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“*Extension the capacity of the cellular network*” – process simulation and optimization



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9th International Conference on Perspectives
in Business Informatics Research

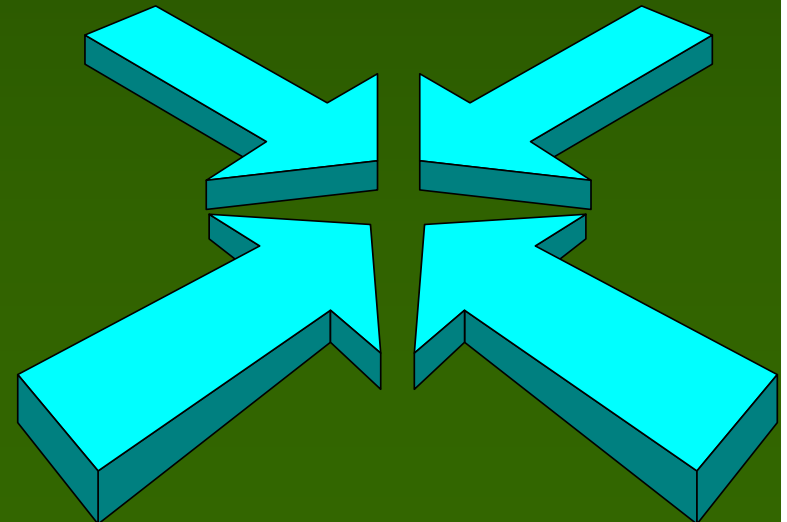


Causes of this work-

explains the answers to the following questions:

- *Why we perform business process management in the TELCO sector ?*
- *Why corporations should not only to model the processes, but also carry out their simulation and optimization ?*
- *Why did we choose this particular process to carry out the simulation and optimization? (Extension the capacity of celluar network)*

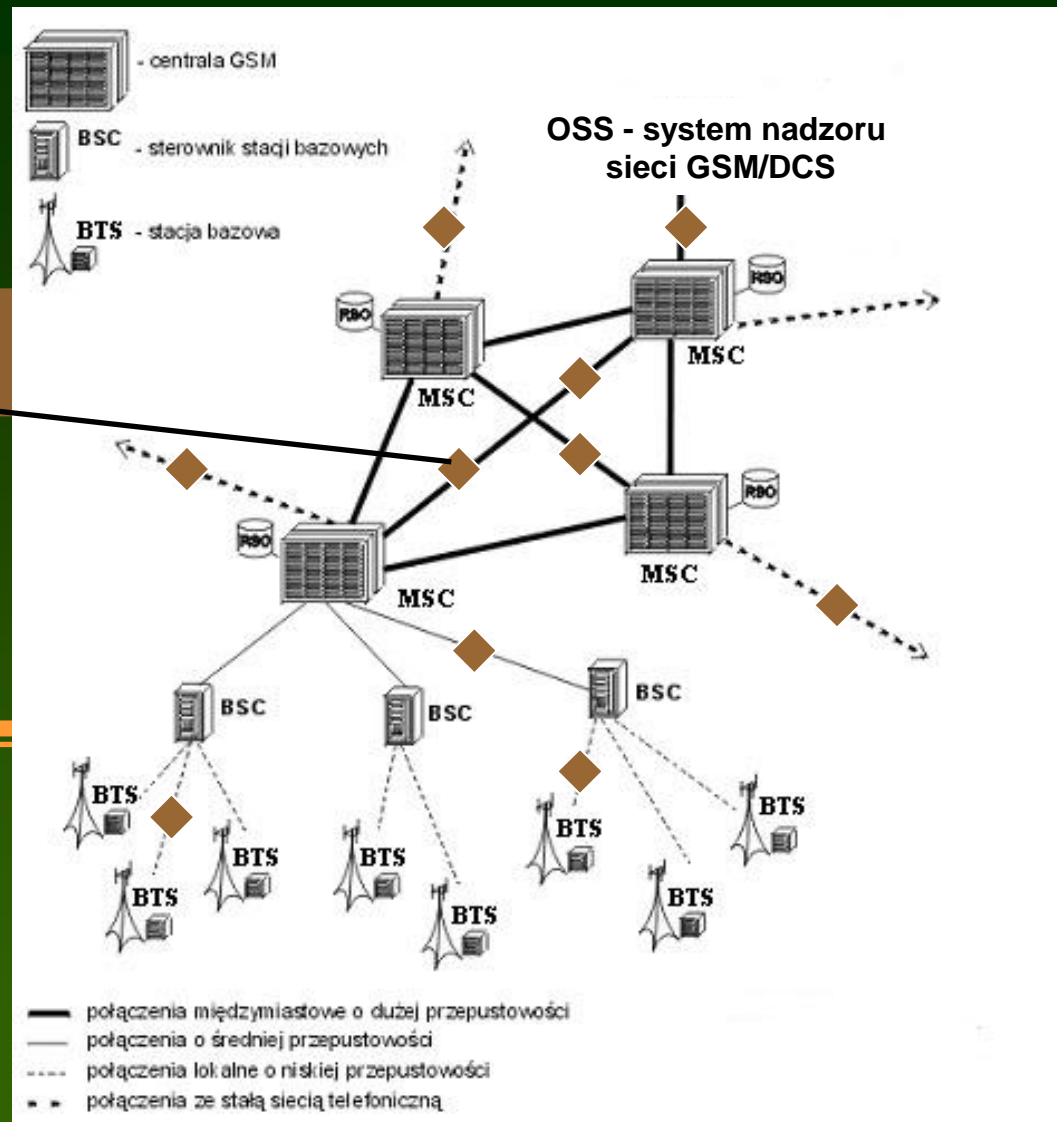
This proces concerns to increase the capacity of the cellular network. This process is customer oriented and enables data transfer increase (fast Internet through mobile network) and provides possibilities to carry more voice calls in a given geographical area. In fact, this process is coordinated by the workflow system but the people, who are responsible for designing the mobile network, make up the concept how to increase the capacity.





Transmission Nodes

The surveillance system transmission network



BTS – Base Transceiver Station – mobile phone base station

BSC – Base Station Controller – Base Station Controller

MSC – Mobile Switching Centre – GSM/DCS

System OSS – Operation Support System - NOKIA software, used in PTK Centertel to monitor the base stations

BTS,

controllers BSC, MSC headquarters and to introduce the parameters of these devices in the mobile network

