Comparison of Graph Visualization Tools for the Problem of Evaluating the Characteristics of SpaceFibre Networks

Ilya Korobkov, Danila Korobkov, Andrey Gurjanov
Saint-Petersburg State University of
Aerospace Instrumentation
Saint Petersburg, Russia
ilya.korobkov@guap.ru, danila.korobkov@yandex.ru,
postmaster@elavt.spb.ru

Anatoly Shukalov
Saint Petersburg National Research University of Information
Technologies, Mechanics and Optics (ITMO University),
Saint Petersburg, Russia
aviation78@mail.ru

***Abstract*—The software tools most suitable for visualization of multidimensional graphs are considered. Comparing of the tools by different criteria is presented. The most convenient software for visualization of multidimensional graphs was chosen.**

I. Introduction

In the development of the onboard networks based on high-speed SpaceFibre [1] standard there is a necessity to evaluate the characteristics of the data transfer process of the designed network: the average packet transmission time, the average size of the queue, etc. For this, the queuing system (QS) proposed in [2] can be used. The QS is based on a Markov stochastic process described as a labeled graph. This graph can also be represented as an OSTN diagram based on the PFDD diagram of the IDEF3 technology [3, 4] according to the method described in [5]. To automate the calculations, a software module was developed that automatically builds the QS graph and then calculates the characteristics of interest. The examination of the correctness of an automatically constructed graph is a significant task. To solve this problem, it is necessary to visualize the graph from the internal representation of the program module into a form that is convenient for human perception. Afterwards, an expert can assess the correctness of the graph. In the case of the error he is able to make changes to the logic of the software module. To solve the graph visualization problem, a review and comparison of existing graph display tools was performed, which is briefly presented below.

II. Comparison of graph visualization tools

A. The most famous software tools for working with graphs

The most famous software tools for working with graphs are aiSee [6], yEd [7], Gerphi[8], Graphia[9] and Tom Sawyer Software[10].

1) AiSee: aiSee is a commercial program tool that automatically places vertices and arcs of the graph. aiSee is described in GDL. Then the user can interactively explore the given graph and save it in various formats. aiSee was originally designed to visualize data structures processed by compilers. aiSee is used in business management (structural diagrams of enterprises, visualization of the business processes), software development (flowcharts, control flow graphs, (function) call graph), etc.

2) YEd: yEd is a software tool released under a proprietary software license. yEd can be used to create graphs, drawings and diagrams. It supports the GML [11] format and many types of diagrams: BPMN diagrams: the BPMN diagrams, genealogical tree, the UML class diagrams, organization charts, etc.

3) Gephi: Gephi is an open-source software for network visualization and analysis. It helps data analysts to intuitively reveal patterns and trends, highlight outliers and tells stories with their data. It uses a 3D render engine to display large graphs in real-time and to speed up the exploration. This project supports xls, graphtml and gml formats.

4) Graphia: Graphia is a new very promising tool for graphs visualization, and large graphs particularly. It's under active development as opposed to abandoned long ago Gephi and it also works much faster.

5) Tom Sawyer Software: Tom Sawyer Software is a complete graph visualization software development kit (SDK) with a graphics-based design and preview environment. The platform integrates enterprise data sources with the powerful graph visualization, layout, and analysis technology to solve big data problems. It is a paid product

B. Comparison of software products

Let's compare above presented software.

1) AiSee: In aiSee there are several modes of automatic placement of graph vertices and arcs and there are a lot of settings for them. Nevertheless, they affect the result to varying degrees.

Let's consider key navigation tools that the aiSee program provides: 1. a desktop that visualizes the entire (whole) graph model. The user receives a static image that cannot be changed, for example, the elements can't be moved; 2. a search tool that allows the user to search for elements of a graph model using their names. It supports defining regular expressions, selecting categories of items for the search, and saving previous search queries

2) yEd: yEd has several modes of automatic placement of graph vertices and arcs and options for them. These options provide the ability to fine-tune the visualization of the user task.

yEd provides navigation tools: 1) the desktop is similar to the desktop provided in aiSee. However, unlike aiSee: a) it is possible to work with several graph models concurrently in a one copy (instance) of the program; b) there is a possibility to edit elements of the graph model the editing options are extensive. You can edit them ranging from changing their position and size to setting attributes that affect their visualization; 2) there is a navigator that displays the graph model with which the user works in the form of a tree; 3) a convenient mini-map showing the whole graph model.

