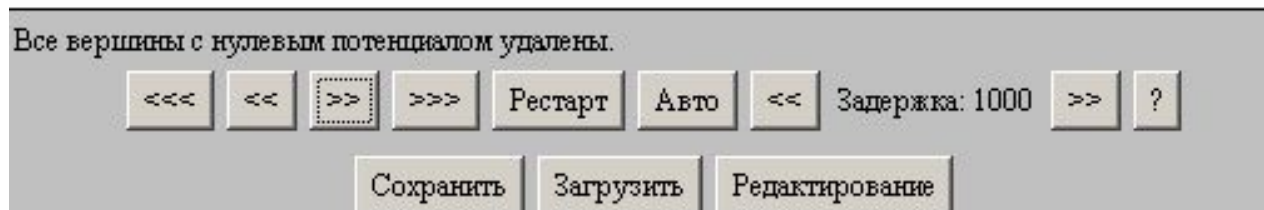
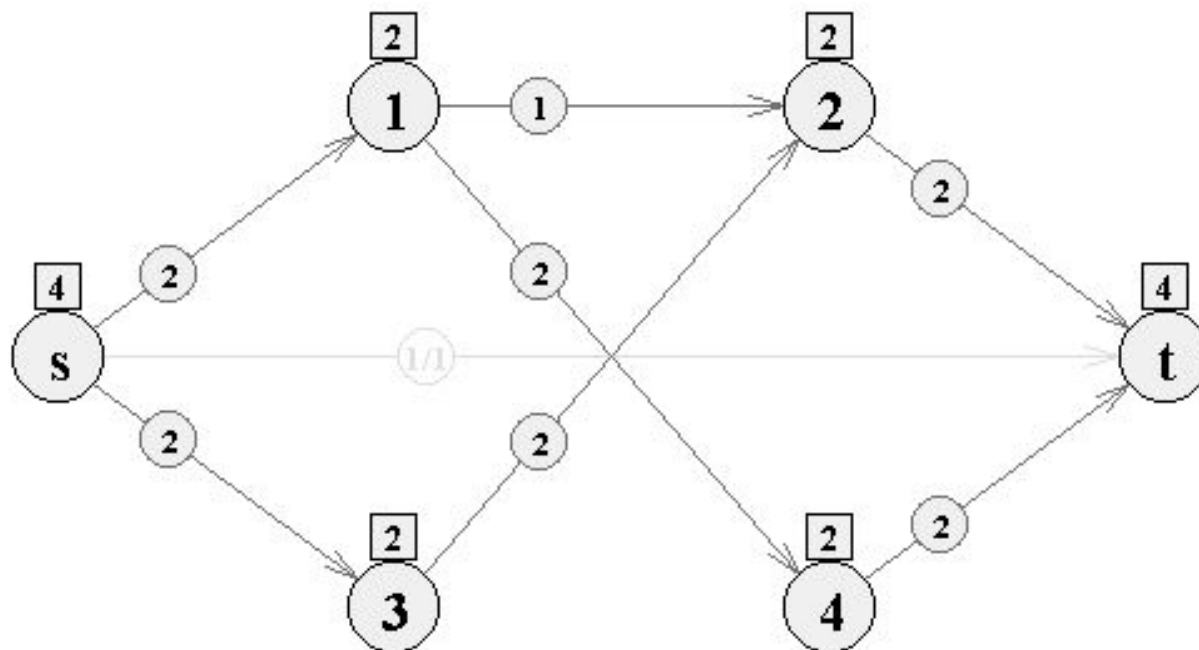
----- 30 ----- Выстрел по цели

Для объекта 'Супервизор':

{ A0(Supervisor): Автомат A0(Supervisor) запущен в состоянии State 1 с событием e10

Visualization Framework

Malhotra,
Kumar,
Maheshwari
network flow
algorithm





Visualization Framework Visualizer Structure

- Model
 - Interactive Automata System Automatically Generated by Algorithm's XML–Description
- View
 - User Interface Based on *Vizi* Library
- Controller
 - *Vizi* Library



Visualization Framework Project Documentation (1)

- Annotation
- Introduction
- Chapter 1. Literature Analysis
- Chapter 2. Algorithm Description
- Chapter 3. Algorithm Implementation
- Chapter 4. Data Model Definition
- Chapter 5. Implementation Transformation
- Chapter 6. User Interface Description



Visualization Framework Project Documentation (2)

- Chapter 7. Configuration Description
- Conclusions
- References
- Appendixes
 - Algorithm Implementations Source Code
 - Transformed Implementation
 - Visualizer XML–description
 - Generated Source Codes
 - User Interfaces Source Codes



Visualized Algorithms

- Malhotra, Kumar, Maheshwari network flow algorithm
- Dinic's network flow algorithm
- Hopcroft–Karp Bipartite Matching algorithm
- Chu–Liu shortest arborescence of a directed graph
- Algorithms on 2–3 trees
- Bitonic salesman problem
- Ukkonen suffix tree construction algorithm
- Prim minimum spanning tree algorithm
- Simple strings and de Bruin cycles construction algorithms



Links

- Project Examples

- <http://is.ifmo.ru/?i0=projects> – Projects Documentation (Russian)
- http://is.ifmo.ru/?i0=projects_en – Projects Annotations (English)
- <http://is.ifmo.ru/?i0=works> – Articles (Russian)
- <http://is.ifmo.ru/?i0=english> – Articles (English)
- <http://unimod.sourceforge.net/> – UniMod Project