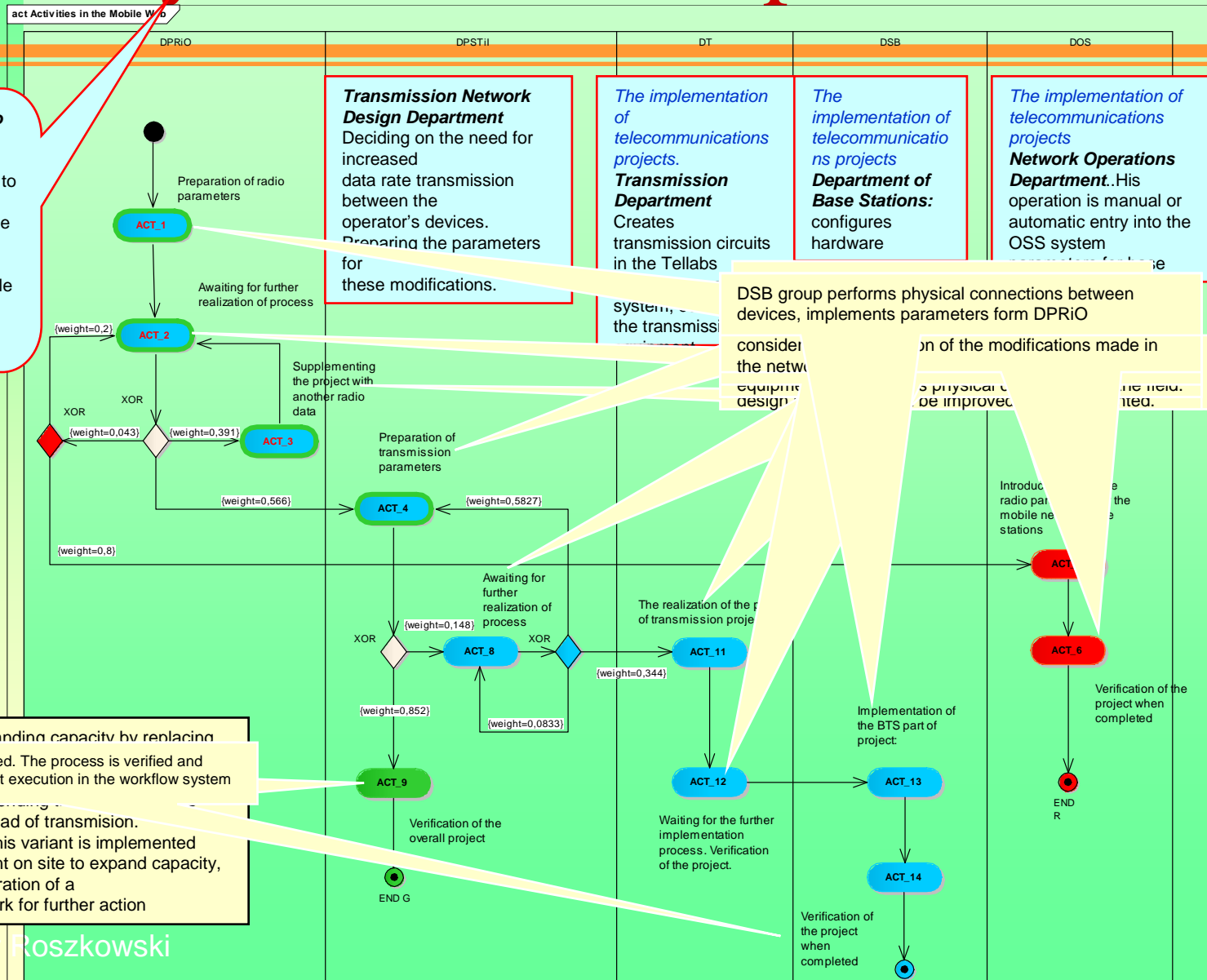
Base station BTS – outside part



Parts of the presentation

- *UML model - description of the process (activity diagram)*
- *Data preparation for the simulation and optimization*
- *Transformation of the model to the BPMN diagram*
- *Simulation and optimization of the process*
- *Interpretation of results*

Activity model of the process



Department of Radio Design and Optimization
Deciding on the need to increase network capacity. Preparing the parameters for the telecommunication equipment, responsible for increasing the mobile network capacity

Transmission Network Design Department
Deciding on the need for increased data rate transmission between the operator's devices. Preparing the parameters for these modifications.

The implementation of telecommunications projects. Transmission Department
Creates transmission circuits in the Tellabs system, the transmissi...

The implementation of telecommunications projects. Department of Base Stations:
configures hardware

The implementation of telecommunications projects. Network Operations Department.
His operation is manual or automatic entry into the OSS system

DSB group performs physical connections between devices, implements parameters form DPRIO consider the network design of the modifications made in the network to be improved.

1). **Control flow red:** Expanding capacity by replacing... All actions have been completed. The process is verified and expects to complete the project execution in the workflow system...
3). **Control flow green:** This variant is implemented when there is no equipment on site to expand capacity, but there is a partial preparation of a telecommunications network for further action

Workflow system(as implementation of business process)

- **Business process**, which is presented in article, has been executed in telecommunications company with the **workflow system**. Every execution of the business process (by employees of the company), called the **business process instance**, has been hierarchically stored in the database system, and each recorded instance of the process includes the following information:
 - The name of the business process,
 - Durations of each activity in the process instance,
 - Process instance IDs of the participants,
 - Process group names
- **Process mining** is a data processing method, which relies on a hierarchical review of entries in the database workflow system in order to explore the information about the instances of business processes. Process mining is done using algorithms that, depending on their design, allow to read information about ongoing processes. In particular, there are algorithms that, based on the record of each instance and their activities, outline the business process model, reflecting the actual (not theoretical) way of enterprise processes.

Required simulation data and algorithms used in their estimation



uwarunkowania alokacja zasobów i
biznesowe czasy

Simulation parameter	The algorithm used to estimate the parameter	Brief description of the results
Process diagram	Heuristic Miner	-graphical model preparation
Responsible groups, Number of people involved in single activity	Organizational Miner	- verification of workers identities, belonging to organizational units, - verification of tasks, performed by an organizational unit - verification the number and identities of processes participants
Activity time, Weights in decision points	Performance Analysis with Petri net	- time parameters and control flow weights from decision points

The required input data for simulation:

- ❑ *Graphical model for BPMN business process*
- ❑ *Organizational units (see diagram allocation functions)*
- ❑ *Possible variants of the process flow (a set of activities performed, the combined symbols of the movement control process)*
- ❑ *Relational operators (types of operators, XOR, AND, OR)*

- ❑ **Business Process Parameters:**
 - average frequency of the input event / time period
 - relational operators (the probability of each output)
 - times of the various stages of the process (waiting time static execution time of an elementary process)

- ❑ **The degree of involvement of human resources (number of participants in the process / number of persons employed in the organizational unit responsible for the implementation phase of the process)**