Software product yEd has advantage – it supports GML format to describe graphs. Description of GML format is presented below.

GML is a fully-featured (full-service) format for describing graphs. It includes a base language for describing the structural properties of a graph and a flexible mechanism for its extension. It allows you to include a description of the graph data specific to the application. In the GML format, you can describe directed, undirected and mixed graphs, hypergraphs, hierarchical graphs, as well as indicate links to external data, application-specific attributes. Unlike other formats for describing graphs, GML uses XML-based syntax. This language is a universal tool for the formation, archiving and processing of graphs.

3) Gephi: Gephi has similar navigation tools as yEd. But this program does not fully support gml files. The graph described in the gml file may not be displayed correctly in the program (Fig. 1).

4) Graphia: Graphia has several disadvantages: currently, it has only one force-directed layout and very limited ways to tune it; right now Graphia is relatively raw. For example, I had to convert graph formats with Gephi in order to put it in Graphia, which crashed on the same graphs represented as CSV. But the main advantage of this program is the speed of work. Graphia was created in the C++ programming language, much quicker, and under active development. For comparison: Gephi needs several hours to layout 173K nodes graph, but Graphia needs only several minutes.

5) Tom Sawyer Software: Tom Sawyer Software has several advantages: construct rich nested drawing representations in support of numerous application domains and complex use cases; faster time to deployment – tobust, easy-to-use API libraries and a rich set of pre-built interactive components simplify the development of customized visualization applications; superior scalable automatic layout – provides scalable global, incremental, and constraint-based automatic layout, labeling, and routing.

Finally, yEd tool was selected for graph visualization task, because it is freeware and it is universal and convenient for working with large graphs and has a more fine-tuned visualization of each graph by the user, and it also has the advantage of supporting the GML markup language [8].

TABLE I. FRAGMENT OF GRAPH DESCRIPTION IN GML FORMAT

GML text format	**Description**
Creator «yFiles» Version «2.15»	GML format version
graph [	Start graph description
hierarchic 1	The graph is hierarchical, unnamed and oriented
label «»	
directed 1	
node [	Beginning of the graph vertex description
id 1	The number of vertices in the graph and the status of queues
label «1 0/0»	
graphics [	Start of vertex display settings
type «roundrectangle»	figure shape: «rectangle»
raisedBorder 0	Default border type
fill «#FFFFFF»	color fill to a shape
outline «#FFFF00»	Yellow lines
outlineWidth 4	line width
]	End of Vertex Display Settings
]	End of graph vertex description
edge [	Start describing arcs of the graph
source 8	From which top and to which top does the arc go
target 6	

GML text format			Description
label	«U1»		Arc signature with transition probability
graphics [			Start Arc Display Settings
	fill	«#0»	Arc color - black
	targetArrow	«standard»	Arc Arrow - Standard
]			End of arc display settings
LabelGraphics [			Start setting display labels on the arc
	fill	«#FFFFFF»	fill colour - white
	fontSize	12	Font size 12
	model	«three_center»	Position the inscription on the arc - arc, and no further 3 positions from the beginning of the arc
	position	«scentr»	
]			End settings display labels on the arc
]			the end of arc of the graph description
]			the end of graph description

III. Conclusion

In this paper, the most popular software products for graph visualization were considered. As a result, it was written a program that automatically outputs the graph in GML format, which is then displayed in yEd (Fig. 2). Squares indicate the service status of the 1st class of applications, hexagons – 2 classes of applications, circles – 3 classes of applications, and a star – the initial state