Data Sources

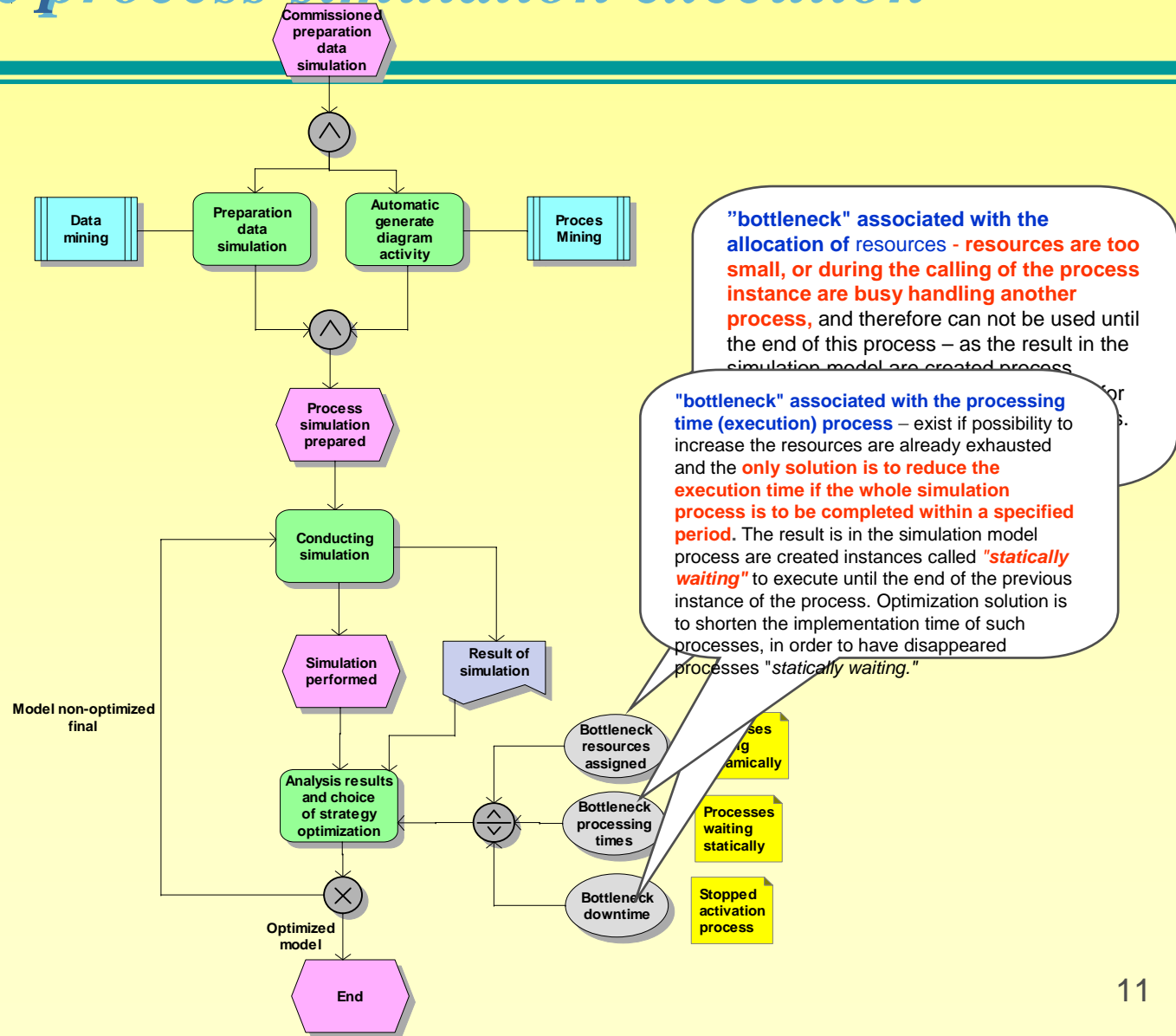
Data Sources

- The workflow database system (event logs)
- Knowledge of organizational structures
- Knowledge of business processes

Data mining techniques:

- Data mining (associated with packages BI - Business Intelligence)
- Process mining - the verification of dynamic business processes

Steps of the process simulation execution



Parameters of the running process (example)

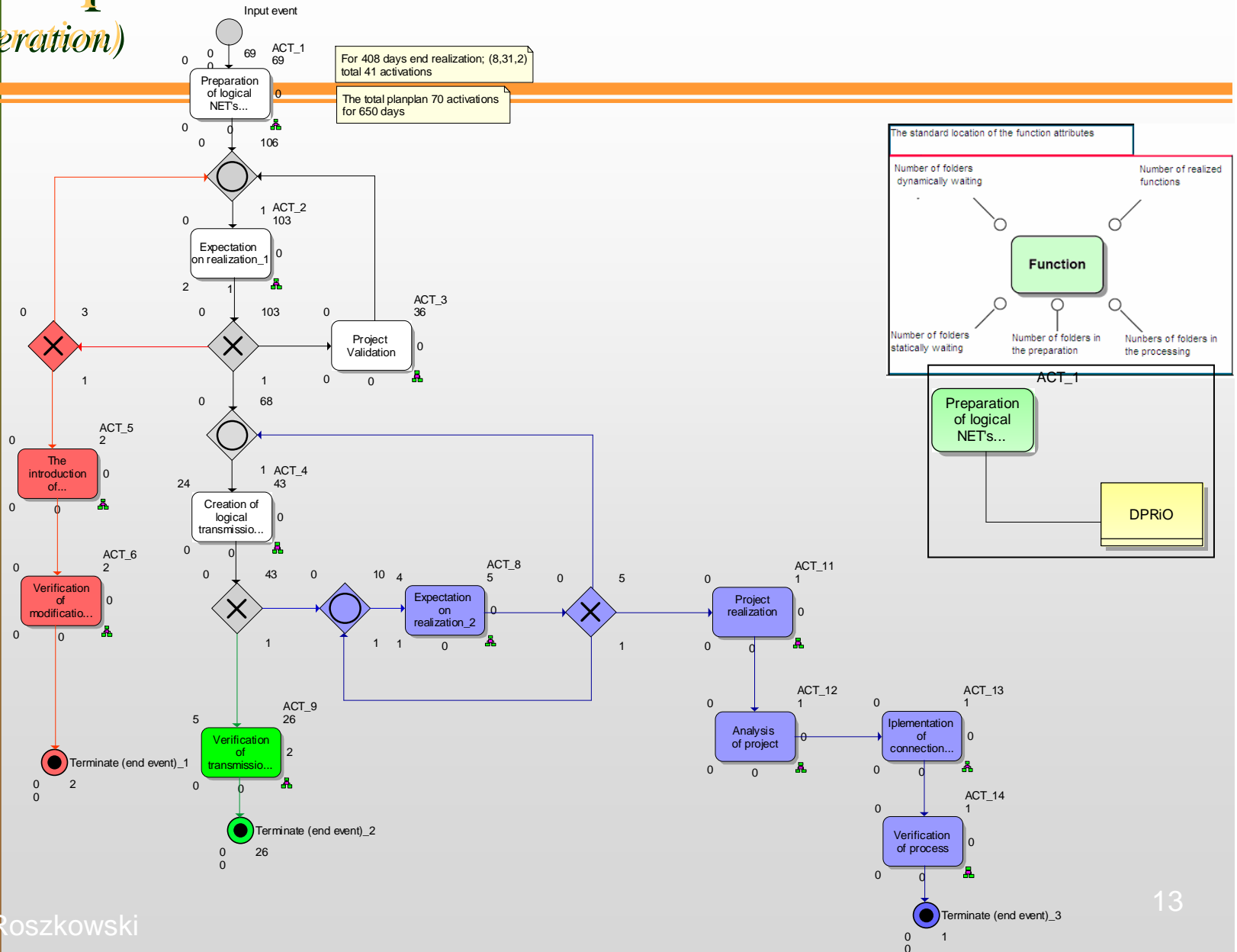
The screenshot shows a dialog box titled "Object properties - Expectation on realization_2". On the left is a tree view with categories: Selection, Help, Assignments, Attributes (selected), Format (with sub-items: Object appearance, Attribute placement (objects)), Information, Occurrences, Relationships, and Variants. The main area is a table of attributes for the selected object.

Attribute name	Expectation on realization_2 (English - Alternative language)
Last user	system
Frequency, annually	
Avg. total costs	
Min. total costs	
Max. total costs	
Static wait time	(0002:00:14:00) Constant
Orientation time	(0000:00:00:00) Constant
Processing time	(0000:00:00:00) Constant
Process folders processed	5
Static wait time sum	0018:02:06:00
Dynamic wait time sum	0448:11:52:49
Orientation time sum	0000:00:00:00
Processing time sum	0000:00:00:00
Process folders in static wait state	1
Process folders in dynamic wait state	4
Process folders in orientation	0

Buttons at the bottom: OK, Cancel, Preview, Reset, Help. A "More attributes..." button is also present.

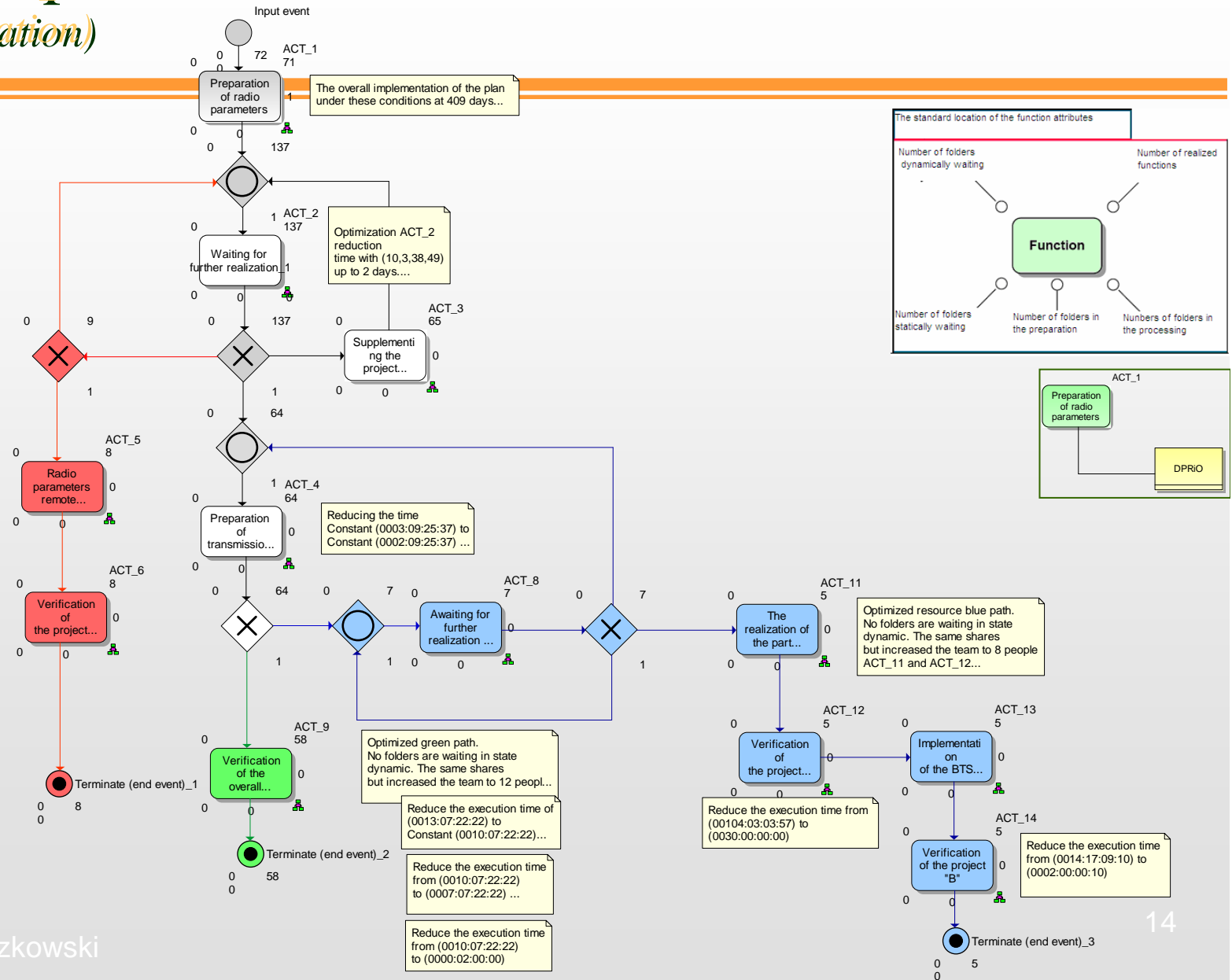
BPMN proces model and simulation results

(first iteration)



BPMN proces model and simulation results

(sixth iteration)



Optimization iterations

❑ Iteration 1 (release 51)

simulation of the initial input data (the main bottlenecks in the main branch RESOURCES (DPSTil): ACT-4 ACT-9, ACT-8)

❑ Iteration 2 (release 52)

simulation after the initial optimization of resources (the main bottlenecks in the main branch RESOURCES (DPSTil): ACT-4 ACT-9, ACT-8) to reduce the time of ACT-9 (the largest, which goes from the processing)

❑ Iteration 3 (release 53)

reduce processing times ACT-2 (waiting time), ACT-4 (processing time)

❑ Iteration 4 (release 54)

lack of satisfactory results from the third iteration

❑ Iteration 5 (release 55)

(Awaiting folders appear in the ACT-4 exempted from the ACT 2) to optimize the resources of ACT-11, ACT-12