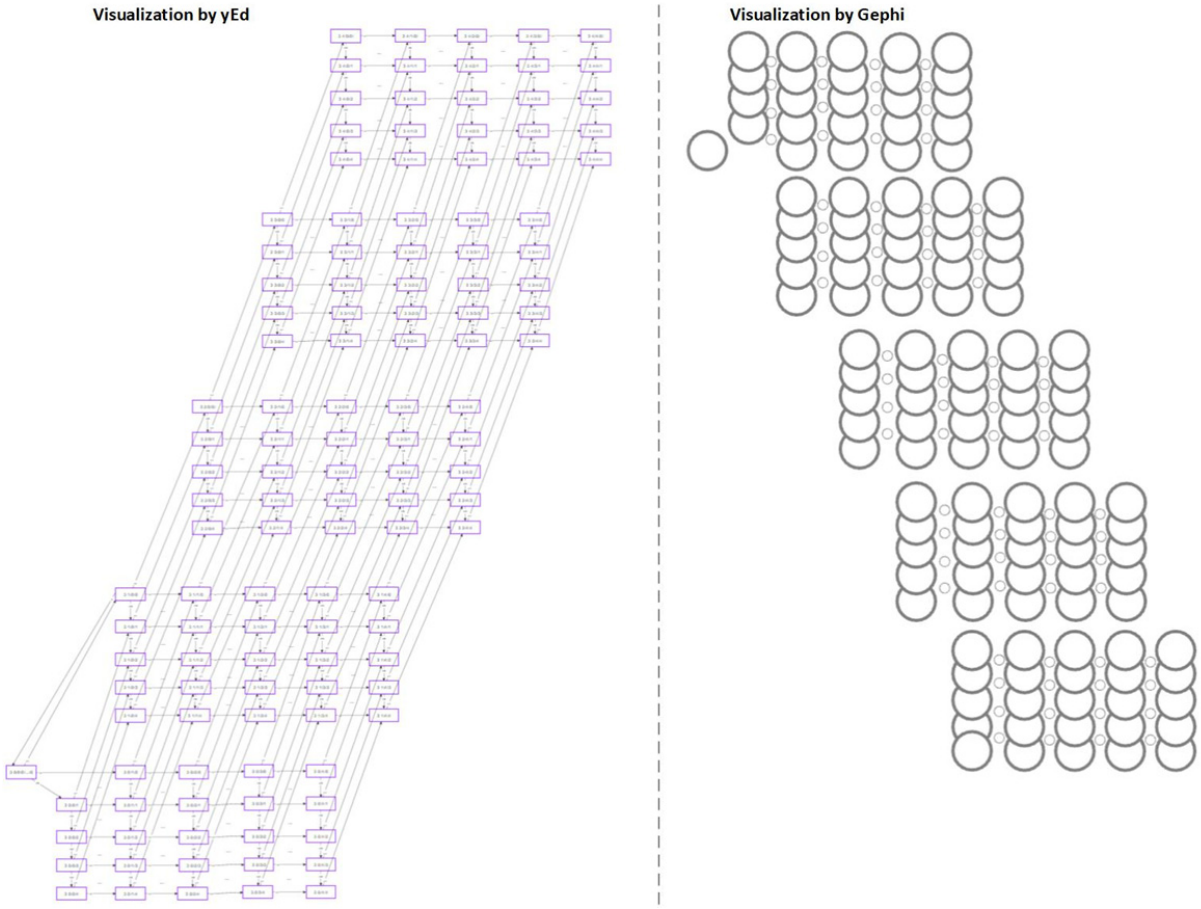

Fig. 1. Example of incorrect graph visualization by the Gephi

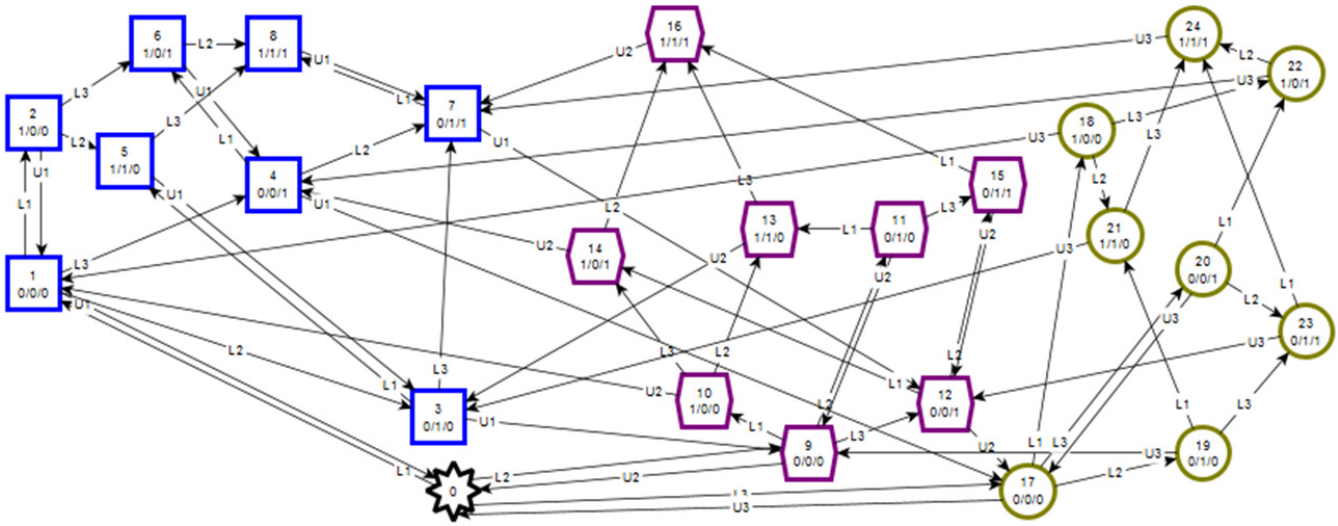

Fig. 2. Visualization of a software-generated graph of Queuing System in yEd

ACKNOWLEDGMENT

The research leading to these results has received funding from the Ministry of Education and Science of the Russian Federation within the project part of the federal assignment under contract N 8.4048.2017/4.6 from 31.05.2017.

REFERENCES

[1] S. Parkes, A. Ferrer, A. Gonzalez, C. McClements, “SpaceFibre – Very high-speed serial link”, ECSS-E-ST-50-11C, ESA-ESTEC, 2019, 233 p.

[2] I. L. Korobkov “Transfer of streaming data according to the SpaceFibre standard as a queuing system”, *Scientific session of the SUAI”*. Proceedings of scientific articles.: in 3 parts. P. I. Technical Sciences, St. Petersburg: SUAI, 2018, pp. 127-139.

[3] G. S Britov. “Method of formal description of PFDD-diagram of IDEF3-technology”, *Information and control systems*, 2014, no. 2, pp. 25-32.

[4] G. S. Britov, T. F. Osipova, “Modeling of business processes”, *Saarbrücken*, Germany: LAPLAMBERT academic publishing. 2014. 124 p.

[5] G. S. Britov, “Methods for constructing an OSTN diagram of IDEF3 technology”, *System analysis and logistics*. 2014. Issue 11. pp. 3-12.

[6] V. N. Kasyanov, T. A. Zolotukhin, “Visual Graph — a system for visualizing complex structured large-volume information based on graph models", 25th Anniversary International Conference (GraphiCon2015), Russia, Protvino (Park Drakino), 2015

[7] Creating flowcharts using the yEd editor. Hana's There. URL: http://rus-linux.net/MyLDP/soft/yed.html (date accessed: 15.12.2019).

[8] Bastian M., Heymann S., Jacomy M. (2009). Gephi: an open source software for exploring and manipulating networks. International AAAI Conference on Weblogs and Social Media.

[9] Graphia, Visualisation tool for the creation and analysis of graphs. URL: https://graphia.app/ (date accessed: 12.12.2020).

[10] Tom Sawyer Software, Graph and Data Visualization, URL: https://www.tomsawyer.com/ (date accessed: 12.12.2020).

[11] GraphML Working Group. The GraphML Specification. URL: http://graphml.graphdrawing.org/specification.html (date accessed: 15.05.2011).