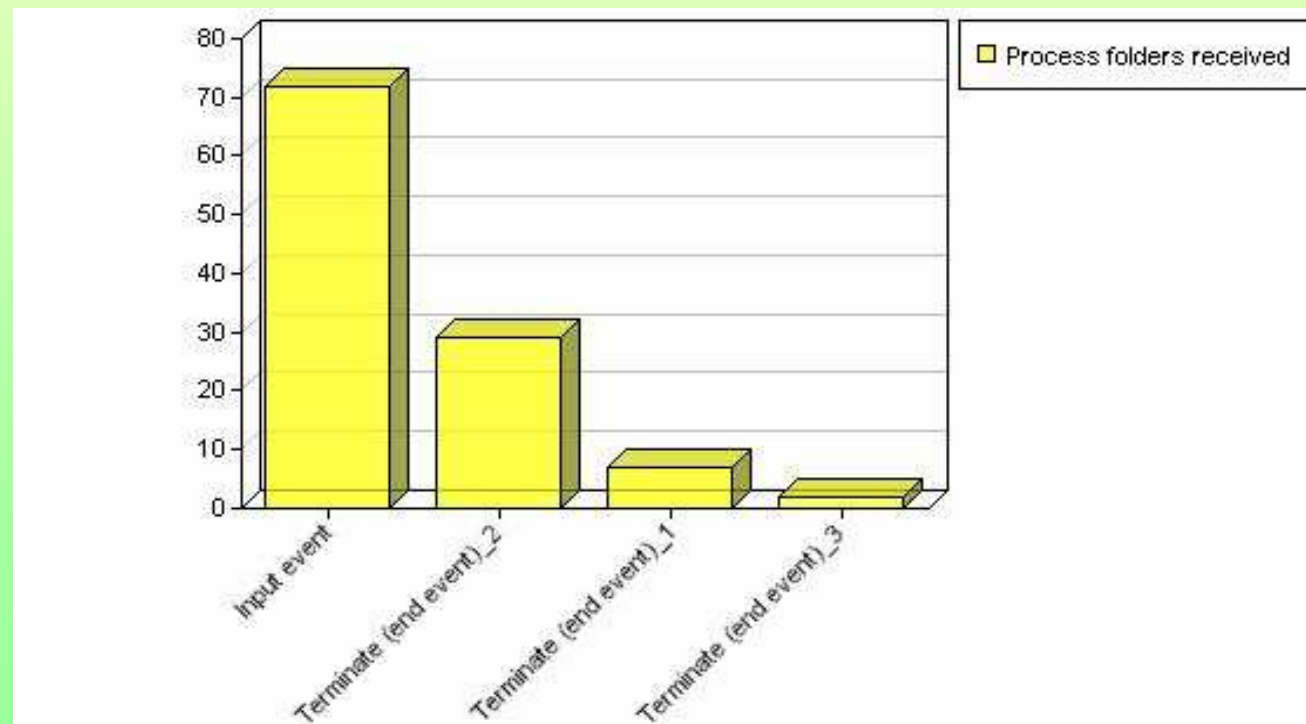
❑ Iteration 6 (release 55)

reduce the execution time of process ACT9 (there are folders exempt from the 4), ACT-12, ACT-14

Some statistical results (1)

□ Iteration 1 (release 51)

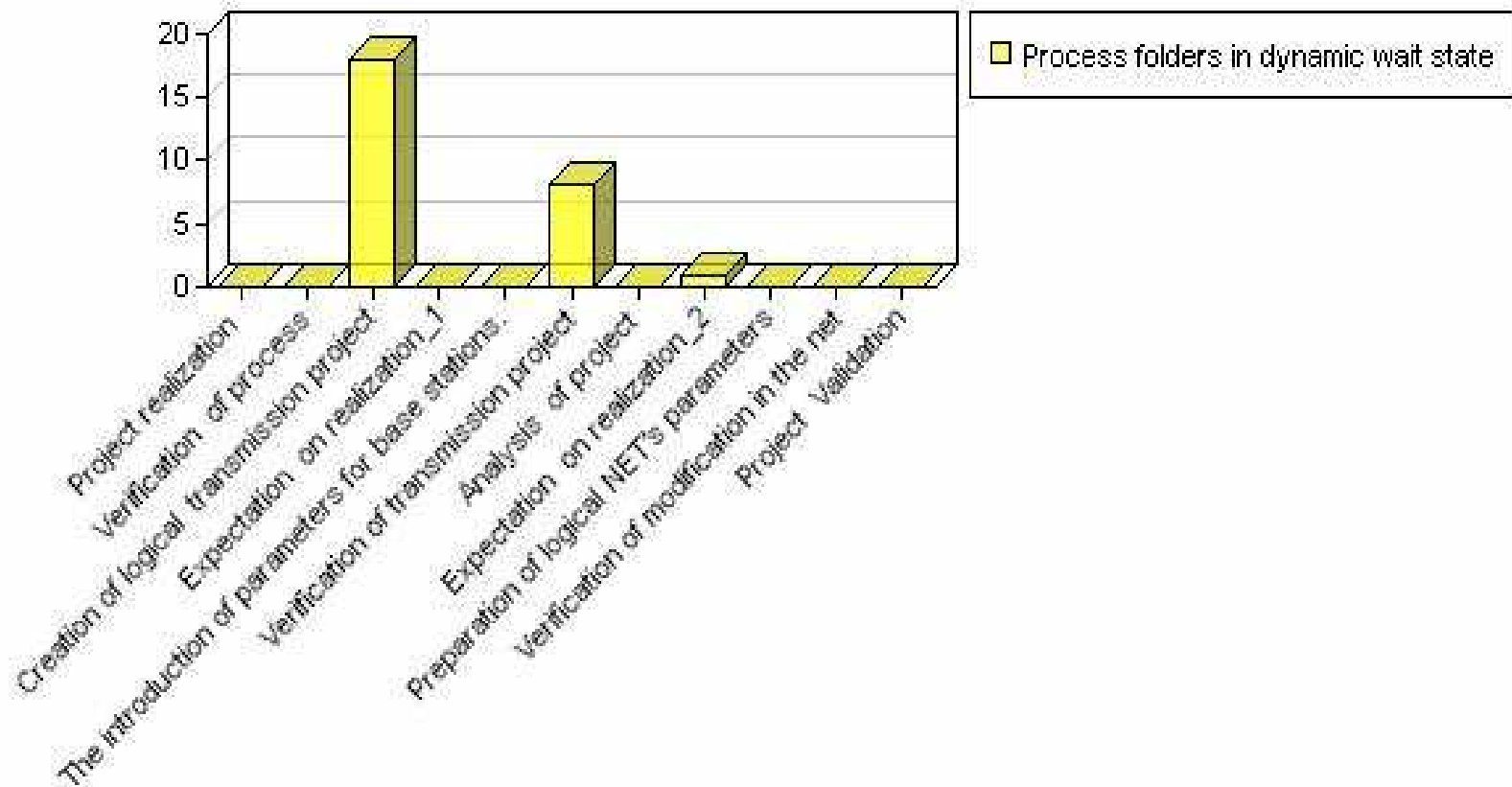
simulation of the initial input data (the main bottlenecks in the main branch RESOURCES (DPSTil): ACT-4 ACT-9, ACT-8)



Some statistical results (2)

Iteration 1 (release 51)

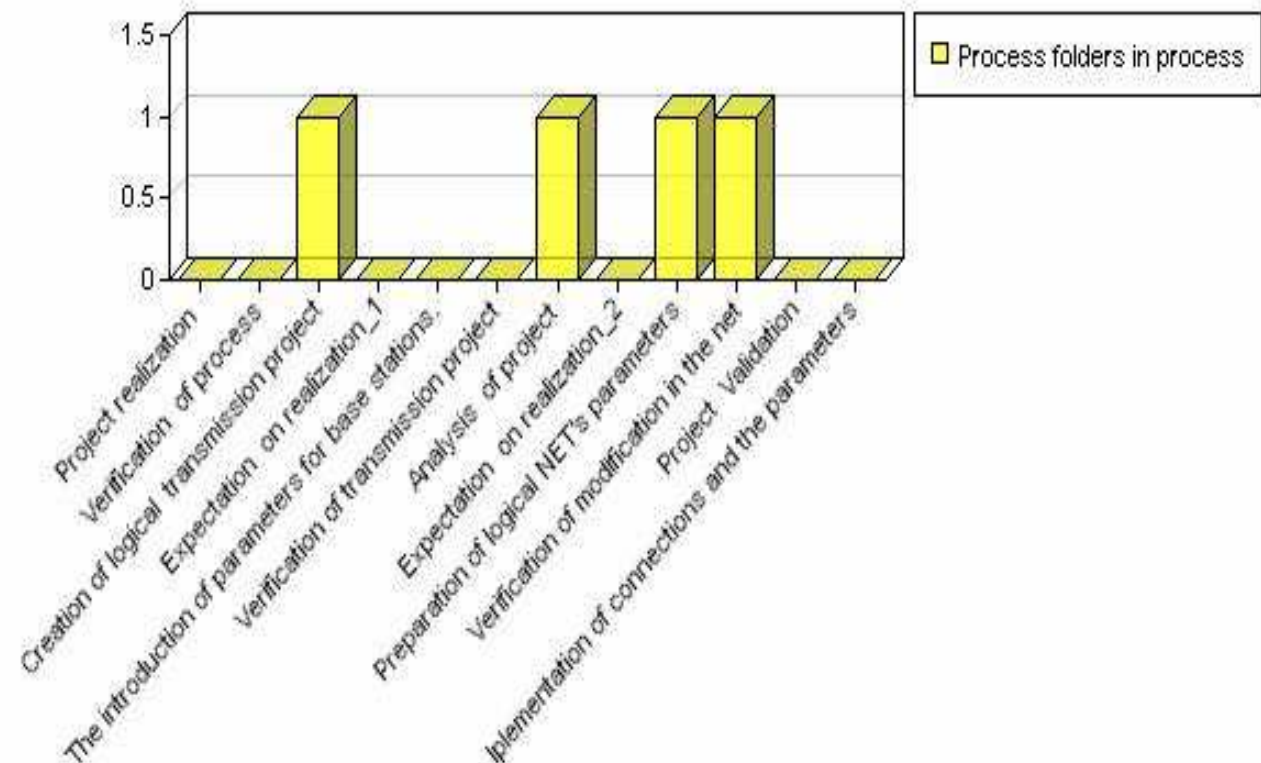
simulation of the initial input data (the main bottlenecks in the main branch RESOURCES (DPSTil): ACT-4 ACT-9, ACT-8)



Some statistical results (3)

□ Iteration 1 (release 51)

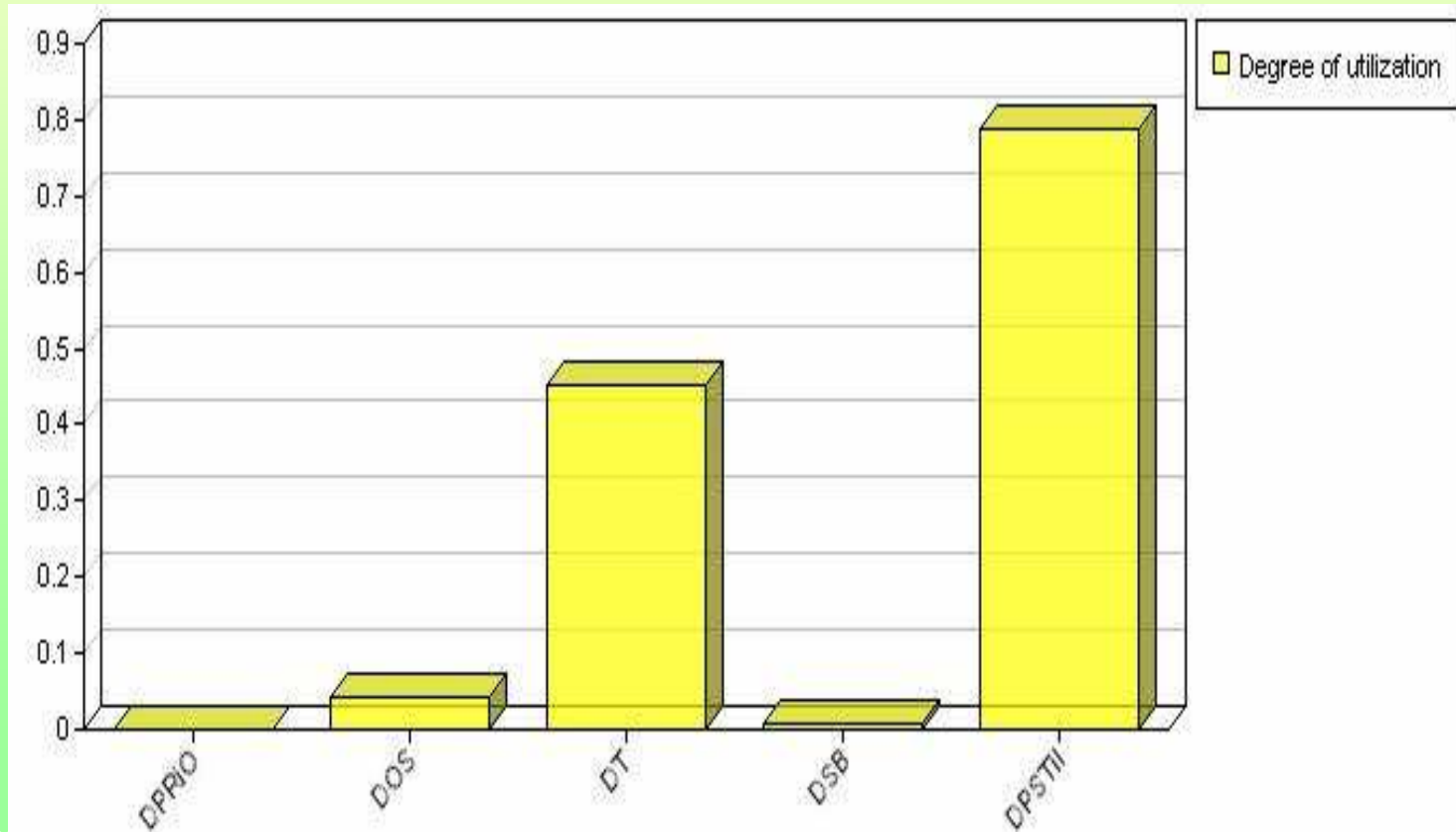
simulation of the initial input data (the main bottlenecks in the main branch RESOURCES (DPSTil): ACT-4 ACT-9, ACT-8)



Some statistical results (4)

□ Iteration 1 (release 51)

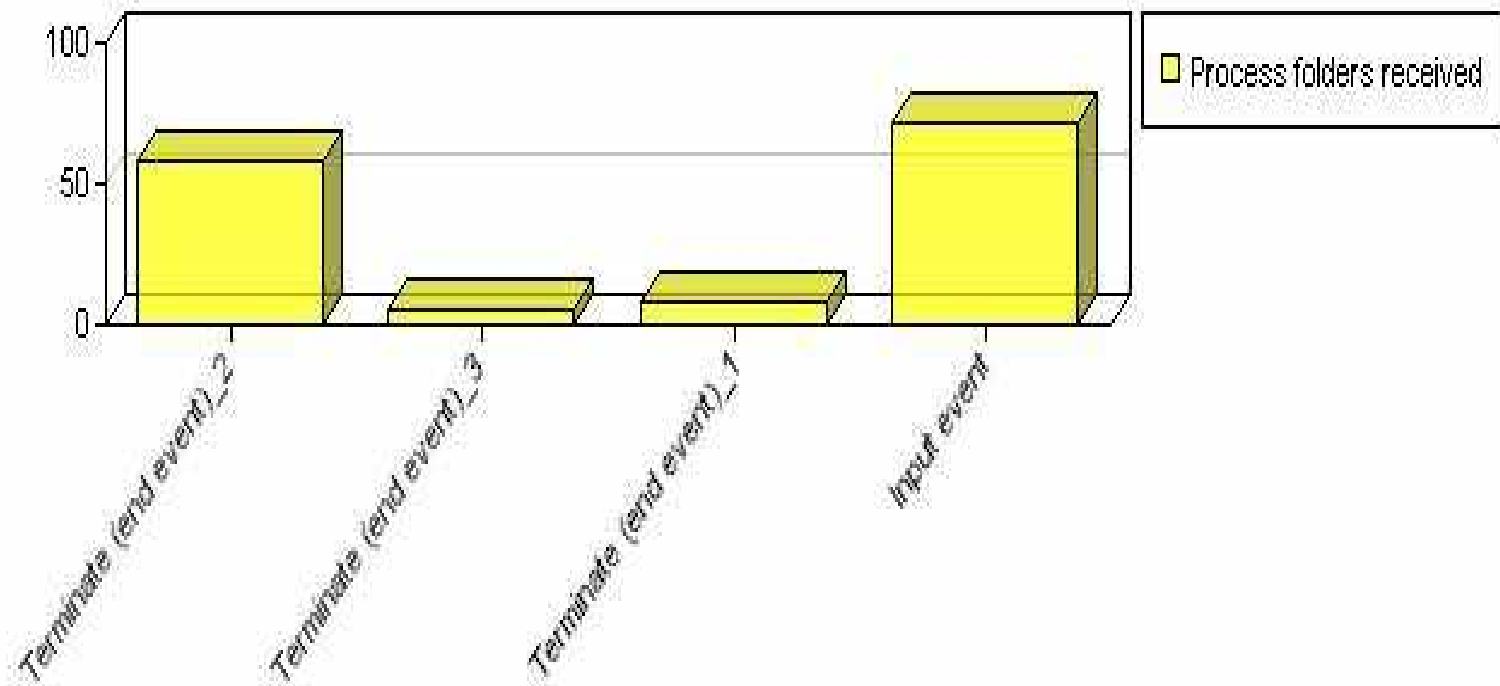
simulation of the initial input data (the main bottlenecks in the main branch RESOURCES (DPSTII): ACT-4 ACT-9, ACT-8)



Some statistical results (5)

Iteration 5 (release 55)

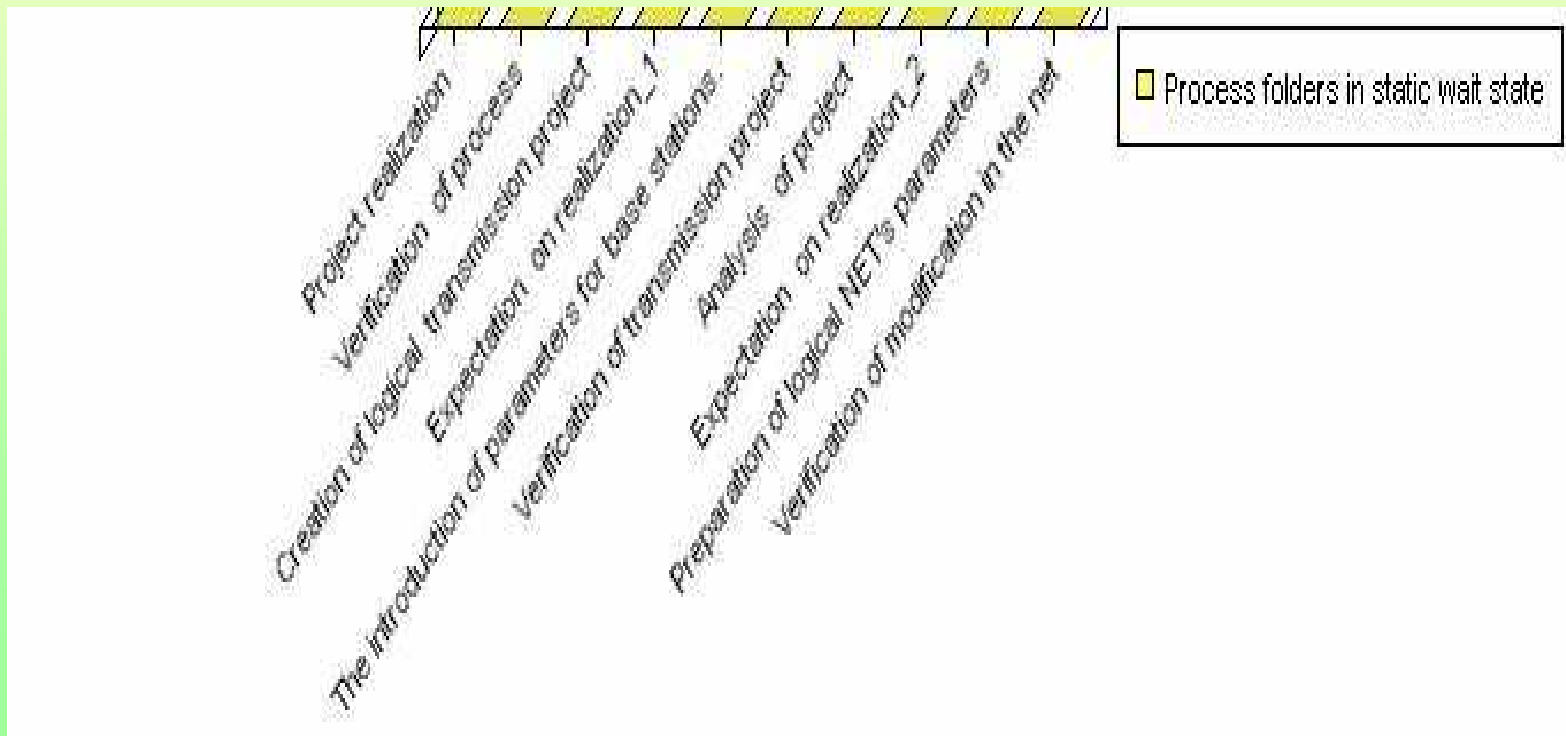
reduce the execution time of process ACT9 (there are folders exempt from the 4), ACT-12, ACT-14



Some statistical results (6)

□ Iteration 6(release 55)

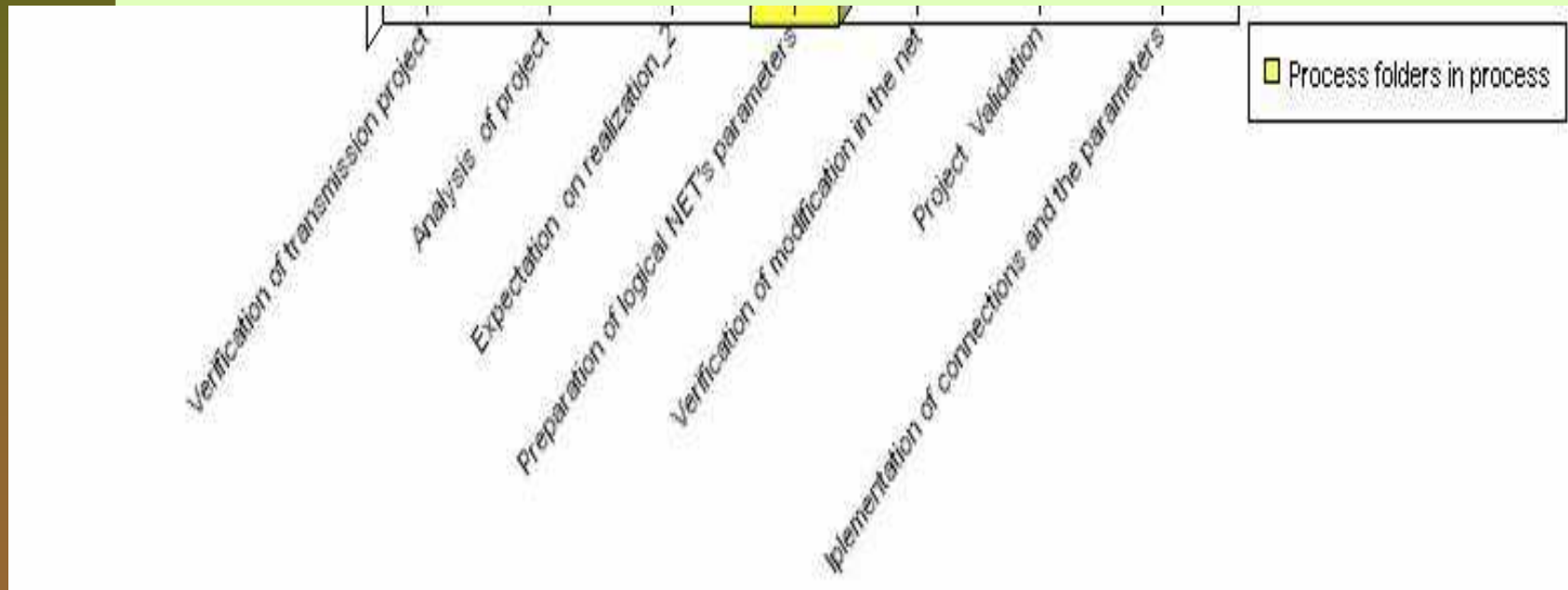
reduce the execution time of process ACT9 (there are folders exempt from the 4), ACT-12, ACT-14



Some statistical results (7)

□ Iteration 6 (release 55)

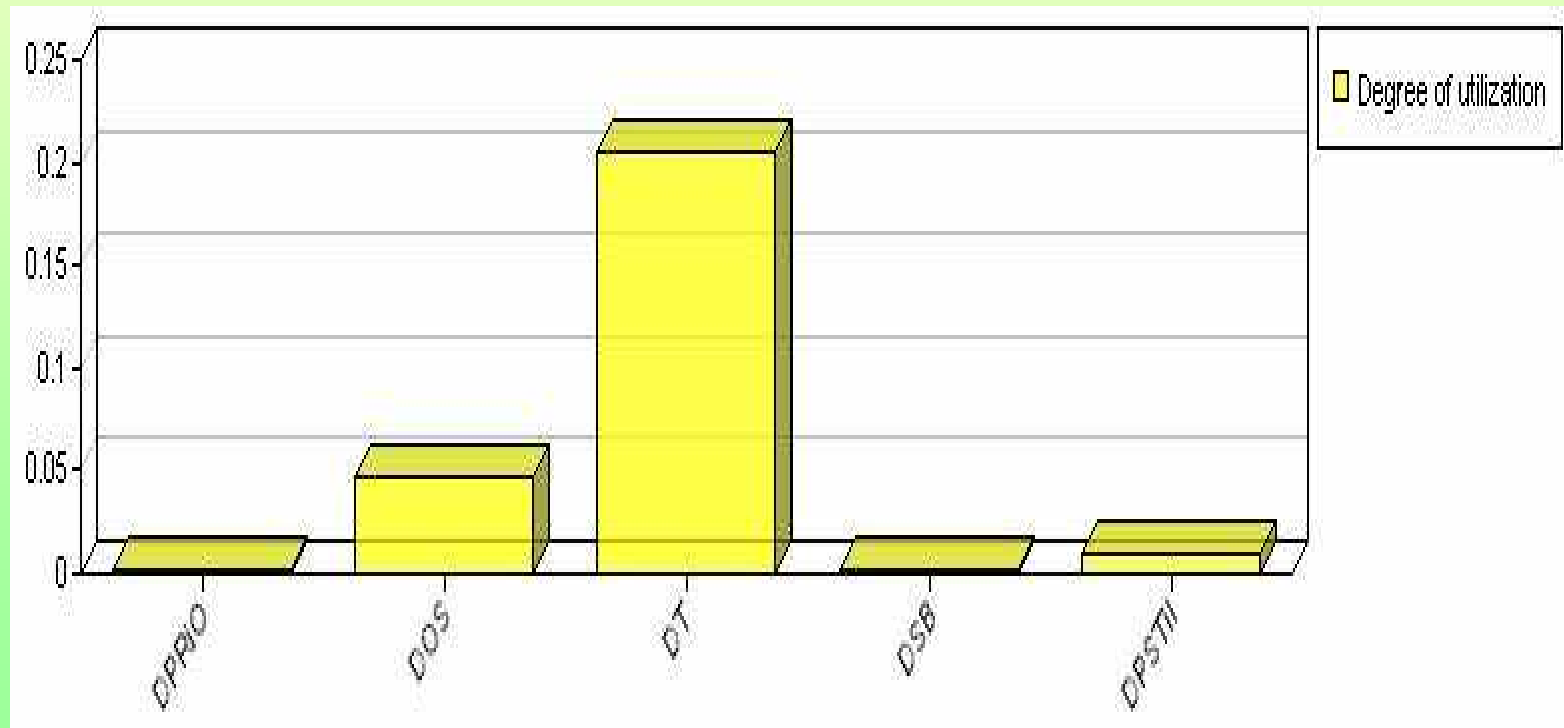
reduce the execution time of process ACT9 (there are folders exempt from the 4), ACT-12, ACT-14



Some statistical results (8)

□ Iteration 6 (release 55)

reduce the execution time of process ACT9 (there are folders exempt from the 4), ACT-12, ACT-14



Conclusions

- ❑ *“Workflow mining” algorithms allowed to estimate business process model and its parameters, necessary for simulation and optimization.*
- ❑ *Performed first simulation provides “bottlenecks”, which caused very long total execution time of instances (much longer than one year).*
- ❑ *Optimization method, executed as set of iterations, has allowed “bottlenecks” elimination and reduction total execution time to one year.*
- ❑ *Set of iteration has been performed with real business condition, which means number of employed people and function time-execution constrains.*
- ❑ *The next step of the study concerns simulating costs, connected with extension the capacity of the cellular network*